Manufacturing prices, productivity, and labor costs in five economies

The United States continues to surge ahead of other major industrial economies in terms of lower prices, higher levels of labor productivity, and better unit labor cost performance; while the depreciation of the dollar plays an important role, real productivity gains are important as well

Bart van Ark

Over the past decade, there have been significant changes in the competitive performance of the world's main industrial nations. Following a massive restructuring in many industries, U.S. manufacturing has shown a strong recovery from the slowdown in output and productivity growth that occurred during the 1970's. For manufacturing as a whole, the United States has clearly maintained its position as a leader in terms of the level of productivity during the 1980's and early 1990's. Since the mid 1980's, the U.S. export volume of manufactured products also has increased rapidly and the Nation's current account position has improved.

During the 1970's and 1980's, the Japanese share of world output increased sharply in several industries, and productivity levels in Japan rose rapidly, especially in investment goods industries. However, the Japanese economy currently faces a need for major restructuring, following a slowdown in domestic demand and a continuous appreciation of the yen. At the same time, the Japanese domestic market continues to be strongly protected against the potential exports of other nations.

The competitive performance of European countries has been diverse. During the 1980's, Germany[1] lost some of its edge in several manufacturing industries. Compared to Germany, France and the United Kingdom experienced a faster rise in productivity and a slower increase in labor cost. German manufactured exports have also grown more slowly than those of France and the United Kingdom since the mid-1980's.

In addition to the changes in competitiveness among themselves, all advanced industrial nations have experienced increasing competitive pressure from traditionally low income countries, in particular from countries in East and South East Asia and Latin America, which have made substantial progress in raising productivity levels over the past two decades.

This article discusses the 1970–93 performance of the major industrial nations in terms of four measures of competitiveness. (See table 1.) All four measures are directly related to each other. The estimates of relative price levels represent the average ratio of producer prices of each country to those of the United States, divided by the currency exchange rate. Value added per hour worked is compared by expressing the output of each country in U.S. dollars using producer price (or "unit value") ratios (UVR's). Labor compensation is compared on the basis of the exchange rate. Unit labor cost repre-

Bart van Ark is an economist with the University of Groningen, Groningen, The Netherlands. The views presented here are the author's own, and do not represent those of the Bureau of Labor Statistics.

sents the ratio of relative labor cost to the comparative productivity levels.

An overview

Table 1 shows that although the United States had substantially higher productivity levels than did Germany, Japan, France and Great Britain, the latter countries were more competitive in terms of prices and unit labor costs in 1970. Between 1970 and 1980, the relative productivity performance of 3 of these 4 "follower" countries (the United Kingdom is excluded) improved significantly. By 1980, France and Germany strongly challenged the U.S. productivity leadership position, and in some major branches such as machinery and equipment manufacturing (in both countries) and chemicals (in Germany), productivity levels were even higher than in the United States by that time.

On the other hand, relative prices and labor compensation rose rapidly in the three European countries and Japan vis-à-vis the United States during the 1970's. This was partly due to a more rapid rise in labor compensation in nominal terms, and partly to the depreciation of the U.S. dollar. As a result, the three European countries were less competitive than the United States in 1980.

Despite a slowdown in the productivity catch-up process, the appreciation of the U.S. dollar led to a shortlived return to lower prices and unit labor costs—relative to those of the United States—in the "follower" countries during the first half of the 1980's. However, between 1985 and 1990, the competitive position of these countries deteriorated again. This was particularly the case for Germany, where a very large rise in labor compensation per hour occurred. Moreover, the comparative productivity level in German manufacturing declined by 10 percentage points between 1980 and 1990.

Between 1990 and 1993, relative prices and unit labor costs in German manufacturing worsened further, but Japan experienced the most dramatic deterioration in competitiveness. Although the latter case may be largely ascribed to the appreciation of the yen, it is striking to note that in recent years the productivity gap between Japan and the United States widened as well.

Table 1. Indexes of manufacturing price levels, labor productivity, and unit labor costs, selected years, 1970–93

[U.S.=100]

Country pair and measure	1970	1975	1980	1985	1990	1993[p]
France-United States						
Relative producer price level	68.8	102.3	117.8	72.8	129.5	[1]133.9
Value added per hour worked	73.3	78.5	89.8	89.8	91.3	87.8
Labor cost per hour	48.4	86.9	110.5	69.9	117.8	111.3
Unit labor costs	66.0	110.6	123.1	77.8	129.1	126.9
Germany-United States						
Relative producer price level	65.7	96.8	113.2	70.1	132.8	[1]140.0
Value added per hour worked	78.7	87.3	95.2	90.5	85.9	82.5
Labor cost per hour	47.0	83.2	106.8	63.4	121.6	125.9
Unit labor costs	59.7	95.2	112.3	70.1	141.6	152.6
Japan-United States						
Relative producer price level	66.1	83.2	91.9	75.7	110.3	[1]121.6
Value added per hour worked	44.5	54.1	66.2	69.9	77.9	76.2
Labor cost per hour	21.4	43.0	52.1	45.8	77.5	101.3
Unit labor costs	48.1	79.5	78.6	65.5	99.5	132.9
United Kingdom-United States						
Relative producer price level	70.3	91.6	140.5	86.2	132.9	[1]132.9
Value added per hour worked	51.3	53.0	52.3	58.3	66.0	69.8
Labor cost per hour	[2]38.0	52.9	76.4	51.1	90.4	87.7
Unit labor costs	[2]75.3	99.8	146.1	87.6	137.1	125.7

[1] Data relate to 1992.

[2] Data relate to 1971.

[p] = preliminary.

NOTE: Relative price levels are defined as the average ratio of producer prices between each country and the United States, divided by the currency exchange rate.

SOURCE: See tables 4 to 7. Updated from 1990 to 1993 on the basis of information from the U.S. Bureau of Labor Statistics.

By 1993, the United Kingdom had reversed the pattern that had prevailed in 1970. At that time, its unit labor cost level was the highest of all "follower" countries, but by 1993 it was the lowest. However, the shift in the U.S. position was most extreme: in 1970, it had had higher relative price levels and unit labor costs than all of the "follower" countries, whereas its position was completely reversed by 1993.

Clearly, these shifts were dominated by the volatility of exchange rate movements since the breakdown of the Bretton Woods system of fixed exchange rates in 1971. However, the strong position of the United States in terms of costs can also be explained, in part, by the Nation's relatively slow increase in labor compensation and its continuously high level of labor productivity. Even though the manufacturing productivity gap between each country and the United States has narrowed when one looks at the period as a whole,

over the past decade, only the U.S.-Japan productivity gap narrowed substantially, while the U.K.-U.S. gap narrowed slightly.

The following sections discuss the estimates summarized above in more detail, and also present the evidence for six major branches of manufacturing. Comparisons of relative *levels* of prices, productivity, and unit labor costs are sparse in the literature, even though such measures add substantially to our knowledge on the comparative performance of nations in terms of production potential and competitive position. In particular, the estimation of productivity levels is complicated by theoretical problems concerning the concepts of output to be compared, methodological problems in valuing output in a common currency, and the lack of internationally comparable data at the industry level.

The estimates presented here are derived from the comparative analytical framework provided by the International Comparisons of Output and Productivity (ICOP) project at the University of Groningen. Although the primary purpose of ICOP is to throw light on the output and productivity performance by industry of origin,[2] it also produces unit value ratios (or "purchasing power parities" by industry) that can be compared to the exchange rates to obtain measures of relative price levels. Finally, its productivity measures are combined here with comparisons of relative labor cost per hour worked to obtain unit labor cost estimates.

Relative price levels for manufactures

Unit value ratios (UVR's), as defined here, are estimates of price relatives for manufactured goods. Specifically, they are ratios of the producers' sales value per unit of output for matched products between each country and the United States. (In other studies, such measures have been called "purchasing power parities.") Although these measures were compiled primarily to convert the value of output by industry in each nation's own currency to U.S. dollars, when compared to the official exchange rate they are themselves one of the most straightforward measures of cost competitiveness.

Developing UVR's. Unit values are obtained from each country's production census or survey for a recent benchmark year (in this study, 1987) by dividing producers' sales values by the corresponding quantities of sales. Matches are then made for as many products as possible. However, in practice, only a proportion of manufacturing products could be matched to calculate the unit value ratios. For many products, values are reported, but not quantities. In addition, for some products, there is no counterpart in the other country, for other products the information is not disclosed for confidentiality reasons, and some products could not be compared because they represent a different mix of product varieties for each country or because there are large quality differences.

For the benchmark comparison between Germany and the United States, 271 unit value ratios were derived, which represented 24.4 percent of German manufacturing shipments and 24.8 percent of U.S. manufacturing shipments. (See table 2.) Coverage was lowest for the France-U.S. comparison, which comprised 109 product matches covering 12.5 and 15.1 percent of shipments in France and the United States, respectively.

As it appeared impossible to match all products between nations, a method was required to fill the holes for the 75 to 85 percent of output that could not be covered by unit value ratios. This method, which is explained in more detail in appendix B, basically involves a stage-wise aggregation of the UVR's, using quantities (in the first stage, from product to industry level) and value added (in the subsequent stages up to branch level and total manufacturing) as weights. The original product UVR's are therefore successively reweighted according to their relative importance in the aggregate, which makes the aggregate unit value ratios less sensitive to outlier UVR's.[3]

The variation in UVR's was greatest for Japan, with food, beverages, and tobacco having the highest UVR at 320.2 Yen/U.S.$, and machinery and equipment the lowest UVR at 131.2 Yen/U.S.$. (See table 2.) This result indicates the dual nature of Japanese manufacturing. Some branches (in particular electronics and cars) are very competitive on the export market, and other branches (in particular, food) are almost entirely protected from the world market.

Table 3 shows the resulting manufacturing unit value ratios for 1987, along with market exchange rates and with expenditure purchasing power parities (PPP's) for gross domestic product (GDP) from the United Nations' International Comparisons Project. In the case of all four country pairings, the manufacturing UVR's were substantially above the exchange rates in 1987, which implies that the price level of manufactured products was higher in each of the competitor countries than in the United States. Because of the low exchange value of the U.S. dollar in 1987, none of the other countries was able to compete on favorable terms with the United States on the basis of relative prices in 1987, although in this respect the United Kingdom was in a slightly better position than Germany.

The last two columns of table 3 show expenditure purchasing power parities for total gross domestic product from the U.N. International Comparisons Project. The latter are based on relative prices of consumer goods and investment goods, as derived from estimates of gross domestic product. Expenditure PPP's are nowadays provided on a regular basis by international organizations such as EUROSTAT (the statistical office of the European Union), the Organization for Eco-

Table 2. **Number of unit value ratios (UVR's), coverage percentages, and unit value ratios at own-country and U.S. weights, by major manufacturing branch, 1987**

Country pair	Number of UVR's	Matched sales as a percentage of total sales		Unit value ratios (national currency/U.S.$)		
		Own country	United States	Own-country quantity weights	U.S. quantity weights	Geometric average
France-United States			Francs/U.S. $			
Food, beverages and tobacco	13	30.9	34.1	7.30	8.02	7.65
Textiles, apparel, and leather	25	21.4	17.4	7.76	8.72	8.23
Chemicals and allied products	13	6.3	7.3	6.93	8.51	7.68
Basic and fabricated metal products	6	11.4	6.5	7.44	7.61	7.52
Machinery and equipment	35	13.1	13.6	6.47	7.11	6.78
Other manufacturing	17	13.4	5.4	6.82	7.81	7.00
Total manufacturing	109	15.1	12.5	6.87	7.59	7.22
Germany-United States			Marks/U.S. $			
Food, beverages and tobacco	55	47.9	39.0	1.94	2.00	1.97
Textiles, apparel, and leather	59	48.5	49.8	2.66	2.82	2.74
Chemicals and allied products	26	13.6	30.5	2.40	2.51	2.45
Basic and fabricated metal products	31	46.5	23.9	2.16	2.25	2.20
Machinery and equipment	61	24.9	18.7	2.08	2.04	2.06
Other manufacuring	39	19.8	17.0	2.16	2.35	2.25
Total manufacturing	271	24.4	24.8	2.16	2.25	2.21
Japan-United States			Yen/U.S. $			
Food, beverages, and tobacco	20	19.0	17.9	332.6	308.3	320.2
With double deflation[1]	—	—	—	251.0	234.9	242.8
Textiles, apparel, and leather	27	25.1	34.2	181.9	184.7	183.3
Chemicals and allied products	43	20.7	31.9	173.8	217.6	194.4
Basic and fabricated metal products	34	24.9	22.9	164.4	193.7	178.4
Machinery and equipment	45	17.1	16.1	108.7	158.4	131.2
Other manufacturing	21	15.9	11.3	196.4	237.4	215.9
Total manufacturing	190	19.1	19.9 1	150.7	212.2	178.8
With double deflation for food[1]	—	—	—	148.5	202.9	173.6

nomic Cooperation and Development (OECD), and the United Nations.

Some analysts have used these PPP's for comparisons of relative prices at the industry level.[4] This obviously creates biases if relative prices at the industry level differ from those at the level of total GDP. Table 3 shows two variants of the PPP's, from the 1985 and 1990 benchmark studies by the International Comparisons Project; both estimates have been extrapolated to 1987 using national GDP deflators.

The two variants show surprisingly large differences.[5] With respect to the base 1985 variant, the relative price levels in manufacturing (UVR's) are lower than the expenditure price levels (PPP's), vis-à-vis the United States for France, Germany, and Japan, but not for the United Kingdom. However, a comparison of the manufacturing UVR's with the base-1990 variant of the PPP's suggests that France and Germany also have lower expenditure price levels than manufacturing price levels compared to the United States, though not by as much as the United Kingdom. This last observation could imply that, in the European countries, price levels in manufacturing are relatively high compared to those in services, whereas in Japan they are relatively low. Alternatively, it could also be that distribution or transport margins (which are included in the PPP estimates and not in the manufacturing UVR's) are lower in the European countries than in the United States and Japan or that the European prices of intermediate goods (which are included in the manufacturing UVR and not in the PPP) are relatively high.

Other authors have constructed "proxy PPP's" by selecting PPP's for certain expenditure items which were then allocated to industries.[6] Here the problem remains that cross-country differences in transport and distribution margins and net indirect taxes may affect the estimates, and that the prices of imported products are reflected in the expenditure PPP's, whereas the prices of exported products are excluded. D.W. Jorgenson and M. Kuroda came a step closer to measuring relative prices on an industry basis by "peeling off" indirect taxes and trade and transportation margins from the expenditure PPP's.[7] All these adjustments seem an improvement over the use of unadjusted expenditure PPP's, but they also make the PPP's increasingly sensitive to the procedures used and the quality of the data. However, the most fundamental problem of using PPP's from the International Comparisons Project for the purpose of industry comparisons is that those PPP's exclude price measures for intermediate products (iron and steel, cement, pulp and paper and most kinds of semimanufactured goods), which account for a substantial part of manufacturing output.

Therefore, neither expenditure PPP's for total gross domestic product nor proxy PPP's are a good alternative to the UVR's in international comparisons of productivity. What is most needed are more detailed and comparable data on quantities and prices of products to refine the UVR's, which take account of cross-country differences in product mix and product quality. However, at the relatively aggregate level of the six major manufacturing branches, the results presented here are not so much affected by such factors.[8]

Covering the entire period. As a next step, the UVR's for 1987 have been extrapolated to other years, through the use of price deflators derived from each country's national accounts. Chart 1 shows the relation between the manufacturing UVR and the exchange rate for the period 1970 to 1990. If a country's manufacturing UVR is below the prevailing exchange rate, its relative price level in manufacturing is lower than that of the United States, implying that it can compete on favorable terms with the United States in the world market.

The chart shows that, following the collapse of the Bretton Woods system of fixed exchange rates in 1971, the French franc, the German mark, and the Japanese yen all appreciated against the dollar, with the result that the relatively low price levels of all countries compared to the United States were largely eroded by 1975. By 1980, only Japan still enjoyed lower price levels than the United States. Between 1975 and 1980, the United Kingdom showed a strong rise in relative price levels. The "high dollar" period, from 1980 to 1985, meant a short-lived return to low price levels for all of the competitor countries, but since 1985, their price levels have again risen rapidly and the competitiveness of the United States, so far as relative prices are concerned, has increased substantially.

Developments by industry branch. Table 4 shows relative price levels for six major manufacturing branches.[9] The appreciation of the franc, the mark, and the yen during the early 1970's led to a rise in manufacturing price levels in all major branches in France, Germany, and Japan compared to the United States. In France and Germany, the increase was rather rapid for food, beverages, and tobacco products, and for textiles, wearing apparel, and leather goods, but was slower for basic metals and metal products.

By 1980, France and the United Kingdom had lost their price advantage over the United States in all major branches, and Germany still enjoyed a small advantage in only one branch, machinery and equipment.[10] In the United Kingdom, relative price levels were very high for food, beverages, and tobacco and for "other manufacturing."

In 1980, only Japan still had lower price levels than the United States, especially for machinery and equipment. That branch even showed a slight decline in price level between 1975 and 1980 despite the appreciation of the yen. In contrast, relative prices of food, beverages, and tobacco products increased rapidly between 1970 and 1980. After 1980, there was even more diversity in Japanese price levels by branch. By 1990, the Japanese price level for food products, beverages, and tobacco was about 85 percent above the U.S. level, whereas that for machinery and equipment was 15 percentage points below the U.S. level.

The diversity in relative price levels in France and Germany was much less than in Japan. In 1990, all manufactur-

Table 2. Continued—Number of unit value ratios (UVR's), coverage percentages, and unit value ratios at own-country and U.S. weights, by major manufacturing branch, 1987

Country pair	Number of UVR's	Matched sales as a percentage of total sales		Unit value ratios (national currency/U.S.$)		
		Own country	United States	Own-country quantity weights	U.S. quantity weights	Geometric average
United Kingdom-United States	Pounds sterling/U.S. $					
Food, beverages, and tobacco	31	24.4	21.3	0.679	0.771	0.723
Textiles, apparel, and leather	54	40.2	50.3	.670	.677	.673
Chemicals and allied products	41	22.5	29.2	.587	.641	.613
Basic and fabricated metal products	8	21.4	12.4	.661	.677	.669
Machinery and equipment	20	9.3	13.6	.642	.649	.646
Other manufacturing	22	11.5	7.5	.809	.956	.880
Total manufacturing	176	17.6	18.1	.670	.748	.708

[1] Double deflation for food products was calculated by applying a UVR for agricultural inputs for 1985 derived from Prasada Rao, "International Comparisons of Agricultural Output and Productivity," FAO Economic and Social Development Paper no. 112 (Rome, FAO, 1993), extrapolated to 1987.

NOTE: See original sources for details at level of 14 to 16 branches.

SOURCES: See appendix a; B. van Ark and R.D.J. Kouwenhoven, "Productivity in French Manufacturing: An International Comparative Perspective," Research Memorandum GD-10 (Groningen, The Netherlands, Groningen Growth and Development Center, 1994) for France and the United States; B. van Ark and D. Pilat, "Productivity Levels in Germany, Japan, and the United States: Differences and Causes," *Brookings Papers on Economic Activity: Microeconomics 2*, December 1993, for Germany-United States (table A.1) and Japan-United States (table A.2); and B. van Ark, "Comparative Productivity in British and American Manufacturing," *National Institute Economic Review*, November 1992, for the United Kingdom-United States.

Table 3. **Unit value ratios (UVR's) for manufacturing, exchange rates, and gross domestic product-based purchasing power parities (PPP's), 1987**

Country	Unit value ratio	Exchange rate	Relative price level (United States = 100)	GDP purchasing power parities	
				1985-base	1990-base
France	7.22	6.01	120	7.68	6.78
Germany	2.21	1.80	123	2.57	2.15
Japan	178.8	144.64	124	235.71	213.83
United Kingdom	.708	.612	116	.604	.567

[1] Ratio of UVR to exchange rate.

NOTE: UVR's and gross domestic product-based PPP's are geometric averages of UVR's and PPP's weighted at national and U.S. weights.

SOURCE: For UVR's, see table 2. PPP's for 1985 and 1990 were provided by Eurostat and extrapolated to 1987 using gross domestic product deflators from Organization for Economic Cooperation and Development, *National Accounts 1960-1991, Main Aggregates, Volume I* (Paris, OECD, 1992).

ing branches in these two countries had relatively high price levels (15 to 35 percent above the U.S. level), with the exception of the textiles, wearing apparel, and leather products branch, which showed even higher relative price levels. In the United Kingdom, relative price levels in 1990 were high in other manufacturing (which includes wood and paper products and nonmetallic mineral products), but rather low in basic and fabricated metal products and even slightly below the United States' level in chemicals.

It may be concluded that, in terms of price competitiveness, the United States has improved its performance over the past two decades, especially in light industries such as food, beverages, and tobacco products and textiles, wearing apparel, and leather products. However, this U.S. price advantage is to a large extent due to the depreciation of the U.S. dollar during the 1970's and second half of the 1980's, and not simply to a more moderate rise in costs in terms of national prices. Against the tide of an appreciating currency, only Japan has been able to keep its price levels, in particular for machinery and equipment, relatively low into the late 1980's.

Comparing productivity levels

Productivity is one of the most important determinants of competitiveness. Productivity (especially labor productivity) improvements are a necessary prerequisite for producing high quality products at a reasonable cost. Productivity growth indicates how a company, an industry, or a country manages to raise output with a minimum increase in inputs. Comparisons of productivity levels show how much the average practice within an industry, within a sector, or for the economy as a whole differs between countries. If the "numéraire" country is the world productivity leader, such comparisons indicate how much each country differs from best practice.

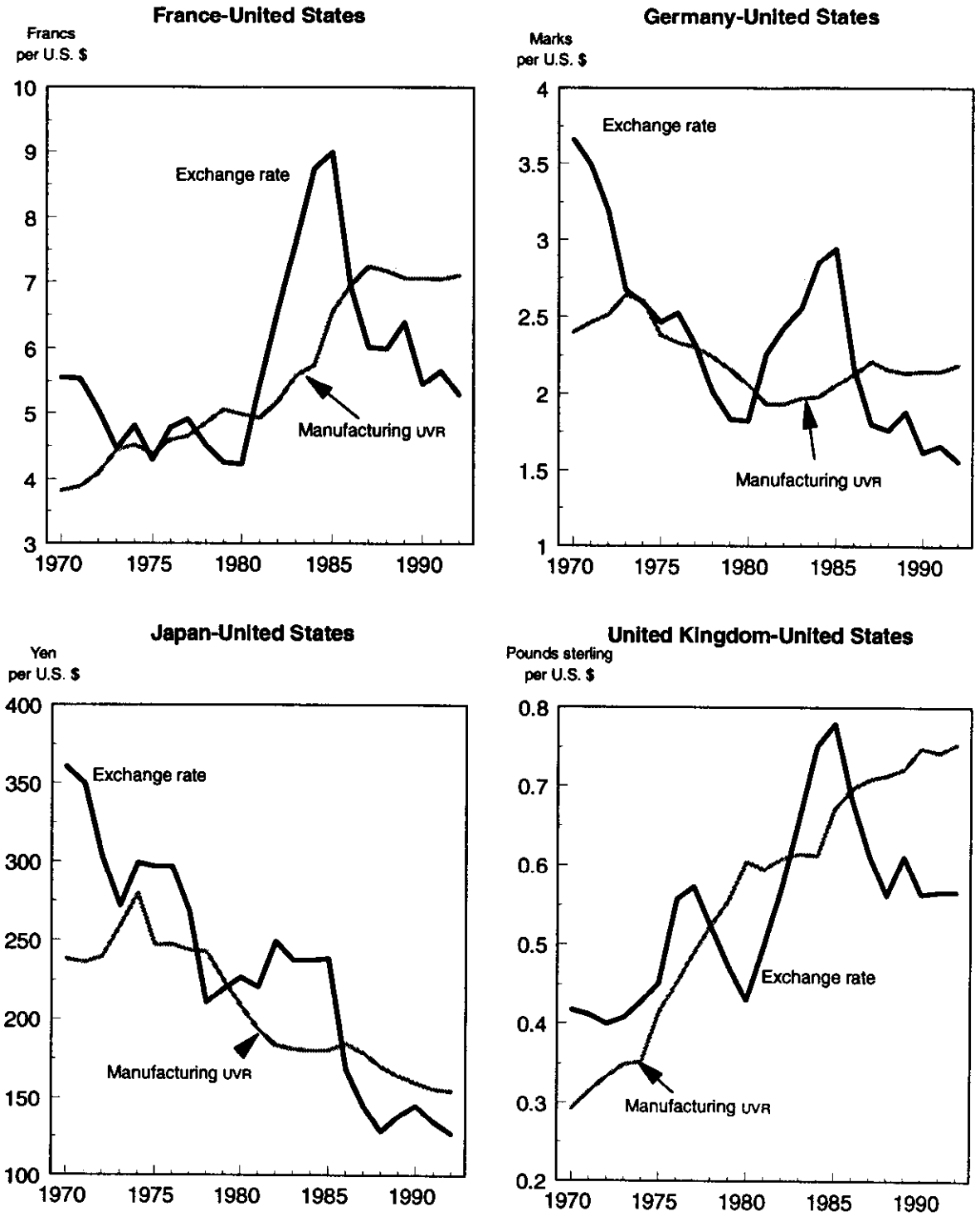
The methodology in brief. The adequate comparison of productivity levels between countries depends on two components, namely reliable and comparable indicators of output and labor input for each country, and a suitable conversion factor to translate output values to a common currency unit. The exchange rate is not suitable for the latter purpose, because it is heavily influenced by capital flows and speculation and, in general, does not indicate real price differences between countries. Therefore, the unit value ratios discussed in the previous section have been used here.

The basic data for the comparisons of manufacturing productivity in this article are derived from the manufacturing census of each of the countries. Accordingly, estimates of output and labor input are derived from one and the same survey of manufacturing establishments, which implies a relatively consistent data framework. Although production censuses and surveys are not as well harmonized across countries as, for example, national accounts, the detail in these sources is such that one can obtain data according to the same concepts of employment and value added and the same classification scheme of industries across the countries.

The industry UVR's discussed in the previous section may be used to convert either gross output or value added to a common currency, after which labor productivity comparisons can be made. It has been suggested that the use of value added as the productivity concept in combination with unit value ratios based on gross output complicates the connection between productivity and competitiveness.[11] Indeed, at the industry level there are important theoretical advantages to measuring productivity using gross output and treating intermediate inputs symmetrically with capital and labor inputs.

However, at the relatively aggregate level of this analysis, value added is a more useful measure because it avoids double counting of the value of intermediate inputs. If estimates were derived from gross output measures by industry, aggregation would then require separate deflation of gross output and intermediate inputs. In practice, this procedure easily leads to volatile results because of important measurement problems.[12] In particular, when intermediate inputs make up a large part of gross output, small measurement errors tend to become magnified in the double-deflated value added measures. The measures used here are therefore based on the "adjusted single deflation method," through which value added at national prices is converted to a common currency on the basis of gross output unit value ratios. This approach provides more robust results than the double-deflation method.[13]

Chart 1 **Manufacturing unit value ratios (UVR's) and currency exchange rates, 1970–92**



SOURCES: Manufacturing UVR's for 1987 are from table 2, extrapolated using national accounts deflators for manufacturing. (See appendix A.) Exchange rates are from Organization for Economic Cooperation and Development, *National Accounts, Vol. 1* (Paris, OECD, 1992).

The relative productivity estimates were benchmarked on 1987, and extrapolated using national time series of output and labor input that are derived primarily from national accounts for the period 1970 to 1990. Table 5 shows the productivity estimates for the six major branches in selected years relative to the United States. For an adequate analysis, one also needs to take account of the relative growth performance of each country. Chart 2 presents the same estimates in terms of value added per hour worked in 1987 U.S. dollars.

International developments. Between 1970 and 1980, France, Germany, and Japan strongly converged towards U.S. productivity levels, which in fact was a continuation of a process that had begun during the 1950's.[14] By 1980, France and Germany had higher productivity levels than the United States in the manufacture of machinery and equipment, and Germany was also ahead in chemicals and allied products. During the 1970's, almost no convergence took place in the United Kingdom, and in some major branches (particularly textiles, basic metals and metal products, and machinery and equipment) quite some divergence occurred.

During the first half of the 1980's, the trend by which France was "catching-up" with the United States stagnated, and the manufacturing productivity of Germany and the United States even began to diverge. These developments were related in part to the acceleration of productivity growth in the United States during this period; in addition, Germany suffered a substantial slowdown in productivity growth during the 1980's.[15] Germany's deterioration in comparative terms was seen especially in chemicals and allied products and in machinery and equipment. By 1990, German productivity levels, relative to those of the United States, in these two major branches were below those of 1970. In comparison to France, Germany had substantially lower productivity levels in 1990 in the chemicals, machinery and equipment, and "other manufacturing" branches, whereas it was more or less at par with France in food, beverages, and tobacco products and in textiles, wearing apparel, and leather products.

Japan continued to "catch up" to U.S. productivity levels during the 1980's, although at a rate slower than during the 1970's. As a result, Japan was much closer to German and French productivity levels in 1990 than in 1980. However, there is a wide spread in productivity levels by manufacturing branch in Japan. In machinery and equipment, Japan surpassed U.S. productivity performance during the late 1980's, and in basic metals and metal products, Japan stood roughly at par with the United States. The performance in food, beverages, and tobacco, and in textiles, apparel, and leather has been especially poor compared to that in machinery and equipment. The performance of the food sector

Table 4. Relative producer price levels by major manufacturing branch, selected years, 1970–90

[United States = 100]

Country pair	1970	1975	1980	1985	1990
France-United States					
Food, beverages, and tobacco	70.4	106.7	159.2	86.8	127.2
Textiles, apparel, and leather	60.0	107.6	140.1	82.0	148.2
Chemicals and allied products	70.6	97.1	114.1	73.4	114.5
Basic and fabricated metal products	94.7	112.1	119.0	76.2	128.7
Machinery and equipment	59.0	92.6	101.8	67.6	136.4
Other manufacturing	73.3	119.1	126.8	70.2	128.7
Total manufacturing	68.8	102.3	117.8	72.8	129.5
Germany-United States					
Food, beverages, and tobacco	60.4	86.9	118.0	63.2	116.7
Textiles, apparel, and leather	77.1	122.2	150.9	86.8	168.3
Chemicals and allied products	70.4	104.8	120.5	77.8	131.3
Basic and fabricated metal products	83.0	98.0	110.3	68.9	125.1
Machinery and equipment	50.2	81.9	95.3	64.1	132.7
Other manufacturing	78.2	115.1	130.4	74.0	137.9
Total manufacturing	65.7	96.8	113.2	70.1	132.8
Japan-United States					
Food, beverages, and tobacco	62.6	81.0	135.5	124.3	184.6
Textiles, apparel, and leather	51.5	73.5	89.8	76.1	128.7
Chemicals and allied products	67.5	70.7	90.9	72.3	110.4
Basic and fabricated metal products	86.7	89.0	96.4	74.7	114.5
Machinery and equipment	65.8	84.9	72.3	60.6	84.8
Other manufacturing	73.5	113.5	118.3	90.5	138.2
Total manufacturing	66.1	83.2	91.9	75.7	110.3
United Kingdom-United States					
Food, beverages, and tobacco	—	—	168.5	91.1	132.5
Textiles, apparel, and leather	—	—	139.7	80.2	137.0
Chemicals and allied products	—	—	112.1	72.7	97.0
Basic and fabricated metal products	—	—	139.2	79.2	118.6
Machinery and equipment	—	—	119.2	77.9	130.8
Other manufacturing	—	—	185.2	111.8	163.7
Total manufacturing	70.3	91.6	140.5	86.2	132.9

NOTE: Relative price levels are defined as the average ratio of producer prices between each country and the United States, divided by the exchange rate.

SOURCE: Based on 1987 benchmark UVR's from table 2, extrapolated using national accounts deflators for manufacturing (appendix A). Exchange rates are from Organization for Economic Cooperation and Development, *National Accounts*.

seems related in part to the small scale of its firms, but probably also reflects a lack of competition.[16]

In contrast to its performance during the 1970's, the United Kingdom showed remarkable improvement in productivity during the 1980's. In comparison to the United States, U.K. productivity levels rose especially rapidly in food, beverages, and tobacco products and in chemicals and allied products (particularly during the second half of the 1980's) and in textiles, wearing apparel, and leather products and in basic metals and metal products (particularly during the first half of the decade). By 1990, the U.K. productivity performance in chemicals and allied products was even better than that of France, Germany, and Japan, although for the manufacturing sector as a whole, it still lagged substantially behind that of the other three countries.

In summary, in terms of productivity performance, the United States has been the best performer throughout the period, although it faced increasing challenges from France and Germany before 1980 and from Japan thereafter. Presently, leadership in manufacturing productivity is shared between Japan and the United States, a situation that is likely to last for some time given the large differences in the comparative productivity performance among the major manufacturing branches and the slight widening of the U.S.-Japanese productivity gap in recent years. Although France and Germany are closer to the U.S. productivity level than is Japan, there are no industry branches in which they clearly lead, although the French performance in machinery and equipment and the German performance in basic and fabricated metal products was relatively good in 1990.

Labor compensation and unit labor costs

The estimates of manufacturing UVR's and productivity levels presented earlier provide an opportunity to look at two other indicators of competitiveness, namely hourly labor costs and unit labor costs. Because labor costs are the largest part of value added in advanced countries, unit labor costs serve as an important indicator of economic health. The U.S. Bureau of Labor Statistics regularly publishes trend estimates of manufacturing unit labor costs.[17]

For the calculations of comparative levels of unit labor costs, labor costs per hour derived from each country's national accounts were combined with the estimates of value added per hour presented above. The labor costs refer to total compensation, that is, wages and salaries before tax, employer's social security contributions, contributions to pension, insurance, and health plans, and other expenses related to employment. These figures are more comprehensive than the labor cost estimates shown in the manufacturing censuses, which often exclude at least part of employers' contributions to compensation of labor.

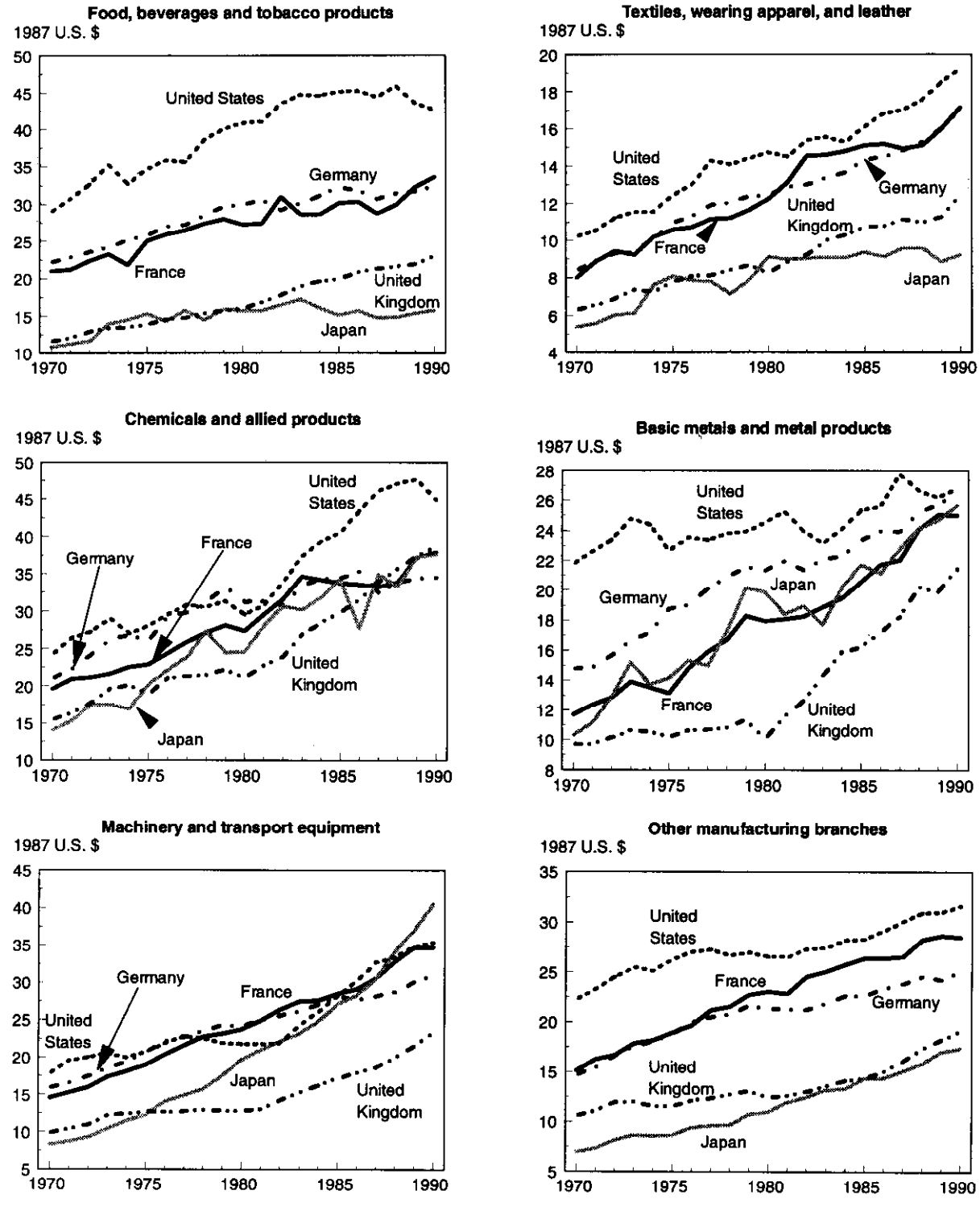
Table 5. Value added per hour worked in manufacturing, by major manufacturing branch, selected years, 1970–90

[United States = 100]

Country pair	1970	1975	1980	1985	1990
France-United States					
Food, beverages, and tobacco	72.3	72.2	66.7	66.9	78.8
Textiles, apparel, and leather	78.2	85.2	83.2	93.7	89.0
Chemicals and allied products	81.1	81.6	92.4	83.3	84.4
Basic and fabricated metal products	53.7	58.1	73.2	80.9	93.2
Machinery and equipment	81.8	91.6	108.8	101.0	98.0
Other manufacturing	67.9	72.0	86.6	93.3	90.1
Total manufacturing	73.3	78.5	89.8	89.8	91.3
Germany-United States					
Food, beverages, and tobacco	76.5	74.4	73.3	71.6	75.8
Textiles, apparel, and leather	82.9	88.0	84.5	89.0	88.2
Chemicals and allied products	86.7	92.8	105.6	84.9	76.7
Basic and fabricated metal products	67.7	82.9	86.9	92.0	98.8
Machinery and equipment	89.9	99.6	110.8	99.7	87.6
Other manufacturing	66.0	71.5	80.3	79.9	79.3
Total manufacturing	78.7	87.3	95.2	90.5	85.9
Japan-United States					
Food, beverages, and tobacco	37.4	44.2	38.5	33.5	37.0
Textiles, apparel, and leather	52.6	65.1	61.9	58.1	48.0
Chemicals and allied products	58.0	71.9	83.1	84.4	83.8
Basic and fabricated metal products	47.2	62.5	81.1	85.6	95.6
Machinery and equipment	46.8	59.2	90.0	96.2	114.4
Other manufacturing	31.3	33.0	41.3	50.6	54.9
Total manufacturing	44.5	54.1	66.2	69.9	77.9
United Kingdom-United States					
Food, beverages, and tobacco	40.0	40.1	39.2	44.2	53.8
Textiles, apparel, and leather	61.7	62.7	56.0	66.7	64.8
Chemicals and allied products	63.8	67.5	71.3	73.7	86.1
Basic and fabricated metal products	44.5	44.9	40.9	64.0	79.9
Machinery and equipment	55.3	61.4	58.6	60.8	65.8
Other manufacturing	47.4	43.8	46.6	50.5	60.4
Total manufacturing	51.3	53.0	52.3	58.3	66.0

SOURCE: See appendix A; and sources cited in table 2.

Chart 2. **Value added per hour worked in manufacturing by major manufacturing branch, in 1987 dollars, 1970–90**



SOURCE: Table 5.

Table 6 shows labor costs per hour worked of all employees by major branch of manufacturing. The figures are converted from national currency values to a common currency using the average exchange rate for each year. The trends in comparative labor costs are therefore determined not only by changes in labor costs in national currency values, but also by exchange rate fluctuations.[18]

Between 1970 and 1980, labor costs per hour worked more than doubled relative to those of the United States for all four competitor countries. In 1980, relative labor costs in French and German manufacturing were approximately 10 percent above the U.S. level; in the United Kingdom, they were about three-quarters of the U.S. level; and in Japan, about half. Following the appreciation of the dollar during the early 1980's, relative labor costs in all four countries were significantly reduced, although much more so in the European countries than in Japan. During the second half of the 1980's, the relative labor cost level rose most rapidly in Germany, driven by the rapid appreciation of the mark. As a result, Germany had the highest relative labor costs of all countries by 1990, followed by France, the United States, the United Kingdom, and Japan.

There is some variation in hourly labor costs across the manufacturing branches, but it is significantly less than the spread in the productivity ratios presented in table 5. In all of the European countries, labor cost levels in textiles, wearing apparel, and leather products were relatively high compared to the those of the United States. France and the United Kingdom had relatively low labor cost levels in basic and fabricated metal products and in machinery and equipment, whereas Germany had lower labor cost levels than France and the United Kingdom in food, beverages, and tobacco products. In Japan, labor cost levels were relatively high in chemicals, but otherwise were lower than in any of the other countries.

The trends in hourly labor cost are basically the same across the major branches. This is, of course, to be expected in countries where wage settlements are relatively centralized. Only in the United Kingdom were there fairly substantial differences in the trends in relative labor cost levels across the branches during the 1980's.

The relationship to productivity Unit labor costs are based on the ratio of labor costs per hour worked to productivity per hour worked. In U.S. dollars, the unit labor cost of each country X can therefore be expressed as:

$$(1) \qquad ULC^X = \frac{(LCH^X) \,/\, ER^{XU}}{(OH^X) \,/\, UVR^{XU}}$$

where ER^{XU} is the exchange rate between countries X and U; UVR^{XU} is the UVR between countries X and U; LCH^X are the labor costs per hour in country X; and OH^X is output (value added) per hour in country X.

The labor cost comparison thus is based on exchange rates, whereas that of productivity is based on unit value ratios. Unit labor costs can therefore be directly derived by dividing the estimates in table 6 by those in table 5. For each of the four competitor countries, chart 3 shows relative labor costs per hour worked, relative value added per hour worked, and unit labor costs for total manufacturing.

Although relative productivity levels in France and Germany improved significantly during the 1970's, that trend was slower than the relative increases in labor costs so that the unit labor cost position of these countries relative to that of the United States deteriorated. Because of France's lower productivity level in comparison to Germany, it was the first country to post unit labor costs in manufacturing that were higher than those of the United States. France did so in 1975, followed by Germany and the United Kingdom, in 1978. The "high dollar" period from 1980 to 1985 led to a short-lived return to low unit labor cost levels in France and Germany, but the slowdown in comparative productivity performance and the rise in labor compensation levels after 1985 caused another increase in relative unit labor costs. By 1990, the unit labor cost level in Germany was more than 40 percent above the U.S. level; by 1993, it was more than 50 percent higher. (See table 1.)

Because of the substantially lower levels of productivity in U.K. manufacturing, the relative level of unit labor cost around 1980 was higher than in any of the other countries. Similarly, despite the somewhat slower rise in labor compensation in the United Kingdom during the second half of the 1980's, unit labor cost levels were much higher than in the United States during this period. However, table 1 and chart 3 show that the unit labor cost position of the United Kingdom had slightly improved by 1993.

Except in 1978, relative labor costs in Japan stayed below relative productivity up to 1985. Although Japan's labor cost position deteriorated during the second half of the 1980's, its unit labor cost level for total manufacturing more or less equalled that of the United States in 1990. However, unit labor costs in Japan rose dramatically between 1990 and 1993 (table 1 and chart 3), which may be partly ascribed to the appreciation of the yen, but also to the decline in comparative productivity performance.

Table 7 shows the differences in unit labor cost levels for the major manufacturing branches. It is clear that France experienced relatively high unit labor cost levels during the 1970's in all branches except machinery and equipment. Unit labor costs in the latter branch were also relatively low in Germany during the 1970's. Following the decline in unit labor cost levels during the early 1980's, another rise occurred during the second half of the past decade. In 1990, unit labor cost levels in textiles, wearing apparel, and leather products proved very high in France and Germany. Further-

Table 6. **Labor costs per hour worked by major manufacturing branch, selected years, 1970–90**

[United States = 100]

Country pair	1970	1975	1980	1985	1990
France-United States					
Food, beverages, and tobacco	56.6	105.3	126.0	76.0	[1]121.1
Textiles, apparel, and leather	53.3	105.1	134.8	85.7	[1]125.9
Chemicals and allied products	55.8	94.1	113.0	71.1	[1]100.9
Basic and fabricated metal products	44.1	73.8	89.8	60.1	[1] 87.7
Machinery and equipment	44.2	79.8	104.5	65.2	[1] 97.2
Other manufacturing	47.8	89.0	120.2	76.8	[1]106.9
Total manufacturing	48.4	86.9	110.5	69.9	117.8
Germany-United States					
Food, beverages, and tobacco	43.9	70.1	83.9	47.7	91.9
Textiles, apparel, and leather	55.0	99.0	127.7	75.6	143.2
Chemicals and allied products	51.7	89.5	112.9	68.1	122.8
Basic and fabricated metal products	46.3	77.9	98.3	61.3	119.8
Machinery and equipment	42.8	79.2	104.2	60.6 1	18.8
Other manufacturing	46.0	80.0	104.5	60.8	110.7
Total manufacturing	47.0	83.2	106.8	63.4	121.6
Japan-United States					
Food, beverages, and tobacco	20.4	38.6	46.5	41.1	79.1
Textiles, apparel, and leather	23.3	45.8	62.0	46.5	66.5
Chemicals and allied products	30.2	55.7	72.3	68.9	119.4
Basic and fabricated metal products	22.2	43.4	50.5	47.4	78.0
Machinery and equipment	19.6	41.5	48.9	42.8	72.8
Other manufacturing	20.6	42.1	52.7	46.1	75.6
Total manufacturing	21.4	43.0	52.1	45.8	77.5
United Kingdom-United States					
Food, beverages, and tobacco	—	—	80.5	55.7	100.5
Textiles, apparel, and leather	—	—	135.0	61.3	102.4
Chemicals and allied products	—	—	82.1	53.4	95.9
Basic and fabricated metal products	—	—	66.7	48.1	91.5
Machinery and equipment	—	—	70.9	46.7	82.8
Other manufacturing	—	—	81.2	55.0	93.3
Total manufacturing	[2]38.0	52.9	76.4	51.1	90.4

[1] Data relate to 1989.

[2] Data relate to 1971.

NOTE: Estimate for total manufacturing for France in 1990 based on extrapolation from 1989 on the basis of information from the U.S. Bureau of Labor Statistics.

SOURCE: For labor costs and employment, see appendix A.

more, by 1990, France had high unit labor costs in food products, and Germany, in chemicals and allied products.

In the United Kingdom, unit labor cost levels in 1980 were exceptionally high in food products, beverages, and tobacco and in textiles, wearing apparel, and leather products, and this was still the case in 1990. However, unit labor cost levels in the United Kingdom were substantially below those of Germany in chemicals, basic metals and metal products, and machinery and equipment.

The Japanese experience shows a larger diversity among manufacturing branches, as well as in changes over time, than the other countries. In 1970, Japan had lower unit labor cost levels than Germany in all major branches, but the differences were substantial only for textiles, wearing apparel, and leather products and for basic metals and metal products. After 1970, the diversity among the branches further increased. Food products, as well as chemicals and textiles, showed increasingly high unit labor cost levels over time, whereas in basic metals and metal products and machinery and equipment, relatively low unit labor costs were maintained despite the rising exchange rate. In 1990, Japan enjoyed a very substantial unit labor cost advantage in machinery and equipment.

In summary, in terms of unit labor costs, France and Germany had already lost most of their competitive edge in manufacturing to the United States by the early 1980's, and since then have competed only on the basis of the appreciation of the U.S. dollar during the first half of the 1980's. During the second half of the decade, a sharp deterioration of French and German competitiveness took place (which, for Germany, continued into the 1990's) due to slow productivity growth, rapid wage increases, and currency appreciation.

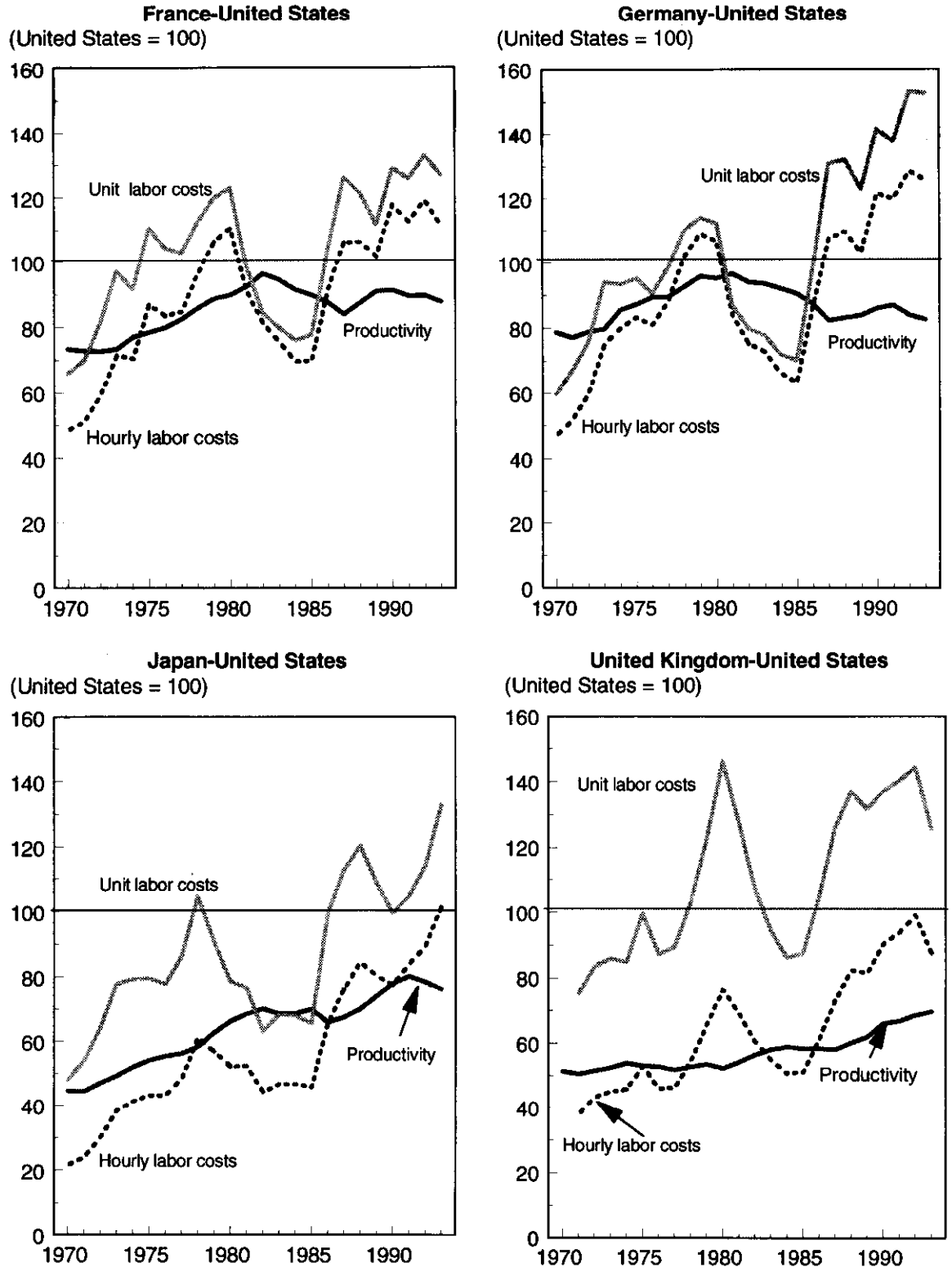
During the 1970's, Japan greatly benefitted from relatively low wage levels. However, during the 1980's, Japan's performance varied widely by major branch. Several manufacturing branches were not able to respond to the appreciation of the yen by way of increasing productivity and cutting costs, and therefore posted very high levels of unit labor costs. However, particularly in metals and machinery and equipment, Japanese companies appeared able to achieve high productivity levels and remained competitive against U.S. producers. Between 1990 and 1993, however, Japan's unit labor cost position deteriorated strongly.

The broader aspect of competition

Of course, the countries discussed here do not compete only among themselves, but also with other countries. Therefore, certain aspects of the ever-widening world of international trade merit some discussion.

First, there has been great concern about competitive pressures generated by the low wage economies, such as South

Chart 3. **Indexes of relative hourly labor costs, labor productivity, and unit labor costs, 1970–93**



SOURCE: Tables 5, 6, and 7.

Table 7. Unit labor cost levels by major manufacturing branch, selected years, 1970–90

[United States = 100]

Country pair	1970	1975	1980	1985	1990
France-United States					
Food, beverages, and tobacco	78.2	145.9	189.0	113.6	[1]151.3
Textiles, apparel, and leather	68.1	123.4	162.0	91.5	[1]145.8
Chemicals and allied products	68.8 1	15.3	122.2	85.3	[1]129.3
Basic and fabricated metal products	82.1	127.0	122.7	74.3	[1] 91.8
Machinery and equipment	54.0	87.2	96.0	64.5	[1] 97.7
Other manufacturing	70.3	123.6	138.8	82.3	[1]115.8
Total manufacturing	66.0	110.6	123.1	77.8	129.1
Germany-United States					
Food, beverages, and tobacco	57.4	94.2	114.5	66.6	121.2
Textiles, apparel, and leather	67.0	112.4	151.1	84.9	162.4
Chemicals and allied products	59.6	96.4	106.9	80.2	160.0
Basic and fabricated metal products	68.4	94.0	113.1	66.6	121.3
Machinery and equipment	47.9	79.6	94.1	60.8	135.6
Other manufacturing	69.8	112.0	130.2	76.1	139.7
Total manufacturing	59.7	95.2	112.3	70.1	141.6
Japan-United States					
Food, beverages, and tobacco	54.5	87.3	121.0	122.8	213.5
Textiles, apparel, and leather	44.2	70.4	100.2	80.1	138.5
Chemicals and allied products	52.1	77.4	87.1	81.6	142.5
Basic and fabricated metal products	47.0	69.5	62.2	55.4	81.5
Machinery and equipment	41.8	70.1	54.3	44.4	63.7
Other manufacturing	65.8	127.7	127.6	91.1	137.8
Total manufacturing	48.1	79.5	78.6	65.5	99.5
United Kingdom-United States					
Food, beverages, and tobacco	—	—	205.5	126.1	186.8
Textiles, apparel, and leather	—	—	241.2	92.0	157.9
Chemicals and allied products	—	—	115.3	72.4	111.4
Basic and fabricated metal products	—	—	163.2	75.2	114.6
Machinery and equipment	—	—	121.0	76.8	125.9
Other manufacturing	—	—	174.3	108.8	154.6
Total manufacturing	[2]75.3	99.8	146.1	87.6	137.1

[1] Data relate to 1989.

[2] Data relate to 1971.

NOTE: Total manufacturing for France in 1990 based on extrapolation from 1989 on the basis of information from the U.S. Bureau of Labor Statistics.

SOURCES: Labor costs are from table 6. Relative value added per hour worked is from table 5.

Korea. A recent study by Dirk Pilat shows that relative levels of unit labor costs in Korea were much lower than those in the United States during the 1970's and 1980's. However, as in Japan, the variation in unit labor cost levels was quite large among Korea's major manufacturing branches. In 1989, Korean unit labor cost levels were higher than those of the United States in food products, beverages, and tobacco, and in chemicals and allied products, although they were only half the U.S. level in basic metals and metal products and in machinery and equipment. Pilat emphasises that in making comparisons with low income countries such as Korea, one needs also to take account of other costs, such as those of capital, which account for a larger share of value added than in high income countries. Given the low value of the U.S. dollar, average price levels in Korean manufacturing were in fact 11 per cent above the U.S. level in 1990.[19]

Second, the countries discussed in this article are all relatively large in terms of their share of world manufacturing output. There are a substantial number of smaller industrialized nations that have much larger export-output ratios than do the countries considered here, a typical example being the Netherlands. A recent International Comparisons of Output and Productivity study has shown that Dutch manufacturing labor productivity was approximately 5 percent higher than the U.S. level in 1993. This high productivity was partly associated with a relatively large share of capital intensive industries, especially basic chemicals and textile industries, in Dutch manufacturing. Furthermore, because of fairly strong wage moderation during the 1980's, labor compensation in Dutch manufacturing was even slightly lower than U.S. wages in 1993, so that the country's unit labor cost was only 94 percent of the U.S. level.[20]

Finally, in recent years and under the influence of authors such as Michael Porter, the literature has made an increasingly strict distinction between competitiveness related to efficiency and competitiveness related to differentiation. In Porter's view, efficiency refers to lowering of costs per unit of output, whereas differentiation refers to the creation of additional value added per unit of output through the improvement of product quality, customization, or improved after-sales services. In both cases productivity is increased, but the mechanism through which it is achieved is different. Although Porter acknowledges that both types of competitive advantage are important, he points out that any successful competitiveness strategy needs to focus on only one of the two factors. For the advanced industrial nations, this usually implies a strategy based on differentiation.[21]

This article posits that, not only in the short term but also in the long term, the most competitive nations are those that have simultaneously operated at relatively low cost levels and that have improved their productivity through an increase in product volume and, in particular, product quality. There are

at least two reasons why high income countries should not concentrate only on differentiation. First, as the productivity gaps among the high income countries themselves narrow, a reduction of costs and prices may be more effective in maintaining a competitive edge than differentiation, because all countries at the productivity frontier may be able to pursue the latter strategy. Second, improving cost and price competitiveness through cutting costs denominated in national currency not only improves the cost and price position relative to other countries, but also increases the room for maneuver to introduce and strengthen aspects of competitiveness based on differentiation strategies. □

Footnotes

ACKNOWLEDGMENT: This article is an extension of an earlier article by Dirk Pilat and the author, "Competitiveness in Manufacturing: A Comparison of Germany, Japan and the United States," *Banca Nazionale del Lavoro Quarterly Review*, June 1994. The author thanks Dirk Pilat for sharing the ideas on the earlier article and for his comments on an earlier draft. The author also thanks Angus Maddison, Arthur Neef, and Karin Wagner for helpful comments.

[1] Throughout this article, "Germany" refers to the former Federal Republic of Germany.

[2] For an up-to-date description and presentation of the International Comparisons of Output and Productivity project, see A. Maddison and B. van Ark, "Comparisons of Real Output and Productivity," Research Memorandum GD-6 (Groningen, The Netherlands, Groningen Growth and Development Centre, 1994). Most of the project's studies so far have dealt with the manufacturing sector. Research has been conducted for 20 countries: Argentina, Australia, Brazil, China, Czechoslovakia, Ecuador, France, Germany (Federal Republic of Germany and German Democratic Republic), India, Indonesia, Korea, Japan, Mexico, the Netherlands, Portugal, the former Soviet Union, Spain, the United Kingdom, and the United States. See B. van Ark and D. Pilat, "Productivity Levels in Germany, Japan, and the United States: Differences and Causes," *Brookings Papers on Economic Activity: Microeconomics 2*, December 1993, pp. 1–48, on Germany, Japan, and the United States; and B. van Ark, *The Economics of Convergence, A Comparative Analysis of Industrial Productivity Since 1950* (Aldershot, Edward Elgar publishers, forthcoming) on most countries mentioned above. Substantial progress has also been made on studies for other sectors of the economy, including agriculture (A. Maddison and H. van Ooststroom, "The International Comparison of Value Added, Productivity and Purchasing Power Parities in Agriculture," Research Memorandum GD-1 (Groningen, The Netherlands, Groningen Growth and Development Centre, 1993)) and distribution (N. Mulder and A. Maddison, "The International Comparison of Performance in Distribution: Value Added, Labor Productivity and PPPs in Mexican and U.S. Wholesale and Retail Trade 1975/7," Research Memorandum GD-2 (Groningen, The Netherlands, Groningen Growth and Development Centre, 1993)). See D. Pilat, *The Economics of Rapid Growth: The Experience of Japan and Korea* (Aldershot, Edward Elgar Publishers, 1994) for a total economy comparison based on sectoral estimates.

[3] The first industry of origin studies often made comparisons on the basis of comparing physical output quantities (tons, liters, units). See for example L. Rostas, *Comparative Productivity in British and American Industry* (London, Cambridge University Press, National Institute of Economic and Social Research, 1948); A. Maddison, "Productivity in Canada, the United Kingdom and the United States," *Oxford Economic Papers*, October 1952; and, at least partly, D. Paige and G. Bombach, *A Comparison of National Output and Productivity* (Paris, OEEC, 1959). However, as over the course of time the number of product items to be compared increased and the number of product varieties rose exponentially, it became increasingly difficult to arrive at satisfactory coverage of output with physical quantity indicators. In the literature on national accounts and real output series, a consensus emerged that the representativity of measured quantities for nonmeasured quantities is not as good as that of measured prices for unmeasured prices. See for example S. Fabricant, *The Output of Manufacturing Industries 1899–1937*, NBER no. 19 (New York, National Bureau of Economic Research, 1940); and R. Stone, *Quantity and Price Indexes in National Accounts* (Paris, OEEC, 1956). The use of unit value ratios in industry of origin studies was first adopted in A. Maizels, "Comparative Productivity in Manufacturing Industry: A Case Study of Australia and Canada," *The Economic Record*, April 1958; and in Paige and Bombach, *A Comparison*.

[4] See, for example, D. Dollar and E.N. Wolff, *Competitiveness, Convergence and International Specialization* (Cambridge, MA, MIT Press, 1993).

[5] See A. Maddison, *Monitoring the World Economy, 1820–1992* (Paris, OECD Development Center, 1995), appendix C, for a more detailed account of differences in PPP's and per capita income estimates from various International Comparisons Project rounds. For the countries in this study, Maddison's estimates suggest that the PPP estimates from ICP IV (for 1980) and ICP VI (for 1990) are more consistent with each other than the ICP V estimates (for 1985). As the UVR's presented here are of a binary nature, they are compared with the unpublished Fisher variant of the gross domestic product-based PPP's instead of the published multilateral variants. (See also appendix B).

[6] See P. Hooper and K.A. Larin, "International Comparisons of Labor Costs in Manufacturing," *The Review of Income and Wealth*, December 1989, pp. 335–56.

[7] D.W. Jorgenson and M. Kuroda, "Productivity and International Competitiveness in Japan and the United States, 1960–1985," *The Economic Studies Quarterly*, December 1992, pp. 313–25.

[8] A study of the McKinsey Global Institute (*Manufacturing Productivity* (Washington, 1993)) looked in more detail at several of the International Comparisons of Output and Productivity project UVR's for the Germany-U.S. and Japan-U.S. comparisons. In some cases (in particular in the machinery and equipment sector), substantial adjustments were made at the product level to correct for different product mixes or qualities among the countries. However, no systematic bias in the original International Comparisons of Output and Productivity estimates was found, so that at the aggregate level at which the estimates are presented here, these adjustments led to changes of the results on the order of only 3 to 5 per cent. See H. Gersbach and B. van Ark, "Micro Foundations for International Productivity Comparisons," Research Memorandum GD-11 (Groningen, The Netherlands, Groningen Growth and Development Center, 1994); and H. Gersbach and M.N. Baily, "Explanations of International Productivity Differences: Lessons from Manufacturing," in K. Wagner and B. van Ark, eds., *International Productivity Differences, Measurement and Explanations* (Amsterdam, North Holland, forthcoming).

[9] Unfortunately, appropriate deflators to extrapolate the relative price levels by major branch to the period before 1978 could not be constructed for the United Kingdom.

[10] Clearly there may have been industries with lower relative price levels within other major branches. The fairly aggregate analysis in this article locates only those areas of manufacturing in which countries enjoy an overall competitive advantage.

[11] See, for example, 'Comment by Dale Jorgenson,' in van Ark and Pilat, "Productivity Levels," pp. 45–56.

[12] Firstly, double-deflated estimates are very sensitive to the weights used in the index. This may be overcome by the use of translogarithmic indexes, which are based on the average value shares of the two countries in each binary comparison. (See, for example, the comparison of Japan and the United States by Jorgenson and Kuroda, "Productivity and International Competitiveness."). However, the latter method still requires meticulous measurement of the value and prices of output and material inputs. In particular, in the case of material inputs, the coverage of measured prices needs to be quite substantial. Further-

more, it is necessary to have an integrated framework of intersectoral accounts, the production census, and the national product accounts. These conditions are difficult to meet in practice. Comparable price measures for intermediate inputs are rarely available, and, as mentioned above, by definition, cannot be obtained from International Comparisons Project expenditure PPP's.

[13] See B. van Ark, "International Comparisons of Output and Productivity," Monograph Series no. 1 (Groningen, The Netherlands, Groningen Growth and Development Center, 1993); van Ark, *The Economics of Convergence;* and Pilat, *The Economics*, for a description of estimates using double-deflation techniques. An exception to "adjusted single deflation" was made in the case of the food products branch in Japan, for which the "double-deflated" UVR from table 2 was used. As intermediate inputs were excessively high priced in Japan, it was felt necessary to derive a specific "value added" UVR for this extreme case.

[14] For example, in 1950, value added per hour worked in manufacturing in France and the United Kingdom was only 38 percent of that in the United States; in Germany, it was 39 percent, whereas in Japan, it was only 12 percent. See van Ark, *The Economics of Convergence*.

[15] The annual compound growth rates of value added per hour worked in manufacturing between 1979 and 1990 were 3.1 percent for France, 1.8 percent for Germany, 4.9 percent for Japan, 4.8 percent for the United Kingdom, and 2.8 percent for the United States.

[16] See McKinsey Global Institute, *Manufacturing Productivity*.

[17] See Arthur Neef, Christopher Kask, and Christopher Sparks, "International comparisons of manufacturing unit labor costs," *Monthly Labor Review*, December 1994, pp. 47–58; and M. Greiner, Christopher Kask, and Christopher Sparks, "Comparative manufacturing productivity and unit labor costs," *Monthly Labor Review*, February 1995.

[18] Compare, for example, the estimates of changes in unit labor costs on a national currency basis and on a U.S. dollar basis as presented regularly at the back of the *Monthly Labor Review*.

[19] See Pilat, *The Economics*, pp. 193–204.

[20] See B. van Ark, "Arbeidsproduktiviteit, arbeidskosten en internationale concurrentie," *Economische en Statistische Berichten*, November 23, 1994, updated; and van Ark, *The Economics of Convergence*.

[21] See, for example, M. Porter, *The Competitive Advantage of Nations* (New York, The Free Press, 1990), pp. 37–38.

Appendix A: Statistical sources

Unit value ratios (table 1) for 1987 are derived from the following sources: For France, from Service d'Etude et des Statistiques Industrielles/Organisation professionnels/Service Central des Enquetes et Etudes Statistique, *Enquêtes de Branches 1987*, Paris. For Germany, from Statistisches Bundesamt, *Produktion im Produzierenden Gewerbe 1987*, Wiesbaden. For Japan, from Ministry of International Trade and Industry (MITI), *Census of Manufactures 1987, Report by Commodities*, Tokyo. For the United Kingdom, from Business Statistics Office, *Business Monitor, Quarterly Sales Inquiries*, various issues. For the United States, from Bureau of the Census, *1987 Census of Manufactures, Industry Series*, Washington.

Value added and employment for productivity calculations for 1987 are derived from the following sources: For France, from Institut National de la Statistique et des Etudes Economiques (INSEE) *La situation de l'industrie en 1987. Résultats définitiefs de l'enquête annuelle d'entreprise 1987*, Paris. For Germany, from Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*, Wiesbaden. For Japan, from MITI, *Census of Manufactures 1987, Report by Industries*, Tokyo. For the United Kingdom, from Business Statistics Office, *Business Monitor, Report on the Census of Production*, various issues. For the United States, from Bureau of the Census, *1987 Census of Manufactures, Industry Series*, Washington.

The series on value added, employment, and deflators are derived from the following national accounts sources:. For France, from INSEE, *20 ans de comptes de la nation*, Paris, 1992; and INSEE, *Rapport sur les comptes de la nation*, Paris, 1993. For Germany, from Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Revidierte Ergebnisse 1950-1990*, Wiesbaden, 1991; and Statistisches Bundesamt, *Volkswirtschaftliche Gesamtrechnungen, Konten und Standardtabellen 1991*, Wiesbaden, 1992. For Japan, from Economic Planning Agency, *Report on National Accounts from 1955 to 1989*, Tokyo, 1991, and Economic Planning Agency, *Annual Report on National Accounts 1993*, Tokyo, 1993. For the United Kingdom, from Central Statistical Office, *United Kingdom National Accounts*, various issues. U.K. employment from Department of Employment, *Employment Gazette*, and additional series supplied by the Department of Employment. For the United States, from Bureau of Economic Analysis, *The National Income and Product Accounts of the United States, 1929–1982*, Washington, 1986, and *Survey of Current Business*, April 1991 and May 1993.

For the calculations of hours, see the detailed explanations in B. van Ark and R.D.J. Kouwenhoven, "Productivity in French Manufacturing: An International Comparative Perspective," Research Memorandum GD-10 (Groningen Growth and Development Center,1994) for France; van Ark and D. Pilat "Productivity Levels in Germany, Japan, and the United States: Differences and Causes," *Brookings Papers on Economic Activity: Microeconomics 2*, December 1993, for Germany, Japan, and the United States; and van Ark, "Comparative Productivity in British and American Manufacturing," *National Institute Economic Review*, November 1992, for the United Kingdom, though the time series of the last has been revised on the basis of more up-to-date information kindly provided by Mary O'Mahony of the National Institute of Economic and Social Research, London.

Labor compensation and employment estimates for labor cost calculations are derived from the following sources: For France (1977–89), from Organization for Economic Cooperation and Development (OECD), *National Accounts Volume II*, Paris, 1993; and for France (1970–77), from INSEE, *Les Comptes de l'industrie en 1987*, Les collections de l'INSEE no. C150, 1988. For Germany, Japan, and the United States, from the national accounts sources cited above. See also D. Pilat and B. van Ark, "Competitiveness in Manufacturing: A Comparison of Germany, Japan and the United States," *Banca Nazionale del Lavoro Quarterly Review*, June 1994. For the United Kingdom (1983–90), from national accounts sources as described above; for the United Kingdom (1975–83), from OECD, *National Accounts Volume II, 1975-87*, Paris; and for the United Kingdom (1971–75), from OECD, *National Accounts Volume II, 1971–83*, Paris.

Appendix B: The aggregation of unit value ratios

For purposes of this study, the manufacturing sector was divided into 16 branches, which roughly correspond to the International Standard Industrial Classification (ISIC) of the United Nations. For each binary comparison, a maximum number of industries within each branch was distinguished as producing the same products in each country. Matches were then made for as many products as possible within each industry. The average unit value ratio for the industry was obtained by weighting the unit values by the corresponding quantity weights for one of the two countries:

$$\text{(B.1a)} \qquad UVR_j^{XU(X)} = \frac{\sum_{i=1}^{s} P_{ij}^X * Q_{ij}^X}{\sum_{i=1}^{s} P_{ij}^U * Q_{ij}^X}$$

at quantity weights of country X, and:

$$\text{(B.1b)} \qquad UVR_j^{XU(U)} = \frac{\sum_{i=1}^{s} P_{ij}^X * Q_{ij}^U}{\sum_{i=1}^{s} P_{ij}^U * Q_{ij}^U}$$

at quantity weights of country U (here, the United States), where i=1...s is the sample of matched items in matched industry j.

In the International Comparisons of Output and Productivity studies of manufacturing, the first-stage aggregation was applied only for so-called "matched" industries, for which at least 25 percent of output in both countries could be matched. For industries within each branch with lower coverage percentages, equations (B.1a) and (B.1b) customarily were used for all items within a branch to obtain the UVR for each "non-matched" industry UVR, which therefore resulted in the same UVR across all nonmatched industries in the branch.

The second stage of aggregation from industry to branch level was constructed by weighting the unit value ratios for gross output (UVR_{go}) as derived above from the value added of each industry in country X or country U, that is:

$$\text{(B.2a)} \qquad UVR_k^{XU(U)} = \frac{\sum_{i=1}^{r}\left[UVR_{j(go)}^{XU(U)} * VA_j^U\right]}{VA_k^U}$$

for the UVR of branch k at quantity weights of country U, and:

$$\text{(B.2b)} \qquad UVR_k^{XU(X)} = \frac{VA_k^X}{\sum_{j=1}^{r}\left[VA_j^X \,/\, UVR_{j(go)}^{XU(X)}\right]}$$

for the UVR of branch k at country X's quantity weights, where j = 1...r are the industries j in branch k).

In the final stages, branch UVR's were weighted at branch value added to obtain unit value ratios for major groups of branches (such as in table 2) and for total manufacturing.

Industry of origin UVR's are usually based on binary comparisons between pairs of countries, in contrast to expenditure PPP's which are usually based on index numbers of a multilateral nature. This makes the results sensitive to the choice of the numéraire country, which in this case is the United States. This implies that comparisons of three countries based on binary UVR's are not transitive. For example, a direct comparison between Germany and the United Kingdom does not yield a result identical to that from an implicit comparison between these countries based on UVR's for Germany-United States and United Kingdom-United States.See D. Pilat and D.S. Prasada Rao, "A Multilateral Approach to International Comparisons of Real Output, Productivity and Purchasing Power Parities in Manufacturing," Research Memorandum no. 440 (Groningen, The Netherlands, Institute of Economic Research, 1991) for experimentation with multilateral weights in industry studies. In general, the differences between PPP's using binary and multilateral weights are not very large for a small sample of countries with comparable price structures.