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# AN EMPIRICAL DEMONSTRATION OF CLASSICAL COMPARATIVE COST THEORY\*

Bela Balassa

ECONOMIC theory can be regarded as consisting of a number of models designed to explain economic phenomena and to yield predictions for the future. Any choice among alternative models should be based on their explanatory value — a model (or hypothesis) can be regarded as superior to another if it better explains actual phenomena and it is more helpful in predicting future events.

The theory of international trade abounds in theoretical models, some of them complementary, others conflicting. Alternative approaches towards explaining the causes of international specialization are followed, for example, by classical economists on the one hand, and by Heckscher and Ohlin on the other. While the hypothesis advanced by the former presupposes the existence of inter-country differences in production functions, the latter assume identical production functions and qualitatively identical factors of production in the trading countries and attribute international specialization to differences in factor endowments. The empirical testing of the Heckscher-Ohlin hypothesis by Leontief led to inconclusive results, and the interpretations and explanations given to the Leontief paradox have demonstrated that the assumptions of this model require modification.<sup>1</sup> In the present paper, we

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<sup>1</sup>W. W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-examined," *Economia Internazionale*, (February 1954), 9-38; "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis," this REVIEW, xxxviii (November 1956), 386-407. Also, P. T. Ellsworth, "The Structure of American Foreign Trade: A New View Examined," this REVIEW, xxxvi (August 1954), 279-285; Stefan Valavanis-Vail, "Leontief's Scarce Factor Paradox," *Journal of Political Economy*, lxi (December 1954), 523-528; N. S. Buchanan, "Lines on the Leontief Paradox," *Economia Internazionale* (November 1955), 791-794; and the discussion in the supplement to the February 1958 issue of this

will not attempt to test the Heckscher-Ohlin hypothesis, but will rather inquire into the validity of the classical model.

According to the original formulation of the classical theory, comparative advantage based on relative productivity differentials determines international specialization. It has subsequently been realized that inter-country differences in the wage structure and in the capital-labor ratios of various industries may compensate for productivity differentials; a country possessing a relative productivity advantage in a particular industry may still import the commodity in question if it paid relatively higher wages and/or had higher capital costs per unit of output in that industry.<sup>2</sup> Still, the defenders of classical theory — among others, Taussig — expressed the opinion that the latter factors are not sufficiently important to warrant significant changes in the trade pattern as determined by relative differences in productivity.<sup>3</sup>

Let us adopt the following notation:

$C$  = unit cost

$A$  = labor input per unit of output

$W$  = wage rate

$T$  = ratio of capital plus labor costs to labor costs

Subscripts I and II refer to country I and country II, respectively.

Capital letters refer to commodity  $X$ , small letters to commodity  $Y$ .

The modified classical hypothesis can now be written:

If

$$\frac{A_I}{A_{II}} < \frac{a_I}{a_{II}}, \quad (1)$$

it is likely also that

$$\frac{C_I}{C_{II}} < \frac{c_I}{c_{II}}, \quad (2)$$

when the latter expression is equivalent to

REVIEW, by Stefan Valavanis-Vail, Romney Robinson, G. A. Elliott, Beatrice Vaccara, and W. W. Leontief, 111-122.

<sup>2</sup>For references, see Jacob Viner, *Studies in the Theory of International Trade* (New York, 1937), 493-512.

<sup>3</sup>F. W. Taussig, *International Trade* (New York, 1927), 43-68.

$$\frac{A_I W_I T_I}{A_{II} W_{II} T_{II}} < \frac{a_I w_I t_I}{a_{II} w_{II} t_{II}}. \quad (3)$$

Consequently, country I will export commodity X, and country II will export commodity Y.

In order to test the classical hypothesis, MacDougall compared relative export volumes and relative productivity differences for American and British manufacturing industries, and found that in 20 out of the 25 industries examined, "where American output per worker was more than twice the British, the United States had, in general, the bulk of the export market, while for products where it was less than twice as high the bulk of the market was held by Britain."<sup>4</sup> At the same time, relying on data of 13 industries MacDougall concluded that although we can, to some extent, better explain differences in export shares if considering unit labor costs instead of productivity, productivity differentials are but scarcely modified by wage disparities.<sup>5</sup>

The present paper can be regarded as a continuation of MacDougall's work, with differences in the choice of data and in methodology. Whereas MacDougall relied on Rostas' productivity estimates for the 'thirties,<sup>6</sup> we will make use of Paige and Bombach's more inclusive observations that refer to 1950.<sup>7</sup> At the same time, we will attempt to reach some conclusions as to the relative importance of productivity, wages, and capital costs in determining the pattern of exports.

### Productivity and Exports

American and British productivity comparisons have been made by Paige and Bombach for 44 selected industries that include about one-half of manufacturing production in the two countries.<sup>8</sup> Productivity is measured as

<sup>4</sup> G. D. A. MacDougall, "British and American Exports: A Study Suggested by the Theory of Comparative Costs," Part I *Economic Journal* LXI (December 1951), 697-698.

<sup>5</sup> *Ibid.*, 706-707.

<sup>6</sup> L. Rostas, *Comparative Productivity in British and American Manufacturing* (Cambridge, 1948).

<sup>7</sup> Deborah Paige and Gottfried Bombach, *A Comparison of National Product and Productivity of the United Kingdom and the United States* (Paris: Organisation for European Economic Co-operation, 1959).

<sup>8</sup> The industries were selected on the basis that productivity comparisons for these are considered reliable inasmuch as the inter-country output comparison is relatively good and employment data are not likely to be subject to substantial errors resulting from differences in classification.

net output (gross output minus purchased inputs other than labor) per worker.<sup>9</sup> The index numbers for productivity (U.K. = 100) are calculated separately at U.S. and U.K. prices and a geometric average of these figures is taken.

For the purposes of the present investigation, it was necessary to exclude several industries from the sample. First, industries whose output did not exceed one-third of one per cent of the value of manufacturing production in the two countries have not been included since these industries are not representative of manufacturing as a whole. In the absence of the necessary information, the same procedure was followed with regard to industries processing agricultural raw materials, such as grain milling, canning, and breweries, because easy access to such materials affects export possibilities but not the net output per worker. Finally, we had to disregard electrical household equipment and passenger automobiles since in the period under investigation third countries discriminated against American consumer durables as compared with British. Our sample thus covers 28 industries which produced 43.1 per cent of manufacturing output in Britain and 41.4 per cent in the United States.

Relative productivity differences in these industries are compared with their export performance in the two countries.<sup>10</sup> In comparing American and British exports we exclude trade between the two countries themselves since this is obviously greatly influenced by the relative height of American and British tariffs. In other words, we ask the question to what extent productivity differences determine the success of U.S. and U.K. industries in exporting to third countries. No attempt will be made, however, to correct for the differential effects of Commonwealth preference, discrimination against American goods other than consumer durables, and locational factors. It would be difficult to give numerical expression to these influences in the present context; they should therefore be used as qualifications to the results derived from the model.

<sup>9</sup> Depreciation is not deducted from the net output figures, hence net output also equals value added plus depreciation.

<sup>10</sup> The sample includes 48 per cent of British and 41 per cent of American manufacturing exports.

Further problems arise in determining the ratio of American to British exports. Theoretically, one should deal with export quantities rather than export values. This is what MacDougall attempted to do. However, he ran into difficulties in regard to heterogeneous commodity groups that comprise by far the larger part of his sample in terms of production value. In some cases, he used value data (machinery, outer clothing), in others, a system of weighting (motor cars, leather footwear, hosiery). Both of these solutions entail errors, and one could also question the advisability of mixing quantity and value data in the same sample.

Because of the unreliability of quantity comparisons in most of the industries included in our sample, we have chosen to work with export values. In other words, we propose to

investigate the impact of productivity differences on export shares in third markets. By doing this we implicitly assume that the elasticity of substitution between American and British exports of the same commodity (or commodity group)<sup>11</sup> exceeds unity, since substitution elasticities equal to or less than unity would lead to inconclusive results. To give an example, if productivity ratios were equal to price ratios, and the elasticity of substitution between the two countries' exports

<sup>11</sup> The elasticity of substitution between American and British exports of a given commodity is

$$\frac{d\left(\frac{q_I}{q_{II}} \cdot \frac{p_I}{p_{II}}\right)}{d\left(\frac{p_I}{p_{II}} \cdot \frac{q_I}{q_{II}}\right)} = \frac{d \log (q_I/q_{II})}{d \log (p_I/p_{II})}$$

when I and II refer to American and British, respectively.

TABLE I. — AMERICAN AND BRITISH PRODUCTIVITY, WAGES, UNIT COSTS, AND EXPORTS

Industries	Export Value U.K. = 100 (1)	Output per Worker U.K. = 100 (2)	Wage Ratio \$ per £ U.K. = 100 (3)	Unit Labor Cost \$ per £ U.K. = 100 (4)	Net Unit Cost Ratio \$ per £ U.K. = 100 (5)
1. Woolen and worsted	2.7	185	1017	550	335
2. Shipbuilding and repairing	20.9	111	899	810	802
3. Cement	31.4	116	756	652	572
4. Structural clay products	40.9	197	804	408	498
5. Tanneries	48.9	168	904	538	370
6. Footwear, except rubber	66.5	171	805	471	440
7. Cotton spinning and weaving	68.4	249	928	373	280
8. Tools and implements	77.3	190	1041	548	570
9. Tires and tubes	84.9	241	1014	421	438
10. Knitting mills	86.3	187	914	489	359
11. Rayon, nylon, and silk	87.8	226	958	424	354
12. Iron and steel foundries	92.6	202	928	459	398
13. Bolts, nuts, rivets, screws	94.7	256	1223	478	523
14. Wirework	103.4	244	1042	427	409
15. Outerwear and underwear	110.9	170	1016	598	535
16. Soap, candles, and glycerine	114.8	249	1101	442	581
17. Generators, motors, transformers	117.6	239	998	418	466
18. Rubber products, except tires and footwear	136.3	250	1013	405	393
19. Blast furnaces	186.9	408	828	203	370
20. Radio	191.4	400	948	237	291
21. Steel works and rolling mills	196.6	269	879	327	338
22. Automobiles, trucks, and tractors	205.7	466	942	202	247
23. Basic industrial chemicals	213.2	372	947	255	322
24. Pulp, paper, and board	233.9	338	1021	302	297
25. Metal-working machinery	277.5	221	1108	501	459
26. Containers, paper and card	290.4	428	1146	268	229
27. Agricultural machinery, except tractors	291.8	429	958	223	224
28. Paint and varnish	320.1	363	980	270	255

SOURCE:

Column 1:

Great Britain, Customs and Excise Department, *Annual Statement of the Trade of the United Kingdom, 1954, Compared with the Years 1951-1953*, III (London: Her Majesty's Stationery Office, 1956).

United Nations, Statistical Office, *Commodity Trade Statistics, January-December 1951* (New York, 1952).

United Nations, Statistical Office, *Yearbook of International Trade Statistics, 1952* (New York, 1953).

United States, Bureau of the Census, Report No. FT410, *United States Exports of Domestic and Foreign Merchandise, Calendar Year 1951*, Parts I and II (Washington, 1952).

Columns 2, 3, 4, and 5:

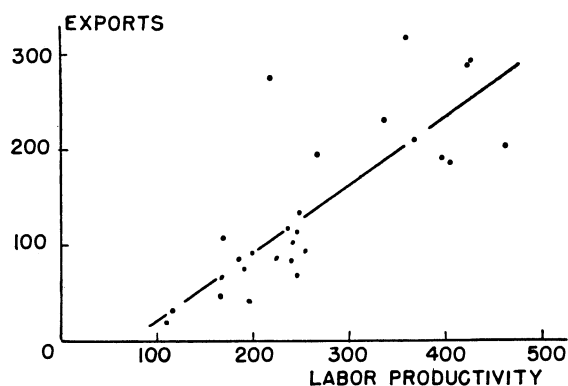
Paige, Deborah, and Gottfried Bombach, *A Comparison of National Output and Productivity of the United Kingdom and the United States* (Paris, OEEC, 1959).

were unity, *export values* would be identical. The findings of Kubinski, MacDougall, and Zelder indicate, however, that elasticities of substitution significantly exceed unity.<sup>12</sup> Therefore, it can be expected that — if a positive correlation between productivity and export quantities exists — relative productivity advantages will lead to larger export shares.<sup>13</sup>

The export data used in the calculations refer to 1951. This year has been chosen partly because we can expect a lag between changes in productivity and changes in export shares, partly because export values in 1950 do not yet reflect the full effect of the 1949 devaluation. Separate calculations were made for the years 1954–56.

The relevant data are found in columns (1) and (2) of Table 1. The scatter diagram, plotted on a natural scale (Chart 1) gives indication of a definite relationship between the two variables. As a first approximation, a straight line regression was fitted to the data,

CHART 1. — U.S./U.K. EXPORT AND PRODUCTIVITY RATIOS 1950 AND 1951 (NORMAL SCALE)



reflecting the hypothesis that there is a linear relationship between productivity ratios and export ratios. Introducing the symbols,  $E$  for export value and  $P = 1/A$ , the regression equation will assume the following form:

<sup>12</sup> A. Kubinski, "The Elasticity of Substitution between Sources of British Imports, 1921–38," *Yorkshire Bulletin of Economic and Social Research* (January 1950), 17–29; MacDougall, *op. cit.*; R. E. Zelder, "The Elasticity of Demand for Exports, 1921–38" (unpublished doctoral dissertation, University of Chicago, 1955), cited in A. C. Harberger, "Some Evidence on the International Price Mechanism," *Journal of Political Economy*, LXV (December 1957), 506–21.

<sup>13</sup> Still, our results will be influenced by inter-commodity differences as regards the elasticity of substitution.

$$\frac{E_I}{E_{II}} = -53.32 + .721 \frac{P_I}{P_{II}} \quad (4)$$

Thus, on the average, an increase in the U.S.-U.K. productivity ratio from 200 to 220 would lead to an increase of the ratio of export values to third countries from 91 to 105, and the value of American and British exports would become equal in an industry where American productivity exceeded British productivity by 113 per cent.

The correlation coefficient between productivity ratios and export ratios is .80; in other words, 64 per cent of the variance in export shares can be explained by differences in productivity. Since the coefficient of linear correlation might be influenced by extreme values, we also calculated the Spearman rank correlation coefficient. This gives the value of .81, indicating that extreme values did not have an appreciable influence on  $r$ .

The next question concerns the reliability of the results. We have calculated the confidence interval for the linear correlation coefficient with the use of Fisher's  $z$ -transformation. This gives the limits of .60–.90 for  $r$ , at the 5 per cent confidence level. However, we should note that, for the purposes of the present investigation, statistical methods are of limited usefulness in determining what significance can be attached to the estimates, since these presuppose random sampling from a bivariate normal distribution of the variables in question. Although we can assume that the underlying distributions approach a normal curve, the group of industries investigated cannot be regarded as a random sample.

Approaching the problem of reliability in a different way, we note that our sample includes 40–45 per cent of manufacturing production and exports in the two countries; hence it may give a reasonably good approximation for manufacturing as a whole for the period under consideration. It is a different problem whether the same relationship would apply to years other than the ones chosen since the results are affected by errors due to variables not included in the analysis and by observational errors in the independent variable. Productivity data are available only for 1950, but these can be compared with trade figures for later periods.

Surely, the comparison has only limited validity since we disregard possible changes in productivity, but it will still be of some interest if we can assume that year-to-year changes in productivity are small or that export trade follows variations in productivity with a comparatively long time lag. We have proceeded to calculate the correlation between the variables in question using export data for 1954-56,<sup>14</sup> and arrived at  $r = .73$ . Considering the differences in the two time periods, the results are remarkably close and suggest the relative constancy of the observed relationship.

In the above discussion we have assumed the existence of a linear relationship between the variables considered. However, the scatter diagram of Chart 1 indicates increasing deviations from the regression line as the values of observations increase, suggesting that a logarithmic relationship may provide a better fit. If this were so, a one per cent increase in productivity ratios would be associated with a given percentage change in export ratios.

The observations — with one exception — are plotted on a logarithmic scale in Chart 2 and show a close relationship. The exception is the wool industry in which American exports amount to only a small fraction of British exports. The deviation of the data of this industry from the observed pattern is explained by the fact that Britain has differential advantages over the United States in manufacturing woollens inasmuch as she can procure wool at a lower price from Commonwealth countries (Australia and New Zealand) and, also, the quality of British wool products is greatly superior to the American. The difference in quality suggests that the reliability of the comparison is greatly reduced by the differentiation of the product.

If we exclude the wool industry from the investigation, the regression equation takes the form,

$$\log \frac{E_I}{E_{II}} = -1.761 + \frac{1.594}{(0.181)} \log \frac{P_I}{P_{II}} \quad (5)$$

Thus, a one per cent change in productivity

<sup>14</sup> The choice of these years was given by the availability of the data for purposes of a different investigation. Since discrimination against American consumer durables abated by 1954, electrical household equipment and automobiles were included in our sample.

CHART 2. — U.S./U.K. EXPORT AND PRODUCTIVITY RATIOS 1950 AND 1951 (LOGARITHMIC SCALE)



ratios leads to an approximately 1.6 per cent change in the ratio of export values between the two countries. The coefficient of correlation is .86, with confidence limits of .73-.94 at the 5 per cent level of significance. The coefficient of determination is .74; that is, 74 per cent of the variance in export ratios can be explained by relative productivity differences.<sup>15</sup>

### Productivity, Wages, and Exports

The next question to be answered is whether the explanation of export ratios given here can be improved upon if we consider not only productivity differences but also wage ratios as the determinants of export shares. Wage ratios (U.S./U.K.) are found in Column (3) of Table 1. A multiple regression equation can be fitted using productivity ratios and wage ratios as independent, and the ratio of export values as dependent, variables, since no multicollinearity is present. (The coefficient of linear correlation between productivity ratios and wage ratios is .20.)

Assuming additivity in the effect of the independent variables on export shares, the regression equation will take the form,

$$\frac{E_I}{E_{II}} = -181.2 + \frac{.691}{(.167)} \frac{P_I}{P_{II}} + \frac{.140}{(.102)} \frac{W_I}{W_{II}} \quad (6)$$

<sup>15</sup> If the wool industry were included in the calculations, the correlation coefficient would be .78.

The multiple correlation coefficient is .81, compared with .80 for the simple correlation coefficient. The two values become equal if the adjustment suggested by H. Theil for specification analysis is made.<sup>16</sup> The partial coefficient of correlation between productivity and exports is .77, between wages and exports .24. The latter coefficient is not significant at the 5 per cent confidence level.

The explanatory value of wage differentials as regards to differences in export values changes but little if we fit a logarithmic equation to the data.

$$\log \frac{E_I}{E_{II}} = -5.164 + \frac{1.457}{(.328)} \log \frac{P_I}{P_{II}} + \frac{1.250}{(.566)} \log \frac{W_I}{W_{II}}. \quad (7)$$

Again, there is no significant difference between the multiple correlation coefficient ( $R = .88$ ) and the simple correlation coefficient ( $r = .86$ ). The partial coefficients of correlation are: between productivity and exports, .84; between wages and exports, .11 — the latter is not significant at the 5 per cent level.<sup>17</sup>

These results indicate that a definite relationship between wage ratios and export shares cannot be established. Productivity advantages are not counterbalanced by higher wages paid in industries with higher productivity, and productivity differences continue to account, in a large measure, for differences in export shares. Actually, there is some — although largely inconclusive — evidence that higher relative wages might be associated with higher export shares.<sup>18</sup> If this were so, a possible explanation would be that greater success in exportation may lead to higher wages. This implies that the relationship between wages and export shares is by no means uni-directional; while lower wages could conceivably lead to higher export shares, higher export shares may also make possible paying higher wages.

#### Unit Costs and Exports

We come now to the question of whether our results could be improved upon by including

<sup>16</sup> See his *Economic Forecasts and Policy* (revised edition; Amsterdam 1961), 210 ff.

<sup>17</sup> The wool industry was excluded in estimating the regression equation.

<sup>18</sup> See also I. B. Kravis, "Wages and Foreign Trade," this REVIEW, xxxviii (February 1956), 30.

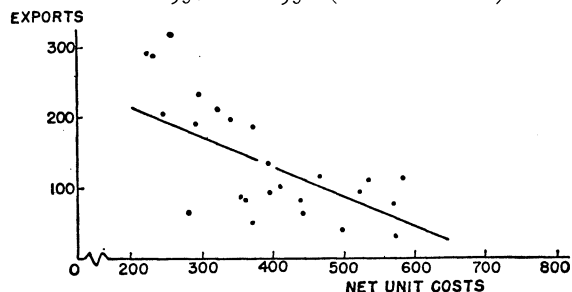
capital costs in the estimates. At this point we encounter statistical difficulties, however. The available data do not provide information on capital cost per unit of output but only on "net costs," inclusive of profits. Net costs as defined by Paige and Bombach are equivalent to net output so that net costs per unit of output refer to value added plus depreciation per quantity of output. We will make use of these figures in the following (see Table 1, col. (5)), while the implications of this procedure will be noted at a later point.

Chart 3 shows the tendency of export shares to favor the country with the lower relative net unit costs. As a first approximation, we have again fitted a straight line regression of the form

$$\frac{E_I}{E_{II}} = 299.8 - \frac{.410}{(.103)} \frac{N_I}{N_{II}} \quad (8)$$

when  $N$  refers to net unit costs as defined above. The correlation coefficient between the two variables is  $-.60$ , with confidence limits of  $-.28$  to  $-.80$  at the 5 per cent level of significance.

CHART 3. — U.S./U.K. EXPORT AND NET UNIT COSTS RATIOS 1950 AND 1951 (NORMAL SCALE)



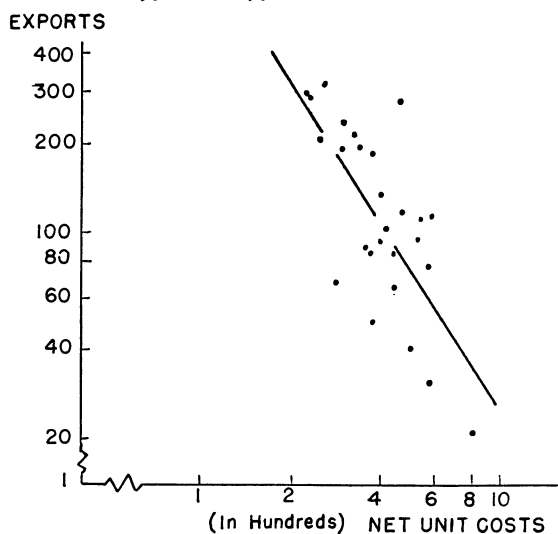
We find a closer relationship between net unit costs and export values if the relevant data are plotted on a logarithmic scale (Chart 4).<sup>19</sup> Fitting a logarithmic regression to the observations, this will assume the form

$$\log \frac{E_I}{E_{II}} = 6.162 - \frac{1.590}{(.301)} \log \frac{N_I}{N_{II}}. \quad (9)$$

Thus, a one per cent increase in the ratio of net unit costs would lead to an approximately 1.6 per cent reduction in the ratio of export values. The coefficient of correlation is  $-.71$ , with confidence limits  $-.44$  to  $-.86$  at the 5 per cent level of significance. Thus, a little

<sup>19</sup> As in all logarithmic regressions, the wool industry is excluded from the data.

CHART 4.— U.S./U.K. EXPORT AND NET UNIT COSTS RATIOS 1950 AND 1951 (LOGARITHMIC SCALE)



over 50 per cent of the variance in export values can be explained by differences in net unit costs.

The results show that a one per cent increase in productivity ratios *or* in net unit cost ratios leads to a 1.6 per cent change in the ratio of export values. At the same time, the correlation coefficient between productivity ratios and export shares appears to be higher than between net unit cost ratios and export shares.

The first question to be answered is whether the difference between the two coefficients (taken without sign) is significant. For the normal regression, the correlation coefficients are .80 and  $-.60$ , respectively; for the logarithmic regression, .86 and  $-.71$ . The value of  $T$  is 1.44 in the first case and 1.51 in the second.<sup>20</sup> Deviations of such magnitude could occur in a normal distribution 13–15 times in 100 cases. Hence, the differences between the observed values of the coefficients does not appear to be significant. However, doubts may arise about the application of this test to the problem at hand, since it presupposes random sampling. If we consider that the difference in the correlation coefficients is maintained if export values for 1954–56 are used in the calculations,<sup>21</sup> it would appear that this difference might not be due to random factors.

If we assume that there is a significant dif-

<sup>20</sup> For a description of this test, see F. C. Mills, *Statistical Methods* (New York, 1955), 506–507.

ference between the correlation coefficients, we face the further problem of indicating why the relationship between productivity and exports is closer than that between net unit costs and exports. A possible explanation is that industries with greater success in export markets enjoy higher profits and this reduces the negative correlation between net costs and exports. This hypothesis would take care of market imperfections that lead to different rates of profits in various industries, but it would require further justification.

#### Evaluation of the Empirical Results

The evidence presented indicates that there is a high correlation between productivity ratios and export shares, and the introduction of further explanatory variables only slightly modifies the results. On the one hand, there is inconclusive evidence that inter-industry wage differences would appreciably affect export shares; on the other, differences in capital cost per unit of output do not seem to have a significant influence on export performance. These results may be surprising to many, although they appear by no means implausible.

Two possible explanations can be given for the absence of a correlation between wage ratios and export shares. Taussig advanced the proposition that the hierarchy of wages in different countries is largely similar because there is little competition between the labor force of various industries (non-competing groups) *and* inter-industry wage-differences are determined by the disutility and regularity of work, the required strength and skill, and other factors all of which act in basically the same way in all countries.<sup>22</sup> On the other hand, I. B. Kravis argued that the labor groups in various occupations do compete with each other and, consequently, in any one country, wage differences are considerably smaller than productivity differences.<sup>23</sup>

As to the first explanation, Stanley Lebergott has shown that, in the years immediately

<sup>21</sup> The correlation coefficient between productivity and exports is .73, while between net unit costs and exports this is  $-.44$ , if export data for 1954–56 are used and the variables are expressed on a normal scale.

<sup>22</sup> *Op. cit.*, 43 ff.

<sup>23</sup> “‘Availability’ and Other Influences on the Commodity Composition of Trade,” *Journal of Political Economy*, LXXIV (April 1956), 146.



following the Second World War, inter-industry wage patterns were almost identical between the United States, the United Kingdom, and Canada, and differed only slightly for Sweden.<sup>24</sup> Similar results have been reached for the United States and Japan by I. B. Kravis.<sup>25</sup> At the same time, it has been shown that — compared with productivity differences — wages paid in different industries tend to cluster around the national average.<sup>26</sup>

In our sample, the coefficient of variation is 37.1 for productivity ratios and 10.7 for wage ratios. This result is in conformity with the argumentation of both Taussig and Kravis, since the low degree of dispersion in wage ratios may be due to similarities in the wage patterns of the two countries, to small inter-industry wage differences in the individual countries, or to a combination of both. Under the latter alternative, one would argue that although different occupational groups are to some extent in competition with one another, the inter-industry wage pattern is still determined by factors such as the skills required in particular industries, that act in a similar fashion in every country. In other words, there is no need for assuming the existence of non-competing groups in order to explain the similarity of the inter-industry wage pattern in various countries.

The absence of correlation between wage ratios and export shares appears to refute the arguments of those who believe that cheap wages have played an important part in determining export patterns in manufacturing industries.<sup>27</sup> At the same time, our results do not establish the frequently-argued correlation between productivity and wages either, considering that the correlation coefficient between productivity ratios and wage ratios is .20.

With respect to the relationship between capital costs and export performance, a frequent misunderstanding should be noted. Ber-

<sup>24</sup> "Wage Structures," this REVIEW, XXIX (November 1947), 274-85.

<sup>25</sup> "Availability' and other Influences on the Commodity Composition of Trade," *Journal of Political Economy*, LXIV (April 1956), 145.

<sup>26</sup> "Wages and Foreign Trade," this REVIEW, XXXVIII (February 1956), 14-30.

<sup>27</sup> Cf., e.g., Karl Forchheimer, "The Role of Relative Wage Differences in International Trade," *Quarterly Journal of Economics*, LXII (November 1947), 1-30.

til Ohlin asserted that the classical economists were guilty of neglecting the capital factor, and in his criticism Ohlin referred to the existing large inter-industry differences of capital-labor ratios. In the United States, for example, the amount of capital per worker was said to vary between \$10,000 in the chemical industry and \$1,700 in tobacco manufacturing.<sup>28</sup> However, in determining the competitive position of any industry, capital costs per unit of output rather than capital-labor ratios are relevant. And it is by no means necessary that high capital costs per unit of output would be accompanied by high productivity, considering that the application of more advanced technological methods associated with higher capital intensity may reduce rather than increase the cost of capital per unit of output in modern plants. In other words, a high capital-labor ratio may correspond to high productivity of labor *and* capital as well. In fact, this result has been reached by Marvin Frankel, who found a slight association between low unit labor costs and low unit capital costs in a cross-section study of American and British industries.<sup>29</sup> Finally, even if we assumed a negative correlation between labor productivity and capital costs, the importance of the capital factor in determining trade patterns would be reduced if the hierarchy of industries with regard to capital intensity were similar in individual countries.

In conclusion, we can state that our results are in conformity with the classical hypothesis: the evidence presented indicates that the consideration of differences in wage patterns and capital costs offers little improvement over the results reached by relating export shares to productivity differences. On the other hand, productivity differentials cannot give a full explanation of export shares, so that we also have to take account of transportation costs as well as non-economic factors (Commonwealth preference, trade and exchange restrictions, good will, etc.) in order to provide a more comprehensive explanation of international specialization. The latter considerations fall outside the confines of this paper, however.

<sup>28</sup> *Interregional and International Trade*, (Cambridge, Mass., 1933), 572.

<sup>29</sup> *British and American Manufacturing Productivity*, Bulletin No. 49, University of Illinois, Bureau of Economic and Business Research (Urbana, 1957), 45.