Real Gross Product of U.S. Companies' Majority-Owned Foreign Affiliates in Manufacturing

By Raymond J. Mataloni, Jr.

*I*N AN initial attempt to remove valuation effects from its measures of the foreign manufacturing activities of U.S. multinational companies (MNC's), the Bureau of Economic Analysis (BEA) has developed experimental estimates of the real gross product of majority-owned foreign affiliates (MOFA's) in manufacturing for 1982–94.[1] Gross product—a measure of value added—is used as a summary measure of economic activity because it is free of double counting, unlike sales or receipts data, which reflect not only value added within the firm, but also the value of intermediate inputs purchased from outside the firm. BEA has long provided current-dollar estimates of gross product for MOFA's and for their U.S. parent companies, but the usefulness of these estimates for comparisons over time or across countries has been limited by the fact that they do not allow changes in real value added to be distinguished from changes in value arising from movements in prices or exchange rates.[2]

As might be expected, removing the effects of changes in prices and exchange rates produces a gross product series that is generally both slower growing and less volatile than the current-dollar series. In real terms, the gross product of MOFA's in manufacturing grew at an average annual rate of 2.5 percent from 1982 to 1994, a rate similar to the rate of growth in host-country industrial production.[3] Year to year, the changes ranged from −4.4 percent in 1991 to 8.4 percent in 1994 (table 1 and chart 1). In terms of current dollars, the product of MOFA's grew at a 5.9-percent rate, and the year-to-year changes ranged from −4.8 percent in 1983 to 18.8 percent in 1987.

Two procedures were used to prepare the estimates of real gross product—a preferred procedure for 19 major host countries that account for over three-quarters of the total gross product of MOFA's in manufacturing and a cruder procedure for other host countries. The preferred procedure consisted of two steps: Estimates for a base year (1993) were

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1. A foreign affiliate is a foreign business enterprise in which there is U.S. direct investment; that is, a U.S. person ("U.S. parent") owns or controls, directly or indirectly, 10 percent or more of the voting securities or the equivalent. (In this definition, "person" is broadly defined to include any individual, branch, partnership, associated group, association, estate, trust, corporation or other organization—whether or not organized under the laws of any State—or any government entity.) A MOFA is a foreign affiliate in which the combined ownership of all U.S. parents exceeds 50 percent.

A U.S. parent comprises the domestic (U.S.) operations of a U.S. MNC. Foreign affiliates comprise the foreign operations of a U.S. MNC over which the parent is presumed to have a degree of managerial influence. MOFA's comprise the foreign operations over which the parent(s) has a controlling interest.

2. For the most recent current-dollar estimates of gross product, see "Operations of U.S. Multinational Companies: Preliminary Results From the 1994 Benchmark Survey," SURVEY OF CURRENT BUSINESS 76 (December 1996): 11–37. For information on methodology and for illustrations of the uses of these estimates, see "Gross Product of U.S. Multinational Companies, 1977–91," SURVEY 74 (February 1994): 42–63.

Employment has sometimes been used as an indicator of MNC economic activity because it is not directly affected by prices or exchange rates, but it is an imperfect measure because it measures the usage of a factor of production rather than production itself and because it does not reflect changes in the hours worked per employee or the usage of nonlabor factors of production.

This article benefited significantly from comments by two reviewers from outside BEA—Peter Hooper and Robert E. Lipsey.

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3. Industrial production indexes are used for this comparison because estimates of real gross product originating in manufacturing are not available for all countries or for all years.

Table 1.—Indexes of Current-Dollar and Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing, 1982–94

[1993=100]

	Current-dollar	Real	Percent change from previous year	
			Current-dollar	Real
1982	56.1	80.7	....	....
1983	53.4	78.9	−4.8	−2.2
1984	54.9	83.3	2.7	5.5
1985	55.7	85.3	1.5	2.4
1986	65.1	85.7	16.8	.5
1987	77.3	90.2	18.8	5.2
1988	89.8	97.1	16.2	7.7
1989	96.8	104.5	7.7	7.6
1990	105.5	103.5	9.0	−1.0
1991	102.4	98.9	−2.9	−4.4
1992	102.4	96.6	−.1	−2.3
1993	100.0	100.0	−2.3	3.5
1994	111.1	108.4	11.1	8.4
Addendum: Average annual rate of growth, 1982–94	....	....	5.9	2.5

first constructed using "purchasing power parity" (PPP) exchange rates rather than the market exchange rates (MER's) that are the basis of the current-dollar estimates; then estimates for other years were constructed by extrapolating the base-year estimates with chain-weighted Fisher quantity indexes similar to those used by BEA to estimate changes in U.S. gross domestic product.

Unlike MER's, the PPP exchange rates used to establish the base-year levels under the preferred procedure approximate the number of foreign currency units required to purchase goods and services—whether or not traded internationally—equivalent to those that can be purchased in the United States with 1 U.S. dollar.[4] MER's, on the other hand, reflect a variety of factors, such as international capital movements and expectations of financial market conditions, that are not directly related to the prices of goods and services. As an example of how MER's may move counter to purchasing power parity, from 1980 to 1985, the U.S.

dollar price of German marks fell by nearly 40 percent even though the average rate of inflation, measured in consumer prices, was more than 2 percentage points *higher* in the United States than in Germany.[5] MER-based translation of a given volume of production by MOFA's under these conditions would have shown a dramatic decrease, even though in fact none had occurred.

For other host countries, the data needed for the preferred procedure were unavailable, and real dollar-denominated estimates were derived simply by deflating the current-dollar estimates (which had been translated at MER's) by the implicit price deflator for U.S. gross domestic product originating in nonpetroleum manufacturing industries. The estimates constructed using this procedure, though crude, appear to provide reasonable approximations of the true values of real gross product for the group even if not for each country. (See the section "Methodology" for further discussion of both procedures.)

The remainder of the article comprises two parts and an appendix. The first part examines trends in the real gross product estimates and their relationship to the current-dollar estimates. The second part provides a detailed description of the methodology used to prepare the estimates. The appendix provides a brief introduction to PPP exchange rates.

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4. PPP exchange rates are not directly observable in the marketplace, but are estimated by international organizations—such as the Organisation for Economic Co-Operation and Development, the United Nations, and the World Bank—by comparing prices for specific goods and services across countries. For additional information on PPP exchange rates see the appendix.

Although more appropriate for this exercise than MER's, the PPP exchange rates used pertain to prices to the consumer rather than to the producer, which can cause some measurement error.

CHART 1

Indexes of Current-Dollar and Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing and the Foreign-Currency Price of the U.S. Dollar, 1982-94
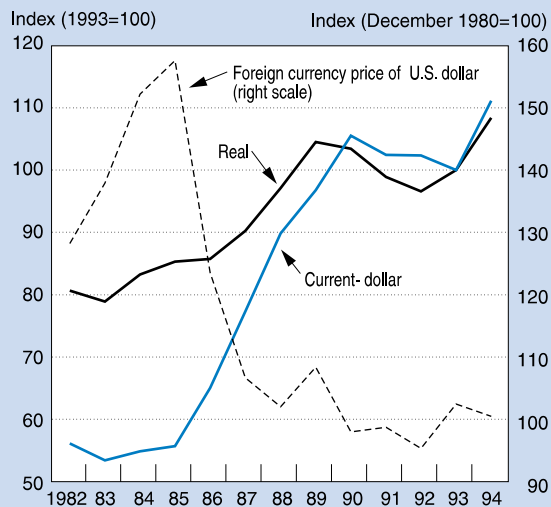
NOTE—The index of the foreign currency price of the U.S. dollar is a trade-weighted average against the currencies of the following 10 countries: Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Sweden, Switzerland, and the United Kingdom.

U.S. Department of Commerce, Bureau of Economic Analysis

Trends in 1982–94

This section examines trends in the real gross product estimates for MOFA's in manufacturing. The trends in the estimates of real gross product are then compared with those in the current-dollar estimates of gross product.

All countries

The real gross product of MOFA's in manufacturing grew at an average annual rate of 2.5 percent in 1982–94—below the 3.1-percent growth rate in real gross product originating in manufacturing industries in the United States but above the about 2-percent growth rate in the real gross product of U.S. parents in manufacturing.[6]

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5. As an example of the failure of MER's to track absolute price levels of a particular good or service, the U.S.-dollar prices of a popular fast-food sandwich in various countries have been compared under the prevailing MER's: In 1994, the sandwich cost $2.30 in the United States, $3.77 in Japan, and $1.66 in Hungary. See Michael R. Pakko and Patricia S. Pollard, "For Here or To Go? Purchasing Power Parity and the Big Mac," *Review* (Federal Reserve Bank of St. Louis, January/February 1996): 3–17.

6. For MOFA's, the industry group "manufacturing" excludes petroleum and coal product manufacturing. MOFA's (and U.S. parents) are classified by an enterprise-based system in which all petroleum-related activities (such as oil extraction, refining, and gasoline retailing) are classified in a separate "petroleum" category. For this reason, the estimate of real gross product originating in all U.S. manufacturing industries used in this comparison excludes petroleum

The patterns of growth in the real gross product of MOFA's in manufacturing differed throughout 1982–94, but these patterns can be roughly divided into three parts: An average annual growth of 3.8 percent from 1982 to 1989, an average annual decline of 2.6 percent from 1989 to 1992, and an average annual growth of 5.9 percent from 1992 to 1994.

Changes in MOFA gross product are the net result of several factors—changes in the capacity utilization of existing MOFA facilities, changes in

and coal products manufacturing. For details on the industrial classification of MOFA's, see "A Guide to BEA Statistics on U.S. Multinational Companies," SURVEY 75 (March 1995): 38–55.

  Rough estimates of real gross product for U.S. parents in manufacturing were derived by deflating the current-dollar estimates at the broad industry level shown in table 4 by the implicit price deflators for U.S. gross domestic product originating in those industries.

productive capacity that result from expansion or contraction of existing affiliates, establishment of new affiliates (or "greenfield investments"), acquisitions of existing foreign firms, and sell-offs. Because the direction of the changes in MOFA gross product corresponds with the direction of the changes in economic conditions in several major host-country locations (including Europe, Canada, and Australia), growth in MOFA gross product during 1982–94 probably was mostly accounted for by growth in existing operations, which would be expected to mirror host-country economic conditions. However, greenfield investments and acquisitions also appear to have contributed significantly to the growth in the gross product of MOFA's in some countries.

Table 2.—Current-Dollar and Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing, by Country, 1982–94

	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1982–89	1989–92	1992–94	1982–94
	Billions of current dollars													Average annual rate of growth			
All countries	**99.8**	**94.9**	**97.5**	**99.0**	**115.6**	**137.4**	**159.7**	**172.0**	**187.6**	**182.1**	**181.9**	**177.7**	**197.5**	**8.1**	**1.9**	**4.2**	**5.9**
19 OECD countries	76.9	75.5	78.3	79.9	95.7	115.0	133.2	141.4	155.0	149.4	143.9	135.7	152.7	9.1	.6	3.0	5.9
Australia	4.3	3.8	4.0	3.4	3.1	3.7	5.0	6.9	6.3	5.3	5.1	5.0	5.7	6.9	–9.2	5.8	2.4
Austria	.2	.4	.4	.4	.5	.4	.5	.7	.7	.8	.9	.9	1.3	16.0	9.3	18.8	14.7
Belgium	2.4	2.7	2.8	2.9	3.8	4.2	4.8	5.0	5.5	5.4	5.9	5.6	6.8	11.0	5.9	7.4	9.1
Canada	16.4	18.0	20.2	20.1	20.7	21.9	25.8	28.9	27.4	23.8	21.6	22.0	25.0	8.4	–9.1	7.6	3.6
Denmark	.2	.2	.2	.2	.3	.4	.4	.4	.4	.5	.5	.5	.6	6.7	7.9	12.7	8.0
Finland	(*)	(*)	(*)	(*)	(*)	(*)	(*)	.1	.1	.1	.1	.1	.3	18.3	24.2	39.2	23.1
France	7.4	6.5	6.5	6.6	8.1	10.5	11.0	11.8	14.0	13.8	14.2	14.1	16.3	6.8	6.3	7.0	6.7
Germany	15.3	15.3	14.0	14.8	19.5	23.5	25.0	25.8	33.6	34.5	35.6	32.8	32.0	7.8	11.2	–5.1	6.4
Greece	.1	.1	.1	.1	.1	.1	.2	.2	.2	.2	.3	.3	.3	5.3	10.5	9.1	7.2
Ireland	1.3	1.5	1.8	1.8	1.7	3.0	3.5	3.5	4.3	4.2	4.6	3.9	4.6	14.8	9.1	.3	10.8
Italy	3.9	3.8	4.2	4.3	5.7	7.0	7.5	7.8	9.2	9.3	8.9	7.1	8.2	10.2	4.6	–4.0	6.3
Japan	2.2	2.5	3.0	3.2	4.5	5.9	7.4	7.7	7.3	8.0	7.9	8.5	10.8	19.7	.9	17.1	14.3
Luxembourg	.2	.2	.2	.2	.4	.5	.5	.5	.6	.6	.7	.6	.7	14.8	8.3	3.7	11.3
Netherlands	2.6	2.7	2.8	2.8	3.9	5.2	5.9	7.8	6.9	6.7	7.0	6.4	7.5	17.2	–3.4	3.7	9.4
New Zealand	.3	.2	.3	.2	.3	.4	.3	.3	.2	.2	.2	.2	.4	1.0	–13.7	37.1	2.2
Norway	.3	.2	.2	.2	.1	.1	.1	.1	.2	.1	.1	.2	.3	–10.3	.3	68.6	2.5
Spain	1.9	1.8	2.0	2.3	3.3	4.3	5.3	5.7	6.4	6.4	5.8	4.8	5.4	17.5	.3	–3.4	9.3
Sweden	.6	.6	.6	.7	.8	.8	.8	1.0	1.0	1.1	.9	.8	.8	7.0	–4.2	–5.0	2.1
United Kingdom	17.3	14.9	15.1	15.8	19.1	23.0	29.0	27.4	30.5	28.4	23.7	21.8	25.7	6.8	–4.7	4.3	3.4
All other countries	22.8	19.5	19.2	19.0	19.9	22.4	26.5	30.6	32.6	32.7	38.1	42.0	44.8	4.3	7.5	8.5	5.8
	Billions of chained (1993) dollars																
All countries	**123.6**	**120.9**	**127.6**	**130.7**	**131.3**	**138.2**	**148.8**	**160.1**	**158.5**	**151.5**	**148.0**	**153.2**	**166.1**	**3.8**	**–2.6**	**5.9**	**2.5**
19 OECD countries	94.0	96.1	103.8	107.0	107.6	111.5	117.8	126.1	123.2	117.4	109.3	111.2	121.6	4.3	–4.6	5.5	2.2
Australia	5.3	4.8	4.9	4.9	4.4	4.6	5.1	6.5	5.8	4.7	4.7	4.9	5.2	2.9	–10.0	4.2	–.3
Austria	.3	.4	.4	.5	.4	.3	.4	.6	.5	.5	.6	.6	.9	11.5	1.4	21.6	10.5
Belgium	3.2	3.9	4.2	4.3	4.4	4.1	4.5	4.7	4.4	4.4	4.5	4.6	5.3	5.6	–1.6	8.6	4.3
Canada	20.2	21.3	24.0	24.3	24.8	24.6	25.8	27.4	25.7	21.8	20.6	21.7	24.8	4.5	–9.0	9.6	1.7
Denmark	.2	.2	.2	.2	.3	.3	.3	.3	.3	.3	.3	.3	.3	1.7	(*)	15.2	3.4
Finland	(*)	(*)	(*)	(*)	(*)	(*)	(*)	(*)	.1	.1	.1	.1	.2	12.4	23.2	47.4	20.3
France	8.4	7.8	8.3	8.2	7.8	8.7	8.6	9.5	9.6	9.9	9.7	10.5	11.7	1.7	.7	10.1	2.8
Germany	20.1	20.8	20.6	22.0	21.4	21.1	21.7	23.3	25.5	26.3	24.9	24.1	23.0	2.1	2.3	–3.9	1.1
Greece	.2	.2	.2	.2	.2	.2	.2	.3	.2	.3	.3	.3	.3	2.3	.9	9.5	3.1
Ireland	1.6	2.0	2.4	2.5	1.9	3.0	3.4	3.4	3.7	3.7	3.8	3.6	4.1	11.4	2.9	3.9	8.0
Italy	5.2	5.1	5.9	6.2	6.2	6.3	6.5	6.7	6.7	6.8	6.4	6.3	7.0	3.6	–1.5	4.7	2.5
Japan	2.4	2.6	3.2	3.4	3.5	4.1	4.6	5.0	4.9	4.9	4.6	4.4	5.2	10.9	–2.3	6.2	6.7
Luxembourg	.2	.3	.3	.3	.4	.4	.4	.4	.5	.5	.5	.5	.5	9.8	3.2	6.1	7.5
Netherlands	2.9	3.1	3.6	3.6	3.9	4.5	4.8	6.5	5.1	5.1	5.1	5.0	5.7	12.6	–8.1	5.9	5.9
New Zealand	.4	.3	.4	.4	.4	.4	.3	.3	.2	.2	.2	.3	.4	–1.9	–12.6	31.1	(*)
Norway	.2	.2	.2	.2	.1	.1	.1	.1	.1	.1	.1	.1	.2	–12.8	–5.1	77.8	.3
Spain	2.3	2.6	2.9	3.3	3.7	4.2	4.7	5.0	4.6	4.6	4.0	4.1	4.7	11.5	–6.5	7.3	6.0
Sweden	.7	.7	.7	.8	.7	.6	.7	.7	.7	.7	.5	.6	.6	1.2	–9.5	4.2	–1.2
United Kingdom	21.6	20.5	22.3	22.6	23.4	24.1	26.4	25.7	24.9	22.4	18.3	19.2	21.6	2.5	–10.6	8.5	(*)
All other countries	29.2	24.6	23.6	23.4	23.5	26.5	30.8	33.9	35.3	34.0	38.7	42.0	44.5	2.2	5.5	7.2	3.6
Residual	–1.1	–.5	–.9	–.7	(*)	–.1	–.6	–.2	–.2	.1	.1	0	(*)	....	....	....	....

* Less than $50 million or less than 0.05 percent.

NOTE.—Chained (1993) dollar series were derived by extrapolating the base-year (1993) PPP-exchange-rate-based current-dollar value of the corresponding series by a Fisher quantity index (see the text for details). Because the formula for the Fisher quantity indexes uses weights of more than one period, the corresponding chained-dollar estimates are usually not additive. The residual line is the difference between the total line and the sum of the most detailed lines.

Although the real estimates are denominated in dollars of 1993, the estimate for 1993 does not equal the current-

dollar estimate for that year, because the two estimates are based on different exchange rates. As explained in the text, the current-dollar estimates are based on market exchange rates and the real estimates are based on purchasing-power-parity exchange rates.

OECD Organisation for Economic Co-Operation and Development

19 OECD countries

From 1982 to 1994, real gross product of MOFA's in manufacturing in 19 member countries of the Organisation for Economic Co-Operation and Development (OECD) grew at an average annual rate of 2.2 percent—the same as the (weighted) average annual rate of growth in total industrial production in these countries (table 2 and chart 2).[7] Even on a year-to-year basis, the movements in the gross product estimates generally tracked the industrial production in the host countries.

From 1982 to 1989, the estimates of real gross product for MOFA's in the 19 countries grew at an average annual rate of 4.3 percent, compared with a 3.1-percent growth rate for host-country

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7. For this comparison, a composite index of industrial production was derived by weighting each country's index by that country's share of the cumulative dollar value of real gross product of MOFA's in manufacturing in 1982–94.

The concepts, coverage, and method of computation of industrial production indexes are similar to those of estimates of real gross product of MOFA's in manufacturing. However, the industrial production indexes include the mining, petroleum refining, and electric and gas utilities industries, and some countries' industrial production indexes are based on the changes in the total output (sales plus inventory change) in specific industries rather than on the gross product originating in them. In addition, the industry-level changes are often aggregated with fixed benchmark-year weights rather than with chained weights like those used for the real gross product estimates.

CHART 2

Indexes of Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing and Host-Country Industrial Production, in 19 OECD Countries, 1982-94

Index (1993=100)

MOFA Majority-owned foreign affiliate
OECD Organisation for Economic Co-Operation and Development

NOTES—The 19 OECD countries covered in this chart are Australia, Austria, Belgium, Canada, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, New Zealand, Norway, Spain, Sweden, and the United Kingdom.
The composite index of industrial production was derived by weighting each country's index by the country's share in the cumulative dollar value of real gross product of MOFA's in manufacturing in 1982-94.

U.S. Department of Commerce, Bureau of Economic Analysis

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industrial production. The growth in gross product was widespread, reflecting an extended period of economic growth in most of the OECD countries. Greenfield investments and acquisitions may have also contributed to the growth in several host countries—such as Ireland, Japan, the Netherlands, and Spain—where MOFA gross product grew much faster than the worldwide average.

From 1989 to 1992, the estimates of real gross product for MOFA's decreased at an average annual rate of 4.6 percent, compared with a growth rate of 0.1 percent for host-country industrial production. The decrease reflected falling capacity utilization for MOFA's (related to slow growth or recession in host-country economies) that more than offset the modest growth in the productive capacity of MOFA's during this period. Among the larger host countries, Australia, Canada, and the United Kingdom had the largest decreases, perhaps because economic recessions began earlier in those countries than in most other OECD countries.

From 1992 to 1994, the estimates of real gross product for MOFA's increased at an average annual rate of 5.5 percent, compared with a 2.0-percent growth rate for host-country industrial production. The increases in gross product were widespread and mainly reflected renewed economic growth in the host countries.

All other countries

From 1982 to 1994, real gross product of MOFA's in manufacturing in "all other countries" grew at an average annual rate of 3.6 percent. Unlike the growth in the 19 OECD countries, the growth in these countries was slowest from 1982 to 1989, partly reflecting the effects of a debt crisis in Latin America. From 1989 to 1994, growth accelerated, reflecting renewed economic growth in Latin America and new investments by U.S. MNC's in emerging markets worldwide.

Comparison of real and current-dollar estimates

All countries.—The real and current-dollar estimates of gross product present very different pictures of the level and growth of U.S. companies' overseas manufacturing activities in 1982–94. The differences can be explained largely by exchange-rate conditions rather than by changes in prices.

Unlike most real and current-dollar series, the levels of the estimates of real and current-dollar gross product do not match in the base year, 1993, of the real series; the current-dollar estimate is $177.7 billion, whereas the real estimate is

$153.2 billion (table 2). The difference results from differences in the exchange rates on which the estimates are based: The current-dollar estimates are based on MER's, and the real estimates are based on PPP exchange rates. The lower level of the real series in 1993 reflects the higher exchange value of the dollar under PPP exchange rates in 1993 than under MER's. Under the prevailing MER, one unit of currency could have purchased more, on average, in the United States than it could have abroad.

During 1982–94, the year-to-year changes in the real estimates differed from those in the current-dollar estimates. Real gross product of MOFA's in manufacturing grew at an average annual rate of 2.5 percent, compared with an average annual growth rate of 5.9 percent for the current-dollar estimates. Most of the divergence occurred in 1985–90 (chart 1). From 1982 to 1985, the two series moved roughly in tandem, probably because changes in the MER value of the dollar were consistent with those needed to maintain purchasing power parity between the dollar and the currencies of the countries where U.S. MNC's were producing; the dollar appreciated at a time when U.S. inflation was generally milder than that of the major host countries (table 3). From 1985 to 1990, the real estimates grew at an average annual rate of 3.9 percent, compared with a 14.0-percent rate for the current-dollar estimates. The difference in the growth rates probably reflects the depreciation of the MER value of the dollar; the dollar depreciated substantially even though U.S. inflation continued to be generally milder than that abroad. From 1990 to 1994, the differences between the two series were smaller, probably reflecting relative stability in the MER value of the dollar.

19 OECD countries.—For most of the 19 OECD countries, the relationship between the current-dollar and the real estimates of gross product was similar to that for all countries. In 1993, the levels of the current-dollar estimates exceeded those of the real estimates in all but two countries (Greece and New Zealand). Like the estimates for all countries, the current-dollar estimates for the 19 countries grew more than twice as fast, on average, as the esti-

mates of real gross product. The differences in the growth rates for the largest OECD host countries were generally most pronounced between 1985 and 1988 (chart 3).

All other countries.—In contrast to the levels for the 19 OECD countries, the levels of the estimates of current-dollar and real gross product for all other countries are identical in 1993, and in the other years, the differences between the two series simply reflect inflation as measured by the U.S. implicit price deflator for gross domestic product originating in nonpetroleum manufacturing industries. This relationship results from the method used to produce the real gross product estimates for these countries.

Methodology

This section describes the methodology for preparing the estimates of real gross product, which were derived by adjusting the current-dollar estimates.

Current-dollar gross product estimates

Gross product for a firm, such as a MOFA, can be measured as its gross output (sales or receipts and other operating income, plus inventory change) less its purchased intermediate inputs (purchased goods and services). Alternatively, gross product can be measured as the sum of the costs incurred (other than for intermediate inputs) and the profits earned in production. The current-dollar gross product estimates for MOFA's are prepared by summing costs and profits. The data on costs and profits are collected in BEA's annual and benchmark surveys of U.S. direct investment abroad and are combined with BEA estimates of some items.[8] Survey respondents are asked to follow U.S. generally-accepted accounting principles (GAAP), which require that revenues and costs denominated in foreign currencies be translated to U.S. dollars, using the average MER for the year.[9] Therefore, the gross product estimates that are derived from these data reflect what a U.S. buyer would pay, at the prevailing MER, to purchase the gross product of MOFA's from abroad.

Real gross product estimates

Two procedures were used to prepare the estimates of real gross product. A preferred procedure was

Table 3.—Average Annual Change in Consumer Prices
[Percent]

	1982–85	1985–90	1990–94
United States	4.3	3.9	3.2
OECD Europe	8.9	5.9	7.3
Canada	6.2	4.4	2.3
Japan	2.2	1.5	1.7

Sources: OECD, *Historical Statistics, 1960–1990* (OECD, Paris, 1992) and *Main Economic Indicators* (OECD, Paris, November 1995)
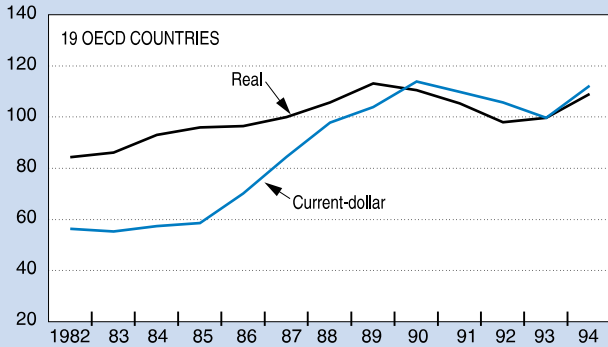OECD Organisation for Economic Co-Operation and Development

8. See "Gross Product of U.S. Multinational Companies, 1977–91."

9. However, in accordance with GAAP, the revenues and expenses of affiliates operating in hyperinflationary economies are translated daily into U.S. dollars at the prevailing daily MER's; thus, the accounts for these affiliates are, in effect, kept in dollars.
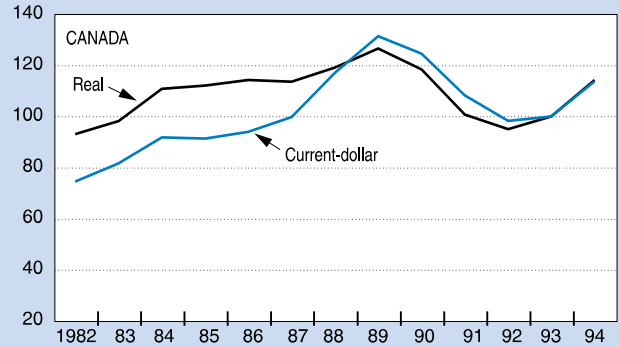
CHART 3

Indexes of Current-Dollar and Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing, by Selected Country, 1982-94
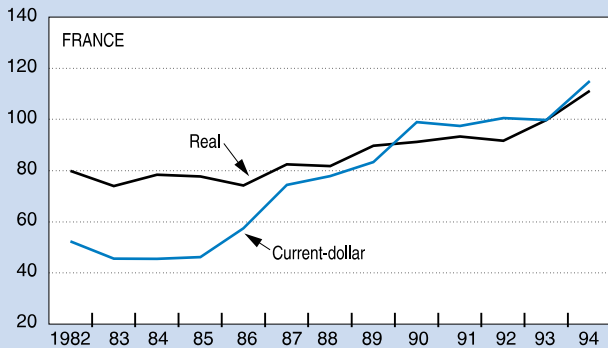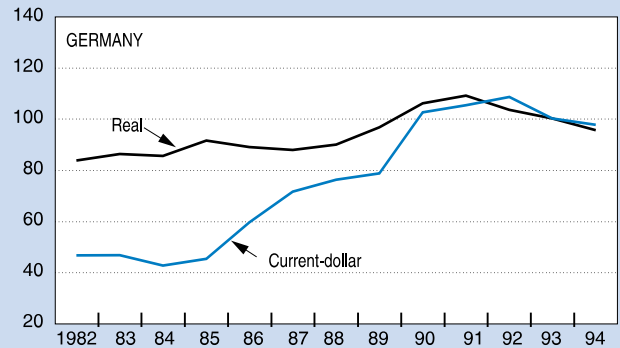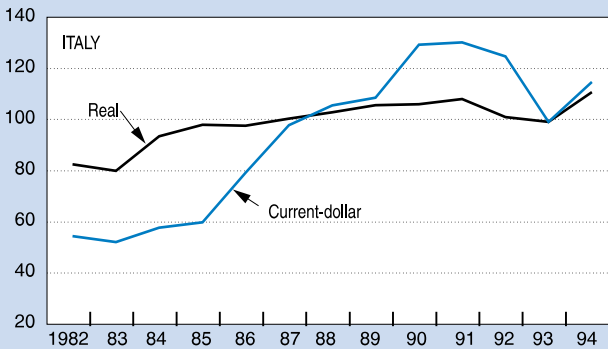
Index (1993=100)

19 OECD COUNTRIES

Real

Current-dollar

Index (1993=100)

CANADA

Real

Current-dollar

Index (1993=100)

FRANCE

Real

Current-dollar

Index (1993=100)

GERMANY

Real

Current-dollar

Index (1993=100)

ITALY

Real

Current-dollar

Index (1993=100)

JAPAN

Real

Current-dollar

Index (1993=100)

NETHERLANDS

Real

Current-dollar

Index (1993=100)

UNITED KINGDOM

Real

Current-dollar

OECD Organisation for Economic Co-Operation and Development

U.S. Department of Commerce, Bureau of Economic Analysis.
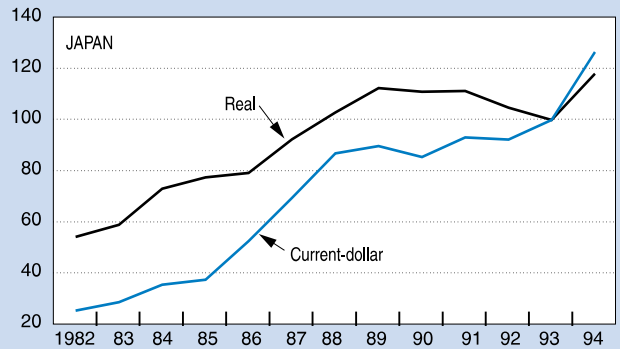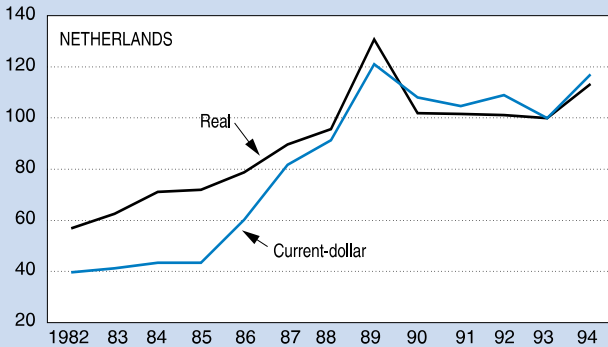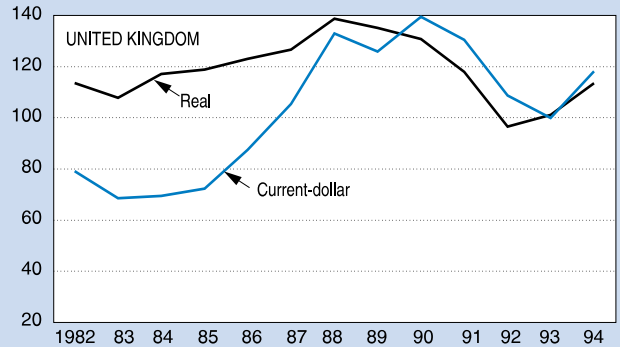
used for the estimates for 19 major host countries that account for over three-quarters of the total gross product of MOFA's in manufacturing. A cruder procedure was used for the estimates for other host countries, because the data needed for the preferred procedure were unavailable.

19 OECD countries.—The estimates of real gross product for the 19 OECD countries were prepared in two steps (chart 4). First, estimates for a base year, 1993, were prepared using PPP exchange rates in place of MER's.

Product-specific, rather than economywide, PPP exchange rates were used because they are considered more appropriate for translating gross product for a particular group of industries, such as manufacturing industries.[10] For the 19 OECD countries, PPP exchange rates for specific final consumption and investment expenditure categories were available from the OECD and were used in deriving the base-year estimates of real gross product for MOFA's in these countries.[11]
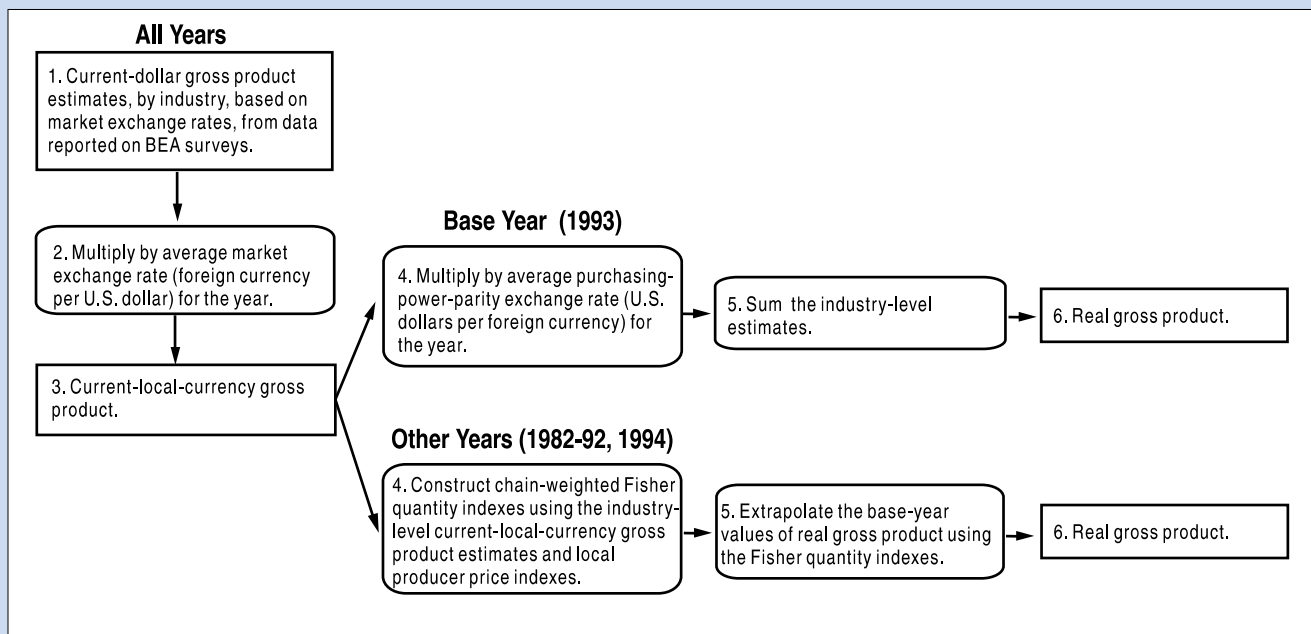
The estimates for the base year were derived as follows (chart 4, "Base Year"). First, the current-dollar estimates for each of the 19 OECD countries and for 7 major manufacturing industries (table 4, column 1) in each country were translated back into current local currency by using the average MER for the year. Second, the estimates for each industry were retranslated into U.S. dollars by using the most appropriate PPP exchange rate (table 4, column 3). Third, the industry-level estimates for each country were summed to produce the base-year estimates by country. Fourth, the estimates for each country were summed to produce the base-year estimate for all 19 countries.

The second step in producing the real gross product estimates was to extrapolate the base-year estimates to other years (1982–92 and 1994) by using chain-weighted Fisher quantity indexes (chart 4, "Other Years"). The current-dollar estimates at the country and industry level were first translated back into current local currency.

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10. See, for example, Peter Hooper, "Comparing Manufacturing Output Levels Among the Major Industrial Countries," in *Industry Productivity: International Comparison and Measurement Issues* (Paris: OECD, 1996).

11. The exchange rates used in this study were published in OECD, *Purchasing Power Parities and Real Expenditures 1993, EKS Results, Volume 1* (Paris: OECD, 1995).

It would have been preferable to use PPP exchange rates that were based on producers' prices rather than on consumers' prices, or that had otherwise been adjusted for differences between expenditure and output prices, but none were readily available. Some analysts, such as Hooper (1996), have attempted to make rough adjustments for some of these factors (such as cross-country differences in distribution margins and indirect taxes).

CHART 4

Derivation of Real Gross Product of Majority-Owned Foreign Affiliates in Manufacturing in 19 OECD Countries

OECD Organisation for Economic Co-Operation and Development

U.S. Department of Commerce, Bureau of Economic Analysis

The resulting estimates by industry were then used, along with country- and industry-specific producer price indexes (table 4, column 2), to construct a chain-weighted Fisher quantity index for each country.[12]

The following Fisher quantity index (Q) was used to estimate the change in the real gross product for MOFA's in a country between any two adjacent years:[13]

$$Q = \sqrt{\frac{\sum p_{i1}q_{i2}}{\sum p_{i1}q_{i1}} \times \frac{\sum p_{i2}q_{i2}}{\sum p_{i2}q_{i1}}},$$

where the p's are prices in local currency, the q's are quantities, the i's are industries, and 1 and 2 are adjacent years.

Because the variables that represent the composites of prices in one period and the quantities in another (such as $p_{i1} q_{i2}$) are not directly observable, the quantity indexes were actually computed using an algebraically equivalent formula consisting of combinations of prices and quantities of the same period (the current-local-currency estimates) and indexes of relative prices in the two periods (the ratios of producer price indexes).[14]

The Fisher quantity indexes were used as the bases for extrapolating the dollar-denominated PPP-based estimates for the base year (1993) to the other years covered (1982–92 and 1994).[15]

12. The industry-specific producer price indexes are from the OECD *Indicators of Industrial Activities* (Paris, OECD, various quarterly issues).

13. A similar equation is used to measure changes in total U.S. gross domestic product. See, for example, "A Look at How BEA Presents the National Income and Product Accounts," SURVEY 76 (May 1996): 36.

14. The rewritten Fisher quantity index is as follows:

$$Q = \sqrt{\frac{\sum \frac{p_{i1}}{p_{i2}} \cdot p_{i2}q_{i2}}{\sum p_{i1}q_{i1}} \times \frac{\sum p_{i2}q_{i2}}{\sum \frac{p_{i2}}{p_{i1}} \cdot p_{i1}q_{i1}}}$$

15. Ideally, the gross product estimates would have been derived using a double-deflation method (applying separate price deflators to output in current local currency and to purchased inputs in current local currency), but source data were not available to use this method. For this reason and because the gross product of MOFA's is calculated from the "income" components (rather than by subtracting purchased inputs from gross output), the quantity index of real output had to be derived by applying a price deflator directly to the current-price gross product estimates.

The estimate for all 19 countries for each year was derived by extrapolating the base-year estimate using a Fisher quantity index that aggregated across countries as well as across industries.[16]

All other countries.—Real gross product estimates for all other countries were derived using a cruder method because of the limited availability of data. The estimates were prepared on the basis of the assumption that MER's tend to maintain purchasing power parity between these countries' currencies and the U.S. dollar. Therefore, the real gross product estimates were derived by simply deflating the current-dollar gross product estimates with the U.S. implicit price deflator for gross domestic product originating in manufacturing.

The assumption that MER's maintain purchasing power parity between currencies is clearly naive, but certain factors precluded the use of the method followed for the 19 OECD countries. First, some of the most important host countries in this group experienced hyperinflation during much of the period being examined, and the use of the available average annual MER's could not be relied upon to produce estimates that approximated the actual local-currency-denominated values.[17] Second, although economywide PPP exchange rates were available for many (if not all) of these countries, PPP exchange rates can be very imprecise and difficult to interpret for pairs of countries—such as the United States and many lower income non-OECD countries—for which the patterns of consumption and production differ so sharply as to almost preclude the construction of a common representative market basket of goods and services.[18] Because of

16. In contrast to the computation of the index for each country, the current-local-currency estimates (such as $p_{i1}q_{i1}$) for each country had to be translated to a common currency before they could be used in computing the index for the 19 countries combined. The current-local-currency estimates for all years (1982–94) were translated to U.S. dollars using the PPP exchange rates for 1993, yielding dollar-denominated series that reflected host-country price conditions. Though not true PPP-based current-dollar series (because they reflected foreign rather than U.S. price conditions), these dollar-denominated series had to be constructed as an intermediate step in deriving an extrapolator for the base-year aggregate.

17. As noted earlier, the data underlying the estimates for such countries typically would have been translated into dollars by MNC's on a daily basis.

18. These limitations notwithstanding, future refinements to the estimates might include incorporating PPP-exchange-rate data for some of these

Table 4.—Categories Within the Manufacturing Industry Used for Price Deflation and Currency Translation

Gross product	Producer price index for foreign countries [1]	Purchasing-power-parity exchange rate [2]
Food and kindred products	Food and beverages	Food consumption
Chemicals and allied products	Chemicals	Total gross domestic product
Primary and fabricated metals	Primary and fabricated metals	Total gross domestic product
Industrial machinery and equipment	Nonelectrical machinery	Nonelectrical equipment investment
Electronic and other electric equipment	Electrical machinery	Electrical equipment investment
Transportation equipment	Motor vehicles	Personal transportation equipment consumption
Other manufacturing	Total manufacturing except petroleum	Total gross domestic product

1. See chart 4, "Other Years," item 4.
2. See chart 4, "Base Year," item 4.

these methodological limitations, real gross product estimates were not produced for these countries individually.

Despite the widespread divergences of MER's from PPP exchange rates, there is reason to believe that the cruder methodology provides reasonable estimates at a highly aggregated level. MER's and PPP exchange rates may tend to converge over the long term, particularly for groups of countries (because the overvaluation of some currencies, in a PPP sense, may tend to be offset by the undervaluation of others).[19] In addition, the real gross product estimates for this group of countries tend to track—with, as would be expected, a lead—long-term changes in MOFA employment during 1982–94.

A Fisher quantity index for extrapolating the base-year estimates of all countries combined was derived using the same data and procedure used to create the index for the 19 OECD countries except that the estimates for all other countries combined were included in the computation as an additional observation.

Appendix: Purchasing-Power-Parity Exchange Rates

To compare gross product among countries, a common unit of measure, such as the U.S. dollar, is needed. To translate gross product estimates denominated in foreign currencies into U.S. dollars for international gross product comparisons, PPP exchange rates should be used, because they approximate the number of foreign currency units required in a foreign country to buy goods and services that are equivalent to those that can be bought in the United States with 1 U.S. dollar.[20]

PPP exchange rates are derived by comparing the domestic prices for goods and services in different countries. For example, in a hypothetical one-good, two-country world economy, the PPP exchange rate would equal the ratio of the price of the good in one country to the price in the other country; if the good sold for 10 currency units in country A and 1 currency unit in country B, the PPP exchange rate would be 10 units of country A's currency to 1 unit of country B's currency. However, in practice, the derivation of PPP exchange rates is much more complex because of the multitude of goods and services produced and because of the differences among economies in the relative importance of those goods and services. To deal with these complexities, PPP-exchange-rate formulas have been developed.

PPP-exchange-rate formulas

Simple two-country, or bilateral, comparisons are the most basic context in which to compute PPP exchange rates. The most widely used bilateral index is the Fisher formula, which is based on the Fisher Ideal Price Index.[21] It is the geometric mean of the own-country-weighted and partner-country-weighted averages of prices (expressed in each country's currency) in the two countries for goods and services—traded and untraded alike—that are consumed in both countries.

The Fisher formula (PPP^F) is

$$PPP^F_{A:B} = \sqrt{\frac{\sum p_{Ai} q_{Ai}}{\sum p_{Bi} q_{Ai}} \times \frac{\sum p_{Ai} q_{Bi}}{\sum p_{Bi} q_{Bi}}},$$

where the i's are individual goods and services, the p's are prices, the q's are quantities, and A and B are countries.

For multilateral comparisons, PPP exchange rates must be derived using formulas specifically designed to ensure that the direct comparison of any two currencies is consistent with all indirect comparisons of those currencies via third currencies. When such consistency exists, the exchange rates are said to have the property of "transitivity." For example, to be transitive, the exchange rate for U.S. dollars to German marks must equal the product of the exchange rate for U.S. dollars to Japanese yen and the exchange rate for Japanese yen to German marks. The multilateral PPP exchange rates that were used in this study are based on a formula that was simultaneously and independently developed in 1964 by Ödön Éltetö and Pál Köves and by Bohdan Szulc.[22] The formula is often referred to simply as the "EKS method."[23]

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countries—particularly those whose economies are relatively advanced and are not experiencing hyperinflation.

19. A study by Craig S. Hakkio identifies a tendency for MER's to converge with PPP exchange rates over the long term. See "Is Purchasing Power Parity a Useful Guide to the Dollar?" *Economic Review*, Third Quarter 1992 (Federal Reserve Bank of Kansas City, 1992): 37–51. James R. Lothian and Mark P. Taylor find a similar result in "Real Exchange Rate Behavior: The Recent Float from the Perspective of the Past Two Centuries" *Journal of Political Economy*, 104, no. 3 (1996): 488–509.

20. MER's are, however, more appropriate than PPP exchange rates for some purposes, such as comparing the dollar-denominated production costs of MNC's in various countries.

21. Irving Fisher, *The Making of Index Numbers* (Boston: Houghton Mifflin, 1922).

22. Ö. Éltetö and P. Köves, "On a Problem of Index Number Computation Relating to International Comparisons," *Statisztikai Szemle* 42 (1964): 507–518 (in Hungarian); B. Szulc, "Indices for Multiregional Comparisons," *Przeglad Statystyczny* 3 (1964): 239–254 (in Polish).

English translations of these articles are being published in the January/February 1997 issue of *Eastern European Economics* 35, no. 1.

23. This formula can be found in László Drechsler, "Weighting of Index Numbers in Multilateral International Comparisons," *Review of Income and Wealth* 19, no. 1 (March 1973): 17–34.

Developing PPP exchange rates

The task of producing a multilateral system of PPP exchange rates is formidable: A list of the goods and services that are common to a group of countries must be defined, and the items being compared must be similar in features and quality; price and quantity data for each item in each country must be collected; and the PPP exchange rates must be calculated.

Pioneering work in this area began in the 1950's.[24] In 1968, the first organized effort to produce PPP exchange rates on an ongoing basis was undertaken by the United Nations under the name International Comparison Project (ICP). The first results of the ICP, covering 1970, were published in 1975.[25] The OECD countries, while continuing to participate in the ICP, began their own program to produce PPP exchange rates for member countries in the early 1980's. The PPP exchange rates used in this article were obtained from the OECD study covering 1993. 📈

24. Milton Gilbert and Irving Kravis, *An International Comparison of National Products and the Purchasing Power of Currencies* (Paris: Organisation for European Economic Co-Operation, 1954).

25. Irving Kravis, Zoltan Kenessey, Alan Heston, and Robert Summers, *A System of International Comparisons of Gross Product and Purchasing Power* (Baltimore: Johns Hopkins University Press, 1975).

For a review and evaluation of the ICP, see Irving B. Kravis and Robert E. Lipsey, "The International Comparison Program: Current Status and Problems," in *International Economic Transactions: Issues in Measurement and Empirical Research*, edited by Peter Hooper and J. David Richardson (Chicago: University of Chicago Press, 1991): 437–64.