THE DOLLAR IN FOREIGN EXCHANGE AND U.S. INDUSTRIAL PRODUCTION

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PREFACE

Much concern has been expressed about the effects of the present exceptionally strong dollar on U.S. manufacturing industries. This paper evaluates the relationship between the value of the dollar in foreign exchange and domestic industrial production. The study was requested by Senator Lawton Chiles, ranking minority member, Senate Committee on the Budget.

Elliot Schwartz, of the Congressional Budget Office's Natural Resources and Commerce Division, prepared the study under the general supervision of David L. Bodde and Everett M. Ehrlich. Valuable assistance in the conceptual development of the paper was provided by Lewis Alexander and Thomas Lutton. The author owes special thanks to Edward Gullason, who ran the many econometric estimations and prepared an initial draft of Appendix A, and Gwyn Adams, who provided data base support and prepared the tables in Appendix B with the assistance of Roy Fleischer. The author appreciates the many comments of his colleagues at the CBO: Bruce Vavrichek, Dan Kaplan, David Moore, Robert Hartman, Stephan Thurman, Steve Parker, and Matthew Salomon. Johanna Zacharias edited the manuscript, which was prepared for publication by Kathryn Quattrone. Inquiries can be directed to the author at (202) 226-2940.

Rudolph G. Penner
Director

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SUMMARY

The rapid rise in the value of the U.S. dollar in foreign exchange between 1980 and 1984 has had multiple effects. It has increased the purchasing power of consumers buying with dollars by reducing the dollar price of foreign goods. The large net inflows of capital that account in part for the dollar's sharp appreciation have allowed the United States to finance deficit spending and private investment and through the effect on the dollar's value have helped to slow the inflation rate. But a high-valued dollar also makes U.S. goods more expensive for foreigners to buy, thus exerting pressure on domestic exporters. Similarly, the low relative cost of foreign goods that benefits consumers spending dollars diverts part of the domestic market for U.S. goods. This study examines these latter issues--how the performance of the dollar affects U.S. manufacturers.

With two exceptions, the Congressional Budget Office finds overall responsiveness of domestic production to changes in the dollar exchange rate to be slight. Small unit changes can become quite large, however, as the cumulative effect of exchange-rate appreciations grow: a 30 percent rise in the exchange rate can lead to a substantial deterioration in overall industrial production. But, not all industries react in the same way to fluctuations in the exchange rate. The output of some, primary metals for example, is closely linked to the dollar's value, but others, such as processed food, are barely affected.

Besides the exchange rate, various other factors help explain changes in the performance of specific industries. Changes in overall income and in the relative prices of individual products are normally more important to industrial performance than are exchange-rate movements. Thus, the high exchange rate may accelerate the deterioration of some industries, where decline is already under way, or slow an industry's expansion; but a high-valued dollar is not usually the main cause of an industry's problems.

SECTION 1

OVERVIEW

For many observers, the value of the dollar in foreign exchange has come to be a barometer of the condition of U.S. industries, with a high-valued dollar presaging poor conditions in the U.S. manufacturing sector involved in trade. The Congressional Budget Office has attempted in this study to quantify this relationship.

CAUSES OF THE DOLLAR'S APPRECIATION

What accounts for the recent, unprecedented appreciation of the dollar in foreign exchange? Many analysts point to the present large U.S. budget deficit as the basic cause of both the dollar's significant appreciation and the United States' trade deficit. 1/ This widely shared view rests on the premise that the deficit requires the U.S. government to undertake new borrowing, which "crowds" capital markets, in turn heightening the competition for money and driving up U.S. interest rates. Observing these higher interest rates, portfolio managers and savers both in the United States and abroad arrange the composition of their holdings to emphasize U.S. assets. This creates large net capital inflows such as have recently been recorded. These capital inflows, in turn, have had a moderating effect on U.S. interest rates, allowing more capital formation than would otherwise have occurred, given the large budget deficit. But the greater demand for U.S. assets means a greater demand for the dollars with which to buy them, forcing the foreign price of the dollar--the exchange rate--upward.

This description can be expanded to put in a broader context the relationship between the budget deficit, the exchange rate, and current trade account deficit. Seen in this wider context, the core of the problem is that U.S. aggregate demand (of which the budget deficit is part) has been growing faster than the U.S. production. For example, U.S. purchases of goods and services have increased by about 15 percent over the past two years, but U.S. production, measured by the GNP, has risen by 10.5 percent, from $1.48 trillion to $1.64 trillion between 1982 and 1984. The gap between

1. The fiscal year 1985 budget deficit was $211.9 billion. The net trade deficit for calendar year 1985 is estimated at $145.6 billion. See Congressional Budget Office, *The Economic and Budget Outlook: An Update* (August 1985).

U.S. demand for goods and services and the U.S. supply of them is filled by other nations. But for foreign manufacturers to be willing to produce goods for sale in the United States and to lend the wherewithal to purchase those goods, both the profits from sales and the return from money lent must be high.

High interest rates and exchange rates, therefore, are necessary to meet these conditions. High exchange rates assure the profitability of sales to the United States, and high interest rates provide a strong incentive for foreigners to lend the United States their funds. Thus, so long as the growth in the U.S. demand for goods and services outstrips the rate at which the United States can meet them, high exchange and interest rates--and the resulting trade deficit--results. The opposite conditions prevail abroad. In sum, the current account deficit and the dollar's exchange rate are not *sui generis.* They reflect the fundamental economic conditions shaped by the federal budget deficit. That is not to deny that other factors are at work as well. For example, the political stability of the United States adds to the attractiveness of its investment environment.

Why has the demand for goods and services surged in the United States, though not abroad? The strength of the United States' economic recovery is largely responsible: U.S. wages and incomes are rising, while prices are not. Augmenting the recovery are such factors as lower marginal tax rates, productivity growth and technological advance, legislation to deregulate the energy, communications, and transportation industries, and the favorable psychology that accompanies all these factors--creating global confidence in the U.S. economy. Other economies, in contrast, have suffered from weak investment, rising taxes, obstacles to structural adjustment from traditional manufacturing to high technology, and in some countries austerity measures related to the international debt problem. Under these circumstances, weak foreign demand comes as no surprise.

The dollar's value and the resulting trade deficit create real difficulties for the U.S. economy. They handicap industries that must compete against imports in U.S. markets or export their products overseas. Painful adjustment for U.S. communities and families is an early effect. A later result can be a "whipsaw," should the situation reverse itself. Borrowing from foreigners, if sustained at current levels, can leave the United States with massive external debts, forcing it to produce billions of goods and services annually to repay foreign debtors, and leaving the U.S. economy vulnerable to foreign investors' decisions to withdraw their funds.

At the same time, however, these same circumstances also have beneficial effects. The high levels of import competition now characterizing the economy have been a major contributor to the price stability that has accompanied this recovery. Large foreign capital inflows have lowered U.S. interest rates from the levels they might have achieved had these inflows not occurred, and they have therefore aided interest-sensitive industries. Thus, in the absence of foreign production and capital inflows, the surging demand for U.S. goods and services would be accompanied by higher prices (which would slow the demand for goods) and still higher interest rates (which would resolve the competing demand for money). Rather than handicapping the United States' exporting or import-competing industries, the nation would be forced to accept larger, across-the-board burdens, particularly in those sectors that are sensitive to interest rates--for example, housing, capital goods, and consumer durables. The ultimate outcome would be a reduction in the United States' standard of living greater than would occur given the availability of capital inflows.

RECENT PERFORMANCE OF THE DOLLAR AND U.S. MANUFACTURING

A high dollar has two effects: first, it makes U.S. goods more expensive to foreign buyers, who must convert their own currencies to dollars before making purchases; second, it makes foreign-made products cheaper--hence more attractive--for U.S. consumers. A falling dollar has the converse effects. A rising dollar has dominated foreign exchange markets for the last several years. From early 1980 throughout 1984, the dollar rose in value by more than 65 percent against the currencies of other major industrialized countries in Europe and Japan.[2] Thus, concern has mounted that, despite some of the benefits of a strong currency, the appreciated dollar has caused severe damage to U.S. industries, particularly in the manufacturing sector.

The effects of the exchange rate are significant for many industries. Many analysts contend that trade represents the most important or dynamic portion of an industry's sales, making the difference between profitable production and just breaking even. The loss of this segment can be devastating to particular firms. Moreover, in some sectors, the dollar can prompt firms to relocate production facilities abroad, causing loss of employment at the outset and shrinking domestic capacity in affected industries in the long run.

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2. Federal Reserve Board index of weighted average value of U.S. dollar against currencies of other Group of Ten countries plus Switzerland.

The performance of the dollar, however, is one of many factors influencing U.S. trade and industrial performance. As a general rule, when there are domestic and foreign equivalents, low-cost imports will displace or lower domestic output, while exports will raise it. *How much of the U.S. manufacturing sector's recent difficulty can be attributed to the dollar's strength?*

The CBO's econometric analysis of the responsiveness of domestic production to changes in the exchange rate estimates that, at the margin, the effect is relatively small. For each 1.0 percent change in exchange rates, a change of between approximately -0.10 percent and -0.15 percent in aggregate manufacturing output may follow.[3] But as the cumulative effect of exchange-rate appreciations grows, these small changes become large. A 30 percent rise in the dollar's value in foreign exchange, for example, can lead to a deterioration in manufacturing production of between 3 percent and 4 percent. In 1984, this translated to a range around two-thirds of the U.S. merchandise trade deficit that year.

When the dollar's appreciation and U.S. industry's deterioration are isolated (which disregards some overall positive effects of a strong currency), the 65 percent appreciation that characterized the 1980-1984 period corresponds with a loss of between roughly 20 percent and 30 percent of the output for those industries hardest hit. This group includes primary metals, transportation equipment, and petroleum products (see Table 1). Even with the 30 percent appreciation that has prevailed since 1982, two-thirds of the industries show a deterioration in production of more than 5 percent from the levels that might, other things being equal, have prevailed with a lower-valued dollar.

Besides the high dollar, however, various other factors must also be weighed in analyzing changes in industrial performance and structure, especially when considering specific industries. Two factors that can have significant influence on industrial production are the long-term trend in the overall level of economic activity and the short-term effects of the business cycle. Because of the current economic expansion, many industries have managed to prosper despite setbacks in foreign trade, particularly those producing defense-related goods. Moreover, industrial performance is ultimately related to investment (including research and development), labor productivity and wage growth, technology, changing tastes, and a host of other factors that are manifested not just through the exchange rate itself. Thus, though adverse trade conditions can slow an industry's expansion or

3. These percentages are estimations of the effect of changes in the exchange rate on industrial production derived from different estimated equations. See Appendix A for details.

TABLE 1. PERCENTAGE CHANGES IN INDUSTRIAL PRODUCTION RESULTING FROM A CUMULATIVE 65 PERCENT AND 30 PERCENT APPRECIATION OF THE DOLLAR IN FOREIGN EXCHANGE

High (-19.5 to -32.0)	Medium (-13.0 to -19.0)	Low (-6.5 to -12.5)
Dollar Appreciation of 65 Percent		
Primary Metal Products	Leather and Leather Products	Non-Electrical Machinery
Transportation Equipment	Textile Mill Products	Stone, Clay, and Glass Products
Petroleum Products	Furniture and Fixtures	Miscellaneous Manufacturing
	Tobacco Products	Instruments and Related Products
	Electrical Machinery	Food and Kindred Products
	Fabricated Metal Products	
High (-9.0 to -14.5)	Medium (-6.0 to -8.5)	Low (-3.0 to -5.5)
Dollar Appreciation of 30 Percent		
Primary Metal Products	Leather and Leather Products	Non-Electrical Machinery
Transportation Equipment	Textile Mill Products	Stone, Clay, and Glass Products
Petroleum Products	Furniture and Fixtures	Miscellaneous Manufacturing
	Tobacco Products	Instruments and Related Products
	Electrical Machinery	Food and Kindred Products
	Fabricated Metal Products	

SOURCE: Congressional Budget Office.

NOTE: Industries are grouped on the basis of their average coefficient estimates of the elasticity of industrial production with respect to a change in the exchange rate. That is, industries listed within each category had, on average, an estimated change in industrial production within the range stated in parenthesis. Industries not listed had estimated coefficients that were not statistically significant at the 0.10 level. See Appendix A, Table A-3 for details.

hasten deterioration that is already under way, they are not, under normal conditions, the sole or even principal cause of an industry's problems.

The 1980-1984 period, however, has not been "normal." During this period, the U.S. economy went through two recessions and a sustained recovery. While the recovery has produced some obvious benefits, the 65 percent increase in the value of the dollar has caused problems for many industries, although the recent slackening in the exchange rate should moderate these problems. Nevertheless, the sheer size of the dollar's appreciation has brought with it highly unusual effects. Indeed, the uniqueness of the last five years raises the question of whether fundamental changes have taken place in underlying economic relationships that would call into question any simple statistical relationships based on historical trends. Nonetheless, this paper assumes that, although the recent past was decidedly abnormal, no underlying structural shifts have taken place.

SECTION 2

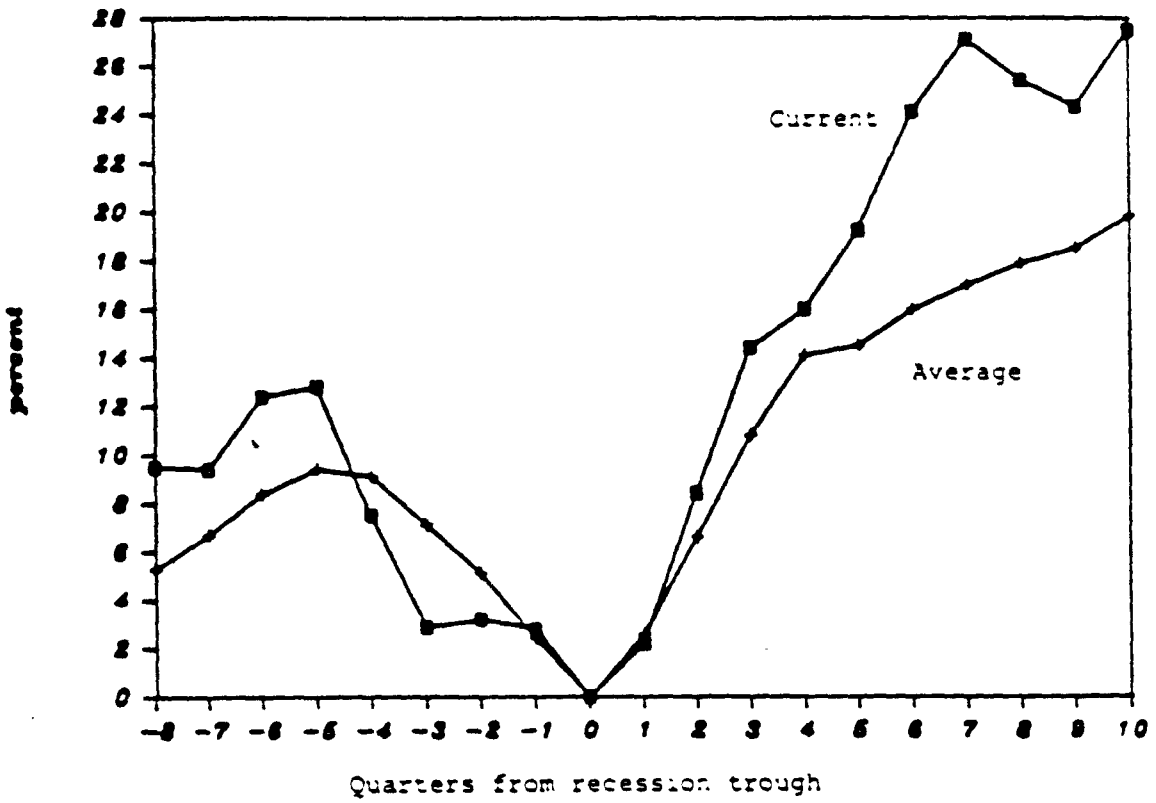
TRADE AND THE RECENT PERFORMANCE OF THE U.S. ECONOMY

A clear picture of the imbalance characterizing recent economic performance emerges from a review of the following contrasting statistics. In the first quarter of 1985, real gross national product (GNP) was 11.3 percent higher than it was five years earlier. Industrial output was up 11.1 percent over the same span. At the same time, the inflation rate, as measured by the GNP deflator, fell between 1980 and 1984 from a 9.2 percent annual rate of increase to 4.3 percent. Other developments during this period include a 5.7 percent increase in total employment--despite an increase in the civilian unemployment rate from 7.1 percent to 7.5 percent at the end of 1984, as more people who sought work had trouble finding it. In international trade, however, the United States went from a current account *surplus* in 1980 of $1.9 billion to a *deficit* of $101.5 billion in 1984. During this period, merchandise exports (in current dollars) actually decreased from $224.3 billion to $217.9 billion. Merchandise imports, meanwhile, surged from $249.8 billion to $341.2 billion. Part of the imbalance in merchandise trade can be assigned to the sharply appreciated value of the dollar, which has had a direct and obvious effect on industrial production through its effect on the prices of both imported and exported goods.

Industrial production over the course of the current recovery has actually outpaced the average of six previous recoveries in the postwar period (as shown in Figure 1), although the pace of increase has slackened considerably over the last three quarters. The trade deficit probably accounts for much of the recent deterioration, despite the beneficial effects of increased capital flows that have shored up capital spending. One reason why the recovery has been better than usual is that the recession preceding it was so deep. Another reason is that, though foreign trade is of major importance to many industries, it still represents a relatively small share of overall production and consumption of manufactured goods. In 1982, U.S.-manufactured exports accounted for only 9.1 percent of all manufacturing shipments; imports provided 8.5 percent of new supply of manufactured goods (domestic shipments plus imports). 1/ Imports undoubtedly displaced an increased portion of domestic manufacturing output, and analysts cannot gauge how much industrial production might have grown had the inroads

1. These figures are calculated on the basis of sales. Using National Income and Product Account definitions would result in higher percentages.

FIGURE 1. INDUSTRIAL PRODUCTION INDEX (Percentage change)



made by foreign goods not been substantial. Increased imports, however, have had some positive effects on industrial production: they have held down price rises by increasing the supply of goods, reduced the costs of imported components, and encouraged productivity and product improvements. Moreover, imports have been associated with increased sales and employment in the U.S. service sector, notably through retail sales.

A further reason for the high growth rate of industrial production in this business cycle expansion is that, since 1980, personal and business tax cuts have combined with increased defense procurement to boost industrial production. Overall, industrial production appears to be more sensitive to monetary and fiscal policies than to the prices of competing foreign goods. This has led some analysts to argue that the main cause for concern about the declining competitiveness of U.S. industries lies not in foreign trade but in the United States itself.

Robert Lawrence provides a simple analytic framework showing that, up to 1980, trade had not been the cause of the declining share of manufacturing in total employment and output. From 1980 to 1982, however, Lawrence finds that changes in trade did account for a substantial portion of manufacturing output and job losses. 2/ Using an input/output table and data for industry shipments, exports, and imports, Lawrence breaks down overall production changes (including the indirect effects of trade) into those attributable to domestic use (consumption plus investment and inventories) and those attributable to the trade balance. By Lawrence's calculations, 1980's foreign trade--which was then in surplus--contributed less than 1 percent to total value added ($2.6 billion), while reducing employment by 0.2 percent (100,000 jobs). In 1982, however, as much as half of the decline in manufacturing employment (750,000 of a total 1.51 million jobs) Lawrence attributes to the influence of foreign trade.

Lawrence's results thus suggest that trade is not the driving force behind long-term industrial performance, despite the evidence of the 1980-1982 period. Using disaggregated data, Lawrence shows that some industries have a greater degree of sensitivity to foreign trade than do others. Industries such as apparel, chemicals, footwear, engines and turbines, electrical and industrial equipment, motor vehicles, and radio and television equipment show greater susceptibility to the effects of foreign trade than to domestic use. But other industries are influenced more by domestic, not foreign, factors.

Traded and Non-Traded Goods

Recognizing that some industries are more sensitive than others to trade conditions, some analysts asked: Do industries that have a greater percentage of their output exposed to international trade perform differently from industries that are less exposed? 3/

Attempting to answer this question, the Congressional Budget Office has focused on several special performance criteria of a number of traded

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2. See Robert Z. Lawrence, *Can America Compete*, (Washington, D.C.: Brookings Institution, 1984).

3. See Attiat Ott, "Competitive Performance of U.S. Manufacturers," (Mimeo, September 1983).

and nontraded industries (see Table 2). 4/ Different conclusions can be reached depending on whether one assumes that the traded sector is a constant group of industries over time, or if it is viewed as a variable group, with annual changes determined by a given year's performance. Looking at the data as a constant group of industries (on the basis of 1980 performance), one can easily conclude that the traded sector of the economy has been more productive, rewarding, and dynamic than the non-traded sector. 5/ Shipments, employment, and wage growth in the traded sector all outpace the non-traded group over the entire period. But looking at the sample as variable (based on each year's performance), one gets a different impression. Until 1980, the traded group still shows its dynamism. In fact, the variable sample shows a growing trade sector up to 1980, with shipments rising from about 60 percent of the total to nearly 75 percent between 1972 and 1980; employment in the traded sector grew by 40 percent, but it declined in the non-traded group. From 1980 to 1984, however, all of this reversed. Shipments, while still growing in the traded group, rose nearly 15 percent less than in the non-traded group. Moreover, employment in traded industry fell, while in non-traded industry, it rose.

What do these data mean? First, they help dispel the notion that all industries that are exposed to trade are declining. Except in the most recent years, traded industries as a group have grown faster than non-traded ones. Even in the 1980-1984 period, traded industries have grown in output, and employment declines have been evident only if one excludes industries that no longer qualify after 1980 as being traded, that is, in the variable sample, which lacks direct year-to-year comparability. Second, the data offer no basis for determining whether adverse trade conditions damages the U.S. manufacturing sector. With the exception of the most recent decline in employment and output growth in the variable sample of traded industries, the traded sector has outperformed the non-traded group. Moreover, in the constant-sample group, growth in employment and shipments remain better in the traded group than in the non-traded one, even over the 1980-1984 period marked by the dollar's dramatic appreciation.

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4. See Appendix B for details of this analysis. The analysis was based on industry data from the four digit level of the Standard Industrial Classification. Industries were classified as "traded" if either exports were greater than 5 percent of shipments, or imports were greater than 5 percent of shipments plus imports (defined as new supply). The analysis was limited to 179 industries that met the criteria of: a) having shipments greater than $1 billion in 1980; and b) having data covering the period 1972 to 1984.

5. The constant group uses import, export, and shipments data for 1980 to establish whether or not each industry should be considered "traded."

TABLE 2. PERFORMANCE OF TRADED AND NONTRADED MANUFACTURING INDUSTRIES FOR SELECTED YEARS

	1972	1976	1980	1984
Non-Traded Industries				
Based on Constant Sample [a]				
Value of shipments (In billions of dollars)	153.9	229.0	343.1	445.6
Employment (In millions)	3.7	3.6	3.8	3.7
Average hourly wages (In dollars)	3.85	5.28	7.17	9.21
Based on Variable Sample [b]				
Value of shipments (In billions of dollars)	200.0	281.5	343.1	475.0
Employment (In millions)	5.1	4.2	3.8	4.1
Average hourly wages (In dollars)	3.85	5.25	7.17	9.13
Traded Industries				
Based on Constant Sample [a]				
Value of shipments (In billions of dollars)	359.3	599.9	987.7	1,252.0
Employment (In millions)	7.4	7.5	8.4	8.4
Average hourly wages (In dollars)	4.17	5.73	7.98	10.50
Based on Variable Sample [b]				
Value of shipments (In billions of dollars)	313.2	547.3	987.7	1,222.5
Employment (In millions)	6.0	6.9	8.4	8.0
Average hourly wages (In dollars)	4.25	5.76	7.98	10.58
Total				
Value of Shipment (In billions of dollars)	513.2	828.8	1,330.8	1,697.6
Employment (In millions)	11.1	11.1	12.2	12.0
Average Hourly Wages (In dollars)	4.06	5.60	7.66	10.02

SOURCES: U.S. Department of Commerce and Congressional Budget Office, Appendix B.

a. Determination of trade status based on 1980; industries held constant.

b. Determination of trade status based on each year's trade and shipments data.

SECTION 3

EFFECTS OF THE DOLLAR'S VALUE ON INDIVIDUAL INDUSTRIES

The exchange value of the dollar is a major determinant of the relative prices of domestic and foreign goods, and it should therefore be a major determinant of the balance of merchandise trade. But other factors also influence the trade balance. This section provides an analysis of changes in industrial production using econometric equations developed by the Congressional Budget Office. The analysis permits an assessment of the effects of changes in the exchange value of the dollar and other variables on the overall output of individual manufacturing industries. As with any analysis of this type, th estimates discussed here are approximate, and are subject to the assumptions that underlie the model. (Details of the analysis are presented in Appendix A.)

AN OVERVIEW OF INDUSTRIAL PRODUCTION

Though the U.S. economy has experienced strong growth over the last two years, not all sectors have shared fully in the recovery. Throughout the manufacturing sector, average output in 1985 is up 19 percent from 1982, but some industries lag behind. (The losers include leather goods, textiles, and petroleum products.) Overall manufacturing employment has fallen by 4 percent since 1980, although it has risen by nearly 1 million workers since the recession trough in 1982. The strong dollar has been blamed by most observers for an alleged shortfall in the performance of the manufacturing sector, even though manufacturing output is in fact actually running ahead of past recoveries.

As stated in CBO's August 1985 economic report, the most dramatic change in the composition of final demand in the U.S. economy since 1980 has been the deterioration in net exports. [1] The $83 billion increase in the merchandise trade deficit between 1980 and 1984 is attributable to four factors:

- Relative movements in real GNP levels among trading nations,
- Austerity measures adopted by Third World countries with debt problems,

1. See Congressional Budget Office, *The Economic and Budget Outlook*; p. 49.

- o Weakness in the markets for many primary commodities, and
- o Appreciation of the exchange value of the dollar.

Table 3 reproduces estimates of the long-run price elasticities of demand for U.S. merchandise exports and imports. These price elasticities are aggregate measures of the sensitivity of export and import demand to a change in the (real) exchange rate. These estimates can be used to evaluate how much the dollar's appreciation has contributed to change in the trade deficit. One of the more recent studies cited in the table allocates 87 percent of the deterioration in the trade balance between 1980 and 1984 to the dollar's appreciation. 2/ Using the elasticities estimated in William Helkie's study of -0.90 for exports and -0.85 for imports (which are at the high end of the range of recent estimates, although lower than the average of all estimates), the implied deterioration in total industrial production attributable to a 1 percentage point rise in the foreign exchange rate is -0.17 percent, based on 1984 trade and industry data. 3/ That is, for each 1 percentage point increase in the exchange rate, industrial production can be expected to fall by nearly one-sixth of a percentage point. Similarly, the elasticities used in the DRI model imply a deterioration in industrial production of -0.13 percent. 4/

Use of other long-run price elasticities in analysis would lead to somewhat different estimates. The smallest price elasticities shown in the table imply that about 40 percent of the deterioration in the trade balance was a direct result of the dollar's high value. The largest elasticities suggest that more than twice the total increase in the real trade deficit was attributed to dollar's appreciation. These results imply that other factors, such as lower inflation and greater access to capital in the United States, actually worked to improve the trade balance.

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2. See William L. Helkie, "A Forecasting Model for the U.S. Merchandise Trade Balance," paper presented at the Fifth International Symposium on Forecasting, June 9-12, 1985, Montreal, Canada (Washington, D.C.: Board of Governors of the Federal Reserve System, International Finance Division, processed).

3. Manufactured goods comprise about 80 percent of both exports and imports. Multiplying the price elasticities for exports and imports by 0.80 of their respective values, yields a downward change of $3.88 billion, which was equal to 0.17 percent of manufacturing shipments in 1984.

4. An updated version of the DRI model (version US85B) uses different elasticities than those shown in Table 3. The new elasticities are -0.71 for exports and -0.94 for non-fuel imports. These elasticities would raise the implied deterioration in industrial production somewhat.

TABLE 3. LONG-RUN PRICE ELASTICITIES OF DEMAND FOR U.S. MERCHANDISE EXPORTS AND IMPORTS

Exports			Imports		
Study or Model	Year of Estimate	Elasticity	Study or Model	Year of Estimate	Elasticity
Adams *et al.*	1969	-0.60	Adams *et al.*	1969	-1.16
Houthakker-Magee	1969	-1.51	Houthakker-Magee	1969	-1.03
Basevi	1973	-1.44	Armington	1970	-1.73
Hickman-Lau	1973	-1.38	Taplin	1973	-1.05
Samuelson	1973	-1.13	Beenstock-Minford	1976	-1.04
Stern *et al.*	1976	-1.41	Stern *et al.*	1976	-1.66
Goldstein-Khan	1978	-2.32	Gylfason	1978	-1.12
Gylfason	1978	-0.62	Geraci-Prewo	1980	-1.23
Amono *et al.*	1981	-0.32	Goldstein-Khan	1980	-1.12
DRI Model	1982	-0.83	DRI Model	1982	-0.56
Helkie	1983	-0.90	Helkie	1983	-0.85
Wharton Model	1984	-0.98	Wharton Model	1984	-0.64
Average	---	-1.12	Average	---	-1.10

SOURCES: Congressional Budget Office, with information from Morris Goldstein and Mohsin S. Khan, "Income and Price Effects in Foreign Trade," in *Handbook of International Economics*, vol. 2, edited by R.W. Jones and P.B. Kenen (Amsterdam: Elsevier Science Publishers B.V., 1985); Data Resources, Inc. *Quarterly Model of the U.S. Economy* (version US83A); William L. Helkie, "A Forecasting Model for the U.S. Merchandise Trade Balance," Board of Governors of the Federal Reserve System (1985); Wharton Econometric Forecasting Associates, Inc., Quarterly Model of the U.S. Economy.

NOTE: Minus sign denotes an inverse relationship, that is, price increases lead to decreases in quantity demanded.

Timing also seems influential, and the differences in estimates seem related to when the estimates were made. Older estimates, such as Houthakker-Magee, show much higher elasticities than do more recent estimates. Moreover, earlier studies, with the exception of Adams *et al.*, showed price elasticity estimates that were greater for exports than for imports, and income elasticity estimates (not shown here) that were much larger for imports than for exports. The more recent studies--those later than 1980--show lower price elasticities overall, although the difference between export and import elasticities remains (with the exception of the Helkie study). The reason for the lower estimates may reflect both the increasing use of non-price mechanisms, such as orderly marketing arrangements and voluntary quotas, to regulate foreign trade, and the fact that oil, which is traded in dollars and is therefore less subject to exchange-rate shifts (and has a realtively low price elasticity), would only have a major effect on the estimates after 1973.

Estimates of Industrial Production

The question of how large an effect the value of the dollar has had on U.S. manufacturing has no single answer. Most of the empirical research into this question has examined the relationship between the exchange rate and the overall trade balance. But such studies tend to disregard both the broader question of how the dollar's value affects the United States' entire industrial base, and the narrower question of its effect on specific industries. To fill this gap, the CBO has developed a series of econometric equations to measure the influence of the foreign-exchange value of the dollar on individual industries. (For a full explanation of this model, see Appendix A.) The results of this analysis are fairly consistent with those of previous studies that focused solely on trade.

The general results of CBO's analysis indicate that the most consistently significant explanation of the change in industrial production is not, in fact, the exchange rate but the overall level of economic activity. The economic activity variable, keyed to cyclical changes in real Gross National Product, has had a much greater measurable effect on industrial production then have either price or exchange-rate variables. This indicates that in general, U.S. industrial output is very cyclical, rising and declining more than the rest of the economy. Within the overall measure, non-durable goods (such as food, chemicals, and paper) tend to be more stable over the business cycle, while durable goods (such as metals, machinery, rubber, and transportation equipment) tend to be very sensitive to short-run changes in income. Table 4 presents a range of estimates of the relationship between the exchange value of the dollar and industrial production derived from vari-

TABLE 4. NEGATIVE SENSITIVITIES OF INDIVIDUAL INDUSTRIES TO A 1 PERCENT CHANGE IN THE TRADE-WEIGHTED EXCHANGE RATE OF THE DOLLAR

High Response (-0.30 to -0.49)	Medium Response (-0.20 to -0.29)	Low Response (-0.10 to -0.19)
Primary Metal Products	Leather and Leather Products	Non-Electrical Machinery
Transportation Equipment	Textile Mill Products	Stone, Clay, and Glass Products
Petroleum Products	Furniture and Fixtures	Miscellaneous Manufacturing
	Tobacco Products	Instruments and Related Products
	Electrical Machinery	Food and Kindred Products
	Fabricated Metal Products	

SOURCE: Congressional Budget Office.

NOTE: Industries are grouped on the basis of their average coefficient estimates of the elasticity of industrial production with respect to a change in the exchange rate. That is, industries listed within each category had, on average, an estimated change in industrial production within the range stated in parenthesis. Industries not listed had estimated coefficients that were not statistically significant at the .10 level.

ous specifications of the basic CBO equations for industrial production. Less weight should be placed on the specific numbers than on the relative sizes of the estimates, particularly in making comparisons across industries. 5/

The regression results indicate that some industries will respond with greater changes in output as a result of a change in the exchange rate, and others will be less sensitive. At the low end of the spectrum are industries (such as food, instruments, and miscellaneous manufacturing including jewelry, musical instruments, and toys) in which production seems to fall only slightly (between -0.10 percent and -0.19 percent) when the exchange rate rises by 1 percent. At the high end are industries (such as petroleum, transportation equipment, and primary metals) that are very sensitive to changes in the dollar's exchange rate (between -0.30 percent and -0.49 percent for the highest values). *In the aggregate, industrial production is estimated to change--negatively--by between -0.10 percent and -0.15 percent with each 1.00 percent increase in the nominal*

5. Industries are categorized on the basis of the average of statistically significant estimates of the elasticity of industrial production with respect to changes in the exchange rate. See Appendix A, Table A-3 for details.

foreign-exchange value of the dollar. 6/ This compares to the -0.13 percent and -0.17 percent figures cited above--that is, the deterioration in total industrial production implied by the effect of the exchange rate on manufacturing trade. 7/

Perhaps more important than the effects identified above is the adverse influence of the dollar in foreign exchange on the United States' future production. One such effect is the tendency of the strong dollar to encourage U.S. firms to purchase productive assets overseas and to shift production from domestic plants to foreign ones. This can occur because, when the dollar is particularly strong, foreign assets are cheaper to buy than are domestic ones, and foreign-made goods are cheaper to produce and easier to sell in the United States. In other words, the strong dollar may prompt U.S. producers to seize the same advantage that foreign competitors enjoy. Indeed, non-U.S. producers already have succeeded in penetrating U.S. markets at the inducement of the strong dollar, and many have not lowered prices as much as cost advantages would have permitted. Instead, they preferred to exploit short-run profit opportunities and to allow themselves breathing room to maintain sales without having to raise prices, should the dollar depreciate in value and make their products more expensive in the U.S. market. 8/

Thus, the long-term damage to U.S. production following from an episode of a high-valued dollar may outweigh the near-term effects. Even as the dollar recedes in value (as it has done in the latter half of 1985), many foreign goods may be able to hold on to their market shares because consumers, who are now familiar with these products, may remain loyal to them. Prolonging this effect is foreign producers' ability to take advantage of established sales and distribution networks. Thus, only a large and sustained depreciation in the value of the dollar can have a major impact on future U.S. industrial production.

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6. The aggregate statistic is not based on the sum of the individual industry statistics, but rather was estimated separately on the basis of aggregate relationships. As such it does not represent the true mean of the distribution of specific industry estimates. Nevertheless, it lies within the band of industry estimates and may be used in comparison with estimates made by other models of total manufacturing sensitivity to exchange rate movements.

7. The CBO model is based on nominal exchange rates, whereas the Helkie and DRI models are based on real rates. Because the nominal exchange rate is greater than the real rate, the CBO estimates should appear smaller than estimates based on real rates. An adjustment for the difference between real and nominal rates would tend to put the other estimates within the CBO range.

8. See Wing T. Woo, *Exchange Rates and the Prices of Nonfood, Nonfuel Products*, Brookings Paper on Economic Activity, 1984:2, pp. 511-537.

SECTION 4

OTHER CAUSES OF INDUSTRIAL CHANGE

Significant changes other than the effects of the strong dollar have taken place within the manufacturing sector of the U.S. economy. This section examines the long-term effects of seven influential factors:

- The maturation of basic industries,
- Increased international competition,
- A slowdown in productivity and capital formation,
- Heightened cyclical fluctuations,
- Changes in federal tax and spending policies,
- Higher interest rates, and
- The effects of oil crises.

The resulting changes generally manifest themselves through relative price changes, which reflect the fact that industries have performed differently from each other over the recent past (see Table 5). [1] Some industries--such as electrical and non-electrical machinery, instruments, and printing--grew in both output and employment. But most others did not, although many saw output increase while employment declined. In average hourly earnings, and productivity, industries experienced widely different rates of growth. Increases in hourly earnings were highest in chemicals, paper, petroleum, primary metals, tobacco, and transportation. Productivity, on the other hand, showed the greatest gains in electrical equipment, non-electrical machinery, instruments, and textile mill products. [2]

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1. For a full exposition of this topic, see Congressional Budget Office, *The Industrial Policy Debate* (December 1983).

2. It should be noted that these dates fall at different positions in the business cycle. The economy was in the middle of a business cycle expansion in 1972 and was hitting a recession trough in 1982. Data limitations prevent extension of this table beyond 1982.

TABLE 5. AVERAGE ANNUAL RATES OF CHANGE IN SELECTED INDICATORS FOR TWENTY INDUSTRIES, 1972-1982 (In percents)

Industry	Real Output[a]	Employ-ment	Hourly Earnings[b]	Produc-tivity[c]
Food and Kindred Products	2.03	-0.48	11.81	2.81
Tobacco Manufacturers	0.11	-1.27	20.44	2.88
Textile Mill Products	-0.25	-2.44	11.27	4.29
Apparel and Other Mills	1.11	-1.31	9.37	3.32
Lumber and Wood Products	-0.85	-1.64	11.31	1.92
Furniture and Fixtures	0.21	-0.59	10.98	1.91
Paper and Allied Products	1.66	-0.49	13.62	3.20
Printing and Publishing	2.93	2.25	8.54	1.60
Chemicals and Allied Products	1.74	0.36	13.31	2.43
Petroleum and Coal Products	1.44	0.85	14.02	1.19
Rubber and Plastic Products	1.83	1.01	10.70	1.49
Leather and Leather Products	-1.84	-2.66	9.36	1.97
Stone, Clay, and Glass Products	-1.31	-1.49	12.26	0.92
Primary Metal Industry	-2.72	-2.52	14.90	1.53
Fabricated Metal Products	-0.30	-0.30	11.51	0.86
Non-Electrical Machinery	5.34	1.91	11.60	5.11
Electrical Machinery	13.02	1.59	11.96	13.01
Transportation Equipment	-0.75	-0.59	13.45	1.37
Instruments and Related Products	8.13	3.71	11.66	4.86
Miscellaneous Manufacturing	0.30	-1.43	10.65	3.04
Manufacturing Total	2.00	-0.28	11.99	3.66

SOURCE: Congressional Budget Office based on data published in U.S. Department of Commerce, *Industrial Outlook, 1985*.

NOTE: Minus sign denotes negative change.

a. Constant dollar value 1972 = 100.

b. Average hourly earnings of production workers.

c. Real output divided by total production workers' hours worked.

Maturing Industries. The maturation of basic industries has brought about important changes in the U.S. manufacturing sector. As industries mature, their growth tends to slow. In part, this can be the result of saturation in consumption (as occurred with automobiles), or of the nearing completion of the spread of technological change that encourages the production of new substitutes (as occurred when semiconductors replaced vacuum tubes in radios and televisions). To give a historical perspective on these patterns, Table 6 shows the changes in apparent consumption (shipments minus exports plus imports) of manufactured goods from 1972 through 1982. The industries shown as growing less than the GNP average can be considered mature industries. That is, consumption of such products as textiles, apparel, lumber, furniture and fixtures, leather, primary metals, fabricated metals, and stone, clay, and glass merchandise has decreased over time relative to all manufacturing consumption and GNP. In a healthy economy, new expanding industries can compensate for the decline of older ones and lead to a new cycle of growth. Data on compositional change indicate that, during the 1970s, the rate at which new industries replaced older ones may have slowed down, contributing to U.S. economic problems. 3/

Table 7 ranks industries by the range of values obtained for the long-term income trend variable (GNP*) under the econometric analysis discussed above. Values of greater than one indicate a rising share of output in GNP (that is, industry output rises faster than GNP), values of less than one indicate a falling share, and negative values indicate not only a falling share but also falling real levels of output. As shown, petroleum products, instruments, rubber and plastics, and electrical machinery are the industries with the greatest rising shares of production as long-term income has risen. Primary metals shows declining industrial production--in fact, output of primary metals has fallen by 28.3 percent since 1972.

International Competition. Increased competition from abroad has accelerated the change in the composition of U.S. industrial output and employment. Competition, not only from Japan and Europe but also from the newly industrializing countries in Asia and elsewhere, has caused the United States to lose much of its predominance in world trade. In 1965, the United States accounted for 14.6 percent of all world trade; that figure now stands at 10.9 percent. Some U.S. industries have lost their export markets and part of their domestic markets to foreign competition, creating major problems of adjustment for the managements, workers, and communities affected. The changes in the percentage of net trade (exports minus

3. See CBO, *The Industrial Policy Debate*, pp. 16-20.

TABLE 6. TOTAL PERCENTAGE CHANGE IN APPARENT CONSUMPTION BY INDUSTRY, 1972 THROUGH 1982

Benchmark and Industry	Percent Change
Gross National Product	24.8
Instruments and Related Products	57.4
Electrical Machinery	32.8
Apparel Products	21.4
Food and Kindred Products	18.2
Rubber and Plastics	18.0
Furniture and Fixtures	15.8
Printing and Publishing	11.3
Non-Electrical Machinery	10.2
Paper and Allied Products	10.0
Petroleum Products	3.5
Chemicals and Allied Products	2.3
Leather and Leather Products	2.0
Miscellaneous Manufacturing	1.9
Transportation Equipment	-1.2
Fabricated Metal Products	-3.8
Tobacco Products	-4.5
Lumber and Wood Products	-11.8
Textile Mill Products	-15.1
Clay, Glass, and Stone Products	-17.7
Primary Metal Products	-23.6
All Manufacturing	-1.1

SOURCE: Congressional Budget Office based on data provided by the U.S. Department of Commerce.

NOTES: Apparent consumption is based on constant dollar shipments minus exports plus imports.

TABLE 7. TREND IN SHARE OF MANUFACTURING PRODUCTION BASED ON COEFFICIENT ESTIMATES

Highest Rising	Moderately Rising	Steady	Falling
Petroleum Products	Electrical Machinery	Chemicals and Allied Products	Primary Metal Products
Rubber and Plastics	Non-Electrical Machinery	Food and Kindred Products	
Instruments and Related Products	Printing and Publishing		
	Paper and Allied Products		

SOURCE: Congressional Budget Office.
NOTE: Percent change in industrial production with a 1 percent change in potential GNP. See Appendix A for details.

imports divided by shipments) shown in Table 8 indicate the degree to which the rest of the world has grown in importance for all U.S. manufacturers. For some industries, such as chemicals, non-electrical machinery, and tobacco, the percentage of net exports in total product shipments has grown significantly. On the other hand, some industries, notably leather goods, apparel, primary metals, transportation, and furniture and fixtures, have seen a greater deterioration in their net trade positions.

Productivity. One of the most significant developments of the past decade was the slowdown in productivity growth. Although this has rebounded with the economic recovery since 1982, recent quarterly changes in productivity have been lower than expected in comparison with previous cyclical averages. Total manufacturing productivity rose at an annual rate of 2.1 percent between 1972 and 1982.[4] This was far less than the 3.7 percent average annual rate of growth over the previous ten years. From 1982 to 1984, manufacturing productivity rose 7.9 percent (nearly 4 percent a year). The decline in productivity gain of the 1970s has been a major factor in reducing the overall competitiveness of U.S. industries. As

4. As reported by the Bureau of Labor Statistics, manufacturing output per hour of all persons.

TABLE 8. NET TRADE AS A PERCENT OF INDUSTRY OUTPUT, 1972 AND 1982

Industry	1972	1982	Total Growth
Non-Electrical Machinery	8.34	12.75	4.42
Lumber and Wood Products	-4.09	-0.46	3.64
Chemicals and Allied Products	4.24	7.30	3.06
Tobacco Manufacturers	3.63	6.61	2.99
Textile Mill Products	-2.65	-0.96	1.69
Food and Kindred Products	-1.09	0.54	1.63
Rubber and Plastic Products	-1.79	-0.55	1.23
Petroleum and Coal Products	-5.51	-4.42	1.09
Fabricated Metal Products	1.06	2.12	1.06
Instruments and Related Products	4.99	5.79	0.80
Paper and Allied Products	-2.27	-1.58	0.69
Printing and Publishing	0.49	0.95	0.46
Stone, Clay, and Glass Products	-1.35	-1.19	0.15
Electrical Machinery	-1.41	-1.29	0.11
Furniture and Fixtures	-2.16	-3.28	-1.12
Transportation Equipment	-2.06	-3.43	-1.37
Primary Metal Industry	-5.75	-9.99	-4.24
Apparel Products	-5.99	-13.47	-7.48
Miscellaneous Manufacturing	-6.22	-18.23	-12.01
Leather and Leather Products	-16.10	-41.25	-25.15
All Manufacturing	-0.78	-1.81	-1.03

SOURCE: Congressional Budget Office based on data provided by the U.S. Department of Commerce.

NOTES: Net Trade as a percent of industry output is defined as exports minus imports divided by shipments. Positive numbers indicate a movement toward a trade surplus; negative numbers reflect a movement toward a trade deficit.

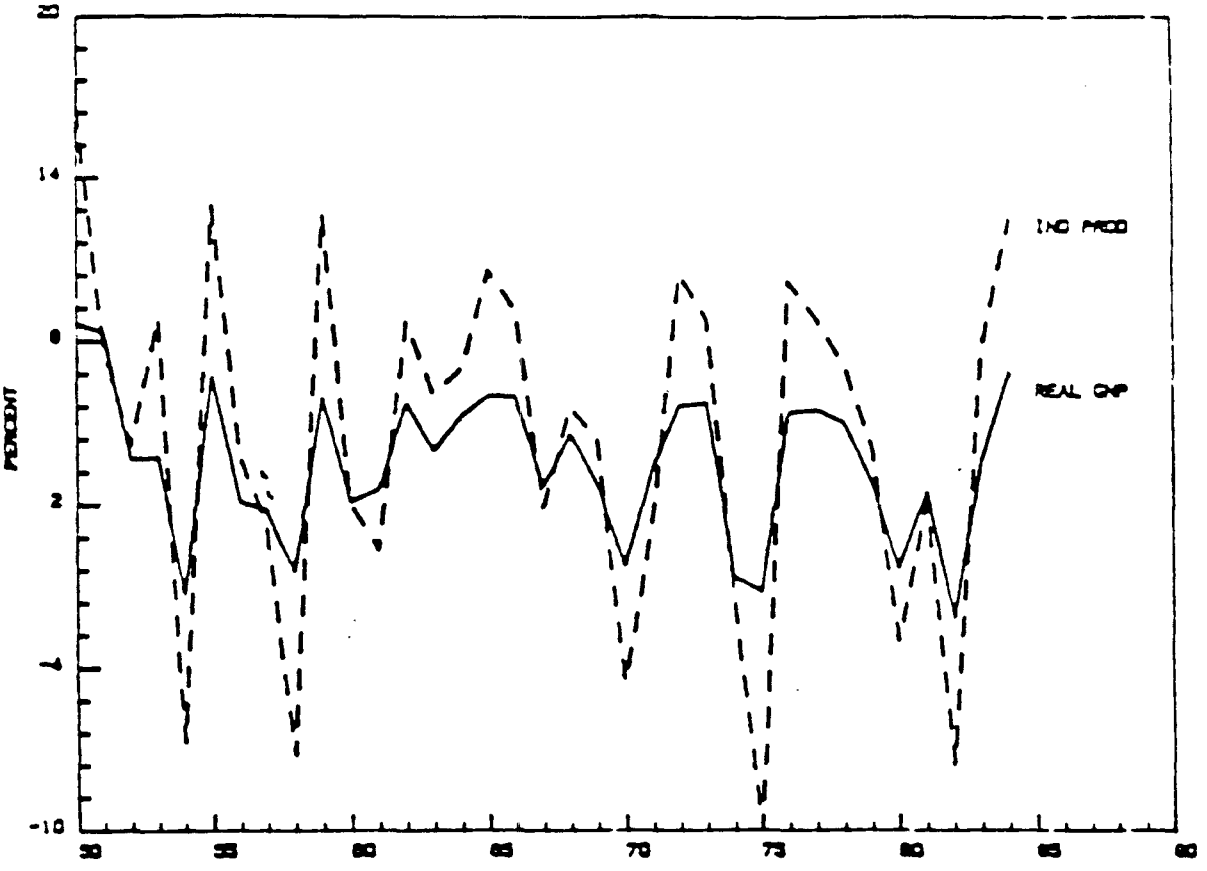
the data in Table 5 indicate, the deterioration in productivity growth was felt most severely in stone, clay and glass products, printing and publishing, petroleum, rubber and plastics, transportation equipment, and primary metals. Productivity gains were strongest in electrical machinery, non-electrical machinery, textile mill products, and instruments. 5/

Business Cycles. Cyclical swings in the U.S. economy tend to be more important to manufacturing industries than to the rest of the economy. In both upturns and downturns, the percentage changes in real growth experienced in the manufacturing sector are significantly greater than those experienced by the rest of the economy. Figure 2 shows changes in the growth rate of real output and of manufacturing output. Since 1969, there has been an apparent increase in the frequency and amplitude of the business cycle compared to the pattern of the 1960s, although if the current expansion is sustained, this pattern reverses. Within manufacturing, some industries show even greater sensitivity to the business cycle than do others. Table 9 shows the range of estimates of the responsiveness of industrial production to short term, cyclical changes in income derived from the regressions discussed above (as measured by the variable GNP/GNP*, the ratio of real GNP to long-term trend GNP). As the table shows, industries such as primary metals, fabricated metal products, and rubber and plastics exhibit a high degree of sensitivity to short-term income changes (that is, the coefficients are much greater than one). Other products, most of which are non-durable goods such as paper, chemicals, printing and publishing, and food, show little change in response to cyclical income changes.

Tax and Spending Policies. In recent years, the federal government's tax and spending policies have had a particularly significant effect on the composition of the economy. Overall, federal spending is now more goods-oriented than services-oriented than it was 5 years ago. As defense spending has increased as a proportion of the budget, production of defense related goods, many of which are high technology products, has grown significantly. Tax policy, meanwhile, has encouraged investment spending--particularly on equipment--as opposed to structures, although recent analytic evidence suggests that the boom in investment may not be directly trace-

5. Martin Neil Bailey provides a similar, but different, list based on performance comparisons of the 1973 through 1981 period versus 1953 through 1973. This analysis shows furniture, leather and apparel with no slowdown; and transportation equipment, printing, lumber, chemicals and petroleum refining with the largest deterioration. See Martin Neil Bailey, *The Productivity Growth Slowdown by Industry*, Brookings Papers on Economic Activity, 1982:2, pp. 423-461.

FIGURE 2. PERCENT CHANGES IN MANUFACTURING OUTPUT AND REAL GROSS NATIONAL PRODUCT, 1950-1984



able to tax cuts.[6] In general, accelerated depreciation write-offs and other tax reductions have improved the cash-flow position of U.S. industry and have provided a stimulus to expansion. Moreover, the federal budget deficit, while straining borrowing costs, has clearly provided short-run stimulus to both consumption and production of manufactured goods.

Similarly, the anti-inflationary course the Federal Reserve has followed has had a dramatic effect on interest sensitive sectors of the economy, many of which are also trade sensitive. Lower inflation and interest rates have encouraged both the investment boom and increased consumer spending. The recent recovery in private housing construction, boosted in part to lower interest rates, has brought spending on structures back to its long-term trend level.

6. See Barry Bosworth, *Taxes and the Investment Recovery*, Brookings Papers on Economic Activity, 1985:1, pp. 1-47.

TABLE 9. CYCLICAL BEHAVIOR OF U.S. MANUFACTURING INDUSTRIES BASED ON COEFFICIENT ESTIMATES

High	Medium	Low
Primary Metal Products	Transportation Equipment	Paper and Allied Products
Fabricated Metal Products	Furniture and Fixtures	Chemicals and Allied Products
Rubber and Plastic Products	All Manufacturing	Printing and Allied Products
	Stone, Clay, and Glass Products	Food and Kindred Products
	Petroleum and Coal Products	
	Non-Electrical Machinery	
	Electrical Machinery	
	Textile Mill Products	
	Leather and Leather Products	
	Apparel Products	
	Instruments and Related Products	
	Miscellaneous Manufacturing	

SOURCE: Congressional Budget Office.

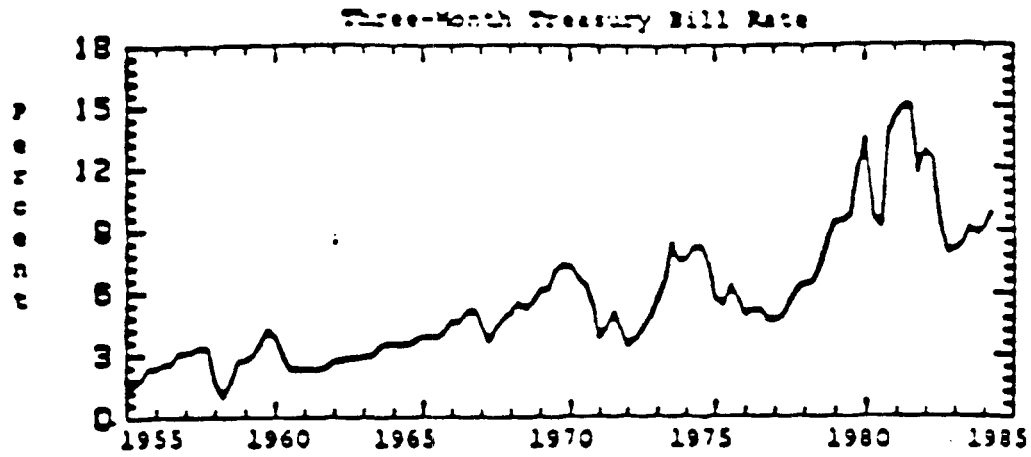
NOTE: Percent change in industrial production with a 1 percent change in the ratio of actual to potential gross national product. See Appendix A for details.

Interest Rates. Both nominal and real interest rates are extraordinarily high compared to historical experience. As shown in Figure 3, interest rates since 1980 have been far above their normal levels. Many factors help explain why interest rates are so high: inflationary fears based on the double-digit inflation of the 1970s is one reason, volatility in money growth rates is another, and deregulation of financial markets may be a third. Most economists believe that the large federal budget deficit has played a major role in keeping real interest rates high. 7/

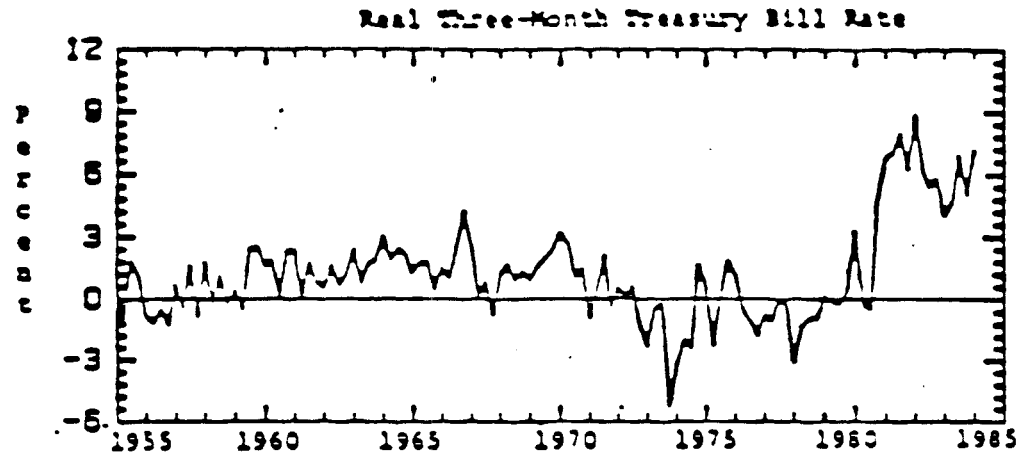
Whatever the reason for the high interest rates, the effects on industry have been both to raise the cost of production and to lower the ability of buyers to obtain financing. These effects are uneven across industries. Some industries, such as construction, capital goods and consumer durables are particularly sensitive to interest rates, while others, such as food, tobacco, and textiles, are less vulnerable to interest rate movements. Thus, some of the depressing effects on some industries may be attributable to the historically high interest rate rather than to the exchange rate.

7. For a detailed discussion of interest rate issues see the statement of Rudolph G. Penner, Director, Congressional Budget Office, before the Joint Economic Committee, Subcommittee on Economic Goals and Inter-governmental Policy, September 13, 1984.

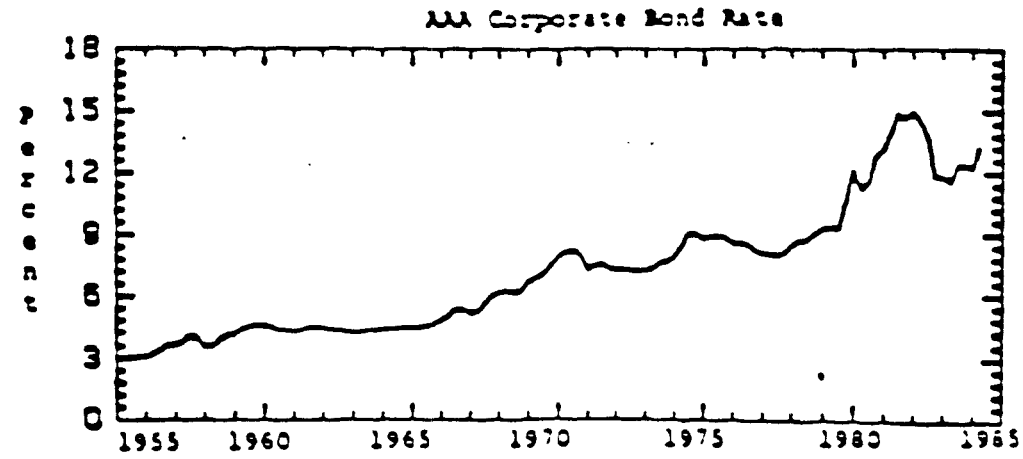
FIGURE 3. SELECTED INTEREST-RATE MEASURES, 1955-1984



SOURCE: Federal Reserve Board



SOURCE: Congressional Budget Office



SOURCE: Moody's Investors' Service.

At the same time, however, the high interest rate has attracted larger inflows of savings from other countries, mitigating to some degree the negative effects of high rates. Such capital inflows have increased the money for both investment and consumption that otherwise would not have been available. In fact, despite the higher cost of borrowing, even the sectors most affected by interest rates (such as capital goods) have experienced rapid growth during the economic recovery and expansion.

Oil Crises. The oil crises of the 1970s did direct harm to the U.S. economy, raising the rate of inflation and cutting real incomes. They also helped foreign competitors capture large portions of certain domestic and international markets. Loss of prominence in automobile production was an especially conspicuous effect, as U.S. consumers shifted to smaller, fuel-efficient cars that had been developed elsewhere. 8/ Other industries that suffered included rubber and plastics, and refined petroleum products.

The resulting uncertainties, as reflected in higher real interest rates and a yield curve that heavily discounts long maturities, have helped shorten the focus of U.S. businesses, causing them to be more concerned with short-term goals. Moreover, the oil crises may have had an effect on the existing capital stock, making much of it obsolete. 9/ This premature disuse is believed to be a contributing factor in the productivity slowdown of the 1970s.

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8. See Congressional Budget Office, *Current Problems of the U.S. Automobile Industry and Policies to Address Them* (July 1980).

9. See, for example, Martin Neil Bailey, *Productivity and the Services of Capital and Labor*, Brookings Papers on Economic Activity, 1981:1, pp. 1-50. For a contrary view, see Barry P. Bosworth, *Capital Formation and Economic Policy*, Brookings Paper on Economic Activity, 1982:2, pp. 273-327.

SECTION 5

PERFORMANCE AND CHANGING COMPOSITION OF U.S. INDUSTRY

Analysis of the Congressional Budget Office's econometric estimates reveals that some industries consistently show a high responsiveness of output to changes in the dollar's exchange rate; others, however, show consistently low levels of responsiveness. Yet, the responsiveness of industry output to the changes in the exchange rate does not fully explain changes in industrial performance. This section more closely examines four industries to see how they performed and what other factors may have been involved in determining their performance. These industries are representative of a range of circumstances. One is the most sensitive to exchange-rate changes; one is among the least. One is a dynamic, growing industry; two are in a state of secular decline.

Primary Metal Products. The primary metals industry--including basic steel, copper, and aluminum production--shows the greatest responsiveness to changes in the dollar's exchange rate (see Table 10). (The exchange-rate coefficients were estimated between about -0.25 and -0.50. Here, as below, coefficient estimates are stated in a short-hand, summary fashion. They should be interpreted as showing the percentage change in industrial production associated with a 1 percent change in the stated variable, in this case, the exchange rate.) It also emerged as the most extremely cyclical--that is, output in primary metals rises and falls more than in other economic activity over the short-run business cycle.

Primary metals manufacturing is a mature industry already in decline because of various domestic and foreign factors. The decline is secular, not cyclical. Domestic factors include changing tastes and technology leading to saturation of consumption, particularly for steel, and an aging and outdated production capacity. Foreign factors include worldwide oversupply, newer and more efficient production capacity overseas--and in recent years, the effect of the high exchange rate.

The industry's problems emerge clearly in CBO's analysis. The estimated coefficient for long-term income obtained in the model is negative, implying declining output, as shown by the industrial production index. Employment has also been falling, down 28 percent from 1972. Productivity in the industry, while rising, has lagged behind the overall U.S. manufacturing average. Average hourly earnings remain about 25 percent above the manufacturing average, making competition more difficult.

The effects of the dollar's appreciation are also clear. Import penetration has been severe, with the percentage of imports in new supply rising from 8.9 percent to 14.6 percent between 1972 and 1982. The trade balance deteriorated from $2.9 billion to $16.8 billion. Exports have declined since 1982, while imports have climbed 31 percent.

TABLE 10. PROFILE OF THE PRIMARY METALS INDUSTRY, SELECTED YEARS 1972-1984

Categories	1972	1977	1982	1984
Industrial Production Index	100.8	100.0	65.7	82.4
Employment (in thousands)	1,142.9	1,113.7	854.4	824.2
Percent of Manufacturing Output	7.1	6.9	5.1	4.9 a/
Productivity b/	100.0	108.1	115.3	N/A
Average Hourly Earnings (in dollars)	4.67	7.40	11.34	11.47
Imports (in millions of dollars)	4,355.6	9,889.2	16,921.4	22,169.2
Exports (in millions of dollars)	1,481.4	2,915.6	5,500.5	5,403.8
Trade Balance (in millions of dollars)	-2,874.2	-6,973.6	-11,420.9	-16,765.4
Export/Shipments (in percents)	2.8	3.0	5.0	N/A
Imports/New Supply (in percents)	8.9	10.0	14.6	N/A

SOURCES: Congressional Budget Office based on data provided by the Federal Reserve Board, U.S. Department of Commerce, and U.S. Department of Labor.

NOTE: N/A = Not Available.

a. Data for 1983.

b. Productivity is calculated as shipments divided by production workers hours worked (1972 = 100).

Food and Kindred Products. The processed food industry has shown reasonably good performance from the early 1970s until the early 1980s (see Table 11). According to CBO analysis, this industry has been relatively insulated from exchange-rate shifts (the estimated exchange rate coefficient was about -0.10 to -0.11). The processed food industry is also relatively insensitive to short-run income fluctuations (the estimated coefficient is between 0.30 and 0.41).

TABLE 11. PROFILE OF THE FOOD AND KINDRED PRODUCTS INDUSTRY, SELECTED YEARS 1972-1984

Categories	1972	1977	1982	1984
Industrial Production Index	88.0	100.0	114.9	127.1
Employment (in thousands)	1745.2	1711.0	1635.9	1618.6
Percent of Manufacturing Output	8.1	8.1	8.4	8.1 a/
Productivity b/	100.0	113.3	128.1	N/A
Average Hourly Earnings (in dollars)	3.60	5.37	7.92	8.38
Imports (in millions of dollars)	4300.3	6842.5	9561.2	12027
Exports (in millions of dollars)	3051.7	7249.4	11078.6	11066
Trade Balance (in millions of dollars)	-1248.6	406.9	1517.4	-961
Export/Shipments (in percents)	2.9	4.1	4.2	3.8 c/
Imports/New Supply (in percents)	3.9	3.8	3.6	4.0 c/

SOURCES: Congressional Budget Office based on data provided by the Federal Reserve Board, U.S. Department of Commerce, and U.S. Department of Labor.

NOTE: N/A = Not Available.

a. Data for 1983.

b. Productivity is calculated as shipments divided by production workers hours worked (1972 = 100).

c. Estimated.

Real output, as measured by the industrial production index, has risen by 44.4 percent between 1972 and 1984, but production as a percent of all manufacturing output did not increase, and employment declined from 1.7 million to 1.6 million. One reason why employment has been falling is that productivity in the food industry has increased at an annual rate of 2.8 percent, which until recently has outpaced output growth, leading to lower labor requirements. Although the industry experienced a decline in output share from the immediate postwar period, industry output as a percent of all manufacturing output has held stable since 1972, and in fact, rose briefly through the period. This is reflected in the long-term income coefficients of between 0.95 and 1.19. Wages in the food industry are close to average in manufacturing, and they have risen at about the same pace as the average, although slipping somewhat in recent years.

Food industry exports grew dramatically from 1972 through 1982, but they have not grown since 1982. Exports grew 26.3 percent annually, while imports only grew at a 12.2 percent pace. The trade balance went from a negative position of -$1.2 billion to a positive position of $1.5 billion, but then it turned negative again in 1984. Import penetration has not changed significantly in this industry. Some of this may be attributable to U.S. protection policies, such as controls on dairy and sugar imports. In sum, the rising dollar has probably had little measurable effect on this industry.

Non-Electrical Machinery. This industry group, profiled in Table 12, encompasses firms engaged in manufacturing machinery and equipment, (except electrical and transportation equipment). Products included are engines and turbines, farm, construction, and other specialized industrial equipment (including metalworking machinery), and office, computing and accounting machines. The CBO estimates of the responsiveness of production in this industry was near -0.20 percent with a 1 percent change in the exchange rate.

As shown in Table 6, consumption of non-electrical machinery has been growing rapidly--10.2 percent annually, in real terms. The industrial production index more than doubled between 1972 and 1984, and employment was up 7 percent. The CBO equation estimates also showed long-term responsiveness to income growth (with coefficients between 1.28 and 2.01). In addition, the industry is highly cyclical; coefficients on this variable were between 1.21 and 1.84.

Much of the growth of this industry has come from increased exports. As shown Table 8, non-electrical machinery led all industries in growth in net trade position over the 1972-1982 period. The export/shipments ratio

grew, over the period, from 14.9 percent to 23.2 percent. The imports/new supply ratio also rose, however, to 8.5 percent by 1982. More recently, this industry has not fared well in trade. From 1982 through 1984, total imports increased nearly 72 percent, while exports actually fell slightly. Thus, the trade surplus, which was as high as $22.8 billion in 1982, fell to $9.6 billion in 1984.

TABLE 12. PROFILE OF THE NON-ELECTRICAL MACHINERY INDUSTRY, SELECTED YEARS 1972-1984

Categories	1972	1977	1982	1984
Industrial Production Index	79.7	100.0	128.4	172.4
Employment (in thousands)	1,992	2,083.4	2,176.6	2,133.1
Percent of Manufacturing Output	11.0	11.9	13.0	11.1 a/
Productivity b/	100.0	127.7	168.9	N/A
Average Hourly Earnings (in dollars)	4.32	6.25	9.26	9.96
Imports (in millions of dollars)	3,201.1	7,044.7	16,050.9	27,579.5
Exports (in millions of dollars)	8,689.1	21,373.1	38,866.0	37,204.9
Trade Balance (in millions of dollars)	5,488.0	21,365.7	22,815.1	9,625.4
Export/Shipments (in percents)	14.9	19.5	23.3	N/A
Imports/New Supply (in percents)	5.4	6.3	8.5	N/A

SOURCES: Congressional Budget Office based on data provided by the Federal Reserve Board, U.S. Department of Commerce, and U.S. Department of Labor.

NOTE: N/A = Not Available.

a. Data for 1983.

b. Productivity is calculated as shipments divided by production workers hours worked (1972 = 100).

Leather and Leather Products. The leather industry (see Table 13) comprises several major subgroups including non-rubber footwear, leather tanning and finishing, luggage, and wearing apparel. This industry was in the medium-high range of responsiveness to exchange-rate changes in CBOs econometric analysis (estimates between about -0.20 and -0.30). The equation showed a declining share of output associated with long-run income (0.52 and 0.55) and a slightly procyclical responsiveness to short-run income changes (1.12 to 1.24).

TABLE 13. PROFILE OF THE LEATHER AND LEATHER PRODUCTS INDUSTRY, SELECTED YEARS 1972-1984

Categories	1972	1977	1982	1984
Industrial Production Index	116.4	100.0	81.6	76.7
Employment (in thousands)	273.4	242.5	200.6	190.3
Percent of Manufacturing Output	0.9	0.7	0.7	0.7 a/
Productivity b/	100.0	113.7	119.7	N/A
Average Hourly Earnings (in dollars)	2.68	3.60	5.33	5.71
Imports (in millions of dollars)	1029.1	1881.3	4496.2	6798
Exports (in millions of dollars)	100.3	264.7	497.7	526
Trade Balance (in millions of dollars)	-928.8	-1616.6	-3998.5	-6272
Export/Shipments (in percents)	1.8	3.8	5.7	N/A
Imports/New Supply (in percents)	15.9	21.1	33.9	N/A

SOURCES: Congressional Budget Office based on data provided by the Federal Reserve Board, U.S. Department of Commerce, and U.S. Department of Labor.

NOTE: N/A = Not Available.

a. Data for 1983.

b. Productivity is calculated as shipments divided by production workers hours worked (1972 = 100).

In fact, the U.S. leather industry is in secular decline: production fell from 1.5 percent of manufacturing output in 1951 to 0.7 percent in 1983, a decline of more than 50 percent. Real output and employment fell throughout the 1970s. Production in 1984 was only 65 percent of its 1972 level. Productivity growth was below industry averages. Hourly earnings lagged far behind the average as well, equalling only about 60 percent of the manufacturing average in 1984.

Nonetheless, both exports and imports grew between 1972 to 1984. The negative trade balance deteriorated from -$928.8 million in 1972 to -$6272 million in 1984. Import penetration in the leather industry was the highest of any industry, rising by 18 percentage points over the period. Other international trade effects also had major effects on the industry. The derived demand for leather resulting from shoe production fell off dramatically as U.S. shoe production decreased. This decline was in response to imports from Brazil and other developing countries, which have the cost advantage of cheaper labor in an industry that is very labor intensive.

CONCLUSION

An examination of these four industries illustrates that the high dollar has, for some, made a bad situation worse, while for others it has either had little noticeable effect, or its effect has only been to dampen some of the industry's rapid growth. This range of effects is probably representative of the manufacturing sector generally, although individual firms may feel the effect of the strong dollar more sharply than do whole industries. It is always difficult, moreover, to assign a specific portion of the blame for poor economic performance to one cause or another. It should be kept in mind that the strong dollar has had positive macroeconomic effects that benefit all of the industries discussed above, such as helping to keep down the rate of increase in costs and increasing the availability of capital for investment.

APPENDIXES

APPENDIX A

REGRESSION EQUATIONS AND STATISTICAL RESULTS

This Appendix presents an overview of regression equations, estimation procedures, and coefficient interpretations supporting the analysis in the main body of the paper. The nature of the analysis--interindustry comparisons--dictates a simple yet systematic approach to estimating the effects of changes in the exchange rate and other variables on industrial production. The approach entails estimating the coefficients of regression equations for each of 20 industries and an industry aggregate.

EQUATION VARIABLES

Table A-1 identifies the variables that appear in the regression equations. Industrial production (in the aggregate and by industry) is postulated to be a function of six independent, or explanatory, variables including the exchange rate. The purpose of this equation is to isolate the effects of the exchange rate on industrial production. The explanatory variables include:

- The trade-weighted foreign exchange value of the dollar (EXVUS), which is assumed to be inversely related to domestic output. As the dollar rises in value, U.S. goods become more expensive to foreigners and foreign goods become cheaper to U.S. buyers, tending to reduce U.S. output.
- Income effects, including the potential (or trend) level of income (GNP*), the cyclical component of income expressed as the ratio GNP/GNP*, and the level of foreign income (GNPF). With the exception of foreign income, which is probably a small factor in overall U.S. industrial production, these variables are expected to have positive and significantly important effects on U.S. manufacturers.
- Price effects, including the real price of domestic manufactured products (PPIi/PY) and the price of U.S. goods relative to foreign ones (PPIi/PPIF). These price terms show the cost movements of U.S. manufactured goods relative to all other U.S. products and to similar foreign goods. If the exchange rate only captured relative price differences, all of the effect of such relationships would be captured by the PPI/PPIF variable and the exchange rate coefficient would equal zero. Because demand tends to be more impor-

TABLE A-1. DEFINITIONS OF VARIABLES USED IN THE REGRESSION EQUATIONS

Variable	Definition	Expected Sign and Value
Dependent Variable IP_i	Industrial Production Index for industry i	1977 = 100, values as reported from the Federal Reserve Board.
Independent Variables EXVUS	Trade-weighted exchange value of the U.S. dollar, FRB index of group of 10 countries plus Switzerland.	Negative values between -0.00 and -0.99 show inverse relationship between industrial production and the exchange rate.
GNP/GNP*	Real gross national product divided by potential GNP, representing the position of the economy over the business cycle.	All values are expected to be positive. Cyclical industries should register a value of greater than 1; non cyclical industries should be less than 1.
GNP*	Potential GNP as estimated historically by the Council of Economic Advisers and extended using CBO assumptions, measuring the long-term trend of the industry in combination with the cyclical variable.	Value should reflect the changing share of industry output in the economy, positive and greater than 1 where industry share is growing; and negative where industry share and output are declining
PPI_i/PY	The Producer Price Index for industry i divided by the GNP deflator. This essentially represents relative real price changes for the industry.	Negative values, representing inverse relationship between price and output in demand.
$PPI_i/PPIF$	The Producer Price Index for industry i divided by a trade-weighted average of foreign producer price indexes.	Negative values representing inverse relationship between price and output in demand.
GNPF	Foreign GNP, trade-weighted for five major U.S. trading partners.	No prior expectation. Positive if foreign income pulls U.S. production through increased exports; negative if foreign growth displaces U.S. products.
RHO	Estimate of the autoregressive parameter produced under the Cochrane-Orcutt procedure.	Positive, between 0 and 1.

SOURCE: Congressional Budget Office.

tant in determining short-run price and output movements, the price variables are expected to have an inverse relationship to industrial output. As the relative price of U.S. manufactured products rises, demand and output can be expected to fall.

Ideally, one might like to include more variables in the explanation of changes in industrial production, particularly when one is interested in the effect of foreign factors. For example, PPIi/PPIF measures the relative prices of U.S. and foreign goods, but data limitations prevent a consistent calculation of the prices that specific foreign goods sell for in this country and the prices that U.S. goods sell for overseas. Theoretically PPIF should also be subscripted and should vary by commodity with the prices of substitute and complementary foreign goods of all trading partners. Such a commodity-specific data set is, unfortunately, not available. Moreover, data on foreign income and prices are limited to variables obtained from the Big Five industrialized economies outside of the United States (Canada, France, the United Kingdom, Germany, and Japan).

The model is essentially a reduced-form equation that was assumed to be demand driven in the short run--that is, lagged cyclical and potential domestic GNP are assumed to be important determinants of current-period industrial production. Similarly, the last period's foreign income level affects current-period production. As domestic and foreign income variables change, they presumably affect the demand for industrial output, quite apart from relative domestic or foreign prices or the exchange rate. It is in this sense that the model is "demand driven." For simplicity, and to take account of potential nonlinearities, the equation is estimated in double log form. All explanatory variables are lagged one quarter.[1/] Coefficient estimates can be interpreted as elasticities, other things being equal. The coefficient value a_2 represents the percent change in industrial production in industry i with respect to a 1 percent change in the exchange rate, holding other exogenous variables constant. The basic equation is:

$$\ln(IPi) = a_1 + a_2*\ln(EXVUS) + a_3*\ln(GNP/GNP^*) + a_4*\ln(GNP^*) + a_5*\ln(PPIi/PY) + a_6*\ln(PPIi/PPIF) + a_7*\ln(GNPF) + \text{error}$$

1. Studies in the trade literature often find long lags in the exchange-rate impact on exports and imports. Variants of the single-lag approach were used in the model formulation. Lags of up to six quarters were employed. Results of such formulations were disappointing. Full details are available from the author.

In the presence of first-order serial correlation among the error terms, a phenomenon common in time series estimates such as this one, the Cochrane-Orcutt estimation procedure is preferable to least squares, and used accordingly. 2/

This equation, with quarterly data spanning the last decade and one-half, is used to estimate coefficients for aggregate manufacturing and for 20 two-digit industries (based on the Standard Industrial Classification). No attempt was made to alter individual industry equations beyond the inclusion of industry-specific price data, to reflect particular industry circumstances. In principle, changes in EXVUS and other variables may affect each industry's production differently.

REGRESSION RESULTS

For the most part, the regression results obtained for the aggregate equation and the industry-specific equations confirm prior sign and in some cases magnitude expectations. Table A-2 shows the parameter estimates for the basic model (t-statistics are shown in parentheses). Table A-3 presents the coefficient estimates (and t-statistics) of the exchange rate variable for four alternative versions of the basic model. 3/

For many industries, the standard error associated with the effects of the exchange rate on output--that is, the estimated coefficient a_2--are quite large, and the t statistics small. It is not possible to statistically reject the hypothesis that $a_2 = 0$ at the 5 percent level, for some industries,

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2. The Cochrane-Orcutt procedure is an efficient iterative solution technique that relies upon successively estimating new values of the serial correlation coefficient. See for example, Eric A. Hanushek and John E. Jackson, *Statistical Methods for Social Scientists* (New York: Academic Press, 1977), pp. 142-174.

3. Several other variations on the basic model were run, but are not presented here because of space limitations. The results of those runs were within the range of the estimates presented and are included in tables in the main body of the paper. It should be noted that in some cases estimates changed significantly over different time periods or were significant in one time period but not in another. This phenomenon may be due to the way in which foreign producers react to exchange rate changes. If they do not pass these changes through to consumers, but absorb them out of profits, then domestic production may not react--that is, the elasticity of production with regard to the exchange rate may be reduced. For evidence of such price behavior, see Wing Woo, "Exchange Rates and the Prices of Nonfood, Nonfuel Products," *Brookings Papers on Economic Activity* (1984:2), pp. 511-537.

TABLE A-2. REGRESSION RESULTS FOR BASIC EQUATION ESTIMATED FOR THE PERIOD 1973:3 TO 1985:1

	Intercept	EXVUS	GNP/ GNP*	GNP*	PPI/ PY	PPI/ PPIF	GNPF	RHO	F	R^2
All Manufacturing	-2.11	-0.13	1.55	1.67	0.03	-0.84	-0.01	0.48	234	0.97
	(-1.21)	(-2.10)	(4.37)	(2.19)	(0.11)	(-2.37)	(-0.02)	(4.25)		
Food and Kindred Products	-3.82	-0.01	0.26	1.06	-0.06	0.02	0.08	0.73	878	0.99
	(-3.63)	(-0.40)	(1.28)	(2.28)	(-0.42)	(0.12)	(0.20)	7.68		
Tobacco Products	-1.41	-0.17	-0.38	-0.21	-0.51	0.33	0.59	0.23	9	0.57
	(-0.53)	(-2.84)	(-1.02)	(-0.24)	(-1.58)	(1.25)	(0.80)	(1.61)		
Textile Mill Products	10.52	-0.16	1.70	0.81	-0.85	-0.41	-0.89	0.72	20	0.76
	(1.55)	(-1.04)	(1.94)	(0.35)	(-1.18)	(-0.54)	(-0.50)	(7.06)		
Apparel Products	-5.35	-0.01	1.66	1.64	0.09	0.13	-0.73	0.75	29	0.82
	(-0.75)	(-0.05)	(2.08)	(0.75)	(0.09)	(0.20)	(-0.46)	(7.44)		
Paper and Paper Products	-5.33	0.08	0.05	-0.71	-0.65	-0.59	1.84	0.53	124	0.95
	(-2.18)	(1.17)	(0.10)	(-0.65)	(-1.85)	(-1.50)	(1.95)	(4.36)		
Printing and Publishing	-6.99	0.04	1.14	2.82	0.31	-0.40	-0.69	0.79	1,091	0.99
	(-5.45)	(0.85)	(3.93)	(4.29)	(1.45)	(-1.95)	(-1.28)	(21.90)		
Chemicals and Related Products	-3.54	-0.04	0.59	0.13	-0.16	-0.29	0.92	0.78	179	0.97
	(-1.68)	(-0.47)	(1.23)	(0.12)	(-0.49)	(-0.90)	(1.05)	(10.48)		
Petroleum Products	11.55	-0.37	1.35	2.91	1.24	-1.48	-1.86	0.55	37	0.85
	(4.16)	(-4.12)	(2.30)	(2.31)	(2.46)	(-2.64)	(-1.69)	(5.18)		
Rubber and Plastic Products	-4.72	-0.06	2.44	3.78	-0.41	-0.44	-1.55	0.46	145	0.96
	(-0.99)	(-0.48)	(3.43)	(2.31)	(-0.79)	(-0.65)	(-1.10)	(3.58)		

(Continued)

TABLE A-2. (Continued)

	Intercept	EXVUS	GNP/ GNP*	GNP*	PPI/ PY	PPI/ PPIF	GNPF	RHO	F	R^2
Leather and Leather Products	13.75	-0.24	0.98	1.00	-0.09	0.08	-1.59	0.62	55	0.89
	(3.55)	(-1.85)	(1.29)	(0.55)	(-0.16)	(0.15)	(-1.01)	(5.18)		
Lumber and Wood Products	-3.02	0.17	-0.22	3.77	-0.42	1.07	-2.68	0.85	29	0.82
	(-0.65)	(0.82)	(-0.21)	(1.67)	(-0.63)	(1.58)	(-1.50)	(10.70)		
Furniture and Fixtures	-0.25	-0.08	1.91	1.99	-0.15	-0.91	-0.44	0.80	206	0.97
	(-0.08)	(-0.81)	(3.55)	(1.52)	(-0.27)	(-0.06)	(-0.42)	(18.44)		
Clay, Glass, and Stone Products	-1.09	-0.14	1.36	0.33	0.01	-0.32	0.58	0.85	69	0.91
	(-0.38)	(-1.16)	(2.32)	(0.24)	(0.03)	(-0.68)	(0.53)	(10.96)		
Primary Metal Products	4.37	-0.12	3.23	-1.73	-0.38	0.54	1.07	0.56	47	0.88
	(0.64)	(-0.59)	(2.84)	(-0.65)	(-0.45)	(0.49)	(0.47)	(4.79)		
Fabricated Metal Products	1.90	-0.07	2.40	0.51	0.37	-0.36	0.12	0.69	89	0.93
	(0.80)	(-0.77)	(5.01)	(0.46)	(1.00)	(-0.96)	(0.13)	(6.55)		
Non-Electrical Machinery	-5.29	-0.19	1.85	2.06	0.13	-1.00	0.11	0.64	411	0.98
	(-2.60)	(-2.72)	(4.48)	(2.18)	(0.34)	(-3.38)	(0.14)	(6.86)		
Electrical Machinery	-12.47	-0.14	1.67	3.36	-0.21	-0.74	-0.27	0.79	893	0.99
	(-6.25)	(-1.71)	(3.62)	(3.31)	(-0.44)	(-2.42)	(-0.32)	(21.73)		
Transportation Equipment	-5.53	-0.08	1.31	1.03	-1.08	0.46	0.07	0.77	31	0.83
	(-1.21)	(-0.50)	(1.37)	(0.48)	(-1.19)	(0.70)	(0.04)	(8.11)		
Instruments	-0.61	-0.15	1.10	0.42	-0.34	-0.38	0.55	0.74	242	0.97
	(-0.43)	(-2.92)	(3.41)	(0.59)	(-1.03)	(-1.75)	(0.93)	(7.42)		
Miscellaneous Manufacturing	3.26	-0.23	1.34	1.44	0.32	-0.80	-0.39	0.67	57	0.90
	(1.52)	(-2.70)	(3.03)	(1.44)	(1.04)	(-2.22)	(-0.45)	(9.09)		

SOURCE: Congressional Budget Office.
NOTE: T-statistics are in parentheses.

TABLE A-3. ESTIMATES OF THE COEFFICIENT A_2 UNDER ALTERNATIVE SPECIFICATIONS[a/]

	Set 1	Set 2	Set 3	Set 4
All Manufacturing	-0.13 (-2.10)	-0.06 (-1.30)	-0.11 (-2.01)	-0.15 (-1.81)
Food and Kindred Products	-0.01 (-0.40)	0.01 (0.54)	-0.04 (-1.18)	-0.11 (-2.80)
Tobacco Products	-0.17 (-2.84)	-0.21 (-3.54)	-0.23 (-3.10)	-0.26 (-2.62)
Textile Mill Products	-0.16 (-1.04)	-0.21 (-1.93)	-0.17 (-1.22)	-0.27 (-1.67)
Apparel Products	-0.01 (-0.05)	0.03 (0.24)	0.07 (0.47)	0.09 (0.53)
Paper and Paper Products	0.08 (1.17)	0.08 (1.68)	-0.01 (-0.14)	-0.18 (-1.61)
Printing and Publishing	0.04 (0.85)	0.07 (1.16)	0.06 (0.95)	0.02 (0.32)
Chemicals and Related Products	-0.04 (-0.47)	-0.10 (-1.54)	-0.10 (-1.25)	-0.07 (-0.82)
Petroleum Products	-0.37 (-4.12)	-0.24 (-2.79)	-0.15 (-1.45)	-0.12 (-1.13)
Rubber and Plastic Products	-0.06 (-0.48)	-0.10 (-1.16)	-0.16 (-1.29)	-0.23 (-1.28)
Leather and Leather Products	-0.24 (-1.85)	-0.29 (-3.35)	-0.20 (-1.78)	0.0 (-0.01)
Lumber and Wood Products	0.17 (0.82)	0.06 (0.39)	-0.16 (-0.98)	-0.15 (-0.80)

(Continued)

TABLE A-3. (Continued)

	Set 1	Set 2	Set 3	Set 4
Furniture and Fixtures	-0.08	-0.01	-0.09	-0.22
	(-0.81)	(-0.15)	(-0.86)	(-1.99)
Clay, Glass, and Stone Products	-0.14	-0.12	-0.21	-0.18
	(-1.16)	(-1.41)	(-2.05)	(-1.72)
Primary Metal Products	-0.12	-0.26	-0.48	-0.35
	(-0.59)	(-1.60)	(-2.33)	(-1.18)
Fabricated Metal Products	-0.07	-0.09	-0.20	-0.03
	(-0.77)	(-1.26)	(-2.22)	(-0.27)
Non-Electrical Machinery	-0.19	-0.12	-0.13	-0.05
	(-2.72)	(-1.41)	(-1.35)	(-0.50)
Electrical Machinery	-0.14	-0.09	-0.11	-0.20
	(-1.71)	(-0.97)	(-1.22)	(-2.03)
Transportation Equipment	-0.08	-0.05	-0.34	-0.31
	(-0.50)	(-0.36)	(-1.89)	(-1.43)
Instruments	-0.15	-0.14	-0.16	-0.12
	(-2.82)	(-3.11)	(-2.64)	(-1.80)
Miscellaneous Manufacturing Products	-0.23	-0.15	-0.19	-0.14
	(-2.70)	(-2.11)	(-1.98)	(-1.34)

SOURCE: Congressional Budget Office.

a. Set 1 = Basic Equation (see Table A-2) over period 1973:3 to 1985:1.
Set 2 = Basic Equation over period 1967:2 to 1985:1.
Set 3 = Basic Equation over period 1967:2 to 1982:4.
Set 4 = First Difference of logs over period 1967:4 to 1985:1.

although it is possible to do so for the aggregate manufacturing sector as a whole. Some colinearity among the regressors is apparent that may bias the standard error estimates upward. Clearly, greater variation in the exchange rates over a sample period might provide more confidence in individual industry coefficient estimates.

The individual regressions exhibited good fits: all had very high R^2s, generally 0.95 or better. Cochrane-Orcutt procedures always result in smaller R^2 values than least square estimations. The fact that the R^2 values are relatively high suggests that a substantial portion of the variance in industrial output may be explained by the equations. The F statistics, which are all significant, test the null hypotheses that $a_1 = a_2 = \ldots a_7 = 0$. Thus, although it is not possible to reject the hypothesis that individual coefficients may be zero, it is possible to reject the hypothesis that all coefficients are zero. This is an encouraging result, given the level of aggregation and apparent collinearity among regressors. More significant than the statistical inferences associated with an individual equation is the robust nature of the parameter estimates. Despite many changes in the basic equation, particularly across industries, the effects of the exchange rate on output appear to be confined to a relatively narrow range. Taken together, a 10 percent increase in the exchange rate produces decreases in industrial production from almost zero to 4.8 percent, depending on the industry.

The most consistently significant variable across industries, based on t statistics, was GNP/GNP*. (With over 60 degrees of freedom, a t statistic of greater than 2.00 implies statistical significance at the 5 percent level.) The estimated coefficient of (GNP/GNP*) is, as expected, generally positive and significant. Its magnitude differs depending upon the industry in question. Nondurable products that need continual replacement, such as food, oil, and textiles, appear to be less sensitive to changes in business cycles than goods that are more durable, such as furniture, leather, metals, machinery, and rubber, whose cyclical income elasticities are greater than one.

On average, the coefficients of the long-term trend income variables (GNP*) are also positive and significant. The own real price effect as measured by the coefficient of PPIi/PY is negative as expected. Its absolute value is, for the most part, greater than that of EXVUS and that of PPIi/PPIF. The sign of the estimated coefficient of PPIi/PPIF is also generally negative, but its effect in influencing manufactured output in the U.S. is limited since exports and imports are a small percentage of GNP. This same reason helps to explain the sign and significance level of GNPF.

CONCLUSION

The results of the econometric analysis, at the aggregate level and for individual industries, indicate that a 1 percent unit increase in the foreign exchange value of the dollar decreases manufactured output on average by anywhere from -0.11 percent to -0.13 percent, as judged by the two significant coefficients for EXVUS shown in Table A-3. This band of percentage values remains fairly constant with respect to other explanatory economic variables (including lags) and when the forecasting equation is estimated over different time periods.

The income effects produced by changes in the business cycle and by rising real levels of income over time appear to be more important than the effects of the exchange value of the dollar, based on elasticities. Foreign economic factors, such as foreign price and income changes, have had a small impact on U.S. manufacturing industry.

APPENDIX B

ANALYSIS OF TRADED AND NONTRADED INDUSTRIES

To examine some of the interrelationships between trade and industrial performance, the Congressional Budget Office categorized individual industries (at the four-digit level of the Standard Industrial Classification) into traded and nontraded groups on the basis of their exposure to international trade. The analysis was limited to industries with shipments greater than $1 billion in 1980. Industries were classified as "traded" if exports were greater than 5 percent of shipments, or if imports were greater than 5 percent of shipments plus imports (defined as new supply). Working with published and unpublished data from the Department of Commerce (U.S. Industrial Outlook, 1985), 179 four-digit industries were identified as having data covering the full period 1972-1984 and meeting the minimum value of shipments requirement. These industries accounted for over 70 percent of the total value of industry shipments in 1980.

Table B-1 shows how traded, nontraded, and total industries, based on 1980 trade and shipments ratios, performed on a number of special criteria. 1/ Far from being damaged by trade, the traded sector is consistently more dynamic than the nontraded group. For example, while employment in the nontraded sector declined from 1972 to 1984, employment grew by 13.3 percent in the traded sector over the same period. Shipments in the traded sector grew three and one-half times, while nontraded shipments grew 2.9 times. Average hourly wages were higher in the traded sector at both the beginning and the end of the period. Moreover, wages in the traded group grew faster.

Table B-1 masks certain changes, particularly in the growth of the traded group, because it examines a constant sample based on the split among industries on the basis of trade exposure in 1980. Table B-2 divides the same data base by splitting industries into traded and nontraded groups based on each year's trade ratios. Table B-2 makes it easier to track the changes in the size of the traded and nontraded groups. As shown, the number of traded industries grew from 93 in 1972 to 113 in 1982. 2/ The

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1. See Attiat Ott, "Competitive Performance of U.S. Manufacturers," September 1983, for a discussion of the methods used in this section.

2. A lack of consistent data on ratios of imports and exports to shipments prevents an accurate count of industries in 1984; 1982 data have been used to calculate the division among industries, and estimated data for 1984 have been used to calculate each category listed.

TABLE B-1. SAMPLE OF U.S. MANUFACTURES FOR SELECTED YEARS (In millions of dollars and percents)

Variable	1972	1976	1980	1984
NonTraded Industries (Based on 1980 shipments)				
Employment	3,712	3,612	3,823	3,653
Production workers	2,580	2,479	2,571	2,373
Value of shipments	153,876	228,971	343,077	445,577
Value added	75,980	105,607	158,576	---
Average hourly wages	3.850	5.280	7.170	9.210
Value of shipments per production worker	59.649	92.353	133.436	187.781
Value added per production worker	29.453	42.595	61.676	---
Shipment growth rate	---	48.80	49.83	29.88
Shipments per worker growth rate	---	54.83	44.48	40.73
Employment growth rate	---	(2.69)	5.85	(4.44)
Average hourly wages index	100	137	186	239
Traded Industries (Based on 1980 shipments)				
Employment	7,406	7,475	8,425	8,388
Production workers	5,420	5,374	5,840	5,661
Value of shipments	359,288	599,859	987,727	1,251,986
Value added	161,137	245,255	381,018	---
Average hourly wages	4.170	5.730	7.980	10.500
Value of shipments per production worker	66.281	111.618	169.137	221.142

(Continued)

TABLE B-1. (Continued)

Variable	1972	1976	1980	1984
Traded Industries (Based on 1980 shipments) (Continued)				
Value added per production worker	29.726	45.636	65.245	---
Shipment growth rate	---	66.96	64.66	26.75
Shipments per worker growth rate	---	68.40	51.53	30.75
Employment growth rate	---	0.94	12.71	(0.44)
Average hourly wages index	100	137	191	252
Total				
Employment	11,118	11,087	12,248	12,041
Production workers	8,000	7,854	8,411	8,034
Value of shipments	513,164	828,830	1,330,804	1,697,563
Value added	237,116	350,862	539,594	---
Average hourly wages	4.060	5.560	7.660	10.020
Value of shipments per production worker	64.142	105.536	158.224	211.289
Value added per production worker	29.638	44.676	64.154	---
Shipment growth rate	---	61.51	60.56	27.56
Shipments per worker growth rate	---	64.53	49.92	33.54
Employment growth rate	---	(0.28)	10.48	(1.69)
Average hourly wages index	100	137	189	247

SOURCE: U.S. Department of Commerce and Congressional Budget Office.

NOTE: Parentheses indicate negative values.

TABLE B-2. CHANGES IN TRADED AND NONTRADED INDUSTRIES FOR SELECTED YEARS (In millions of dollars and percents)

Variable	1972	1976	1980	1984 a/
Nontraded Industries (Based on each year's trade ratios)				
Employment	5,083	4,189	3,823	4,057
Production workers	3,630	2,897	2,571	2,726
Value of shipments	199,971	281,537	343,077	475,018
Value added	99,963	121,418	158,576	---
Average hourly wages	3.847	5.250	7.170	9.130
Value of shipments per production worker	55.095	97.374	133.436	174.25
Value added per production worker	27.541	41.994	61.676	---
Shipment growth rate	---	40.79	80.82	38.5
Shipments per worker growth rate	---	14.57	76.74	30.6
Employment growth rate	---	-17.59	-11.05	6.1
Average hourly wages index	100	136	186	237
Number of Industries	86	69	66	66
Traded Industries (Based on each year's trade ratios)				
Employment	6,035	6,898	8,425	7,984
Production workers	4,371	4,956	5,840	5,308
Value of shipments	313,193	547,294	987,727	1,222,545
Value added	137,153	229,444	381,018	---
Average hourly wages	4.249	5.759	7.980	10.576
Value of shipments per production worker	71.656	110.426	169.137	230.300

(Continued)

TABLE B-2. (Continued)

Variable	1972	1976	1980	1984 a/
Traded Industries (Continued)				
Value added per production worker	31.379	46.294	65.245	---
Shipment growth rate	---	74.75	80.47	23.8
Shipments per worker growth rate	---	54.11	53.17	36.2
Employment growth rate	---	14.30	22.14	(-5.2)
Average hourly wages index	100	136	188	248
Number of Industries	93	110	113	113
Total				
Employment	11,118	11,087	12,248	12,041
Production workers	8,000	7,854	8,410	8,034
Value of shipments	513,164	828,830	1,330,804	1,697,563
Value added	237,116	350,862	539,594	---
Average hourly wages	4.060	5.560	7.660	10.020
Value of shipments per production worker	64.142	105.536	158.224	211.289
Value added per production worker	29.638	44.676	64.154	---
Shipment growth rate	---	61.51	60.56	27.6
Shipments per worker growth rate	---	64.53	49.92	33.4
Employment growth rate	---	(0.28)	10.48	(-1.7)
Average hourly wages index	100	137	189	247
Number of Industries	179	179	179	179

SOURCE: U.S. Department of Commerce and Congressional Budget Office.

NOTE: The 1984 split of industries is based on 1982 export and import and shipments data.

period 1980 through 1984 appears to break from previous patterns. For the first time, employment in the nontraded group rose, while traded employment declined, which implies that the traded group grew because of increased import penetration, not greater export concentration. Nontraded shipments grew faster than traded ones. But the growth rate in shipments per worker remained higher for traded industries.

Most clear in Table B-2, however, are the continuing absolute and relative increases in the traded sector. In 1972, traded industries accounted for 61 percent of shipments and 54.3 percent of total employment. In 1984, the traded sector accounted for 72.2 percent of output and 66.3 percent of employment, although these figures were down slightly from 1980 (74.2 percent and 68.8 percent, respectively). Average wages, which were 10 percent higher in the traded sector in 1972, were 15 percent greater than in nontraded industries in 1984. But no appreciable difference developed between the ratios of the value of shipments per production worker between traded and nontraded industries, which held relatively stable at 1.30 percent over the entire period.