Manufacturing costs, productivity, and competitiveness, 1979–93

With unit labor costs as a gauge, U.S. competitiveness within the G–7 countries improved in the last decade and a half; a fuller story regarding competitiveness could be told using multifactor productivity and all input costs

Edwin R. Dean
and
Mark K. Sherwood

Edwin R. Dean is Associate Commissioner for Productivity and Technology, and Mark K. Sherwood is a senior economist in the Office of Productivity and Technology, Bureau of Labor Statistics.

Barriers to world trade are diminishing, and in many countries, exports account for increasing proportions of gross domestic product. As a result, business men and women, labor leaders, and policymakers have become more concerned with the competitiveness of their countries' exports. While there are several variables that can be used to gauge an industry's or a sector's competitiveness, the most obvious may be the price of the industry's or sector's product. To be sure, other factors influence competitiveness, including the quality of the product, the timeliness of its delivery, after-sales service, and the flexibility needed to respond to changes in customers' requirements. Still, price is a leading candidate, particularly because measures of price frequently take changes in the quality of the product into account. This article proceeds on the assumption that, other things being equal, price changes are a useful indicator of changes in an industry's competitiveness. This assumption is supported by a number of studies indicating that the volume of exports tends to rise when export prices fall.[1]

Given, then, that price is a gauge of competitiveness, it is of interest to illuminate factors underlying a country's ability to hold down relative price increases for its products and thereby achieve stronger performance in trade. Such factors are important because they can have policy implications. Further, an examination of these underlying factors as gauges of competitiveness is useful in those cases where measures of output price trends are not readily available or are not accurate.

The costs of the inputs used by the country's industries and sectors to produce a unit of output contribute to the price of its product as well and consequently are also an important indicator of competitiveness. Assuming that exchange rates are constant, if one country's input costs for a product are increasing less than another's, we would expect the first country's trade situation to be improving relative to that of the second.

Unit input costs equal the amount of an input used to make a unit of the product times the price of the input. Consequently, changes in costs can be brought about by changes in the price of the input. Costs can also change through productivity growth, which reflects changes in production that occur without a corresponding change in inputs.

This article examines the relationship that exists among productivity, costs, and prices, illustrating it with data produced by the Bureau of Labor Statistics. The first half of the article studies the relationship using the traditional measures of unit labor costs, labor compensation per hour, and labor productivity. The second half examines the more general concepts of unit total costs, output prices, prices of all inputs, and multifac-

Table 1. **Annual percent changes in manufacturing productivity, unit labor costs, and related measures, 12 countries, 1979–93**

Country	Output per hour	Output	Total hours	Employ-ment	Hourly compen-sation	Unit labor costs: National currency	Unit labor costs: U.S. dollars	Exchange rate[1]
United States	2.5	1.7	-0.8	-1.1	5.3	2.7	2.7	...
Canada	1.7	1.2	-.6	-.7	5.9	4.1	3.4	.7
Japan	3.8	4.5	.7	1.4	4.6	.8	5.8	-4.7
Belgium[2]	4.3	2.3	-1.9	-1.8	5.9	1.5	.8	.7
Denmark	1.5	1.1	-.4	-.1	6.0	4.5	2.9	1.5
France	2.8	.3	-2.4	-1.9	7.8	4.9	2.8	2.1
Germany	1.9	.5	-1.4	-.5	5.6	3.6	4.4	-.7
Italy	4.1	2.0	-2.0	-2.0	11.3	6.9	2.1	4.7
Netherlands	2.6	1.6	-1.0	-.8	3.7	1.1	1.6	-.5
Norway	2.3	.2	-2.1	-2.0	7.7	5.2	2.7	2.4
Sweden	3.2	1.1	-2.1	-2.6	7.9	4.5	.1	4.4
United Kingdom	4.1	.4	-3.5	-3.2	9.4	5.1	2.5	2.5

[1] Value of the U.S. dollar relative to national currencies.
[2] Data for Belgium are for 1979–92.

tor productivity and relates these concepts to competitiveness. In making international comparisons of costs and prices, account must be taken of changing exchange rates. The article addresses this issue as well.

Costs, prices, and productivity

From the perspective of the national economy considered as a whole, the costs of producing output are the costs of capital and labor. When the output of an industry is measured as value added, these two are its costs of production as well.

As measured by the Bureau, labor costs are equal to compensation, which includes both direct and indirect payments to labor. Direct payments to labor equal wages and salaries (including compensation for executives), vacation and holiday pay, all other types of paid leave, commissions, tips, bonuses, and payments in kind. Indirect payments to labor consist of employer contributions to legally required insurance programs and contractual and private benefit plans, including funds for social insurance, private pensions and health and welfare plans, and compensation for injuries.

Nonlabor payments are the excess of value added in an economic sector over labor compensation. These payments include nonlabor costs, such as capital consumption allowances, net interest payments, and property taxes, as well as corporate profits and the profit-type income of proprietors.[2]

To provide insights into competitiveness, labor and nonlabor costs can be related to a unit of output; this offers a means of comparing trends in unit input costs across countries. A comparison of unit input costs, which are the nominal costs of the input per unit of real output, is more meaningful than a comparison of trends in input prices. Because the amount of an input used in production can vary, unit input costs reflect both the price of the input *and* the amount of the input used in the production process.

Productivity is a measure of the relationship between a unit of output and the amount of input needed to produce it. It is important to examine the link between productivity and unit input costs. Beginning with labor, which in U.S. manufacturing represents about 70 percent of the cost of inputs in a value-added framework, unit labor costs can be calculated as compensation per hour divided by output per hour; that is,

$$\text{ULC} = \frac{C/L}{Q/L}, \qquad (1)$$

where

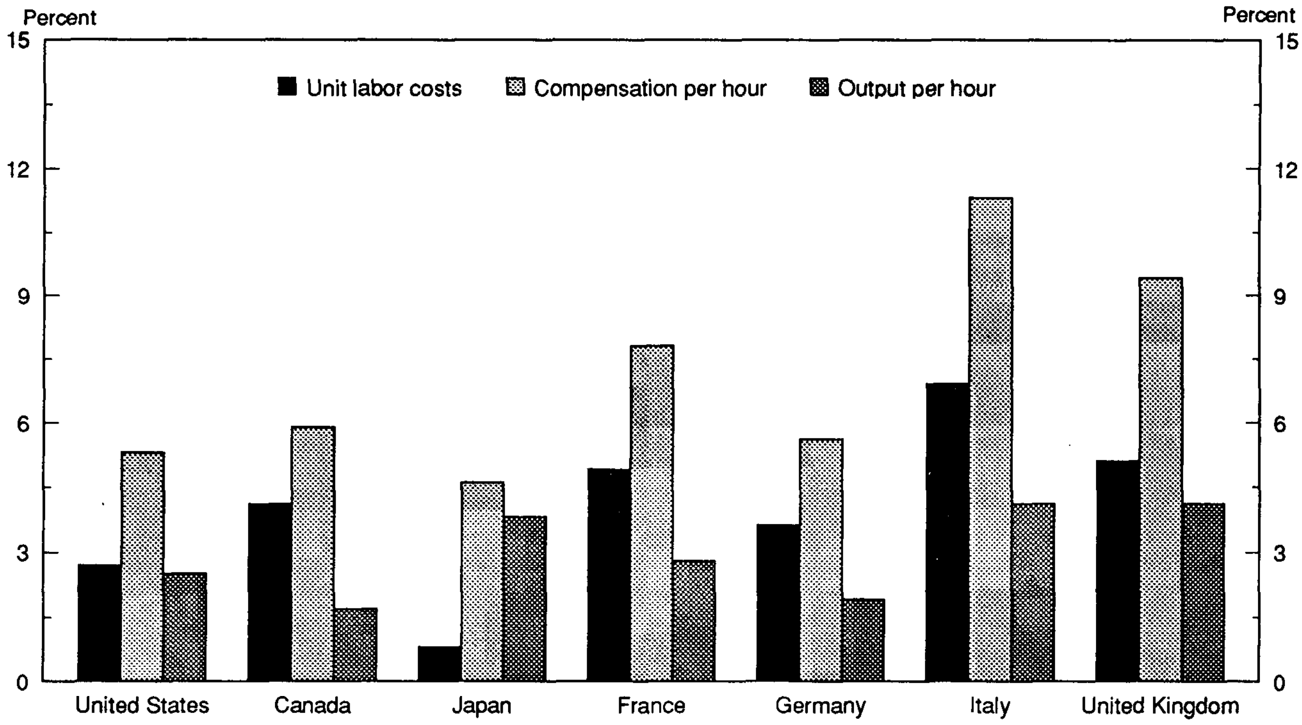
ULC = unit labor costs;
C = total nominal labor compensation;
L = labor hours; and
Q = real output.

The same relationship can be shown to hold for unit capital costs. However, because measures of capital input analogous to hours of labor input are not readily available for most countries, we shall not extend the analysis in this fashion.

The relationships between the trends in the preceding variables can be shown by computing growth rates as follows:[3]

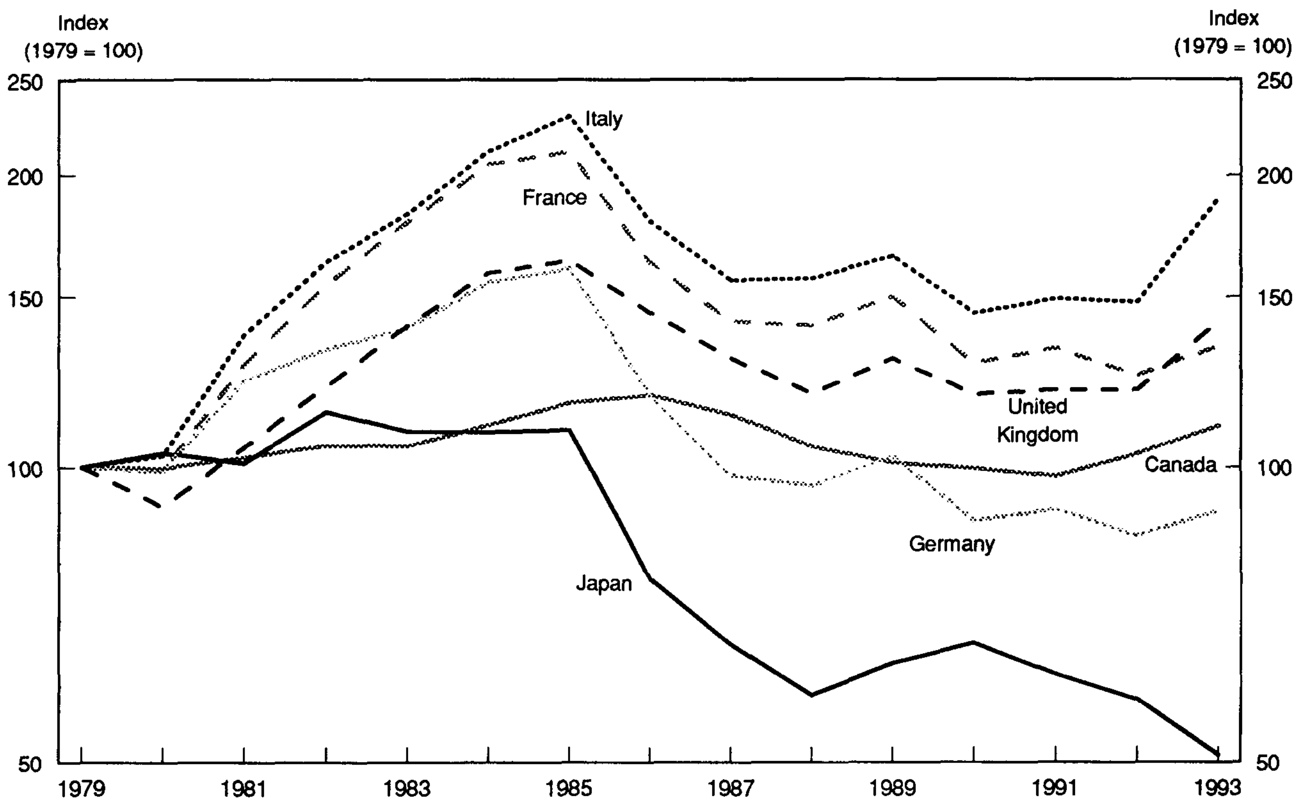
$$\frac{\dot{\text{ULC}}}{\text{ULC}} = \frac{\dot{P}_L}{P_L} - \frac{\dot{B}}{B}, \qquad (2)$$

Chart 1. **Average annual percent change in unit labor costs, compensation per hour, and output per hour in manufacturing in G-7 countries, 1979-93**



NOTE: Unit labor costs and compensation per hour are based on each country's national currency.

Chart 2. **Value of U.S. dollar relative to other G-7 countries' currencies, 1979-93**



where

ULC = unit labor costs;
P_L = labor compensation per hour (C/L); and
B = output per hour (that is, labor productivity, or Q/L).

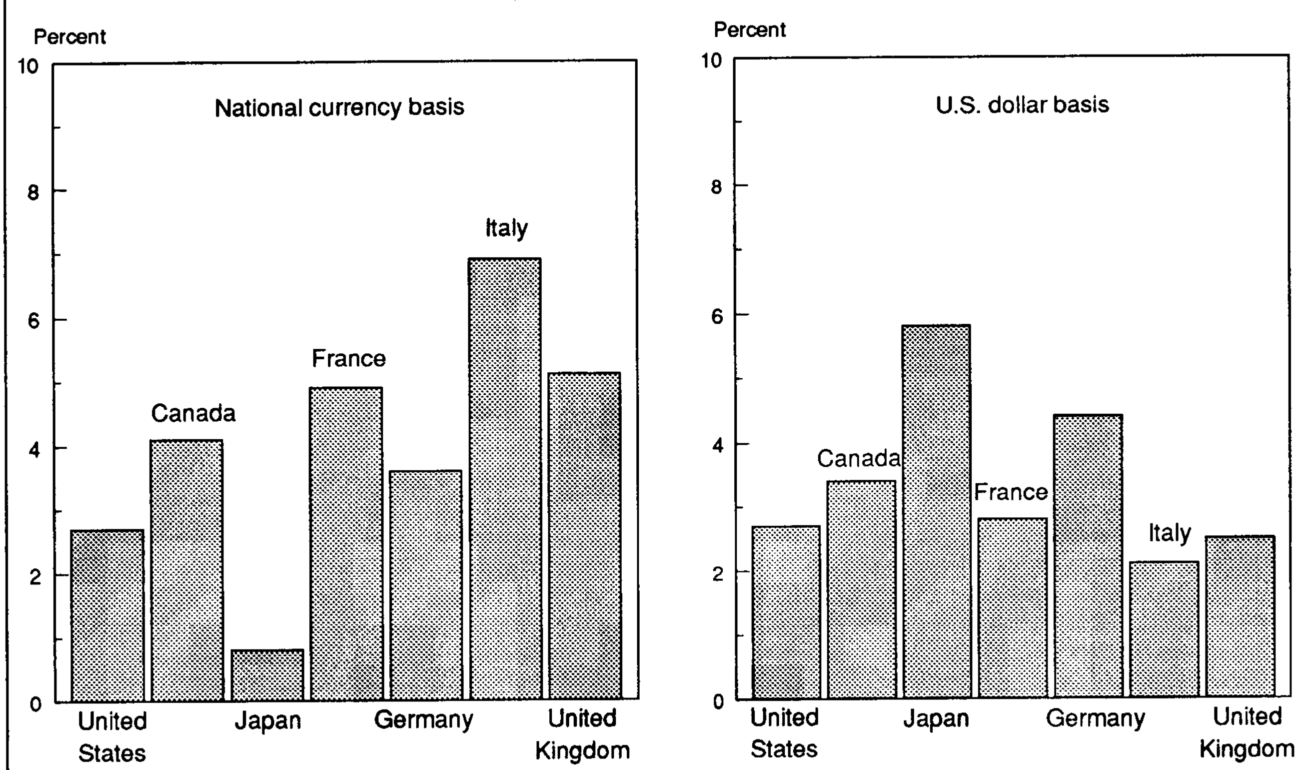
This equation shows that the rate of growth of unit labor costs can be decomposed into the growth rate of compensation per hour less the growth rate of labor productivity. (For the purposes of this analysis, compensation per hour is considered equivalent to the price of the labor input.)

An examination of equation 2 reveals that if an industry's productivity increases, unit labor costs may or may not decrease, because the trend in unit labor costs also depends upon the trend in the price of labor. Thus, a study of unit labor costs alone will provide an indication of competitiveness, but will not reveal the underlying factors contributing to the unit costs. An examination of relative productivity performance may tell a different story about trends in competitiveness than would one of input prices alone.

Some words of caution respecting equation 2 and its ramifications are in order:

- Equation 2 shows the relationship among its variables, but it does not reveal any direction of causation. The direction of causation may be complicated and difficult to trace in practice. For example, an increase in the compensation of labor relative to the return to capital may induce a company to make labor-saving investments. This would raise labor productivity and moderate the change in unit labor costs. In general, changes in the variables on the right-hand side of the equation—that is, hourly compensation and labor productivity—do not have a simple, direct effect on unit labor costs. Similarly, a change in the variable on the left-hand side of the equation—that is, unit labor costs—can always be traced, in an accounting sense, to a change in one of the two variables on the right-hand side, but this tracing may or may not reveal the underlying causal influence.
- In addition, increasing or maintaining competitiveness may be accompanied by welfare or income distribution changes deemed undesirable. For example, unit labor costs might decline due to a steady or drastic decline in hourly compensation. If this decline occurs in real terms as well, it might be held undesirable. Similarly, an increase in productivity may be accompanied by a decrease in unit labor costs because compensation per hour does not rise. Rather, the compensation of another input, such as capital, may increase.

Chart 3. **Average annual percent change in unit labor costs in manufacturing in G-7 countries, 1979-93**



This would amount to a redistribution of income among the factors of production.

- Last, to measure productivity, a number of assumptions are usually made that do not always describe the real world with complete accuracy. These assumptions are discussed in several BLS publications.[4]

Some comparisons

As part of its foreign labor statistics program, the Bureau produces international comparisons of the labor force, employment, and unemployment; productivity and unit labor costs; hourly compensation costs of production workers in manufacturing; indicators related to the family; and consumer prices and other measures. The variables examined in this article—productivity, unit labor costs, and hourly compensation—are available for total manufacturing in the United States and 11 other countries.[5]

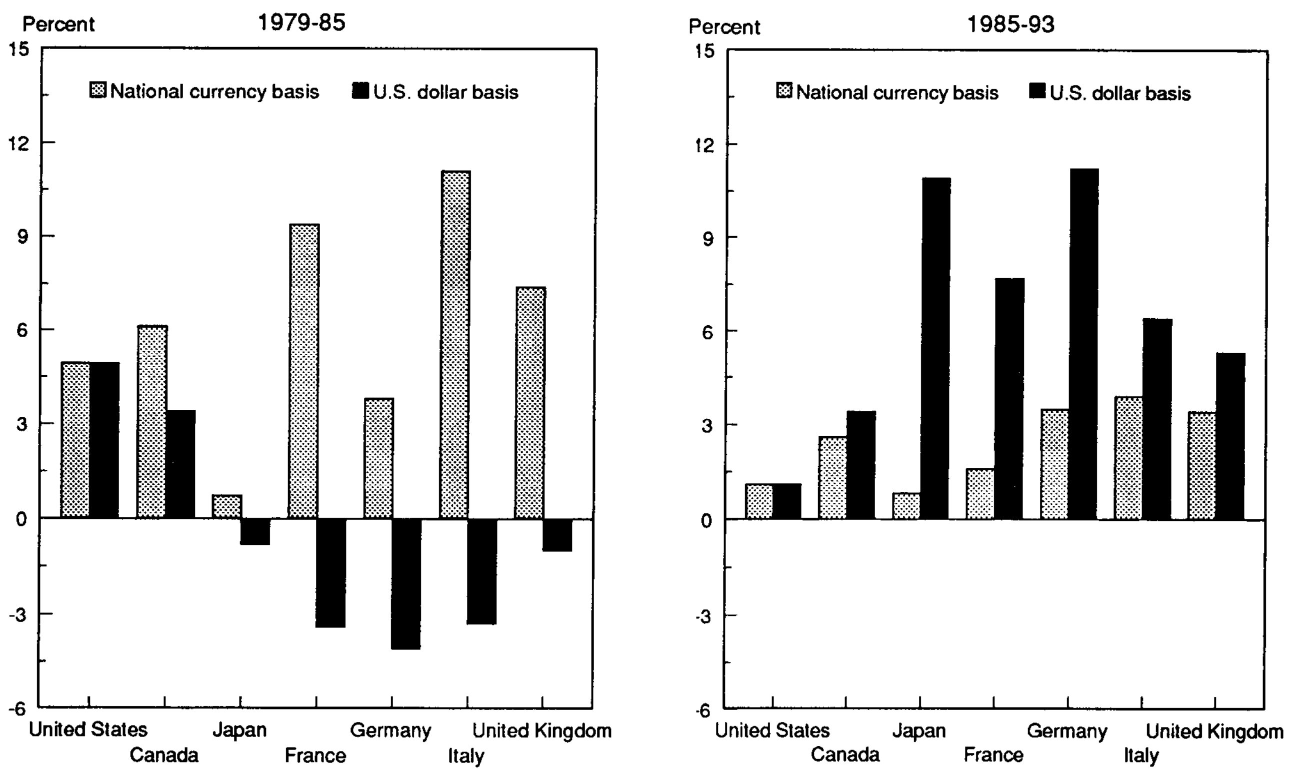
Table 1 shows growth rates for productivity (output per hour), unit labor costs, and hourly compensation of labor for the United States and 11 of its major trading partners for the period 1979–93; international comparisons of these data are not available prior to 1977. The year 1979 is chosen as the initial year because it represents an output peak for the United States. With the exceptions of Japan and the United Kingdom, the countries listed in the table experienced peaks in 1979 or 1980.

Let us first examine productivity growth over the period. Chart 1 shows growth in output per hour (productivity) among the countries attending the recent G–7 Conference in Naples. The U.S. figure is third from last. Japan, the United Kingdom, and Italy all had productivity growth rates higher by 50 percent or more than the U.S. rate. Thus, U.S. competitiveness based upon the productivity growth indicator alone would appear to have slipped relative to four G–7 countries.

However, growth in unit labor costs is a more comprehensive indicator of competitive position, as we have mentioned earlier. A comparison of unit labor costs tells a different story than a comparison of productivity growth. (See chart 1.) Italy had a growth rate of unit labor costs about 2-1/2 times the U.S. growth rate, and the United Kingdom's rate was almost double that of the United States. In fact, the growth rate of unit labor costs in the United States was the lowest of the G–7 countries, except for Japan's, indicating movement toward a *stronger*, rather than weaker, competitive position for the Nation.

From equation 2, it can be seen that an increase in productivity would, by itself, be reflected in a decline in unit labor costs. Increases in the price

Chart 4. **Average annual percent change in unit labor costs in manufacturing in G-7 countries, 1979-93**



of labor, on the other hand, yield unit labor cost increases. This is illustrated in chart 1, where the growth rate of unit labor costs is made up of the growth rate of the price of labor less the growth rate of labor productivity.

The information on productivity and on unit labor costs in chart 1 indicates that U.S. productivity growth was somewhat below the median, but unit labor cost growth enhanced the U.S. competitive position. The favorable growth rate of unit labor costs resulted from relatively slow growth in the price of the labor input, as measured by compensation per hour.

The growth rates of the United Kingdom's and Italy's unit labor costs are a further illustration of the relationship among unit input costs, prices, and productivity. Both of these countries had stronger productivity growth than the United States. A much more rapid growth in hourly compensation in Italy and the United Kingdom, however, overwhelmed the effects of the superior productivity performance, yielding more rapid growth rates in unit labor costs in both countries than in the United States.

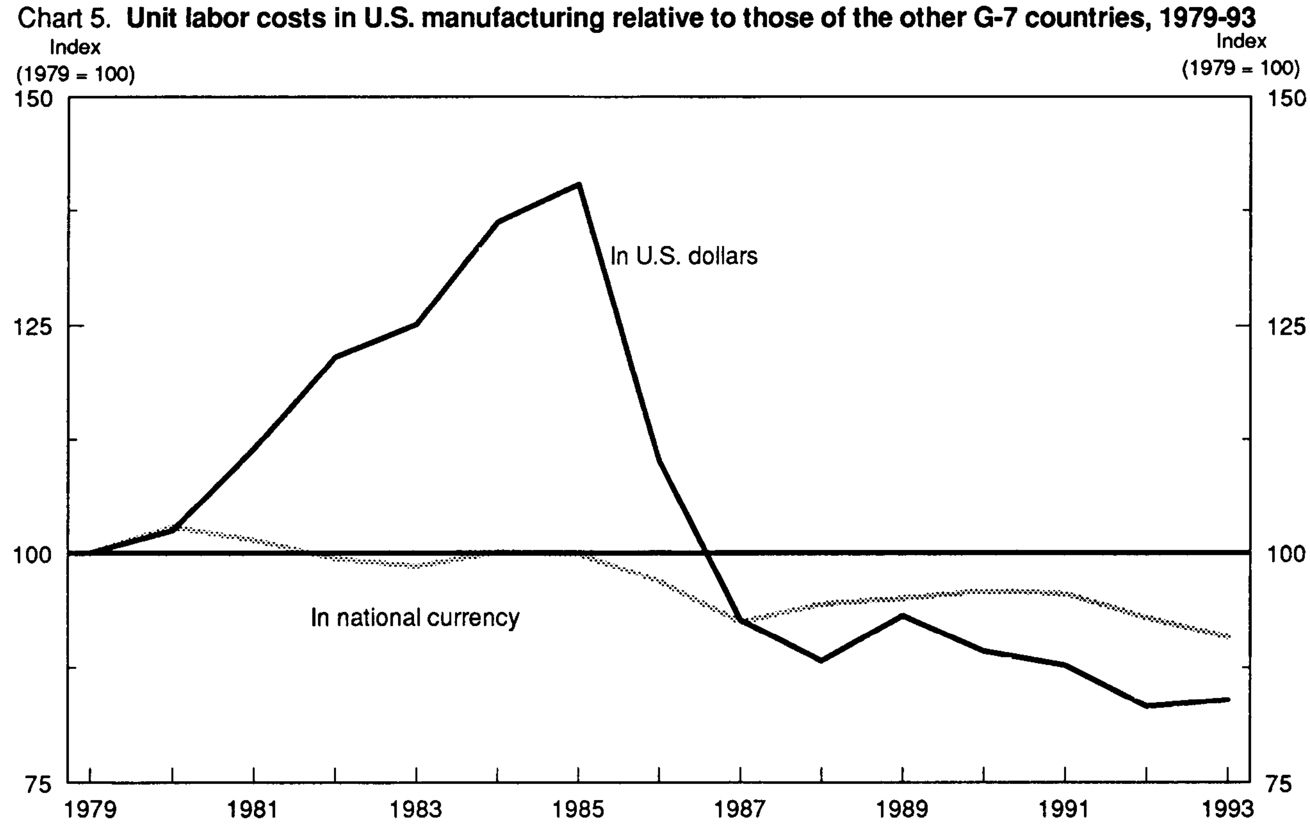
Role of exchange rates

The data presented to this point for countries' labor costs and compensation are valued in those countries' national currencies.[6] In examining trends in competitiveness, it is vital to consider changes in market exchange rates, because trends in the competitiveness of an industry's products will depend both on changes in the prices of those products and on changes in commercial exchange rates. A different story on competitiveness can emerge from adjusted and unadjusted trends in prices and unit labor costs. So these trends should be examined both in national currencies and after adjustment for changes in exchange rates.

Chart 2 shows the relationship of the other G–7 countries' currencies to the U.S. dollar over the study period. Between 1979 and 1985, the dollar appreciated relative to all of the foreign currencies. It then depreciated against all currencies except the Canadian dollar until 1988, at which point it halted its downward trend and began to moderate or level off. (It remained approximately level against the Canadian dollar from 1985 on.) However, in 1993, the yen rose 14 percent and the currencies of Europe fell substantially—particularly the pound, which was down 15 percent, and the lira, down 22 percent.

The chart also indicates the differing relationships of specific foreign currencies to the U.S. dollar. For example, before 1985, the Japanese yen and the dollar maintained a fairly constant relationship, while other countries' currencies de-

Chart 5. Unit labor costs in U.S. manufacturing relative to those of the other G-7 countries, 1979-93



NOTE: Curves represent U.S. indexes relative to trade-weighted indexes for the six other G-7 countries.

Chart 6. **Unit labor costs in U.S. manufacturing relative to those of each other G-7 country, 1979-93**

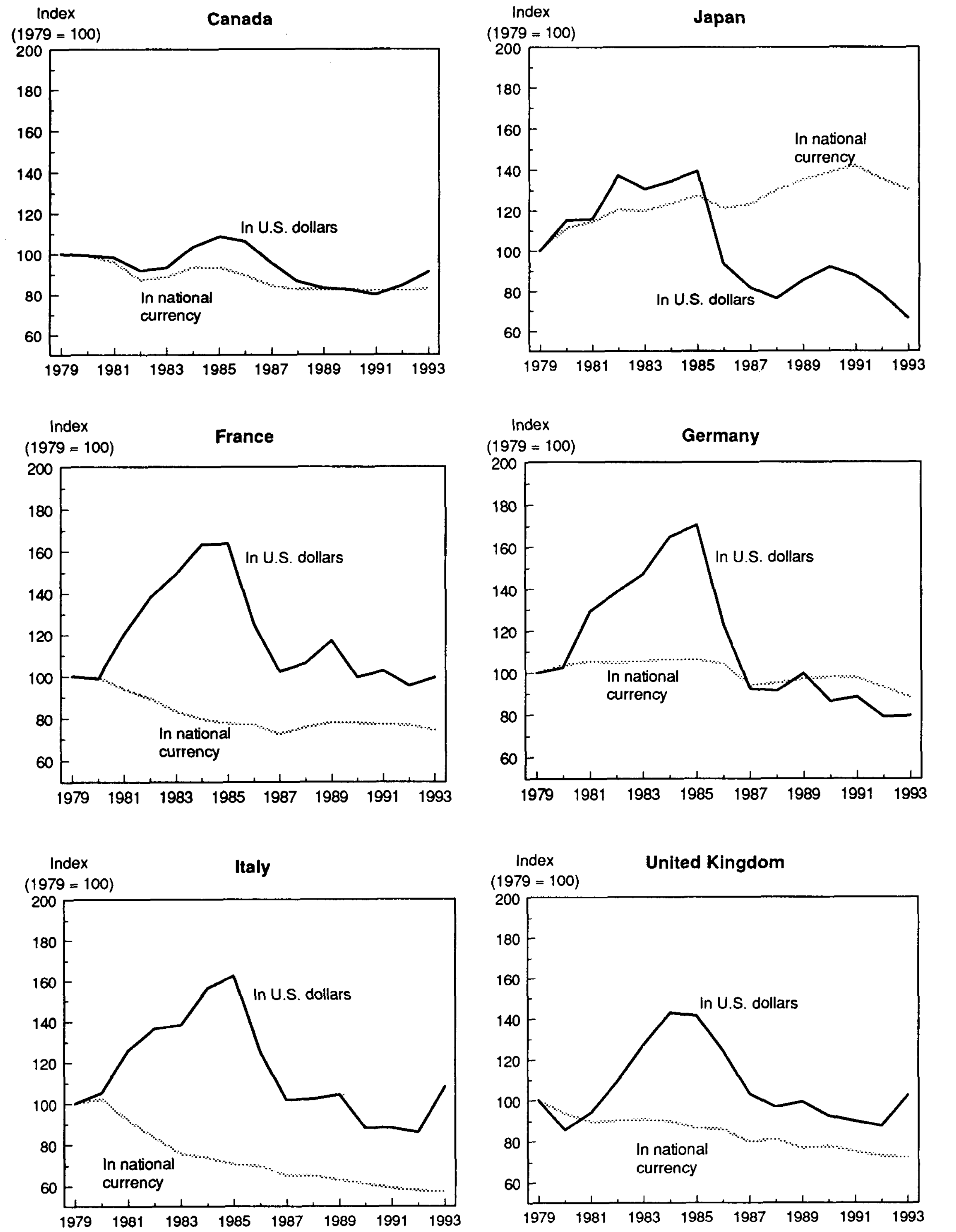
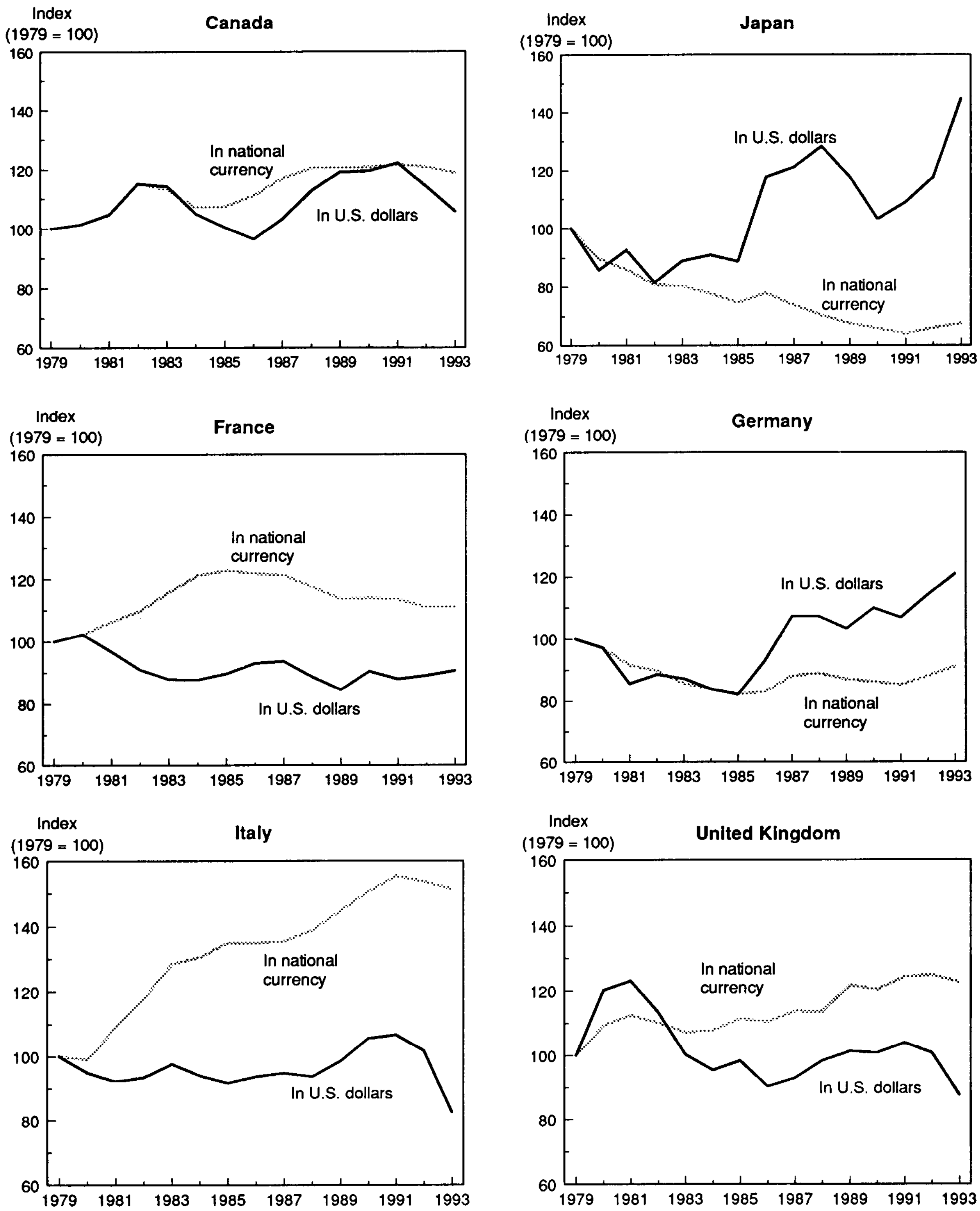


Chart 7. **Unit labor costs in manufacturing in six G-7 countries relative to those of their competitors, 1979-93**



NOTE: Curves represent a country's indexes relative to trade-weighted indexes for the other six G-7 countries.

preciated. But after 1985, the yen appreciated much more than the other currencies. Comparing 1993 with 1979, we see that Germany's and Japan's currencies appreciated relative to the U.S. dollar, while all other countries' currencies depreciated.

Using BLS data on unit labor costs that have been adjusted for these trends in exchange rates, we may make a comparison of a country's position in terms of both national currencies (see chart 3, panel 1) and U.S. dollars (see chart 3, panel 2). The United States has one of the lower unit labor cost growth rates on both a dollar basis and a national currency basis. On the other hand, Japan moves dramatically from the lowest growth rate of unit labor costs in terms of national currencies to the highest based upon a common currency, while Germany moves from third lowest to second highest. All the other countries, whose currencies depreciated between 1979 and 1993, experienced lower unit labor cost growth rates on an exchange-rate adjusted basis.

This story can be carried a step further by dividing the 1979–93 period into two subperiods: pre- and post-1985. (See chart 4.) This comparison allows us to separate the impact of the appreciation of the dollar from that of its subsequent depreciation.

Examining unit labor cost movements on a national currency basis, we see that before 1985 the United States held an advantageous competitive position relative to that of most of the other countries. (See chart 4, panel 1.) When these costs are adjusted for changes in exchange rates, however, the U.S. competitive position is seen to have eroded. Italy and France, whose currencies depreciated the most before 1985, showed the greatest growth in unit labor cost on a national currency basis, but were among the countries with the least growth on the basis of dollars. Unit labor costs in Japan changed very little on an unadjusted basis and very little also on an adjusted basis, given the relative stability of the dollar and the yen prior to 1985. After 1985, the U.S. competitive position on a national currency basis may be seen to have improved considerably when examined on an exchange-rate adjusted basis. (See chart 4, panel 2.)

The competitive position of the United States is summarized in chart 5, in which U.S. unit labor costs are related to the unit labor costs of a composite competitor. This composite is constructed by weighting the unit labor cost indexes of the competitors with trade weights reflecting the relative importance of each of the other countries to the United States as regards trade.[7] The U.S. index is then divided by the composite index, so that an increasing relative implies a decline in the U.S. competitive position. The un-

Chart 8. **Output price, input prices, and multifactor productivity in U.S. manufacturing, 1979-91**

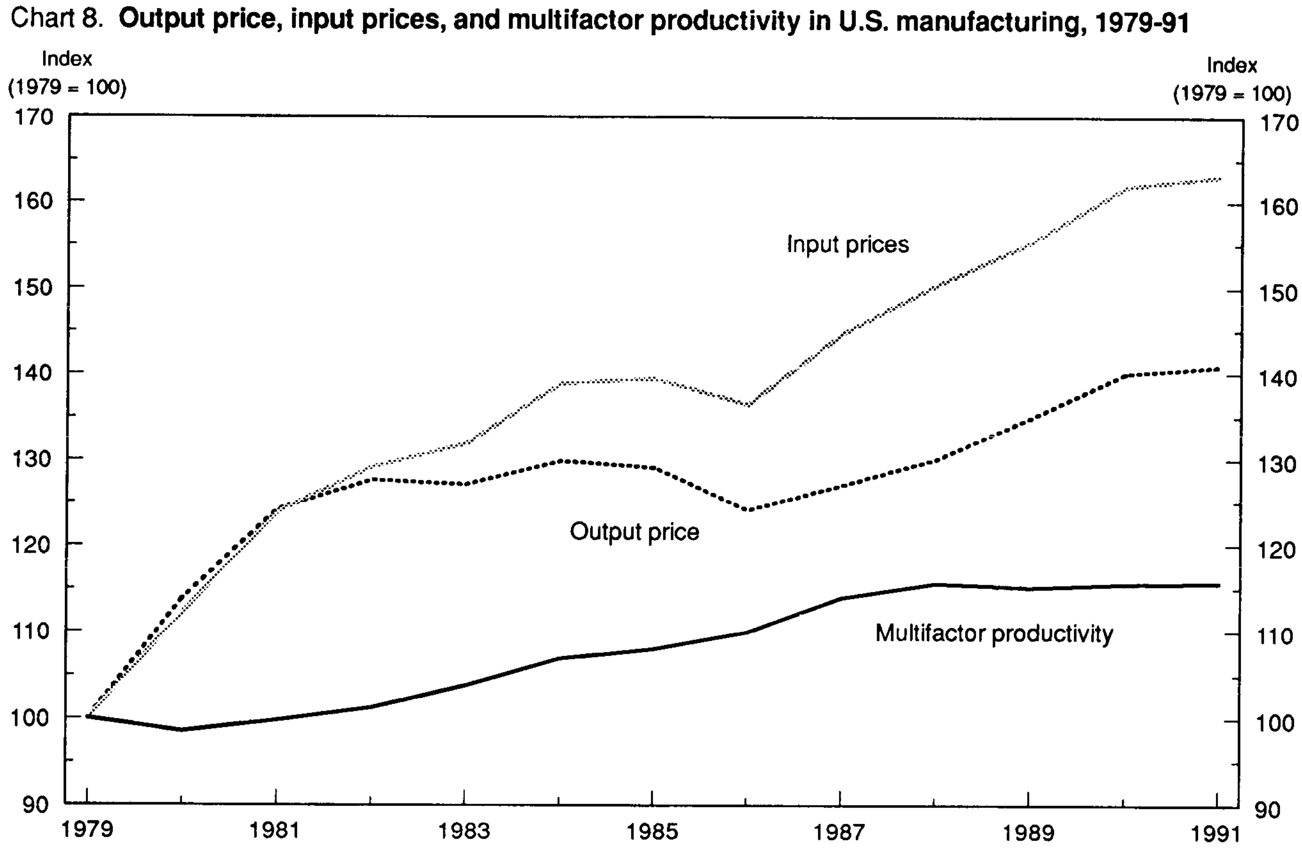
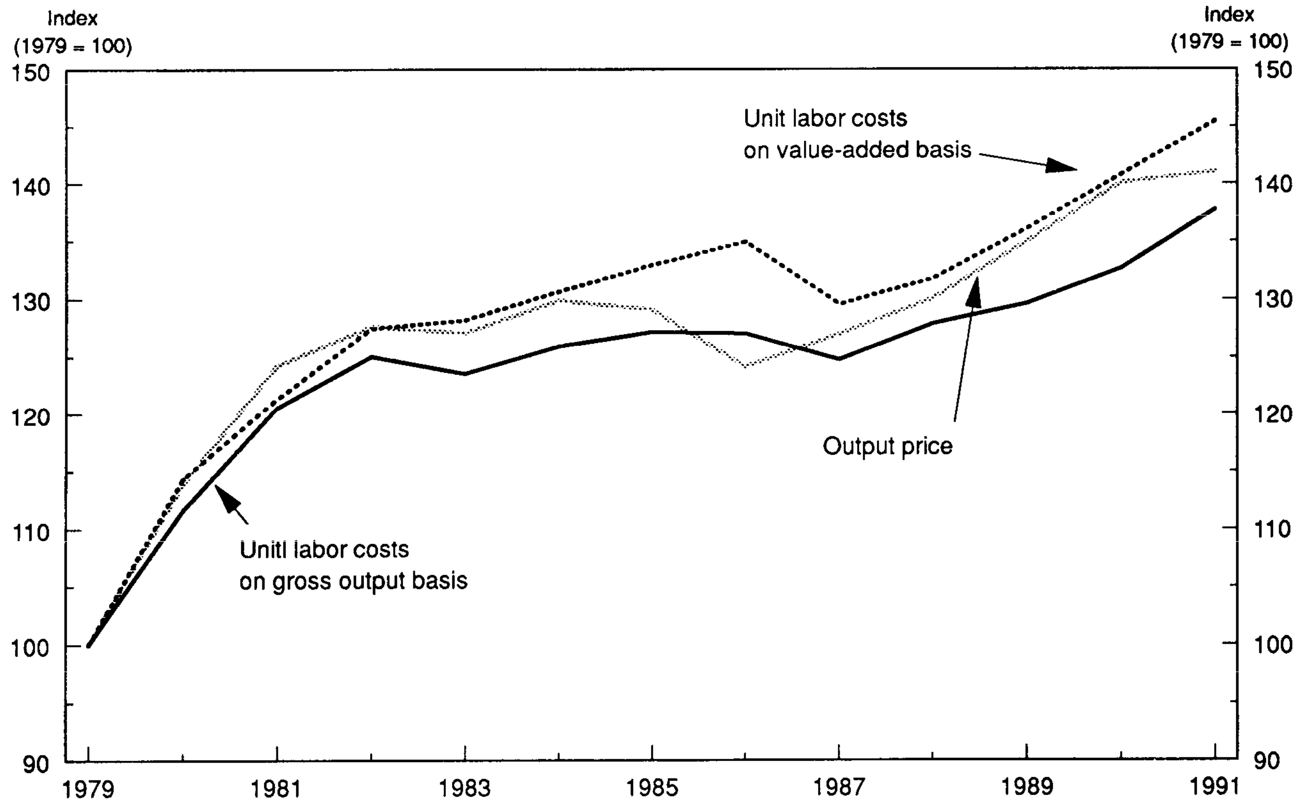


Chart 9. **Output price and unit labor costs in U.S. manufacturing, 1979-91**



derlying indexes for chart 5 are constructed on both an exchange-rate adjusted and an unadjusted basis. On a national currency basis, the United States maintained a relatively constant relationship with its competitors over the entire 1979–93 period, with a gain in competitive advantage over the second part of the period. On an exchange-rate adjusted basis, the U.S. competitive position was slipping before 1985, when it began to recover dramatically until 1987, at which time it exceeded the 1979 position.

Chart 6 shows the country-by-country relationships underlying the composite measures shown in chart 5. In general, the relationship between the United States and each of its competitors reflects the relationship with the composite competitor, but to a different degree. Roughly speaking, all of the countries mirrored chart 5 on a national currency basis, except for Japan, which continued to improve its competitive position relative to the United States in most years. For all of the countries, on an adjusted basis, the U.S. position deteriorated before 1985, as chart 2 would lead us to expect.

Chart 7 presents a comparison similar to that of chart 5 for each of the other six G–7 countries: unit labor costs in each are compared with its composite competitors' unit labor costs.

Before concluding this section, it is important to note that the data on adjusted, as well as unadjusted, unit labor costs provide information that is useful for the analysis of changes in countries' competitive positions. There are lags between orders and deliveries, and contracts may be written in either dollars or the supplier's currency. A contract may even contain adjustments to be made for currency devaluations at the time of delivery. These factors indicate why a change in an exchange rate does not necessarily result in an immediate or completely parallel change in price. But, like a domestic cost increase (or decrease), a change in an exchange rate will, with some possible delay, usually lead to a relative price change.

Multifactor productivity

The productivity figures discussed so far are for single-factor productivity—specifically, labor productivity. A labor productivity measure, however, can tell us only about the ability of an industry to keep its unit cost of a single, albeit important, input growing at a slower rate than its input price. More can be learned from a measure of multifactor productivity, which takes into account growth in all inputs.

The growth rate of multifactor productivity may be defined simply as the growth rate of output less the weighted growth rates of a combined set of inputs. A multifactor productivity measure is similar to a labor productivity measure in one critical respect: both are computed so as to compare the growth of output with the growth of input. In a labor productivity measure, the input is labor only; in a multifactor productivity measure, several inputs are considered.

A labor productivity index is computed by dividing an index of output by an index of hours. Changes in the labor productivity index reflect not only changes in the efficiency of production, but also the substitution of other inputs for labor, economies of scale, and changes in skills and effort of the work force. A multifactor productivity index reflects many of the same influences as the labor productivity measure, but the effects of substituting capital as well as other nonlabor inputs for labor are *not* reflected in it. The reason is that capital and the other nonlabor inputs are included directly in the input measure. Multifactor productivity is thus closer to a measure of overall efficiency of production than is labor productivity.

In combining inputs to develop a comprehensive measure of all of them, each input's weight reflects the value of the input in production and equals its nominal costs divided by the nominal value of output. In a value-added framework, the inputs will be capital and labor only. In a gross output framework, which will be emphasized in the remainder of this article, they are capital, labor, and all other inputs, which we will divide into the categories of energy, nonenergy materials, and services. The equation for the growth rate of multifactor productivity is

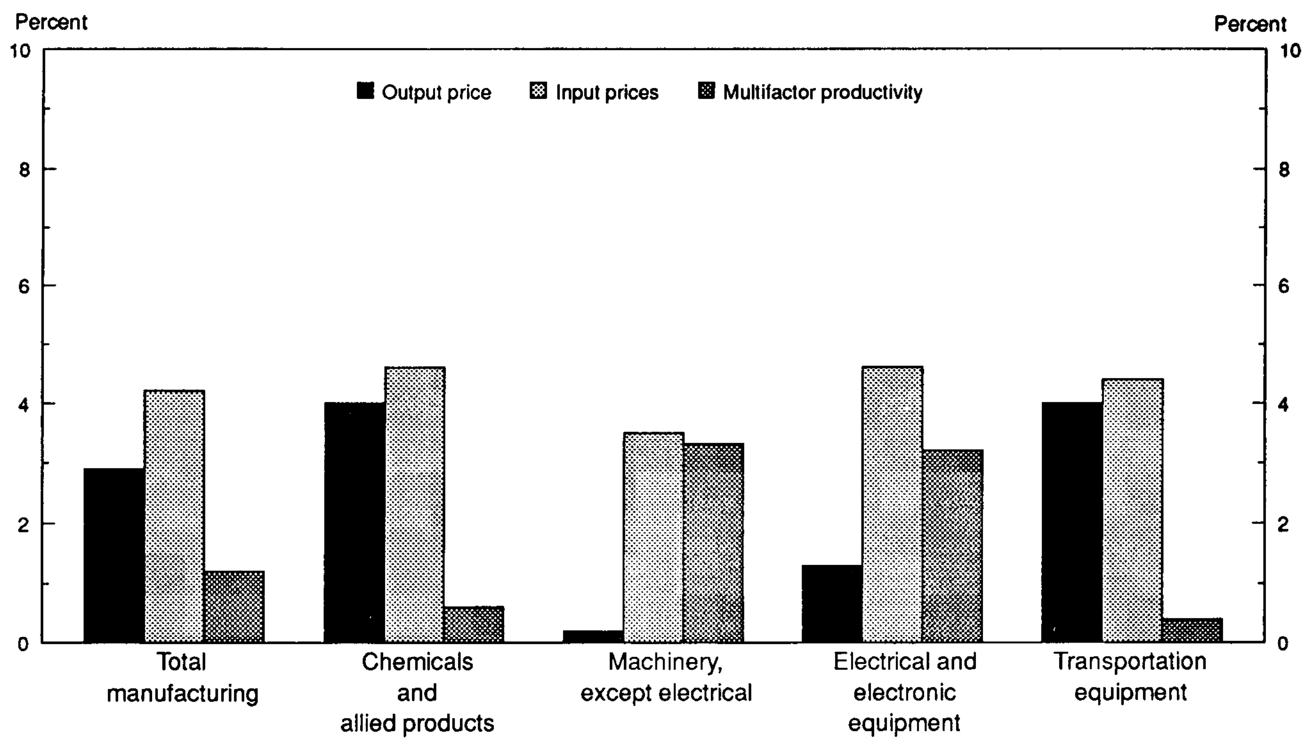
$$\frac{\dot{A}}{A} = \frac{\dot{Q}}{Q} - \sum_i w_i \frac{\dot{I}_i}{I_i}, \qquad (3)$$

where

A = multifactor productivity;
Q = real gross output;
I_i = quantity of input i (inputs include labor, capital, energy, materials, and services); and
w_i = share of input i in the value of production (equals the nominal cost of i divided by the nominal value of output).

Equation 3 is referred to as the *primal* representation of multifactor productivity. Because the right-hand side is the difference between the growth rate of output and the growth rate of a composite of all inputs, the equation represents the extent to which output may grow beyond the impact of an increased use of scarce inputs.

Chart 10. **Average annual percent change in output price, input prices, and multifactor productivity in U.S. manufacturing and four manufacturing industries, 1979-91**



NOTE: Industrial classifications are based on 1987 SIC's.

Table 2. **Average annual percent changes in input prices, multifactor productivity, and output price in U.S. manufacturing industries, 1979–91**

SIC code (1987)	Industry	Capital price	Labor price	Energy price	Non-energy materials price	Services price	Price of all inputs	Output price	Multifactor productivity
20–39	Total manufacturing	2.4	5.4	2.9	3.4	4.4	4.2	2.9	1.2
20–23, 26–31	Nondurable goods	4.0	5.6	2.6	2.1	4.3	3.6	3.3	.3
20	Food and kindred products	8.3	5.0	3.1	1.9	4.3	3.2	2.6	.6
21	Tobacco manufactures	8.2	8.2	3.6	–7.2	4.2	4.3	11.1	–6.1
22	Textile mill products	3.8	5.3	3.9	2.9	4.3	4.0	2.9	1.1
23	Apparel and related products	5.8	4.7	4.3	3.4	4.6	4.2	3.1	1.1
26	Paper and allied products	4.2	5.6	2.5	4.4	4.4	4.7	4.1	.5
27	Printing and publishing	2.7	5.2	3.9	3.6	4.4	4.2	5.4	–1.1
28	Chemicals and allied products	5.1	6.4	1.9	3.3	4.2	4.6	4.0	.6
29	Petroleum products	–4.9	4.5	.9	1.2	4.4	.9	1.1	–.2
30	Rubber and miscellaneous plastics products	5.5	5.3	3.9	5.0	4.4	5.1	3.2	1.9
31	Leather and leather products	5.1	5.1	3.4	3.2	4.5	4.3	3.4	.9
24,25, 32–39	Durable goods	.5	5.3	3.2	5.2	4.5	4.6	2.6	1.9
24	Lumber and wood products	1.2	4.8	3.7	3.9	4.5	3.8	1.9	1.9
25	Furniture and fixtures	3.1	5.8	3.4	3.6	4.5	4.4	4.1	.3
32	Stone, clay, and glass products	–3.0	5.0	2.7	4.0	4.5	3.7	3.3	.4
33	Primary metal industries	–.7	4.3	3.0	3.7	4.4	3.5	2.8	.7
34	Fabricated metal products	1.7	4.8	3.5	4.2	4.5	4.2	3.2	.9
35	Machinery, except electrical	–6.0	5.1	3.3	4.1	4.5	3.5	.2	3.3
36	Electrical and electronic equipment	1.8	5.7	3.9	4.2	4.6	4.6	1.3	3.2
37	Transportation equipment	2.2	5.4	2.7	3.7	4.5	4.4	4.0	.4
38	Instruments and related products	9.5	7.0	3.7	3.7	4.5	5.8	3.7	2.0
39	Miscellaneous manufacturing	8.9	4.6	2.5	2.8	4.4	4.4	3.6	.7

Equivalently, the multifactor productivity growth rate is the difference between the growth rate of a composite price for all inputs and the growth rate of output price. This alternative representation of multifactor productivity, known as the *dual* version, yields the same numerical result for the multifactor productivity growth rate as does the primal version. The dual version takes on a particular significance in the present highly competitive international environment: productivity growth represents the means by which a country's competitive position may be enhanced in the absence of input price reductions, the means by which the effects of input price increases may be mitigated, and the means by which payments to factors of production may rise without increasing prices.

The dual multifactor productivity measure, or the difference between the weighted growth rates of input prices and the growth rate of the price of output, is computed as

$$(4) \qquad \frac{\dot{A}}{A} = \sum_i w_i \frac{\dot{P}_i}{P_i} - \frac{\dot{P}_Q}{P_Q},$$

where

A = multifactor productivity;
P_i = price of input i;
P_Q = price of output Q; and
w_i = share of input i in the value of production.

Rearranging terms yields

$$(5) \qquad \frac{\dot{P}_Q}{P_Q} = \sum_i w_i \frac{\dot{P}_i}{P_i} - \frac{\dot{A}}{A}.$$

Equation 5 is actually an analog of equation 2,[8] which we repeat for convenience:

$$(2) \qquad \frac{\dot{ULC}}{ULC} = \frac{\dot{P}_L}{P_L} - \frac{\dot{B}}{B},$$

where

ULC = unit labor costs;
P_L = labor compensation per hour (*C/L*); and
B = output per hour (that is, labor productivity, or *Q/L*).

The right-hand sides of equations 2 and 5 both show the growth rate of an input price (or input prices) less the growth rate of labor (or multifactor) productivity. Further, the left-hand side of each represents unit input cost. For equation 2, this is unit labor costs. In the case of equation 5, the price of the output is equivalent to unit total costs, because the price of an item is made up of the payments to its factors of production (including before-tax profits), which are paid to capital.

This interesting relationship between the unit labor cost equation and the multifactor productivity dual equation indicates the additional information on competitiveness that can be drawn from multifactor measures. We are now able to look directly at the movement of output prices and then analyze the movement in terms of the prices of all inputs, as well as in terms of the changes in total resources per unit of output. Thus, it is possible to analyze trends in unit total costs or output price in a way that is analogous to the previous examination of trends in unit labor costs. These trends can also be understood in terms of input prices and productivity.

Some comparisons

The Bureau has constructed a multifactor productivity measure on a value-added basis for the private business and private nonfarm business sectors. Measures are also produced on a gross output basis for total manufacturing and 20 two-digit SIC manufacturing industries for the period 1949–91. In addition, multifactor productivity measures are produced for a number of three- and four-digit industries. Table 2 presents data from the dual equation (equation 5) for the gross output-based two-digit manufacturing measures for 1979–91.[9] These data are only half of the story needed for a complete examination of competitiveness, because the necessary foreign data are not available. However, the data can be used to illustrate the usefulness that such a complete series would have if it were available, as well as to discuss differences in individual U.S. industries' abilities to moderate the effect on output price of increases in input prices.

Trends in prices and productivity for total manufacturing are presented in chart 8. From 1979 to 1982, multifactor productivity growth was flat. This is reflected in the chart in the similar movements of output prices and input prices over the period, as indicated in the dual equation. (In the primal equation, the same result would be shown by a similar growth rate for output and combined inputs.)

After 1982, multifactor productivity rose. This is reflected in the chart in the slower growth of output price, compared with input prices, after that year. The relationship is analogous to one presented in the earlier discussion of unit labor costs: the trend in unit total costs (represented in the chart by output price) flattened out after 1982 because the upward pressure from the increased price of inputs was offset by increased multifactor productivity. If similar data were available for foreign countries, we could present the analog of chart 1 for those countries. Using data from the multifactor productivity approach, we would have a more complete indicator of competitiveness with unit total costs than we do with unit labor costs alone.

The potential of this approach can be illustrated by examining the relationship between a unit labor cost measure and a unit total cost measure. Such a comparison is given in chart 9. Unit total cost is represented by output price. (The equivalence of these two measures was discussed earlier.) Unit labor cost is shown computed in two ways: on a value-added basis and on a gross output basis. For gross output, unit labor cost equals labor compensation in nominal terms divided by real gross output. Observe that the two unit labor cost measures move in a similar manner: they both show trends broadly similar to the trend in output price, although the cost and price trends diverge in some years.

Finally, data on individual industries' multifactor productivity and price performance may be examined. Although these data do not directly indicate competitiveness, they provide a basis for examining the industries' different abilities to moderate output price increases in the face of input price increases. Chart 10 presents data on four industries, as well as on total manufacturing, for purposes of illustration. It is instructive to note that the electrical and electronic equipment industry had input price rises similar to those in the transportation equipment industry, but was better able to hold down output price increases because of a larger increase in multifactor productivity. Note, too, that the electrical and electronic equipment industry had the same productivity growth rate as the nonelectrical machinery industry (SIC 35), but a greater rate of output price growth because of a more rapid increase in input prices.

Summary

The traditional analysis of unit labor costs provides useful insights into the determinants of competitiveness. This article has shown how, in the G–7 countries, productivity and hourly labor compensation have interacted in recent years to determine the performance of unit labor costs in manufacturing. Trends in unit labor costs, in turn, may be expected to influence trends in output prices and, hence, in the competitiveness of each country's manufactured goods in export markets. The article also has shown how data on input prices and multifactor productivity can be used to analyze unit total costs or output price as indicators of competitiveness. However, it has presented only half of the story needed for a complete analysis of competitiveness using data on multifactor productivity, because data on other countries' multifactor productivity trends are not available.[10] Still, the data for the United States at least provide a basis for understanding industries' different abilities to moderate output price increases in the face of input price increases. □

Footnotes

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[1] See, for example, the studies cited in *Federal Reserve Bulletin*, May 1994, p. 367.

[2] In this article, the terms *costs* and *payments* will be used synonymously, with profits included under both concepts.

[3] The dot over a variable denotes the derivative of the variable with respect to time. Dividing that change by the variable itself yields the rate of growth of the variable. As an approximation, a dotted variable can be accepted as a representation of the annual change in that variable, and dividing the dotted variable by the variable itself represents the annual percentage change in the variable. However, when annual percentage changes are calculated, a subtractive relationship like that on the right-hand side of equation 2 will hold only approximately.

[4] See, for example, *Handbook of Methods*, Bulletin 2414 (Bureau of Labor Statistics, September 1992), chapters 10, 11, and 13; *Trends in Multifactor Productivity, 1948–81*, Bulletin 2178 (Bureau of Labor Statistics, September 1983), appendix A; and *Labor Composition and U.S. Productivity Growth, 1948–90*, Bulletin 2426 (Bureau of Labor Statistics, December 1993), appendixes A and G. These studies describe the limitations of BLS productivity measures, as well as the assumptions the Bureau makes in computing the measures.

[5] See Arthur Neef, Christopher Kask, and Christopher Sparks, "International comparisons of manufacturing unit labor costs," *Monthly Labor Review*, December 1993, pp. 47–58; and "International Comparisons of Manufacturing Productivity and Unit Labor Cost Trends, 1993," News Release USDL: 94–403 (Bureau of Labor Statistics, Aug. 17, 1994). The data used in this news release are the same as those we employ in this article.

[6] This section draws on William C. Shelton and John H. Chandler, "Technical note: international comparisons of unit labor costs: concepts and methods," *Monthly Labor Review*, May 1963, pp. 538–47. The Shelton and Chandler report contains a discussion of technical difficulties, including exchange rate adjustments, that analysts must confront when making international comparisons of unit labor costs.

[7] The weights take account of the differences in relative importance to U.S. trade in manufactured products among the six economies. They are based upon 1980 data on trade in manufactured goods and account for both bilateral trade and the relative importance of "third country" markets. The weights are: Japan, 0.30; Canada, 0.23; Germany, 0.17; United Kingdom, 0.14; France, 0.10; and Italy, 0.07.

[8] To this point, we have referred to unit labor costs in terms of value-added output; equation 5, however, is in terms of gross output. Nonetheless, it is possible to rewrite equations 2 and 5 so that they are both in value-added terms or, alternatively, both in gross output terms. The gross output concept is more relevant to discussions of international competitiveness because the price of gross output can be observed in international markets, whereas value-added price is an artificial construct.

[9] See William Gullickson, "Multifactor productivity in manufacturing industries," *Monthly Labor Review*, October 1992, pp. 20–32, for a discussion of these data through 1988.

[10] The Bureau of Labor Statistics is working to compute multifactor productivity measures for manufacturing in several countries. Work on the United States was completed some time ago. Considerable progress has been made on multifactor productivity measures for Germany and France, while work on Japanese multifactor productivity in manufacturing is at an earlier stage. Availability of the measures for the various countries will improve the data available for examining competitiveness in manufactured goods. The measures for Germany, France, and Japan are being prepared on a value-added basis, rather than the gross output basis discussed in the text.

APPENDIX: Derivation of equation 2

To derive equation 2 from equation 1, begin by rewriting equation 1 as

$$\text{(A–1)} \qquad \text{ULC} = P_L / B,$$

where

ULC = unit labor costs;
P_L = compensation per hour; and
B = output per hour.

Then take the derivative of each side with respect to time, to obtain

$$\text{(A–2)} \qquad \dot{\text{ULC}} = \frac{B\dot{P}_L - \dot{B}P_L}{B^2}.$$

Finally, divide equation A–2 by equation A–1 to get

$$\text{(A–3)} \qquad \frac{\dot{\text{ULC}}}{\text{ULC}} = \frac{B\dot{P}_L - \dot{B}P_L}{B^2} \times \frac{B}{P_L},$$

$$= \frac{\dot{P}_L}{P_L} - \frac{\dot{B}}{B}.$$