

*ECONOMIC RESEARCH REPORTS*

***SPECIALIZATION AND PRODUCTIVITY  
PERFORMANCE IN LOW-, MEDIUM-,  
AND HIGH-TECH MANUFACTURING  
INDUSTRIES***

by Edward N. Wolff

RR# 96-38

October 1996

**C.V. STARR CENTER  
FOR APPLIED ECONOMICS**



NEW YORK UNIVERSITY  
FACULTY OF ARTS AND SCIENCE  
DEPARTMENT OF ECONOMICS  
WASHINGTON SQUARE  
NEW YORK, NY 10003-6687

**Specialization and Productivity Performance  
In Low-, Medium-, and High-Tech Manufacturing Industries**

Edward N. Wolff\*  
October 1996

Abstract. This study makes use of the OECD Structural Analysis industrial database (STAN) to investigate patterns of industry specialization as measured by a country's share of total industry production for 14 OECD countries over the period 1970 to 1993. I find that these industrialized countries tended to specialize manufacturing production in very different industries, and most countries retained their specialization over the period from 1970 to 1993. There is also very little correlation between industries in which the countries are strong in terms of labor productivity. Regression analysis shows that improvement in relative labor productivity is a powerful predictor of a rising market share. The rate of capital formation also plays an important role in the determination of market share for low-tech industries but is less significant for medium-tech industries and not significant for high-tech ones. The results also show that relatively higher labor costs generally reduces competitiveness in a particular industry and hence market share but, somewhat surprisingly, that this effect is statistically significant only among low-tech industries and only in the 1970s.

JEL Codes: O30, O47, O57.

Keywords: Specialization, Productivity, Market Shares

\* The author is professor of economics at New York University. I would like to thank William Baumol, Robert Lipsey, and Dale Jorgenson for very helpful comments and the Alfred P. Sloan Foundation and the C.V. Starr Center for Applied Economics at NYU for their support of the research reported herein.

**Specialization and Productivity Performance  
In Low-, Medium-, and High-Tech Manufacturing Industries**

Edward N. Wolff  
New York University

October 1996

1. Introduction

This paper investigates patterns of industry specialization as measured by a country's share of total industry production for 14 OECD countries over the period 1970 to 1993. It also employs regression analysis to examine the relationship between specialization and relative productivity performance. The study makes use of the 1994 version of the OECD Structural Analysis industrial database (STAN), which subdivides manufacturing into 33 individual industries. Of particular interest are differences in performance between low-tech, medium-tech and high-tech industries, which are classified into groups on the basis of their R&D intensity.

There are three principal questions of interest. First, given the continued convergence of overall productivity and capital intensity in these countries, how similar are the industries of specialization among these countries and have they become more or less similar over this period? Second, do countries have different strengths in terms of labor productivity and do they maintain their relative productivity positions over time? Third, what factors help explain rising or falling market shares in individual industries?

I find that despite the continued convergence of aggregate productivity and factor abundance, these countries tended to specialize manufacturing production in different industries and to maintain specialization in the same industries in 1993 as in 1970. They also tended to be strong in different industries in terms of labor productivity performance, but correlations over time in relative industry labor productivity performance within country are considerably weaker than those for market shares.

Despite the apparent differences in stability of market shares and relative productivity performance over time, the results show that improvement in relative labor productivity is a powerful predictor of a rising market share. This result holds across all industry groups. The rate of capital formation also plays an important role in the determination of market share for low-tech industries but is less significant for medium-tech industries and not significant for high-tech ones. The results also show that relatively higher labor costs generally reduces competitiveness in a particular industry and hence market share but, somewhat surprisingly, that this effect is statistically significant only among low-tech industries and only in the 1970s.

The remainder of the paper is organized as follows: The next section (section 2) will consider some general guidance from trade theory and review some related research on this issue. Section 3 presents descriptive statistics on specialization and section 4 on the productivity performance of OECD countries over the time period. In Section 5, I present regression results on the relation between production shares and technology indicators. Concluding remarks are made in the last part.

## 2. Theoretical Background

There are two principal approaches found in trade theory which are employed to explain why different countries will specialize production in different industries. The first is the Heckscher-Ohlin (HO) model with factor-price equalization. It makes very sharp predictions about cross-country patterns in labor and total factor productivity at the industry level: namely, that industry productivity levels should be the same in all countries. As a consequence, industries of specialization depend only on relative factor

abundance -- a country will specialize in those industries which use more intensively the factor which is relatively abundant in that country.

Leamer's (1984) empirical study of trade patterns for over 100 economies found that general patterns could be explained fairly well by an endowment-based model with 10 factors, including capital, several types of natural resources and land, and three skill classes of labor. However, it should be noted that in that study manufacturing was disaggregated into only four industry classifications, and the model was considerably more successful at explaining trade in primary products than trade in manufactures. Those results are consistent with the argument that the broad pattern of exports -- primary versus secondary goods, heavy versus light manufactures -- can be explained by general factor endowments, but the specific pattern of exports of manufactures at a more disaggregated level depends on industry-specific factors that do not depend largely on resource endowments.

The second approach emphasizes the role of increasing internal returns to scale (IIRS) and learning-by-doing in the formation of comparative advantage. The underlying theory was developed by Krugman (1979, 1980), Helpman (1984), and Helpman and Krugman (1985), and later expanded in Gomory (1992) and Gomory and Baumol (1992). This line of analysis suggests that it is the presence of economies of scale and/or high startup costs that allow different countries to achieve specialization in different products. The country that enters a new product line first may be able to dominate that line by increasing production to the point at which its costs are so low that potential new competitors are unable to enter the field successfully (at least, without dramatic innovations or sufficient subsidies from their government). Even more important is the accumulation of specialized knowledge that is acquired only by being in the industry. This may include knowledge of the details of production steps, as

well as specialized skills that are mainly acquired on the job, knowledge of marketing channels, and a knowledgeable sales force that is known to customers. This process is also referred to as "learning-by-doing", since the firm or country that first establishes an industry may be able to descend the cost curve by acquiring the expertise that comes through experience in making the product (see Arrow, 1962).

Which industries a country may specialize in may depend on history, and a variety of influences, some of them perhaps fortuitous (for an illuminating discussion of the process, see Krugman 1991). Moreover, an important role can be played by the availability or unavailability of ancillary industries that can substantially facilitate a country's success in the production of some particular product or type of products. Geographical externalities may also play an important role, since once an industry is established in a country or place, there is greater likelihood of suppliers and customers also specializing there. This approach suggests that leadership positions may persist for long periods of time, thus ensuring relatively stable industry specialization over time.

In earlier work with David Dollar (Dollar and Wolff, 1993), we found strong evidence of convergence on the economy-wide level in GDP per worker, the capital-labor ratio, aggregate labor productivity, total factor productivity (TFP), and average real wages for a sample of 9 OECD countries covering the period from 1970 to 1986. We also examined the same variables for 9 manufacturing sectors and found that, except for real wages, convergence at the industry level was generally not as strong as that for the economy as a whole. In fact, aggregate convergence in labor productivity was to some extent attributable to the modest labor productivity leads that different countries enjoyed in different industries. The results are similar for TFP and capital intensity.

A further result of this development is that the export patterns of the industrial countries were not converging or becoming more similar. This result is consistent with our conclusion that specialization has continued at the industry level in the advanced industrial countries. Moreover, in a bilateral comparison of Japan and the U.S., a clear relationship is evident between TFP growth at the industry level and changing comparative advantage. The industries in Japan with growing comparative advantage over this period tended to be those in which its TFP relative to the U.S. increased rapidly. We argued that TFP captures some influence that contributes to comparative advantage, and this factor is likely to be technology as disembodied knowledge, as embodied in machinery, or as reflected in skilled labor.

These earlier results seem less in accord with an a HO type of model than one based on IIRS. HO theory suggests that convergence in aggregate performance, particularly aggregate capital-labor ratios, should be accompanied by a convergence in the trade patterns of these countries. The IIRS approach, in contrast, emphasizes technology differences between countries as the basis of specialization and suggests that trade patterns may shift in accordance with movements in productivity levels.

In this paper I examine whether these results hold up for a larger sample of countries, a more detailed industry classification, and a longer time period. Moreover, using econometric techniques, I analyze more formally the relation between comparative advantage as reflected in a country's market shares in individual industries and relative productivity performance.

It should also be noted that the convergence of real wages at the industry level, found in Dollar and Wolff (1993), greatly strengthens the notion that productivity growth should be an important determinant of changing comparative advantage. Those results imply that among OECD countries

differences in the cost of labor (and, to some extent, capital) were not important determinants of differences in unit costs by the 1980s.<sup>1</sup> Given the similarity in factor prices, trends in relative productivity then may become more crucial determinants of cost competitiveness and production share.

### 3. Convergence of Production Patterns?

In this section I investigate whether industrial production patterns of developed countries have tended toward convergence over the last two decades. I use the 1994 OECD STAN database, available on diskettes. The time period covered is 1970 to 1993. This source provides statistics on value added, which is measured in both current and 1985 local prices;<sup>2</sup> gross capital formation in current prices (though this version unfortunately lacks capital stock data); total employment; employee compensation;<sup>3</sup> and PPP conversion factors for each country and year (though not available on the industry level). Data on each of these variables are provided on the industry level -- a total of 33 manufacturing industries -- though they are not available for non-manufacturing sectors. The STAN database has relatively complete data on 14 OECD countries -- Australia, Belgium, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, Norway, Sweden, the United Kingdom, and the United States.<sup>4</sup>

Comparisons of output among the countries is made on the basis of value added by industry in 1985 local currency converted to 1985 U.S. dollars on the basis of the 1985 PPP rate for that country. This is problematical for two reasons. First, gross output (sales) is the preferable measure to use when computing market share. Second, ideally, conversion to a common currency should be made on the basis of industry-specific PPPs for each country, as is the practice in the ICOP project (see, for example, Maddison and van Ark, 1989).

Despite these limitations, calculations of production shares based on value added are very highly correlated with those calculated from gross output among the industries and countries for which the data exist (correlation coefficients are of the order of 0.95 to 0.98). Second, since manufactures are generally tradables, there is some presumption that local prices will tend toward equilibrium international prices of individual industries. Third, in most of the analysis -- particularly the econometric applications -- I am interested in changes over time in production shares and related variables. Thus, insofar as biases tend to remain stable over time (for example, percentage differences between industry-specific and overall PPPs for a given country), then the biases will "wash out" in equations that use first differences.

I begin (in Table 1) with measures of production shares (PRODSHR) for 33 manufacturing industries in the three largest economies, Germany, Japan, and the U.S. The production share for country  $h$  in industry  $i$  is defined as:

$$(1) \quad \text{PRODSHR}_i^h = Y_i^h / \sum_h Y_i^h$$

where  $Y_i^h$  is country  $h$ 's production of good  $i$  valued in 1985 U.S. dollars, and output is based on value added by industry. The aggregation over  $h$  covers the 14 countries in the STAN database with the requisite data, so that the index shows country  $h$ 's share of the total production of product  $i$  among the 14 countries.

The 33 industries selected are the most detailed ones available with the requisite data. They are all three-digit ISIC industries, with the exception of transport equipment, which is available on the four-digit level. These industries are divided into three technology groups on the basis of the average R&D intensity of production of these industries in OECD countries in

1985, as follows: low-tech -- less than 0.5 times the mean R&D intensity; medium-tech -- from 0.5 to 1.5 the mean R&D intensity; and high-tech -- over 1.5 the mean R&D intensity.

In 1970, Germany accounted for 14 percent of total manufactures of this group of 14 countries, Japan 13 percent, the U.S. 40 percent, and the three together two-thirds. Germany's share of total manufacturing was considerably greater than its share of 14-country GDP (14 versus 9 percent); Japan's share almost identical to its GDP share (13 percent); whereas the U.S. manufacturing share was smaller (40 versus 45 percent).

In 1970, Germany's manufacturing was particularly strong in petroleum refineries (28 percent), petroleum and coal products (22 percent), industrial chemicals (19 percent), motor vehicles (17 percent), electrical machinery (17 percent), and professional goods and scientific instruments (21 percent). Japan's strengths were in food products (20 percent), plastics (22 percent), glass and glass products (21 percent), motor vehicles (18 percent), and other transport equipment (27 percent). The U.S. accounted for about half of the total 14-country output of tobacco products, wood products, paper and paper products, petroleum and coal products, other chemical products, including pharmaceuticals, electrical machinery, and professional goods and scientific instruments and three-fourths of the production of aircraft. Generally speaking, in 1970, the U.S. dominated the high-tech industries, particularly aircraft; both Germany and Japan were strong in the medium-tech transport equipment industries, such as motor vehicles; and the three countries each specialized in different industries within the low-tech group.

The fourth column shows the leading producer in each industry in 1970. It is, perhaps, not surprising that the U.S. dominated almost all industries (29 out of 33) in 1970, since it was by far the largest economy. However,

Germany was the leading producer of beverages, Italy of pottery and china and motorcycles and bicycles, and Japan of other transport equipment.

Between 1970 and 1993, both Germany's and the U.S.' share of total manufacturing production declined by three percentage points whereas Japan's share increased sharply, by 10 percentage points. By 1993, Japan's manufacturing output was more than double Germany's and over 60 percent the level of the U.S. Germany's share of output remained the same or fell in almost every manufacturing industry. The U.S.' share likewise remained unchanged or declined in almost all industries, with the major exception of textiles (28 to 36 percent), wearing apparel (36 to 41 percent), plastics (33 to 38 percent), and non-electrical machinery, including office and computing machinery (38 to 45 percent).

Japan's share, on the other hand, increased in most of the industries -- notably, electrical machinery, including radios, TV, and communication equipment (from 2 to 40 percent), rubber products (rising from 9 to 20 percent), iron and steel (from 16 to 29 percent), shipbuilding (16 to 31 percent), motor vehicles (18 to 29 percent), motorcycles and bicycles (19 to 30 percent), and other transport equipment (27 to 39 percent). Japan's inroads were particularly marked in the medium-tech and high-tech industries. In contrast, Germany basically held its production shares in the medium-tech industries but declined in the high-tech and low-tech industries. The U.S. made its major gains in low-tech industries, such as food, apparel, and wood products; lost share in the medium-tech industries; but retained its share in the high-tech industries.

Despite the major gains of Japanese manufacturing, the U.S. still lead all producers in 1993 in 24 out of the 33 industries. Japan was dominant in four industries -- particularly, shipbuilding, transport equipment, and

electrical machinery; Italy in four -- leather products, footwear, pottery and china, and motorcycles and bicycles; and Germany in only one.

The bottom four rows of Table 1 show the correlation and rank correlation between the distribution of production shares between the countries. There are, of course, statistical problems using a correlation coefficient between two distributions, since the individual elements in each distribution are not independent. In particular, if one share is high, one or more others must be low, since the sum of productions shares within industry and across countries must equal 1.0. The same is true for the ranking of industries. However, the correlation coefficient and the rank correlation do provide rough measures of the similarity between two distributions. What is, perhaps, most striking is the low correlation coefficients among the three countries -- in 1970, 0.07 between Germany and the U.S., -0.57 between Japan and the U.S., and -0.33 between Germany and Japan, and in 1993, -0.06, -0.42, and -0.23, respectively. The rank correlations are similar. The three countries have specialized production in distinctly different industries and there has been very little change over time in the degree of dissimilarity in their patterns of specialization.

While productions shares reveal which countries are the major producers in each product line, they are not a good indicator of specialization since they also reflect the overall size of the economy. A better indicator of specialization is the share of the total production of a given commodity made in an individual country relative to its share of GDP:

$$(2) \quad \text{RELPSHR}_i^h = [Y_i^h / \sum_h Y_i^h] / (\text{GDP}^h / \sum_h \text{GDP}^h)$$

where the GDP figures, obtained from the OECD ISDB, are in 1985 U.S. dollars. This index is analogous to Balassa's Revealed Comparative Advantage (RCA)

measure (Balassa 1965), which is used to measure trade specialization. The numerator of RELPSHR indicates country h's share of the total production of industry i, while the denominator measures country h's share of total GDP for these 14 countries. A value above (below) 1 indicates that country h's share of the group's total production of product i is higher (lower) than its share of the total GDP of this group. This index indicates in which product lines a country's production are concentrated, which is taken as a measure of specialization. In general, some values of RELPSHR for a country will be greater than 1, while others will be less than 1.<sup>5</sup>

Calculations of RELPSHR for Germany, Japan, and the U.S. are shown in Table 2. The rank order of industries within each country is the same as for PRODSHR but the relative magnitudes across countries are quite different. The specialization of Germany in beverages, petroleum refineries, petroleum and coal products, industrial chemicals and professional goods and scientific instruments in 1970 is now apparent (all values of RELPSHR exceed 2.0), as well as in motor vehicles and electrical machinery (both values exceed 1.8). Japan in 1970 was particularly strong in plastics, glass and glass products, and other transport equipment (all values above 1.6). The U.S.' major specialization was aircraft (a value of 1.7).

The specialization patterns are quite different with this new measure. In 1970 Germany had the highest relative production shares among all 14 countries in total manufacturing, all the high-tech industries except aircraft, motor vehicles, and 7 low-tech industries. Italy had the highest value in 5 industries, including textiles, wearing apparel, footwear, and motorcycles and bicycles. Japan was the leader in only one industry (food products), the U.S. in only one (aircraft), Belgium in 3, including industrial chemicals, Sweden in one (wood products), Finland in one (paper and paper

products), Norway in two, including shipbuilding, Australia in two, including railroad equipment, and Denmark, the Netherlands, and the U.K. each in one.

By 1993, Germany remained extremely specialized in only three industries, including motor vehicles, and the U.S. in only aircraft, while Japan was now highly specialized in iron and steel, shipbuilding, motor vehicles, motorcycles and bicycles, other transport equipment, and, especially, electrical machinery (all values above 1.6). Japan now had the highest relative production share in total manufacturing, and in two high-tech industries, non-electrical machinery and electrical machinery, as well as other manufactures. Italy had the highest value in eight industries; the U.K. and Germany in three; the Netherlands, Finland, Belgium, and Australia in two; and Sweden, France, Denmark, Canada, Norway, and the U.S. in one.

I next investigated what has happened to the cross-country dispersion in relative production shares. The first three columns of Table 3 show the coefficient of variation in country values of RELPSHR for each industry. If countries were becoming more alike in their patterns of production, then the coefficient of variation should decline over time. There is no noticeable trend in this direction. Between 1970 and 1993 dispersion in the low-tech group of industries increased in 13 industries and decreased in 10; in the medium-tech group, it rose in 4 and fell in 1; while in the high-tech group, dispersion grew in only 1 and declined in 4. By 1993, the industries with the highest dispersion (coefficients of variation exceeding 0.9) were tobacco products, textiles, leather products, footwear, pottery and china, motorcycles and bicycles, other transport equipment, and aircraft. Those with the smallest dispersion (coefficients of variation less than 0.4) were food, beverages, printing and publishing, plastics, non-metal products, metal products, other chemical products, and non-electrical machinery. Both sets of industries span the gamut between low-tech and high-tech enterprises.

It is also of interest that changes in the degree of specialization were more pronounced between 1979 and 1993 than between 1970 and 1979. In the earlier period, the coefficient of variation changed by more than 0.10 in only 6 industries, whereas in the later period this occurred in 16 industries. This seems to accord with casual observation that much more industrial restructuring occurred during the 1980s than in the 1970s.

One unfortunate property of the RELPSHR measure is that it is both asymmetric and highly skewed, with a range from zero to infinity. As a result, industry production shares greater than average receive greater weight in the computation of the coefficient of variation than those less than average (which range in value from 0.0 to 1.0). An alternative measure is the  $\text{LN}(\text{RELPSHR})$ , the natural logarithm of RELPSHR, which has a more normal distribution and gives equal weight to below and above average production shares. Moreover, since the mean of  $\text{LN}(\text{RELPSHR})$  is close to zero, I have used the standard deviation of  $\text{LN}(\text{RELPSHR})$  in Table 3, rather than its coefficient of variation to measure cross-country dispersion.<sup>6</sup> Results are very similar for the two measures of dispersion. The standard deviation of  $\text{LN}(\text{RELPSHR})$  increased in 15 industries over the 1970 to 1993 period, declined in 15, and remained constant (a change of 0.01 or less) in 3.

One reason why the degree of specialization among manufacturing industries may have changed relatively little is that countries are maintaining specializations in different industries. To examine this idea further, Table 4 lists for each country in 1993 the industries with the highest and lowest RELPSHR indices. Inspection of this table indicates that these countries' production are generally concentrated in different industries. In general, if the RELPSHR for industry  $i$  is high in one country, it is low somewhere else. But there is no algebraic constraint on two or

three countries having similar RELPSHR values. In 1993, Australia's production relative to its GDP was most heavily concentrated in railroad equipment, as was Denmark's; Belgium's in industrial chemicals; Canada's in transport equipment; Finland's and Sweden's in paper and paper products; France's in petroleum refineries; Germany's and the Netherlands' in tobacco products; Italy's in footwear; Japan's in electrical machinery; Norway's in shipbuilding; the U.K.'s in beverages; and the U.S.' in aircraft.<sup>7</sup>

The absolute size of the RELPSHR values is also of interest; small differences in production patterns would be indicated by RELPSHR values that deviate little from 1. In Table 4, however, there are quite a few in the 2 - 8 range, indicating very substantial specialization, especially for the smaller economies. The high degree of specialization for the relatively small economies suggests that economies of scale may be important, either in direct production, or, more likely, in development of the specific capabilities such as knowledge and skilled labor needed to produce particular manufactures.

It is also striking that most countries retain their specialization over time. Table 5 shows correlation coefficients of both RELPSHR and LN(RELPSHR) values by industry between 1970 and 1979, and between 1970 and 1992. The correlations are generally stronger for the latter measures, because, as noted above, the logarithmic form gives equal weight to industries in which production is very high and those in which production is very low. With only a few exceptions, these correlations remain very high over time. Between 1970 and 1979, the correlation coefficients of the logarithmic measure are 0.88 or greater for all 14 countries; and between 1970 and 1993, they are 0.79 or higher for 10 of the 14 countries. The exceptions are Belgium, Japan, Sweden, and the U.K. (though even among them, the correlations exceed 0.60).

Rank correlations are also shown. They are almost as strong for the 1970-79 period as the correlations of LN(RELPSHR), exceeding 0.85 for all 14

countries. However, they are weaker for the 1970-93 period, exceeding 0.70 for 10 countries, in the range of 0.58 to 0.69 for the other four countries (Finland, Japan, Sweden, and the U.K.). These results again suggest greater industrial restructuring in the 1980s than the 1970s.

Though countries tend to retain their industries of specialization over time, it is still possible that the production structures of countries have become more alike over time. This is a difficult issue to test formally. In Table 6, I have presented two ways of looking at the question. The first three columns show the correlation in  $\text{LN}(\text{RELPSHR})$  between the U.S. and other countries, calculated across industries. The correlations were positive for only 3 of the 13 countries in 1970, and only in one case (France) did the correlation exceed 0.20. However, in 1993, the correlations were positive for five countries and exceeded 0.20 for two (France and Denmark). Moreover, between 1970 and 1993, the correlation coefficients increased for all but three countries. The results do suggest that other countries have been growing more similar in their industrial structure to the U.S. over the period, though even by 1993 most countries still had very different industries of specialization than the U.S.

This measure is, unfortunately, problematic for two reasons. First, the U.S.' production structure may itself be unusual, so that changes in the correlation coefficient may reflect mainly changes in the U.S. production structure over time. Second, there is a bias toward showing negative correlations because if the value of  $\text{RELPSHR}$  is high for the U.S. it must, of necessity, be low for other countries. An alternative measure, the sum of squared values of  $\text{LN}(\text{RELPSHR})$ , where the summation is performed across industries within country, is also shown in Table 6. This measure has the virtue, at least, of comparing each country's industry production with the

cross-country average production of that industry. Since the cross-country average value of  $\text{LN}(\text{RELPSHR})$  is generally zero (the average value of  $\text{RELPSHR}$  is close to one), the sum of squared values is similar to a variance measure, showing how different a country's industry production is from the average of the 14 countries.<sup>8</sup> If countries are becoming less specialized over time, then their production structure should be converging on the overall average of the countries, and this index should decline.

In 1970, Denmark was the most specialized country, according to this index, followed by Norway and Canada, and the U.K. the least specialized. It is noteworthy that these indices remain relatively stable over time, with the exception of Japan, for whom the index declines from 18.3 in 1970 to 12.1 in 1993, Norway (it increases from 49.7 to 58.7), and Sweden (from 13.1 to 18.6). The total sum of squares (summed across all countries) is almost identical in 1970 and 1993 (about 382 in both years), though it does fall somewhat between 1970 and 1979 and then rises in the second period.

The general stability in industries of specialization over time would lend support to the IIRS approach and tend to contradict HO type models. The IIRS model stresses the advantages of initial leadership in an industry and the consequent cost reduction emanating from increased production volume. In contrast, the HO model would predict that specialization among the advanced countries would become less marked over time as their relative factor abundance converged. The coefficient of variation in the overall capital-labor ratio (computed from the OECD International Sectoral Database or ISDB) among these 14 countries fell from 0.28 in 1970 to 0.17 in 1992. Despite the growing similarity in relative factor abundance, these countries tended to maintain specialization in the same industries in 1993 as in 1970.

#### 4. Labor Productivity Differences.

I next turn to a comparison of industry labor productivity levels among the same 14 countries. Here there are more problems with missing data, particularly for the transport equipment sub-sectors (ISIC codes 3841 to 3849). Let us first define the labor productivity level, LP, of industry i in country h as:

$$(3) \quad LP_i^h = Y_i^h / L_i^h$$

where  $L_i^h$  is total employment in industry i in country h. The (weighted) average labor productivity of industry i in the 14 countries is given by:

$$\overline{LP}_i = \sum_h Y_i^h / \sum_h L_i^h$$

In analogous fashion to RELPSHR, I also compute

$$(4) \quad RELLP_i^h = LP_i^h / \overline{LP}_i$$

which show productivity in industry i of country h relative to the average productivity in industry i of the 14 countries.

In 1970 U.S. labor productivity in total manufacturing was about 50 percent greater than in Germany and more than double Japan's (see Table 7). U.S. productivity was above average in every industry except beverages and particularly high in tobacco, wood products, paper products, rubber products, iron and steel, industrial chemicals, transport equipment, other chemical products, electrical machinery, and professional goods. Germany's labor productivity was above average in 12 of the 28 industries and exceptionally high in petroleum refineries and petroleum and coal products. Japanese labor productivity exceeded the international average in 7 industries and was particularly strong only in beverages, wearing apparel, leather products, and

glass products -- all low-tech industries. The U.S. led all countries in terms of labor productivity in 12 of the 28 industries, including three out of the four high-tech ones; Germany in 2, Japan in only one (wearing apparel). Canada lead in 4, Australia and Belgium in 3, Italy in 2, and the U.K. in one.

By 1993, Japan had surpassed Germany in labor productivity in total manufacturing, but U.S. productivity was still a third greater than Japan's and 50 percent greater than Germany's. Germany's labor productivity remained high in petroleum refineries and petroleum and coal products; Japan's labor productivity was unusually strong in iron and steel, non-ferrous metals, shipbuilding, miscellaneous manufactures, and other transport equipment; and the U.S. in textiles, wood products, rubber products, metal products, other chemical products, non-electrical machinery, and professional goods. Though the U.S. remained the overall leader in labor productivity in total manufacturing, its lead was cut to only 8 of the 33 industries (excluding 384, transport equipment), though this included four of the five high-tech industries. Belgium led in 8 industries, Italy in 6, France in 5, and Germany, Japan, Australia, Norway, and Finland in one.

It is also of note that there was very little correlation in industry labor productivity between Germany, Japan, and the U.S. The correlation coefficients in industry RELLP for both 1970 and 1993 are negative in every case (the rank correlations are negative in all but one case). These results indicate that the three countries were strong in different industries not only in terms of relative production shares but also in terms of productivity performance.<sup>9</sup>

Table 8 shows the cross-country coefficient of variation in industry RELLP by industry. Considerable convergence had already been achieved in the overall level of labor productivity in total manufacturing among the 14

countries by 1970. The coefficient of variation for 1970 is 0.25, compared to 0.36 in 1963 (see Dollar and Wolff, 1993, p. 52). There was still some additional convergence after that, with the coefficient of variation declining to 0.21 in 1979 and 0.19 in 1992.

On the individual industry level, the time patterns are quite different. Between 1970 and 1979, the coefficient of variation declined in 19 of the 29 industries, increased in 7, and remained constant in the other 4, while from 1979 to 1992, the index declined in 13 industries, rose in 15, and stayed the same in one. Convergence in labor productivity on the industry level was thus much spottier than for total manufacturing over the period 1970 to 1993.<sup>10</sup>

Another striking finding is that the actual value of the coefficient of variation is substantially higher in every industry (except one in each year) than the corresponding value for total manufacturing. For over half of the industries, the index is more than 50 percent greater than that for total manufacturing. These results clearly support the argument that convergence in overall labor productivity in manufacturing has been achieved to a large extent through country's specializing in different industries both in terms of production shares and productivity levels. This has been especially the case in the 1980s.

Correlations over time in industry relative labor productivity levels are shown by country in Table 9. They are quite high for the period 1970 to 1979, exceeding 0.70 in all 14 countries, 0.79 on 12 countries, 0.88 in 5. Rank correlations are quite similar. In contrast, the correlations are much weaker for the period 1979 to 1992, exceeding 0.60 in only 7 countries. In the case of Canada, Denmark, and the Netherlands, the coefficients fell below 0.30 and are not statistically significant. The rank correlations are even weaker for this period, exceeding 0.60 in only one case.

These results indicate that high performance in terms of productivity can erode over time, and poor performance in this dimension can likewise improve. It is also of note that correlations are much weaker for relative industry productivity performance than for industry production shares, particularly for the 1979-92 period. This suggests that there may be other factors, such as resource endowments and specialized skills, which contribute to competitive advantage and industry specialization but are not captured in standard productivity measures and that these factors may remain more stable over time than labor productivity.

Another important difference between relative productivity performance and production share is that whereas countries have generally retained their industries of specialization in terms of production over the period 1970 to 1993, they have become less differentiated in terms of labor productivity. Evidence for this is given in the last three columns of Table 9, where I have computed the sum of squared values of industry values of  $\text{LN}(\text{RELLP})$  for each country. If countries are becoming more similar to the overall (weighted) average in terms of labor productivity, then this index should decline. It is of note that all countries show a decline in the value of this measure between 1970 and 1992, with the exception of France, Norway, and Sweden. Declines are particularly marked for Belgium, Finland, and Japan (15.3 to 4.0). The total sum of squared values (summed across all countries) also shows a pronounced decrease, from 117.3 in 1970 to 95.8 in 1979 and 86.4 in 1992.

##### 5. Changes in Relative Production Share and Productivity Growth

On the surface, at least, there appears to be very little correlation between  $\text{RELPSHR}$  and  $\text{RELLP}$ . The U.S., for example, led in terms of labor productivity in a dozen or so industries but had the highest relative

production share in only one, aircraft (see Tables 2 and 7). The reason is that the larger economies tend to be more diversified than the smaller ones, so that they are not as likely to have as many high values of RELPSHR. As a result, the high labor productivity of the U.S. and Japanese manufacturing industries does not necessarily translate into large relative production shares. In fact, the simple correlation coefficient between RELPSHR and RELLP across all industries and countries is only 0.33 for 1970, 0.35 for 1979, and 0.40 for 1992. However, there may still be a close relationship between changes in relative productivity levels and changes in relative production shares.

The linkage between changes in production share and productivity growth at the industry level is not an easy question to formalize. The reason is that the productivity growth of a particular industry in a particular country should be considered relative to the same industry in other countries and to other industries within the same country. In other words, rapid productivity growth may have no effect on relative production share if it is occurring in the same industry in every country. At the same time, rapid productivity growth in every industry of one country will also have little effect on relative production share since it would not enhance the competitiveness of any industry relative to other industries in the economy.

We now turn to regression analysis to provide a formal analysis of these relations. Two estimating forms are used. The first is:

$$(5) \quad \text{DRELPSHR}_i^h = b_0 + b_1 \cdot \text{DRELLP}_i^h + b_2 \cdot \text{DRELWAGE}_i^h + b_3 \cdot \text{RELKFL}_i^h + \epsilon_i^h .$$

DRELPSHR is the change in the natural logarithm of RELPSHR (relative production share) in industry  $i$  and country  $h$ , and DRELLP is the change in the natural logarithm of RELLP (relative labor productivity) in industry  $i$  and

country  $h$ .  $DRELWAGE_i^h = \Delta[\ln(w_i^h/\bar{w}_i)]$ , where  $w_i^h$  is the average wage (in current U.S. dollars) in industry  $i$  and country  $h$  and  $\bar{w}_i$  is the (weighted) average wage in industry  $i$  among the 14 countries. The conversion to U.S. dollars is based on the actual market exchange rate.

The variable  $DRELKFL_i^h = \ln(kfl_i^h/\bar{kfl}_i)$ , where  $kfl_i^h$  is the ratio of average capital formation (kf) in 1985 U.S. dollars to average employment (l) over the period in industry  $i$  and country  $h$ , and  $\bar{kfl}_i$  is the ratio of the (weighted) average capital formation in industry  $i$  among the 14 countries to the (weighted) average employment in industry  $i$  among the 14 countries.<sup>11</sup> The term  $\epsilon_i^h$  is a stochastic error term, which is assumed to be independently but may not be identically distributed. The regressions reported in Tables 11 and 12 below were estimated using the White procedure for a heteroschedasticity-consistent covariance matrix.

The logarithmic form is used for the dependent variable RELPSHR, because the variable, as noted above, is highly skewed, with a range from zero to infinity, while the logarithm is more normally distributed. The rationale for using first differences for RELPSHR is that industry specialization may be highly dependent on historical developments in a country, as well as its resource base. The levels equation can thus be interpreted as a fixed effect model, and first differencing allows us to remove the unobservables from the equation.

Another rationale for using the first difference form is that relative productivity growth is likely to be measured with greater accuracy than relative productivity levels. The reason is that comparing productivity levels across countries is sensitive to the choice of price deflators and PPP exchange rates. If there are biases in the productivity level estimates, there is a good chance that these biases are relatively stable over time, so

that relative productivity growth rates may be measured with less error than relative productivity levels.

The coefficient  $b_1$  is predicted to have a positive sign. The coefficient  $b_2$  is predicted to have a negative sign, since relatively higher labor costs in a country, measured on the basis of the market exchange rate, should reduce that country's competitiveness in that industry and hence its production share. The coefficient of RELKFL is predicted to have a positive sign. The rationale is that new technology may be embodied in new capital investment, so that greater capital formation relative to employment should be associated with more modern technology in an industry, and therefore with lower costs and greater competitiveness.

The second form is:

$$(6) \quad \text{DRELPSHR}_i^h = b_0 + b_1 \cdot \text{DRELLPC}_i^h + b_2 \cdot \text{DRELWAGC}_i^h + b_3 \cdot \text{RELKFLC}_i^h + \epsilon_i^h .$$

$\text{DRELLPC}_i^h = \text{DRELLP}_i^h - \Delta[\text{Ln}(\overline{\text{LP}}^h/\overline{\text{LP}})]$  where  $\overline{\text{LP}}^h$  is the average labor productivity in country  $h$  (the ratio of GDP to total employment) and  $\overline{\text{LP}}$  is the weighted average labor productivity of the 14 countries (the ratio of total GDP to total employment in the 14 countries).  $\text{DRELLPC}_i^h$  thus shows how an industry's productivity performance in a given country relative to the average productivity performance of that industry compares to the country's overall productivity performance relative to the overall average productivity performance of the 14 countries. The variables  $\text{DRELWAGC}_i^h$  and  $\text{RELKFLC}_i^h$  are defined in like fashion:  $\text{DRELWAGC}_i^h = \text{DRELWAGE}_i^h - \Delta[\text{Ln}(\overline{w}^h/\overline{w})]$  and  $\text{RELKFLC}_i^h = \text{RELKFL}_i^h - \text{Ln}(\overline{kfl}^h/\overline{kfl})$ . The second form is the preferred specification since it accords more closely to the underlying theory. The predictions for the coefficients  $b_1$ ,  $b_2$ , and  $b_3$  are the same as for the first specification.

It should also be noted that there are econometric difficulties with the specifications in equations (5) and (6). By construction, there may be introduced a correlation between RELPSHR and RELLP, since in both cases the numerator is the industry's production share. Therefore, any errors in measurement in industry output will bias the coefficient estimates. Moreover, the two variables are likely to be pro-cyclical, which will cause the same problem to arise. As a result, it would be desirable to use instrumental variables to perform the actual estimation, though, at the moment, no suitable instrument appears to be available.

Regressions are run separately for the 1970-1979 period and the 1979-1993 period. Besides the full set of industries, regressions are run separately on low-tech, medium-tech, and high-tech industries. Moreover, equation (5) is run with one variation, which is to substitute, KFL, the ratio of average capital formation to average employment over the period, for RELKFL. Results for equation (5) are shown in Table 10 and those for equation (6) in Table 11.

The results show a very strong relation between the log change in relative production share (DRELPSHR) and the log change in labor productivity relative to the industry average (DRELLP). The coefficients are all positive and significant at the one percent level except among medium-tech industries in the 1970-79 period. Likewise, the results in Table 11 show an equally strong relation between DRELPSHR and the log change in labor productivity relative to both the industry and country average (DRELLPC). These coefficients are all positive and significant at the one percent level except among high-tech industries in the 1970-79 period.

The coefficient values can be interpreted as elasticities. Among all industries, a one percent increase in an industry's labor productivity relative to the international industry average is associated with about a 0.65

percent gain in the industry's market share. A one percent increase in the industry's labor productivity relative to both the international industry average and the country average is associated with a 0.25 percent gain in the industry's market share in 1970-79 and a 0.41 percent gain in 1979-93.

Wage changes relative to the international industry average (DRELWAGE) has a negative coefficient in every case. For the 1970-79 period, DRELWAGE is significant at the one percent level among all industries and among the low-tech group but not statistically significant among medium-tech and high-tech industries. For the 1979-92 period, the coefficient is significant in only one case -- at the five percent level among low-tech industries. In contrast, the coefficient estimates for DRELWAGC, wage growth relative to both the industry and country average, is significant in only one case -- at the five percent level among medium-tech industries in the 1979-93 period. These results suggest that relative labor costs played a strong role in determining a country's relative production share only among low-tech industries during the 1970s. The effect was very weak during the 1979-93 period. Moreover, it also appears that industries in a given country tend to lose market share if their wages are growing faster relative to the international industry average, not the country average, than the same industry in other countries.

Average investment per worker has a uniformly positive effect on relative production share. The results are generally significant among all industries and among low-tech industries as a group but less significant among medium-tech industries and not significant at all among high-tech industries. RELKFL, average capital formation per worker, relative to the industry average, is statistically significant, at the five percent level, only for low-tech industries in the 1970-79 period and medium-tech industries in the 1979-92 period. KFL, the ratio of capital formation to employment, is

significant at the one percent level among low-tech industries in both periods and at the five percent level among medium-tech industries in the first of the two periods. RELKFLC, the ratio of capital formation to employment, relative to both the industry and country average, is significant at the one percent level among low-tech industries in both periods and at the five percent level among medium-tech industries in the later period.

For both equations (5) and (6), the goodness of fit, as measured by the adjusted  $R^2$  statistic and the standard error of the regression, is almost uniformly superior (with the exception of one case) for the 1979-93 period than the 1970-79 period. Moreover, the coefficient estimates for DRELLP and DRELLPC are also uniformly higher (again with the exception of one case) for the later period than the earlier one. Differences in results between the two periods are particularly marked for the medium-tech industries. These results suggest that competitive advantage has become more dependent on relative productivity performance over time.

There are also important differences among the three industry groups. Capital formation clearly plays a much more important role in explaining market share for low-tech industries than the other two groups and a somewhat more significant role for medium-tech than high-tech industries. These results suggest that low-tech industries, who, by definition, engage in relatively little R&D, acquire much of their new technology through capital investment, whereas medium-tech industries acquire some new technology through this venue and high-tech industries, who are intensive in R&D, acquire very little.

For equation (5), at least, the goodness of fit is markedly superior for high-tech industries than the other two groups. Moreover, the coefficient estimate of DRELLP has the highest value for the high-tech group, suggesting

that relative productivity performance plays the most important role in determining international competitiveness in this group of industries, which includes computers, televisions, and communication equipment. The estimated coefficient of DRELLP is also more than twice as great for the low-tech industries than the medium-tech ones. This suggests that in the latter group, which includes automobiles and other transport equipment, "quality" differences, which are not captured in standard productivity measures, may matter a great deal in determining international competitiveness.

It is also of note that in equation (5), changes in relative wages (DRELWAGE) is significant only among the low-tech industries for the 1970-79 period. In these industries, which include apparel, textiles, metal products, and basic chemicals, relative labor costs and price competition played an important role in determining market share in this period, whereas in the other two technology groups superior productivity performance and technology played the crucial role. Moreover, in the 1980s, by which time the inter-country variation in wages had become quite small, relative labor costs were no longer a significant influence on relative production shares.

It is also notable that though equation (6) is the theoretically preferred specification, the goodness of fit is greater for equation (5), with the exception of medium-tech industries. These results appear to indicate that competitiveness depends more on how an industry in a given country is performing relative to the same industry in other countries rather than to other industries in the same country. This result is consistent with the models developed by Gomory (1992) and Gomory and Baumol (1992) that show that industry output shares of a given country depend on absolute productivity and technology advantage rather than comparative productivity and technology performance (that is, relative to other industries in the same country).

## 6. Summary and Concluding Remarks

Three principal findings emerge from this study. First, despite the continued convergence of overall productivity and capital intensity in manufacturing (the coefficient of variation fell from 0.25 in 1970 to 0.19 1992 for labor productivity and from 0.28 to 0.17 for the capital-labor ratio), the major industrialized countries in the world tended to specialize manufacturing production in very different industries and most countries retained their specialization over the period from 1970 to 1993. This was particular so for the three largest economies -- Germany, Japan, and the U.S. On net, there was no tendency over this period toward greater similarity in industries of specialization, as measured by relative production shares, among the 14 countries. These results appear to be more supportive of an IIRS type of model than one based on the HO theorem.

Second, these countries also tended to be strong in different industries in terms of labor productivity performance. However, whereas countries have generally retained their industries of specialization in terms of relative production share over the period 1970 to 1993, correlations over time in relative industry labor productivity performance within country are considerably weaker than those for relative production shares. These results suggest that high performance in terms of labor productivity can erode over time, and poor performance can change for the better. They also suggest that there are other factors, such as resource endowments, specialized skills, and history, that contribute to industry specialization and remain more stable over time than labor productivity.

Third, despite the apparent differences in the stability of production shares and that of relative productivity performance over time, the regression results strongly support the central thesis of the paper that there is a

positive and significant relation between changes in relative industry market shares and the industry's relative productivity growth. The results are generally stronger for the 1979-93 than the 1970-79 period, suggesting that market share is becoming more dependent on relative productivity performance and technology levels over time. The estimated elasticity of relative market share with respect to relative labor productivity is somewhat higher for high-tech industries than low-tech ones and markedly greater for these two groups than for medium-tech industries. The results suggest that unmeasured quality differences in this latter group which includes automobiles and other transport equipment (except aircraft) may play a crucial role in determining international competitiveness.

The results on capital formation per worker are consistent with the embodiment hypothesis -- namely, that new technology is embodied in new machinery and equipment. Gains in market share appear to depend directly on the new technology embodied in recent investment. Capital formation clearly plays a much more important role in explaining market share for low-tech industries than medium-tech industries and more for the latter than the high-tech group. This result is consistent with the argument that the latest vintage of technology embodied in new capital investment is a major vehicle for productivity gain in low-tech industries; whereas medium-tech industries also rely on their own R&D investments and high-tech ones rely almost exclusively on R&D for new technology.

The results also show that relatively higher labor costs in a country (measured relative to the international industry average), generally reduces that country's competitiveness in that industry and hence its production share, but that this effect is very significant only among low-tech industries in the 1970-79 period. In these industries, which include apparel, textiles,

and basic metal products, it appears that relative labor costs and price competition played an important role along with relative productivity gains in determining market share in the 1970s whereas for medium-tech and high-tech industries and for low-tech industries in the later period superior productivity performance and technology played the crucial role. These results are consistent with those reported in Dollar and Wolff (1993), which found that among OECD countries differences in labor costs were not important determinants of differences in unit costs by the 1980s.

The fact that changes in specialization are generally significantly related to productivity changes does support the view that productivity growth encapsulates the expansion of industry-specific productive factors that contribute, at least to some degree, to competitive advantage. Moreover, this analysis redirects attention to the determinants of high levels of productivity. To the extent that it reflects technology-related assets owned by the firm or embodied in technical labor, clearly investment in research and development and training of skilled labor are important ingredients for promoting rapid productivity growth.

Footnotes

<sup>1</sup> Nakamura's (1989) study of Japan, Germany, and the U.S. also found that by the late 1970s input prices were quite similar among these three countries, so that the "relative TFP level has become the principal determinant of sectoral cost advantage and disadvantage among the three countries..." (p. 713).

<sup>2</sup> The value added is exclusive of value added taxes and other indirect business taxes.

<sup>3</sup> This is defined as the sum of wages and salaries, social insurance taxes, and other employee fringe benefits paid by the employer.

<sup>4</sup> Data are also provided for Austria, Korea, Mexico, New Zealand, Portugal, and Spain, which are unfortunately incomplete for many series. As a result, these countries will not be included in the data analysis reported here.

<sup>5</sup> I have defined RELPSHR as a country's share of the total output of a particular industry relative to its share of total GDP rather than to its share of total manufacturing output in order to reflect the fact that some countries such as Germany and Japan have specialized production in manufacturing relative to non-manufacturing sectors. Countries with a large manufacturing sector will tend to have a large number of industries with values of RELPSHR exceeding one, and conversely. If I had used the share of total manufacturing output as the denominator in equation (2), then by construction, if some values of RELPSHR for a country exceed 1, then others must be less than 1 (unless the country has exactly the same share of every product).

<sup>6</sup> One unfortunate property of the logarithmic measure is that production shares of zero are not defined. I have arbitrarily chosen a value of -3.75 for the LN(RELPSHR) measure in this case because the minimum value observed is -2.75. Experimentation with other values, from -4.0 to -6.0, yields very

similar results on the standard deviation of  $\text{LN}(\text{RELPSHR})$ .

<sup>7</sup> The other side of the ledger tends to be dominated by the various transport equipment products, such as motor vehicles and aircraft, which are produced in only a limited number of countries.

<sup>8</sup> This measure is also similar to a Chi-Square distribution. However, because the values of RELPSHR observed in different countries are not independent (if RELPSHR is high in one country it must be low in others), the sum of squared values does not meet the formal requirements for a Chi-Square distribution.

<sup>9</sup> As in comparing production shares, there are statistical problems using a correlation coefficient between RELLP values in two countries, since the individual elements in each are not independent. In particular, if  $\text{RELLP}_i$  is above unity in one country for industry  $i$ , the value of  $\text{RELLP}_i$  must be less than one in at least one other country, since the weighted sum of  $\text{RELLP}_i$  across countries must equal 1.0. However, there is no algebraic constraint on two countries having similar RELLP values across industries.

<sup>10</sup> Results are very similar on the basis of the standard deviation of the natural logarithm of RELLP, also shown in Table 8. This is partly due to the fact that the distribution of RELLP, unlike that of RELPSHR, is not highly skewed but quite symmetrical, with over 90 percent of the values in the range of 0.5 to 1.5.

<sup>11</sup> I used the capital formation deflator computed from the OECD ISDB to convert capital formation in local currency to 1985 U.S. dollars.

References

- Arrow, Kenneth. 1962. The Economic Implications of Learning by Doing. *Review of Economic Studies* 29, no. 2: 155-73.
- Balassa, Bela. 1965. Trade Liberalization and 'Revealed' Comparative Advantage. *The Manchester School* 33 (May): 99-123.
- . 1978. Exports and Economic Growth: Further Evidence. *Journal of Development Economics* 5 (June): 181-189.
- Dollar, David, and Edward N. Wolff. 1993. *Competitiveness, Convergence, and International Specialization*. Cambridge, MA: MIT Press.
- Gomory, Ralph E. 1992. A Ricardo Model with Economies of Scale. C.V. Starr Working paper 92-29, New York University, (June).
- , and William J. Baumol. 1992. Scale Economies, The Regions of Multiple Equilibria, and Gains from Acquisition of Industries. C.V. Starr Working paper 92-10, New York University (June).
- Helpman, Elhanan. 1984. Increasing Returns, Imperfect Markets, and Trade Theory. In *Handbook of International Economics*, eds. Ronald W. Jones and Peter B. Kenen. Vol. I. Amsterdam: North Holland. 325-365.
- , and Paul R. Krugman. 1985. *Market Structure and Foreign Trade: Increasing Returns, Imperfect Competition, and the International Economy*. Cambridge, Mass.: MIT Press.
- Krugman, Paul R. 1979. Increasing Returns, Monopolistic Competition, and International Trade. *Journal of International Economics* 9. 469-479.
- . 1980. Scale Economies, Product Differentiation, and the Patterns of Trade. *American Economic Review* 70, no. 5 (December): 950-959.
- . 1991. History Versus Expectations. *Quarterly Journal of Economics* 106 (May): 651-667.
- Leamer, Edward. 1984. *Sources of International Comparative Advantage*. Cambridge, MA: MIT Press.

- Maddison, Angus, and Bart van Ark. 1989. International Comparisons of Purchasing Power, Real Output and Labour Productivity: A Case Study of Brazilian, Mexican, and US Manufacturing, 1975. *The Review of Income and Wealth*, ser. 35, no. 1 (March): 31-56.
- Nakamura, Shinichiro. 1989. Productivity and Factor Prices as Sources of Differences in Production Costs between Germany, Japan, and the U.S. *The Economic Studies Quarterly* 40 (March): 701-15.

Table 1  
 Production Shares (PRODSHR) of Germany, Japan, and the United States,  
 And the OECD Leader, 1970 and 1993<sup>a</sup>

ISIC <sup>b</sup> Code	Industry	1970				1993			
		GER	JPN	USA	Leader	GER	JPN	USA	Leader
3000	Total Manufacturing	0.14	0.13	0.40	USA	0.11	0.23	0.37	USA
	<u>Low-Tech Industries<sup>c</sup></u>								
311.2	Food	0.09	0.20	0.30	USA	0.07	0.21	0.33	USA
313	Beverages	0.20	0.19	0.20	GER	0.14	0.15	0.26	USA
314	Tobacco	0.24	0.02	0.50	USA	0.35	0.04	0.29	GER
321	Textiles	0.11	0.16	0.28	USA	0.08	0.12	0.36	USA
322	Wearing Apparel	0.12	0.14	0.36	USA	0.05	0.19	0.41	USA
323	Leather & Products	0.14	0.15	0.21	USA	0.08	0.20	0.20	ITA
324	Footwear	0.12	0.03	0.33	USA	0.06	0.05	0.16	ITA
331	Wood Products	0.09	0.10	0.48	USA	0.08	0.11	0.51	USA
332	Furniture & Fixtures	0.17	0.16	0.32	USA	0.12	0.15	0.34	USA
341	Paper & Products	0.09	0.10	0.48	USA	0.09	0.16	0.45	USA
342	Printing & Publishing	0.06	0.19	0.45	USA	0.05	0.20	0.41	USA
353	Petroleum Refineries	0.28	0.06	0.30	USA	0.21	0.12	0.25	USA
354	Petroleum & Coal Prod.	0.22	0.05	0.49	USA	0.15	0.09	0.53	USA
355	Rubber Products	0.16	0.09	0.42	USA	0.08	0.20	0.40	USA
356	Plastic Products, nec	0.12	0.22	0.33	USA	0.12	0.23	0.38	USA
361	Pottery, China, etc.	0.11	0.15	0.12	ITA	0.08	0.18	0.12	ITA
362	Glass & Products	0.10	0.21	0.41	USA	0.14	0.18	0.31	USA
369	Non-Metal Products, nec	0.15	0.16	0.29	USA	0.13	0.22	0.29	USA
371	Iron & Steel	0.16	0.16	0.45	USA	0.15	0.29	0.30	USA
372	Non-Ferrous Metals	0.12	0.16	0.45	USA	0.15	0.25	0.29	USA
381	Metal Products	0.15	0.10	0.38	USA	0.15	0.18	0.37	USA
3841	Shipbuilding & Repair <sup>h</sup>	0.05	0.16	0.34	USA	0.06	0.31	0.30	JPN
39	Other Manufactures nes	0.06	0.20	0.39	USA	0.04	0.44	0.30	JPN
	<u>Medium-Tech Industries<sup>c</sup></u>								
351	Industrial Chemicals	0.19	0.11	0.37	USA	0.13	0.17	0.37	USA
3842	Railroad Equipment <sup>h</sup>	0.04	0.06	0.20	USA	0.05	0.13	0.20	USA
3843	Motor Vehicles <sup>h</sup>	0.17	0.18	0.38	USA	0.16	0.29	0.32	USA
3844	Motorcycles&Bicycles <sup>h</sup>	0.06	0.19	0.16	ITA	0.06	0.30	0.12	ITA
3849	Other Transport Equip <sup>h</sup>	0.11	0.27	0.00	JPN	0.09	0.39	0.00	JPN
	<u>High-Tech Industries<sup>c</sup></u>								
352	Other Chemical Prod. <sup>d</sup>	0.15	0.11	0.48	USA	0.11	0.20	0.43	USA
382	Non-Electrical Mach. <sup>e</sup>	0.16	0.12	0.38	USA	0.10	0.21	0.45	USA
383	Electrical Machinery <sup>f</sup>	0.17	0.02	0.49	USA	0.10	0.40	0.31	JPN
3845	Aircraft <sup>h</sup>	0.03	0.01	0.74	USA	0.04	0.03	0.73	USA
385	Professional Goods <sup>g</sup>	0.21	0.05	0.54	USA	0.12	0.12	0.56	USA
	GDP Share	0.09	0.13	0.45		0.09	0.18	0.42	
	Correlation with USA	0.07	-0.57			-0.06	-0.42		
	Correlation with GER		-0.33				-0.23		
	Rank Correl with USA	0.17	-0.49			-0.01	-0.28		
	Rank Correl with GER		-0.34				-0.09		

Notes to Table 1.

a. The production share of country h in industry i is defined as:

$$\text{PRODHSR}_i^h = Y_i^h / \sum_h Y_i^h$$

where the aggregation over h is based on 14 OECD countries with pertinent data: Australia (AUS), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (GER), Italy (ITA), Japan (JPN), the Netherlands (NET), Norway (NOR), Sweden (SWE), the United Kingdom (UK), and the United States (USA).

b. Revision 2 ISIC codes.

c. Division of industries into technology groups is based on the average R&D intensity of production of OECD countries in 1985, as follows: low-tech -- less than 0.5 times the mean R&D intensity; medium-tech -- from 0.5 to 1.5 the mean R&D intensity; and high-tech -- over 1.5 the mean R&D intensity.

d. Includes Drugs and Medicines and Other Chemicals, nec.

e. Includes Office and Computing Machinery and Machinery & Equipment, nec.

f. Includes Radio, TV & Communication Equipment and Electrical Apparatus, nec.

g. Includes Scientific Instruments.

h. Calculations exclude Belgium.

Table 2  
Relative Production Shares (RELPSHR) of Germany, Japan, and the United States,  
And the OECD Country with the Highest Value, 1970 and 1993<sup>a</sup>

Industry	1970				1993			
	GER	JPN	USA	Highest	GER	JPN	USA	Highest
Total Manufacturing	1.48	1.01	0.89	GER	1.22	1.27	0.89	JPN
<u>Low-Tech Industries</u>								
Food	0.93	1.56	0.67	JPN	0.84	1.16	0.78	DNK
Beverages	2.15	1.51	0.44	GER	1.62	0.82	0.61	UK
Tobacco	2.62	0.18	1.12	GER	3.94	0.24	0.70	NET
Textiles	1.23	1.25	0.63	ITA	0.86	0.68	0.86	ITA
Wearing Apparel	1.26	1.08	0.81	ITA	0.55	1.04	0.97	ITA
Leather & Products	1.47	1.15	0.48	BEL	0.86	1.12	0.48	ITA
Footwear	1.30	0.25	0.74	ITA	0.68	0.27	0.39	ITA
Wood Products	0.94	0.81	1.08	SWE	0.86	0.59	1.23	SWE
Furniture & Fixtures	1.84	1.21	0.71	GER	1.31	0.85	0.82	ITA
Paper & Products	0.99	0.80	1.06	FIN	0.96	0.88	1.09	FIN
Printing & Publishing	0.62	1.45	1.01	NOR	0.53	1.15	0.98	UK
Petroleum Refineries	2.98	0.47	0.67	GER	2.30	0.67	0.60	FRA
Petroleum & Coal Prod.	2.37	0.39	1.10	GER	1.66	0.52	1.27	NET
Rubber Products	1.68	0.73	0.94	GER	0.94	1.12	0.95	ITA
Plastic Products, nec	1.28	1.72	0.74	AUS	1.31	1.31	0.92	GER
Pottery, China, etc.	1.22	1.19	0.26	ITA	0.88	1.01	0.28	ITA
Glass & Products	1.11	1.65	0.91	BEL	1.56	1.03	0.75	BEL
Non-Metal Products, nec	1.58	1.27	0.65	DNK	1.50	1.22	0.69	AUS
Iron & Steel	1.67	1.28	1.00	GER	1.71	1.66	0.72	GER
Non-Ferrous Metals	1.25	1.28	1.01	NOR	1.65	1.41	0.70	NOR
Metal Products	1.63	0.76	0.85	ITA	1.69	1.02	0.89	GER
Shipbuilding & Repair	0.54	1.26	0.77	NOR	0.72	1.73	0.71	FIN
Other Manufactures nes	0.66	1.59	0.87	UK	0.40	2.46	0.71	JPN
<u>Medium-Tech Industries</u>								
Industrial Chemicals	2.07	0.89	0.84	BEL	1.49	0.96	0.88	BEL
Railroad Equipment	0.43	0.48	0.44	AUS	0.54	0.71	0.49	AUS
Motor Vehicles	1.83	1.38	0.85	GER	1.82	1.64	0.76	GER
Motorcycles&Bicycles	0.68	1.48	0.35	ITA	0.66	1.68	0.30	ITA
Other Transport Equip	1.15	2.07	0.00	NET	1.03	2.20	0.00	CAN
<u>High-Tech Industries</u>								
Other Chemical Prod.	1.57	0.85	1.09	GER	1.19	1.13	1.03	GER
Non-Electrical Mach.	1.74	0.93	0.86	GER	1.10	1.21	1.09	JPN
Electrical Machinery	1.86	0.19	1.11	GER	1.18	2.23	0.74	JPN
Aircraft	0.30	0.11	1.66	USA	0.40	0.15	1.76	USA
Professional Goods	2.29	0.38	1.20	GER	1.35	0.66	1.34	UK

a. See notes to Table 1 for additional details. The relative production share of country h in industry i based on the 14 OECD countries is defined as:

$$\text{RELPSHR}_i^h = [Y_i^h / \sum_h Y_i^h] / (\text{GDP}^h / \sum_h \text{GDP}^h).$$

Table 3  
Relative Dispersion of Indices of Specialization Across 14 OECD Countries,  
For 33 Manufacturing Industries, 1970, 1979, and 1993<sup>a</sup>

	Coefficient of Variation <sup>b</sup> of RELPSHR			Standard Deviation of LN(RELPSHR) <sup>c</sup>		
	1970	1979	1993	1970	1979	1993
Total Manufacturing	0.18	0.18	0.21	0.16	0.17	0.22
<u>Low-Tech Industries</u>						
Food	0.24	0.24	0.29	0.26	0.25	0.29
Beverages	0.37	0.36	0.39	0.44	0.43	0.43
Tobacco	0.81	0.84	1.05	0.76	0.75	0.86
Textiles	0.55	0.61	0.93	0.50	0.48	0.63
Wearing Apparel	0.31	0.49	0.65	0.30	0.56	0.78
Leather & Products	0.74	0.72	1.04	0.64	0.61	0.70
Footwear	0.77	1.16	1.50	0.64	0.77	0.97
Wood Products	0.61	0.59	0.56	0.68	0.59	0.54
Furniture & Fixtures	0.27	0.34	0.48	0.27	0.34	0.43
Paper & Products	0.76	0.77	0.89	0.61	0.57	0.64
Printing & Publishing	0.34	0.28	0.27	0.34	0.29	0.28
Petroleum Refineries	1.04	0.99	0.80	1.06	1.13	0.81
Petroleum & Coal Prod.	0.77	0.78	0.63	1.01	0.95	0.93
Rubber Products	0.44	0.38	0.41	0.49	0.48	0.58
Plastic Products, nec	0.67	0.42	0.31	0.61	0.39	0.33
Pottery, China, etc.	0.97	1.12	1.28	0.79	0.76	0.85
Glass & Products	0.59	0.59	0.70	0.48	0.47	0.56
Non-Metal Products, nec	0.28	0.25	0.36	0.29	0.24	0.38
Iron & Steel	0.51	0.50	0.44	0.66	0.63	0.54
Non-Ferrous Metals	0.64	0.62	0.58	0.76	0.73	0.69
Metal Products	0.42	0.36	0.36	0.37	0.32	0.34
Shipbuilding & Repair <sup>d</sup>	1.06	0.90	0.62	0.95	0.85	0.62
Other Manufactures nes	0.67	0.74	0.83	0.60	0.68	0.69
<u>Medium-Tech Industries</u>						
Industrial Chemicals	0.52	0.62	0.72	0.50	0.50	0.49
Railroad Equipment <sup>d</sup>	0.86	0.77	0.67	1.15	1.10	0.99
Motor Vehicles <sup>d</sup>	0.61	0.69	0.75	0.86	0.94	1.06
Motorcycles & Bicycles <sup>d</sup>	0.98	0.98	1.22	1.30	1.28	1.23
Other Transport Equip <sup>d</sup>	0.90	0.97	1.16	1.50	1.44	1.40
<u>High-Tech Industries</u>						
Other Chemical Prod.	0.36	0.33	0.29	0.35	0.34	0.34
Non-Electrical Mach.	0.41	0.34	0.31	0.42	0.35	0.34
Electrical Machinery	0.41	0.39	0.70	0.49	0.35	0.66
Aircraft <sup>d</sup>	0.96	0.86	0.91	0.98	0.91	0.89
Professional Goods	1.01	0.73	0.68	0.91	0.79	0.85

Notes to Table 3.

- a. See footnotes to Tables 1 and 2 for definitions of production shares (PRODSHR) and relative production shares (RELPSHR) and other technical details in the calculations.
- b. The coefficient of variation is defined as the ratio of the standard deviation to the (unweighted) mean.
- c. LN is the natural logarithm. If RELPSHR equals zero, LN(RELPSHR) is set to -3.75. See text for details.
- d. Calculations exclude Belgium.

Table 4

## Specialization in Manufacturing Industries By Country, 1993

	Highest RELPSHR	Lowest RELPSHR
Australia	Railroad Equipment 4.10 Non-Metal Products, nec 1.88	Motorcycles & Bicycles 0.0 Aircraft 0.24
Belgium	Industrial Chemicals 3.98 Glass & Glass Products 3.35	Professional Goods 0.18 Petroleum & Coal Products 0.20
Canada	Transport Equipment, nec 6.97 Railroad Equipment 2.51	Motorcycles & Bicycles 0.0 Professional Goods 0.0
Denmark	Railroad Equipment 3.02 Shipbuilding & Repairing 2.39	Motor Vehicles 0.0 Aircraft 0.0 Transport Equipment, nec 0.0
Finland	Paper & Paper Products 4.81 Shipbuilding & Repairing 3.52	Aircraft 0.10 Motor Vehicles 0.16
France	Petroleum Refineries 3.15 Motorcycles & Bicycles 1.78	Transport Equipment, nec 0.0 Professional Goods 0.44
Germany	Tobacco Products 3.94 Petroleum Refineries 2.30	Aircraft 0.40 Printing & Publishing 0.53
Italy	Footwear 6.84 Pottery, China etc 6.07	Tobacco Products 0.41 Aircraft 0.43
Japan	Electrical Machinery 2.23 Transport Equipment, nec 2.20	Aircraft 0.15 Tobacco Products 0.24
Netherlands	Tobacco Products 4.09 Transport Equipment, nec 3.51	Railroad Equipment 0.0 Motor Vehicles 0.22
Norway	Shipbuilding & Repairing 2.96 Non-Ferrous Metals 2.65	Motorcycles & Bicycles 0.0 Motor Vehicles 0.07
Sweden	Paper & Paper Products 2.93 Transport Equipment, nec 2.42	Wearing Apparel 0.14 Footwear 0.15
United Kingdom	Beverages 1.98 Tobacco Products 1.78	Non-Ferrous Metals 0.46 Motorcycles & Bicycles 0.47
United States	Aircraft 1.76 Professional Goods 1.76	Pottery, China etc. 0.28 Motorcycles & Bicycles 0.30

Table 5  
 Correlation over Time in Relative Production Share (RELPSHR)  
 In Manufacturing Industries By Country, 1970-1979 and 1970-1993

Country	Relative Production Share (RELPSHR)		Log of Relative Production Share [LN(RELPSHR)]		Rank Correlation Relative Production Share (RELPSHR)	
	1970-1979	1970-1993	1970-1979	1970-1993	1970-1979	1970-1993
Australia	0.97	0.83	0.97	0.85	0.94	0.73
Belgium <sup>b</sup>	0.80	0.67	0.88	0.75	0.86	0.73
Canada	0.98	0.94	0.98	0.93	0.95	0.85
Denmark	0.99	0.92	0.99	0.94	0.97	0.85
Finland	0.98	0.88	0.95	0.79	0.89	0.67
France	0.97	0.90	0.99	0.98	0.87	0.84
Germany	0.96	0.76	0.96	0.82	0.95	0.77
Italy	0.96	0.91	0.96	0.89	0.96	0.86
Japan	0.84	0.58	0.88	0.71	0.86	0.64
Netherlands	0.94	0.75	0.95	0.88	0.90	0.78
Norway	0.98	0.78	0.96	0.79	0.93	0.77
Sweden	0.98	0.75	0.95	0.64	0.92	0.58
United Kingdom	0.92	0.59	0.92	0.61	0.92	0.60
United States	0.96	0.86	0.98	0.95	0.93	0.70

a. Correlations are based on 33 industries unless otherwise indicated.

b. All industries except Shipbuilding & Repair, Railroad Equipment, Motor Vehicles, Motorcycles & Bicycles, Other Transport Equipment, and Aircraft.

Table 6  
 Correlation of the Logarithm of Relative Production Shares (RELPSHR)  
 Between the U.S. and Other Countries and the Sum of Squared Values of RELPSHR,  
 1970, 1979, and 1993<sup>a</sup>

Country	Correlation of LN(RELPSHR) With the United States			Sum of Squared Values of LN(RELPSHR)		
	1970	1979	1993	1970	1979	1993
Australia	-0.10	-0.05	-0.02	31.9	28.0	31.2
Belgium <sup>b</sup>	-0.29	-0.22	-0.16	22.5	14.3	20.6
Canada	-0.25	-0.31	-0.27	42.9	39.5	41.8
Denmark	0.15	0.19	0.28	64.3	60.9	59.3
Finland	-0.21	-0.12	0.05	20.4	18.5	19.3
France	0.36	0.36	0.36	33.5	33.1	32.7
Germany	0.05	0.09	0.03	10.9	8.8	8.4
Italy	-0.41	-0.39	-0.37	18.5	18.8	20.4
Japan	-0.42	-0.38	-0.33	18.3	12.3	12.1
Netherlands	-0.33	-0.22	-0.25	31.1	32.8	33.2
Norway	-0.15	-0.01	0.09	49.7	55.4	58.7
Sweden	-0.40	-0.34	-0.08	13.1	13.4	18.6
United Kingdom	-0.31	-0.24	-0.07	5.0	4.8	4.6
United States	1.00	1.00	1.00	20.4	20.9	21.2
All Countries				382.5	361.5	382.2

a. Correlations and sum of squared values are based on 33 industries unless otherwise indicated.

b. All industries except Shipbuilding & Repair, Railroad Equipment, Motor Vehicles, Motorcycles & Bicycles, Other Transport Equipment, and Aircraft.

Table 7  
Relative Labor Productivity (RELLP) of Germany, Japan, and the United States,  
And the OECD Leader, 1970 and 1993<sup>a</sup>

Industry	1970				1993			
	GER	JPN	USA	Leader	GER	JPN	USA	Leader
Total Manufacturing	0.97	0.63	1.47	USA	0.84	0.93	1.26	USA
<u>Low-Tech Industries</u>								
Food	0.76	0.93	1.15	CAN	0.64	0.74	1.33	ITA
Beverages	0.77	1.42	0.87	CAN	0.64	0.90	1.15	ITA
Tobacco	1.25	0.28	2.00	USA	2.01	0.45	1.06	NOR
Textiles	1.09	0.53	1.46	USA	1.11	0.39	1.44	ITA
Wearing Apparel	0.90	1.35	1.11	JPN	0.81	0.98	1.10	BEL
Leather & Products	0.83	1.26	1.00	BEL	0.84	1.17	0.99	BEL
Footwear	0.86	0.74	1.27	BEL	0.89	0.68	1.13	BEL
Wood Products	0.92	0.34	1.86	USA	0.85	0.47	1.43	USA
Furniture & Fixtures	1.22	1.10	1.04	AUS	0.86	1.12	0.98	BEL
Paper & Products	0.79	0.61	1.54	USA	0.76	0.80	1.36	USA
Printing & Publishing	0.68	0.94	1.32	USA	0.80	0.91	1.05	ITA
Petroleum Refineries	2.18	0.59	0.76	GER	1.83	0.86	0.68	FRA
Petroleum & Coal Prod.	9.88	0.25	1.28	GER	6.01	0.47	1.09	GER
Rubber Products	1.05	0.52	1.56	CAN	0.69	0.73	1.46	BEL
Plastic Products, nec	0.77	0.76	1.34	AUS	0.88	0.82	1.18	FRA
Pottery, China, etc.	0.59	0.64	1.27	BEL	0.62	0.75	1.12	BEL
Glass & Products	0.58	1.46	1.47	USA	0.87	1.06	1.21	BEL
Non-Metal Products, nec	1.18	0.65	1.33	CAN	1.09	0.74	1.16	FRA
Iron & Steel	0.71	1.11	1.69	USA	0.73	1.23	1.35	USA
Non-Ferrous Metals	0.66	1.15	1.46	AUS	0.73	1.25	0.96	FRA
Metal Products	0.88	0.49	1.48	ITA	0.88	0.78	1.45	USA
Shipbuilding & Repair	--	--	--	--	0.85	1.37	0.92	FRA
Other Manufactures nes	0.78	0.78	1.20	UK	0.64	1.74	0.83	UK
<u>Medium-Tech Industries</u>								
Industrial Chemicals	1.10	0.65	1.52	USA	0.68	1.10	1.35	BEL
Transport Equipment	1.07	0.72	1.57	USA	0.89	1.05	1.27	USA
Railroad Equipment	--	--	--	--	0.30	1.06	1.37	AUS
Motor Vehicles	--	--	--	--	0.98	1.15	1.00	ITA
Motorcycles & Bicycles	--	--	--	--	0.51	1.07	0.94	ITA
Other Transport Equip	--	--	--	--	1.14	2.67	NA	JPN
<u>High-Tech Industries</u>								
Other Chemical Prod.	0.90	0.75	1.53	USA	0.64	1.14	1.43	USA
Non-Electrical Mach.	1.04	0.55	1.47	USA	0.71	0.92	1.52	USA
Electrical Machinery	1.06	0.10	1.84	USA	0.73	1.16	1.13	FIN
Aircraft	--	--	--	--	0.60	1.08	1.26	USA
Professional Goods	1.10	0.29	1.59	ITA	0.74	0.64	1.44	USA
Correlation with USA <sup>b</sup>	0.10	-0.54			-	0.22	-0.36	
Correlation with GER <sup>b</sup>		-0.33					-0.39	
Correlation with USA <sup>c</sup>					-	0.19	-0.41	
Correlation with GER <sup>c</sup>							-0.40	
Rank Correl with USA <sup>b</sup>	0.14	-0.53			-	0.16	-0.35	
Rank Correl with GER <sup>b</sup>		-0.62					-0.46	

Notes to Table 1.

a. Relative labor productivity of industry i in country h defined as:

$$\text{RELLP}_i^h = \text{LP}_i^h / \overline{\text{LP}}_i$$

where the calculation of  $\overline{\text{LP}}_i$  is based on 14 OECD countries with pertinent data: Australia (AUS), Belgium (BEL), Canada (CAN), Denmark (DNK), Finland (FIN), France (FRA), Germany (GER), Italy (ITA), Japan (JPN), the Netherlands (NET), Norway (NOR), Sweden (SWE), the United Kingdom (UK), and the United States (USA). The exceptions are as follows:

(1) DEN, NET: 1991 data used for 1992 in all industries except total manufacturing (1992 data used)

(3) GER: 1991 data used for 1992 in Chemicals (351-356)

(4) SWE: 1991 data used for 1992 in Industries 353 and 354

(5) Industries 3841 to 3849:

(a) BEL: missing data for all years.

(b) FRA, ITA: missing data for 1970

(c) AUS: 3842, 3845, 3849: missing data for 1970, 1979.

(d) GER: 3842, 3843, 3844, 3849: missing data for 1970

(e) JPN: 3842, 3844, 3845, 3849: missing data for 1970, 1979

(f) UK: 3842, 3844, 3845, 3849: missing data for 1970

(g) US: 3842, 3844, 3845: missing data for 1970

(h) DNK: 3841, 3842, 3844: missing data for 1990-1992.

(h) 1991 data used for 1992, except CAN, SWE which uses 1990 data.

See footnotes to Tables 1 and 2 for other technical details on the sectoring.

b. Includes 384; excludes 3841-3849.

c. Excludes 384, 3849; includes 3841-3845.

Table 8  
Dispersion of Relative Labor Productivity (RELLP) Across 14 OECD Countries  
For 29 Manufacturing Industries, 1970, 1979, and 1993<sup>a</sup>

	Coefficient of Variation of RELPSHR			Standard Deviation of LN(RELPSHR)		
	1970	1979	1993	1970	1979	1993
Total Manufacturing	0.25	0.21	0.19	0.24	0.21	0.20
<u>Low-Tech Industries</u>						
Food	0.28	0.26	0.30	0.30	0.26	0.31
Beverages	0.29	0.40	0.41	0.32	0.42	0.42
Tobacco	0.74	0.80	0.74	0.77	0.83	0.84
Textiles	0.26	0.23	0.30	0.27	0.27	0.35
Wearing Apparel	0.30	0.24	0.29	0.31	0.25	0.31
Leather & Products	0.53	0.38	0.41	0.47	0.34	0.42
Footwear	0.39	0.24	0.20	0.42	0.23	0.20
Wood Products	0.42	0.31	0.31	0.51	0.35	0.33
Furniture & Fixtures	0.29	0.21	0.25	0.31	0.23	0.25
Paper & Products	0.37	0.27	0.23	0.33	0.26	0.23
Printing & Publishing	0.27	0.24	0.22	0.27	0.24	0.23
Petroleum Refineries	0.73	0.82	0.62	0.93	0.98	0.66
Petroleum & Coal Prod.	1.80	1.71	1.22	1.04	0.94	0.79
Rubber Products	0.42	0.34	0.43	0.39	0.32	0.41
Plastic Products, nec	0.67	0.37	0.17	0.54	0.33	0.18
Pottery, China, etc.	0.49	0.36	0.48	0.44	0.34	0.40
Glass & Products	0.39	0.32	0.33	0.40	0.33	0.33
Non-Metal Products, nec	0.27	0.29	0.27	0.27	0.28	0.28
Iron & Steel	0.48	0.48	0.25	0.45	0.45	0.25
Non-Ferrous Metals	0.46	0.46	0.37	0.45	0.51	0.38
Metal Products	0.38	0.30	0.26	0.36	0.29	0.24
Other Manufactures nes	0.54	0.54	0.76	0.51	0.56	0.75
<u>Medium-Tech Industries</u>						
Industrial Chemicals	0.27	0.32	0.35	0.26	0.31	0.36
Motor Vehicles	0.31	0.36	0.37	0.31	0.35	0.38
Transport Equip exc. Veh. <sup>b</sup>	0.42	0.29	0.36	0.36	0.26	0.34
<u>High-Tech Industries</u>						
Other Chemical Prod.	0.35	0.39	0.32	0.34	0.39	0.30
Non-Electrical Mach.	0.28	0.22	0.31	0.28	0.21	0.31
Electrical Machinery	0.40	0.31	0.33	0.68	0.31	0.38
Professional Goods	0.49	0.37	0.32	0.58	0.41	0.30

a. See footnotes to Table 7 for definition of RELLP and other technical details in the calculations.

b. Includes ISIC codes 3841, 3842, 3844, 3845, 3849.

Table 9

Correlation over Time in Industry Relative Productivity Levels (RELLP)  
By Country and Sum of Squared Values, 1970 to 1993

Country	Correlation over Time in LN(RELLP)		Rank Correlation Over Time in RELLP		Sum of Squared Values of LN(RELLP)		
	1970-79	1970-93	1970-79	1970-93	1970	1979	1993
Australia	0.84	0.45	0.83	0.33	6.0	3.9	5.4
Belgium	0.87	0.75	0.78	0.59	26.0	15.3	15.8
Canada <sup>b</sup>	0.70	0.12	0.79	0.19	3.7	1.9	1.9
Denmark	0.79	0.24	0.64	0.08	14.1	9.6	12.8
Finland	0.79	0.54	0.73	0.47	7.4	7.8	3.2
France <sup>c</sup>	0.80	0.77	0.85	0.79	1.9	2.2	2.5
Germany	0.96	0.88	0.86	0.51	7.5	7.4	6.2
Italy	0.89	0.67	0.84	0.54	7.8	7.1	5.1
Japan	0.72	0.44	0.83	0.60	15.3	7.2	4.0
Netherlands	0.81	0.04	0.79	0.12	3.1	2.4	2.2
Norway	0.81	0.39	0.88	0.23	6.7	12.4	8.6
Sweden	0.90	0.77	0.84	0.56	5.8	7.3	12.3
United Kingdom	0.94	0.68	0.91	0.59	7.9	9.0	4.6
United States	0.88	0.61	0.87	0.56	4.0	2.3	1.8
Total					117.3	95.8	86.4

a. Correlations are based on the 28 3-digit ISIC industries (including 384, transport equipment), unless otherwise indicated.

b. Excludes ISIC 385 (Professional Goods).

c. Excludes ISIC 354 (Petroleum & Coal Products).

Table 10  
 Regressions of the Change in RELPSHR on the Growth in Labor Productivity,  
 Wages, and Capital Formation Relative to the Industry Average<sup>a</sup>

Constant	DRELLP	DRELWAGE	RELKFL	KFL	R <sup>2</sup>	Adj. R <sup>2</sup>	Std. Error	Ind. Samp.	Samp Size
<u>A. 1970-1979 Period</u>									
0.003 (0.27)	0.666** (9.73)	-0.177** (4.13)	0.049* (2.24)		0.425	0.421	0.209	All	377
-0.031* (2.25)	0.678** (17.0)	-0.161** (4.66)		5.43** (3.71)	0.439	0.435	0.207	All	377
0.003 (0.25)	0.748** (12.6)	-0.255** (6.75)	0.055* (2.43)		0.475	0.470	0.189	Lo-Tech	293
-0.035* (2.57)	0.774** (16.8)	-0.241** (6.64)		6.25** (4.57)	0.502	0.496	0.185	Lo-Tech	293
-0.059 (0.93)	0.193 (1.06)	-0.144 (0.98)	0.014 (0.15)		0.111	0.007	0.278	MedTech	28
-0.198* (2.52)	0.224 (1.46)	-0.194 (1.22)		17.61* (2.17)	0.257	0.164	0.254	MedTech	28
0.086** (2.91)	0.745** (7.34)	-0.105 (1.26)	0.035 (0.56)		0.621	0.599	0.213	Hi-Tech	56
0.092 (1.28)	0.738** (8.84)	-0.008 (0.85)		56.73 (0.21)	0.620	0.598	0.213	Hi-Tech	56
<u>B. 1979-1993 Period</u>									
-0.021 (0.45)	0.672** (11.5)	-0.033 (0.59)	0.044 (1.60)		0.454	0.450	0.254	All	404
-0.079** (5.45)	0.636** (17.5)	-0.027 (0.59)		9.24** (6.49)	0.501	0.498	0.243	All	404
-0.045** (3.12)	0.773** (10.2)	-0.129 (1.90)	0.037 (1.90)		0.468	0.463	0.255	Lo-Tech	299
-0.101** (6.13)	0.726** (15.5)	-0.122* (2.09)		9.10** (6.25)	0.527	0.522	0.240	Lo-Tech	299
0.038 (1.19)	0.388** (4.10)	-0.052 (0.48)	0.153* (2.09)		0.424	0.384	0.226	MedTech	47
-0.107 (1.71)	0.329** (4.10)	-0.013 (0.12)		13.66 (1.91)	0.385	0.342	0.233	MedTech	47

0.019 (0.66)	0.945** (10.7)	-0.176 (1.36)	-0.004 (0.09)		0.687	0.670	0.203	Hi-Tech	58
0.009 (0.17)	0.940** (10.2)	-0.179 (1.28)		27.55 (0.25)	0.688	0.671	0.203	Hi-Tech	58

---

a. The dependent variable is DRELPSHR. The absolute values of t-ratios are shown in parentheses below the coefficient estimate. The estimation uses the White procedure for a heteroschedasticity-consistent covariance matrix. Key:

$DRELPSHR_i^h$ : change in the logarithm of RELPSHR (relative production share) of industry  $i$  in country  $h$ .

$DRELLP_i^h$ : change in the logarithm of the ratio of LP (labor productivity) of industry  $i$  in country  $h$  to the 14-nation average LP in industry  $i$ .

$DRELWAGE_i^h$ : change in the logarithm of the ratio of wages of industry  $i$  in country  $h$  to the 14-nation average wages in industry  $i$ .

$KFL_i^h$ : the logarithm of the ratio of capital formation to employment of industry  $i$  in country  $h$  (index).

$RELKFL_i^h$ :  $KFL_i^h$  minus the logarithm of the ratio of the 14-nation average of capital formation to employment in industry  $i$ .

\* significant at the 5 percent level (2-tailed test)

\*\* significant at the 1 percent level (2-tailed test)

Table 11  
 Regressions of the Change in RELPSHR on the Growth in Labor Productivity,  
 Wages, and Capital Formation Relative to Industry and Country Averages<sup>a</sup>

Constant	DRELLPC	DRELWAGC	RELKFLC	R <sup>2</sup>	Adj. R <sup>2</sup>	Std. Error	Ind. Samp.	Samp Size
<u>A. 1970-1979 Period</u>								
-0.458** (7.24)	0.247** (7.20)	-0.065 (0.67)	0.102** (3.78)	0.180	0.173	0.250	All	377
-0.482** (7.29)	0.252** (7.38)	-0.186 (1.89)	0.111** (4.07)	0.191	0.183	0.235	Lo-Tech	293
-0.427** (2.91)	0.242** (3.17)	0.339 (1.06)	0.076 (1.11)	0.277	0.187	0.251	MedTech	28
-0.420 (1.85)	0.275 (1.97)	0.249 (0.76)	0.079 (0.54)	0.198	0.152	0.310	Hi-Tech	56
<u>B. 1979-1993 Period</u>								
0.758** (11.0)	0.408** (10.5)	0.006 (0.08)	0.108** (3.56)	0.301	0.295	0.288	All	404
-0.845** (8.78)	0.453** (8.41)	0.073 (0.68)	0.102** (2.64)	0.298	0.291	0.293	Lo-Tech	299
-0.448** (3.59)	0.263** (4.31)	-0.182* (2.02)	0.170* (2.23)	0.517	0.483	0.207	MedTech	47
-0.796** (5.20)	0.438** (4.64)	-0.225 (1.06)	0.134 (1.85)	0.291	0.252	0.306	Hi-Tech	58

a. The dependent variable is DRELPSHR. The absolute values of t-ratios are shown in parentheses below the coefficient estimate. The estimation uses the White procedure for a heteroschedasticity-consistent covariance matrix. Key:

$DRELPSHR_i^h$ : change in the logarithm of RELPSHR (relative production share) of industry  $i$  in country  $h$ .

$DRELLPC_i^h$ :  $DRELLP_i^h$  relative to the log change of overall labor productivity (LP) in country  $h$  minus the log change of the 14-nation average LP.

$DRELWAGC_i^h$ :  $DRELWAGE_i^h$  relative to the log change of overall average wages in country  $h$  minus the log change of the 14-nation average wages.

$RELKFLC_i^h$ :  $RELKFL_i^h$  relative to the logarithm of the ratio of total capital formation to total employment in country  $h$  minus the logarithm of the 14-nation ratio of total capital formation to total employment.

\* significant at the 5 percent level (2-tailed test)

\*\* significant at the 1 percent level (2-tailed test)