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Uses of International Price and Output Data

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THIS paper was designed as a survey of some of the literature which has used quantitative data on international price and real income comparisons. Interest in this area grew out of a continuing study of the differences in real incomes, productivity, and the structure of relative prices between Canada and the United States. Some of the evidence on the Canada-United States differences and other recent empirical work on income differences for other countries was apparently very much at variance with the main assumptions of international trade theory. Some of the interpretations and evidence from the Canada-United States work appeared to be relevant for other countries as well.

Two sections will deal with the use of quantitative data on inter-country comparisons in estimating and testing some key propositions in economic growth and international trade. A number of valuable and comprehensive surveys in these areas had already been made during the 1960's, but this paper will introduce later evidence and incorporate new concepts in three areas: It will introduce the framework and evidence on real output per person employed, from some of the ten industrialized countries, that have been developed by E. F. Denison, Jean-Pierre Poulhier, and Dorothy Walters. Secondly, the analysis and evidence from some of the work on effective tariff rates will be introduced to provide a rationale for some of the differences in production conditions in manufacturing between countries. Thirdly,

NOTE: This study has been improved by helpful comments on an earlier draft from E. F. Denison, H. G. Johnson, and Irving Kravis.

the recent theoretical formulations by Alchian and Hirshleifer on the role of length of run and total volume of production will be related to specialization in international trade. A number of these concepts and their empirical importance have been developed as part of the continuing study of the differences in real incomes, productivity, and the structure of relative prices between Canada and the United States, and some of these results to date will be drawn on.

INTERNATIONAL INCOME DIFFERENCES

One might have expected to find that the increased interest by economists in economic growth in the postwar period would provide a quantitative framework for studying income differences between countries. However, much of the work in the area of economic growth (with special emphasis on the supply side of the economy) has been formal and theoretical, rather than empirical. When it has been empirical, it has emphasized growth in a particular country, rather than making international comparisons of economic growth experience. The useful survey of economic growth by Hahn and Matthews excluded the quantitative aspects of economic growth and the relations between economic growth and international trade. They outline their scope as follows:

We restrict ourselves (except for occasional references) to the theoretical literature. . . . No discussion is presented of growth theory as applied to international trade. . . . The scope that has been chosen for the present survey reflects the increasingly formal character that has been manifested, for better or worse, in much of the literature in the period since Abramovitz's survey was written (1962).¹

Colin Clark was an early pioneer in this area. Some of his ideas have had an important influence on subsequent work, such as his emphasis on the changing industrial composition of the labor force. He emphasized the long-term decline in agriculture and mining and the long-term increase in the importance of the service industries, and pointed out that similar differences appeared in the industrial structure of

¹ F. H. Hahn and R. C. O. Matthews, "The Theory of Economic Growth: A Survey," in *Surveys of Economic Theory*, New York, St. Martin's Press, 1965, Vol. II, pp. 1 and 2.

countries at various levels of economic development.² His comparisons of real national products in 1950 used information on relative prices for specific product groups, and the third edition incorporated the results of the first OEEC (Organization for European Economic Cooperation) study.³ His work went on from the intercountry comparisons of levels to emphasize the role of industrial structure and changes in it. He also included international comparisons of capital-output ratios.

Simon Kuznets has also been productive in this, as in many other, areas of national income analysis. In a number of his studies of economic growth on a comparative basis he has included comparisons of international income differences. He has incorporated the results of the OEEC studies and the United Nations comparisons of calculated parity ratios.⁴ The latter were based on the 1938 official exchange rates with some adjustments for subsequent price changes in the country concerned, relative to United States price changes. Other parts of his most comprehensive study also considered trends in industrial structure, distribution of product and income, international interdependence, and economic and social structure. One of the points he makes from the intercountry comparisons is the limited spread of modern economic growth.

One of the important contributions to the theory and estimation of economic growth was based on intercountry comparisons of value added in individual manufacturing industries.⁵ Some of the assumptions made by Arrow, Chenery, Minhas, and Solow were that prices of product and material inputs do not vary systematically with the wage level, that overvaluation or undervaluation of exchange rates is not related to the wage level, and that the same technological alternatives are available to all countries.⁶ The data for the intercountry compari-

² Colin Clark, *The Conditions of Economic Progress*, 3rd ed., London, Macmillan, 1957.

³ *Ibid.*, pp. 18-74.

⁴ Simon Kuznets, *Modern Economic Growth: Rate, Structure, and Spread*, New Haven, Yale University Press, 1966, pp. 359-399.

⁵ K. J. Arrow et al. (H. B. Chenery, B. S. Minhas, and R. M. Solow), "Capital-Labor Substitution and Economic Efficiency," *Review of Economics and Statistics*, August 1961, pp. 225-250.

⁶ *Ibid.*, pp. 227-228.

sons of value added by industry were made at official exchange rates or at free market rates where multiple exchange rates prevailed.⁷ It should be noted that when careful comparisons of intercountry price levels are made, there are, typically, significant differences from the official exchange rates. There is also some evidence of a positive relationship between per capita real GNP and the difference between purchasing power and the official exchange rates.⁸ Important though this study is in many respects, the quality of the underlying data on intercountry comparisons of real output by industry do not match the level of sophistication of the basic economic model on the substitution between labor and capital.

The most comprehensive study of economic growth using international comparisons of real income levels as a part of the analysis is the Brookings report, *Why Growth Rates Differ*.⁹ In this study, the comparisons of levels of net national product in United States prices were used as an integral part of the investigation of changes since 1950 in net national product on both a total and per employed person basis. In studying the wide range of individual factors that contribute to economic growth, the report followed the method developed by Denison in his earlier volume on economic growth in the United States.¹⁰ This distinguished between the contribution of the individual factor inputs (labor, capital, and land, with a number of breakdowns within each of those three basic factors), and output in relation to total factor inputs. More than twenty individual contributions to growth were estimated quantitatively for each country.

⁷ *Ibid.*, p. 227.

⁸ Bela Balassa, "The Purchasing-Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, 1964, pp. 584-596, Table 1 and Figure 1 and related text. It might be noted that Balassa emphasized the intercountry differences in prices and wages in the service industries, and the same relationship may not apply in manufacturing. This area was also discussed in the Grunwald-Salazar paper for this conference.

⁹ Edward F. Denison, assisted by Jean-Pierre Poulhier, *Why Growth Rates Differ—Postwar Experience in Nine Western Countries*, Washington, D.C., Brookings Institution, 1967. The same framework has been used for Canada-United States comparisons in Dorothy Walters, *Canadian Income Levels and Growth: An International Perspective*, Economic Council of Canada Staff Study No. 23, Ottawa, The Queen's Printer, 1968.

¹⁰ Edward F. Denison, *The Sources of Economic Growth in the United States and the Alternatives Before Us*, New York, Committee for Economic Development, January 1962, Supplementary Paper No. 13.

In making the comparisons of net national product in real terms, Denison and Poullier updated the earlier pioneering OEEC studies for the nine countries covered.¹¹ In light of the marked changes in relative prices and relative quantities that emerged in the updating, the importance of more recent comprehensive studies of international comparisons of prices and purchasing power emerged.

It would take us away from the main theme of this paper to deal with the broader ramifications of this study.¹² In terms of the use of international comparisons of prices and real incomes as part of a broader study of economic growth over time, two parts of this study should be emphasized.

The first point to emphasize is that the role differences in the environment of the individual countries in 1950 are a significant factor in explaining subsequent differences in growth rates. For example, the individual European countries initially had levels of net national product per employed person well below the United States (whether measured in U.S. or European relative prices). The data and discussion of the individual sources of growth permit the key factors in postwar growth in the various countries to be identified. At the end of the 1940's, the individual European countries still had significant proportions of their labor force in the lower income sectors of agriculture and nonagricultural self-employment, and there was much more scope for growth from this source than in the United States, where this shift had already gone much further. Furthermore, the individual European countries had much lower levels of capital stock (including nonresidential construction, machinery and equipment, and inventories) than the United States, and a special adjustment was made for Germany, which still had an unbalanced capital stock in 1950. The structure of relative prices in Europe was also significantly different from that in the United States. Prices of machinery and equipment and consumer

¹¹ Milton Gilbert and Irving B. Kravis, *An International Comparison of National Products and the Purchasing Power of Currencies*, Paris, OEEC, 1954, and Milton Gilbert and Associates, *Comparative National Products and Price Levels: A Study of Western Europe and the United States*, Paris, OEEC, 1958.

¹² For fuller appraisals, see D. J. Daly, "Why Growth Rates Differ—A Summary and Appraisal," *International Review of Income and Wealth*, March, 1968, pp. 75-93; R. C. O. Matthews, "Why Growth Rates Differ," *Economic Journal*, June 1969, pp. 262-268; John Cornwall, "Postwar Growth in Western Europe: A Re-evaluation," *Review of Economics and Statistics*, August 1968, pp. 361-368.

durables were relatively more expensive in the European countries than in the United States, and, with the rapid growth in the individual European countries, "income elasticities" provided an important source of the higher European growth. From 1950 to 1962, this contributed 0.46 to the growth rate for northwest Europe as a whole. The use of comparisons between the countries at a point in time was essential in identifying these special factors in growth from 1950 to 1962.

The second point to emphasize was that the comparisons between countries at a point in time were used as a basis for appraising some key elements in future growth prospects for the various countries. In summarizing the implications of the study, Denison stated

Comparisons with the post-war growth rates of European countries . . . do not provide grounds for dissatisfaction with the American growth record. The point needs stressing because the conditions that enabled Europe to obtain higher growth rates are not exhausted. Aside from short-term aberrations Europe should be able to report higher growth rates, at least in national income per person employed, for a long time. Americans should expect this and not be disturbed by it. Nothing in this analysis suggests that the conditions making for higher European growth would continue to operate if the European countries were to reach American levels of national income per person employed. . . . Any projection of future European growth must be critically affected by the investigator's judgment as to whether this productivity gap will be reduced in the future and, if so, how much and how fast.¹³

Denison provides information on the relative role of a variety of factors that account for differences in the level of net national product per person employed at a point in time and, also, data on changes over time in these factors. This information would be helpful in appraising medium-term growth prospects for the countries concerned.

More recently intercountry comparisons of level have been made as part of a study of growth over time, with emphasis on Japan and Soviet Russia.¹⁴ This study puts rather more emphasis on differences in level than does Maddison's earlier investigation of comparative experience in Europe and North America. In that one, some of the

¹³ *Why Growth Rates Differ*, pp. 340 and 344.

¹⁴ Angus Maddison, *Economic Growth in Japan and the USSR*, London, Allen and Unwin, 1969.

main conclusions from the OEEC studies were summarized in about three pages,¹⁵ but they were not knit into other parts of the book in any major way.

In summary, a number of studies of comparative growth have used intercountry comparisons of real output per capita or per person employed. This provides perspective on a much wider range of stages of economic development than would be obtained from the history of a single country. But such intercountry comparisons raise a wider range of issues concerning data, comparability of tastes, social and economic organization, and the extent to which theory can point up the key questions involved.¹⁶ Some of these same issues are applicable to international trade theory.

TESTING INTERNATIONAL TRADE THEORY

The availability of data on the differences in real income and relative prices between a number of industrialized and developing countries permits some testing of the main competing and complementary theories of international trade. This section will concentrate on the "real" factors in international trade, such as differences in production conditions and factor quantities—factor prices on the interrelations between domestic production and the extent and composition of international trade.

It is clear that this is a large task. The amount of literature on the real and positive aspects of international trade has been tremendous, but the current state of this area of international trade theory has been well surveyed in the past.¹⁷ However, much of the literature is theo-

¹⁵ Angus Maddison, *Economic Growth in the West*, New York, Twentieth Century Fund, 1964, pp. 39-42.

¹⁶ Irving Kravis, "The Scope of Economic Activity in International Income Comparisons," and Comments and Reply, in *Problems in the International Comparison of Economic Accounts*, Studies in Income and Wealth, Vol. 20, New York, National Bureau of Economic Research, 1957, pp. 349-400.

¹⁷ The main surveys are Jacob Viner, *Studies in the Theory of International Trade*, New York, Harper & Row, 1937; Richard E. Caves, *Trade and Economic Structure: Models and Methods*, Cambridge, Harvard University Press, 1960; Gottfried Haberler, *A Survey of International Trade Theory*, Special Papers in International Economics No. 1, International Finance Section, Department of Economics, Princeton University, 1961; Jagdish Bhagwati, "Some Recent Trends in the Pure Theory of International Trade" in Roy Harrod and Douglas Hague, eds., *International Trade Theory in a Developing World*, London, Macmillan, 1963; Jagdish

retical in that it develops conclusions based on the logical development of certain explicitly stated assumptions. The extent of testing of these conclusions against the real world has been much more limited, however, and the implications of the available data for the theoretical models have not always been made explicit. This section of the paper will review the evidence on the two main theoretical views of the basis of trade, namely, (1) the Ricardian emphasis on differing production conditions in different countries; (2) the Heckscher-Ohlin-Samuelson emphasis on differences in factor supplies and factor prices.

Linder's emphasis on demand conditions will be considered in the next section, on Canada-United States comparisons. The groundwork for these comparisons will be laid by supplementing and modifying the two surveys of this area in the 1960's by Caves and Bhagwati¹⁸ by emphasizing the relative importance of labor costs in value added by industry, by giving more attention to the data problems, and by incorporating results from some studies done since their surveys were completed.

Differences in the Structure of Relative Prices

Almost all the pure theories of international trade emphasize that trade takes place between countries because, in the absence of trade, differences exist in relative prices between the countries concerned. Trade tends to equalize prices of commodities, although the presence of tariffs and transport costs can limit this. The major differences among trade theorists emerge from differing emphases on the *reasons* for the differences in relative prices. Before turning to the empirical reasonableness of the several approaches to trade theory, some refer-

Bhagwati, "The Pure Theory of International Trade: A Survey," in *Surveys of Economic Theory*, Vol. II; W. M. Corden, *Recent Developments in the Theory of International Trade*, Special Papers in International Economics, No. 7, International Finance Section, Department of Economics, Princeton University, 1965; and J. S. Chipman, "A Survey of the Theory of International Trade," three parts in *Econometrica*, 1965 and 1966.

Very useful volumes of readings containing a number of the major articles include Howard S. Ellis and Lloyd A. Metzler, eds., *Readings in the Theory of International Trade*, Homewood, Ill., Irwin, 1950; Richard E. Caves and H. G. Johnson, eds., *Readings in International Economics*, Homewood, Ill., Irwin, 1968; and Jagdish Bhagwati, ed., *International Trade, Selected Readings*, Baltimore, Md., Penguin Books, 1969.

¹⁸ Caves, *Trade*, Chap. X, pp. 263-282, and Bhagwati, "Pure Theory," pp. 159-184.

ences to the evidence on the existence of differences in relative prices will be given.

Among developed countries, the most comprehensive surveys of statistical data on this point are still the two OEEC studies.¹⁹ The first was based on a study of the United States, the United Kingdom, France, Germany, and Italy, primarily for 1950, but with occasional data for 1952 as well. The second study added four additional European countries (Norway, Denmark, Belgium, and the Netherlands) and provided 1955 estimates for the most important aggregates. The primary purpose of these studies was to prepare comparisons of national products and the major expenditure components in "real" terms. As part of the underlying methodology, data were prepared for the individual countries on both the prices and quantities of the individual items, and the data on prices were used as weights to prepare the more aggregative quantity comparisons.

In the first study some attention was given to the differences in relative prices in order to show their influence on the weighted aggregative quantities of the various products used. The product groups were subdivided into slightly more than fifty product classes, and there were significant differences in the purchasing power equivalents between the various pairs of countries. The differences in relative prices between the United States and the individual European countries were ranked from high to low, and grouped into approximate thirds. No allowance for differences in the quantitative importance of the items was made. These differences are shown in Table 1, together with the ratios of the highest to the lowest price relatives for the four individual European countries. It is apparent that the differences in the range of relative prices are very great. The highest price relative between Italy and the United States was about 20 times the lowest, while for the three other countries this ranged between 7 and 10 times! Some of these differences reflect the large relative price differences for services, as developed in the Comment by Balassa. The differences in price ratios for commodities

¹⁹ Gilbert and Kravis, *An International Comparison*; and Gilbert and Associates, *Comparative National Products*. For references and discussion of later international price comparisons, see Wilfred Beckerman, *International Comparisons of Real Incomes*, Development Centre of the Organization for Economic Cooperation and Development, Paris, 1966.

TABLE 1
Selected Market Price Ratios, United States and
Four European Countries, 1950

	U.S.-U.K. (pounds to dollar)	U.S.-France (francs to dollar)	U.S.-Germany (DM to dollar)	U.S.-Italy (lire to dollar)
High	>0.270	>360	>4.20	>670
Low	<0.175	<210	<2.50	<330
Ratio of group bound- aries	1.57	1.71	1.68	2.09
Ratio of highest to lowest price ratio	8	7	10	20

SOURCE: Milton Gilbert and Irving B. Kravis, *An International Comparison of National Products and the Purchasing Power of Currencies*, Paris, OEEC, 1954, Tables 21-24 and Figures 2-5 (pp. 53-56 and 58-59).

are less pronounced. Marked differences in the relative 1950 market prices of broad consumption categories also appear among the eight European countries.²⁰

It is these differences in relative prices between countries at a point in time that contribute to the size of the quantitative differences in real incomes, depending upon which country's prices are used as weights. This raises the whole index number problem, which is quantitatively much more important in comparisons between countries than between different points of time within a particular country. The magnitude of the effect of these differences in relative price weights on real GNP per capita is shown in Table 2. Large differences associated with differences in weights appear quite generally in such international comparisons of real product where incomes differ, and this reappeared in the Bergson paper and the Grunwald-Salazar paper at this conference and was also raised by a number of discussants.

It should be noted that trade from the relatively low-cost supplier to other countries will occur only if the difference in the prices between the lower-cost country and the higher-cost country are equal to, or greater than, the costs of transportation and tariffs between the respec-

²⁰ Gilbert and Associates, *Comparative National Products*, Table 20, p. 62.

TABLE 2

Per Capita Gross National Product of the United States and Eight European Countries Combined, 1955

United States	\$2,310
Total of eight European countries	
(a) U.S. relative price weights	1,237
(b) European relative price weights	953
(c) Geometric average of (a) and (b)	1,086

SOURCE: Milton Gilbert and Associates, *Comparative National Products and Price Levels: A Study of Western Europe and the United States*, Paris, OEEC, 1958, Table 1, p. 21.

tive countries, at prevailing rates of exchange between the countries. Since the end of the Second World War, there has been a marked reduction and elimination of quantitative controls, and the series of general tariff reductions and the achievement of complete free trade in industrial products within the Common Market and EFTA (European Free Trade Association) groups of countries have sharply reduced the importance of tariffs and other restrictions on trade.²¹ With the increased freedom of trade and the narrowing in income differences, one would expect to see a reduction in the extent of differences in relative prices since the OEEC studies of the early 1950's. It would be interesting to see this hypothesis tested in any renewed surveys of relative prices and quantities for any of the countries studied before.

Labor Costs in Total Costs

Before one turns to the data on individual industries, some perspective on the importance of labor as a factor of production and an element in total cost can be obtained by looking at labor's share of national income. Different concepts can be used, but the material from *Why Growth Rates Differ* can illustrate this for the main industrial countries. From Table 3, it can be seen that labor income is almost 80 per cent of net national income in the United States, Canada, and

²¹ For discussion of the continued importance of nontariff barriers to trade, see Gordon Ohlin, "Trade in a Non-Laissez-Faire World," paper presented to the International Economic Association in Montreal, September 1968; and R. Y. Grey, "Some Problems of Canadian Trade in a Non-Laissez-Faire World," paper presented to the Canadian Economics Association, June 1969.

TABLE 3
 Distribution of Net National Income, 1960-62
 (average of annual percentage)

	United States "	Canada	Northwest Europe "
Net national income	100.0	100.0	100.0
Labor income	79.9	78.1	76.5
Dwellings	4.2	4.8	2.4
Property income from abroad	0.7	-2.0	0.4
Other property income	15.2	19.1	20.7
Nonresidential land	2.5	2.9	3.5
Nonresidential structures and equip- ment	10.2	12.8	13.4
Inventories	2.5	3.4	3.8

^a See Edward F. Denison, assisted by Jean-Pierre Poulhier, *Why Growth Rates Differ—Postwar Experience in Nine Western Countries*, Washington, D.C., Brookings Institution, 1967, Table 4-1, p. 38; and Dorothy Walters, *Canadian Income Levels and Growth: An International Perspective*, Economic Council of Canada Staff Study No. 23, Ottawa, The Queen's Printer, 1968, p. 29.

northwest Europe.²² A labor share this high can occur only if high proportions for labor income characterize a majority of the individual industries. Under these circumstances, an initial emphasis on wage and productivity differences in different countries, by industry, seems justified.

Ricardian Analysis

In terms of the initial theoretical formulation as a "logically true" proposition, this formulation dealt with two commodities and two countries, a single input (labor), and constant returns to scale. Differences in the relative labor productivities of different activities in the two countries then played a key role in the pattern of trade between the two countries.

²² Two things about the concepts used by Denison should be noted. The distribution relates to *net* national income, after excluding an allowance for capital consumption at current replacement costs. The estimates also make an imputation for the distribution of income between labor and capital in the agricultural and other individual-enterprise sectors.

In moving from this simple and logically true analysis to an empirically refutable proposition, several additional hypotheses have been introduced explicitly or implicitly in the tests that could be or have been made. The basis of trade will eventually be in differences in relative prices of goods and services in the countries being studied. If labor costs are a large part of value added in the various industries, differences in relative wage rates or differences in relative labor productivities could play a role in the structure of trade. In testing the Ricardian tradition with contemporary data, it is clear that real problems are encountered even when data on real output per employed person are available by industry. Although this is the central thesis of the classical tradition, most economists would recognize the need to check the relative importance of the cost of other factors of production and their relative rates of return, and the relationship between total costs and export prices.

In the light of the relative importance of labor cost in net national income (or net value added), some further discussion of the role of differences in wage rates and differences in output in relation to labor inputs is desirable. However, the data on both these key areas are very limited, especially data on output per person employed in the *same* industry in different countries.

Data are available, however, for the United States and the United Kingdom by drawing on two pioneering studies of intercountry comparisons of productivity by industry.²³ Some data from these studies,

²³ L. Rostas, *Comparative Productivity in British and American Industry*, National Institute of Economic and Social Research, Occasional Papers, No. 13, Cambridge, England, 1948; and Deborah Paige and Gottfried Bombach, *A Comparison of National Output and Productivity in the United Kingdom and the United States*, Paris, OEEC, 1959. There was one important difference in the methods used in the two studies to estimate real output and productivity by industry. Rostas used measures of real output for key commodities (quantities of bricks, cement, rubber, tires, tobacco, coke, etc.) with no allowance for differences in intermediate inputs used. Paige and Bombach tried to obtain measures of value added by industry, which took account of differences in the quantities and prices of intermediate inputs and outputs by industry. Thus, they adopted the Geary method of estimating changes over time in the real value of output by industry and applied it to intercountry comparisons.

This difference in statistical procedure in estimating output by industry is analogous to the discussion of nominal and effective tariff rates by industry. The discussion of effective tariff rates in relation to productivity differences by industry will be discussed later in the context of Canada-United States comparisons.

TABLE 4

United States-United Kingdom Ratios of Output per Worker
and Wages, Selected Manufacturing Industries,
1937 and 1950

Industry	United States-United Kingdom Ratios					
	Output per Worker		Average Wages		Wages per Unit of Output	
	1937	1950	1937	1950	1937	1950
Pig iron	3.6	4.1	1.5	3.0	0.42	0.73
Motorcars	3.1	4.7	2.0	3.4	0.64	0.72
Machinery	2.7	2.4	1.9	3.6	0.70	1.50
Glass containers	2.4	2.7	2.0	3.2	0.83	1.18
Paper	2.2	3.4	2.0	3.6	0.91	1.06
Cigarettes	1.7	2.5	1.5	2.6	0.88	1.04
Leather footwear	1.4	1.7	1.5	2.9	1.07	1.71
Hosiery	1.8	1.9	1.9	3.3	1.06	1.74
Cotton spinning and weaving	1.5	2.5	1.7	3.3	1.13	1.32
Beer	2.0	3.0	2.6	4.0	1.30	1.33
Cement	1.1	1.2	1.7	2.7	1.54	2.25
Woolen and worsted	1.35	1.85	2.0	3.6	1.48	1.95
Men's and boys' outer clothing	1.25	1.7	2.3	3.6	1.84	2.12

SOURCE: Robert M. Stern, "British and American Productivity and Comparative Costs in International Trade," *Oxford Economic Papers*, October 1962, p. 284. The original data are from the Rostas and Paige-Bombach studies referred to in footnote 23.

on the relative levels of output per worker, average wages, and wages per unit of output by industry in the two countries, are shown in Table 4.

An important point illustrated in Table 4 is the very large differences from industry to industry in the output per worker ratios in the two countries in both 1937 and 1950. There are differences also in the ratios of wages by industry, but these are much smaller.²⁴

²⁴ The correlation between relative wages and the relative output per worker by industry in the two countries is not significant. For 1937, the regression is negative, with a value of 0.15 but a standard error of 0.71. For 1950 it has a positive slope of 0.50, but a standard error of 0.73. In each case r^2 is close to zero.

In one of the other studies of intercountry differences in output per worker, this wide variation in productivity by industry was clearly apparent. Table 5 shows this for twelve industries for Canada, the United States, and the United Kingdom for 1935. The United States-Canada ratios range from 84 (for flour milling) to 260 (for coke), while the United Kingdom-Canada ratios range between 37 (biscuits) and 133 (coke). These contrasts are very large. Comparable data on relative wages have not been brought together for that period, but the differences would not be nearly as large as this.

The suggestion from the United States-United Kingdom data that some differences in relative wage rates for individual manufacturing industries exist for different countries is also reflected in a number of other studies, but these wage differences are not too large. Kravis com-

TABLE 5
Output per Wage-Earner Year, 1935
(Canada 1935 = 100)

	Canada	U.K.	U.S.
Soap	100	46	123
Leather footwear			
U.K. price weights	100	73	109
U.S. price weights	100	75	106
Canadian price weights	100	73	112
Rubber tires	100	82	154
Tobacco	100	90	132
Cement	100	123	100
Brewing	100	97	195
Biscuits	100	37	140
Flour milling	100	58	84
Bricks	100	108	130
Vegetable oils	100	90	189
Hosiery			
U.K. price weights	100	102	120
U.S. price weights	100	110	134
Canadian price weights	100	102	118
Coke	100	133	260

SOURCE: A. Maddison, "Productivity in Canada, the United Kingdom, and the United States," *Oxford Economic Papers* (New Series), October 1952, p. 237.

pared the ranking of average hourly earnings in twenty major manufacturing industries in Japan and the United States and found a coefficient of rank correlation of 0.82, which was significant at the 1 per cent level.²⁵ He suggests the probability that "for most industries, international differences in productivity are greater than international differences in wages."²⁶ Hal Lary brought together data on the average annual wage in thirteen industry groups for eleven countries. The ranking of industries from low to high wages was very similar in the seven developed countries (the United States, Canada, Sweden, Australia, the United Kingdom, Germany, and France). Among four developing countries (Mexico, Japan, Brazil and India) the ranking was somewhat less consistent.²⁷ Greater variation in the productivity ratios than in the rates of wages were also found in Canada-U.K. and Canada-U.S. data analyzed by Kreinin.²⁸

The evidence thus far suggests that labor costs are a very significant share of net national income and that large differences in the relative levels of output per person employed in various industries in different countries exist. These output differences are much greater than the differences in earnings. Two further questions have been raised in earlier literature. One question is whether these differences in output per person employed are reflected in export prices and international trade; this literature will be reviewed here. The second question concerns the reasons for these differences in relative productivity levels; this question will be explored further in the next section on Canada-United States comparisons.

The major contribution in testing the Ricardian view on the differences in costs between countries was by G. D. A. MacDougall, using United States and United Kingdom data.²⁹ When relative output per worker was compared to relative exports, a high correlation coefficient

²⁵ Irving B. Kravis, "'Availability' and Other Influences on the Commodity Composition of Trade," *Journal of Political Economy*, April 1956, p. 144.

²⁶ *Ibid.*, p. 145.

²⁷ Hal B. Lary, *Imports of Manufactures from Less Developed Countries*, New York, NBER, 1968, p. 68. He does not deal with the magnitudes of the differentials.

²⁸ Mordechai E. Kreinin, "The Theory of Comparative Cost—Further Empirical Evidence," *Economia Internazionale*, November 1969, pp. 2-14.

²⁹ G. D. A. MacDougall, "British and American Exports: A Study Suggested by the Theory of Comparative Costs," *Economic Journal*, December 1951, pp. 697-724, and September 1952, pp. 487-521.

was obtained and "a difference of 1% in relative price tends to be associated with a difference of 4–5% in relative quantity of exports."³⁰ This two-part article concentrated on the data for the interwar period.

Subsequently, this topic was re-examined for the same two countries for the postwar period. The earlier conclusions were largely reaffirmed, with some indications of some differential changes in output per person employed by industry over time between the two countries, and some allowance for changes in tariffs between the two countries.³¹

Most later studies have accepted the main implications of these studies on the empirical relevance and usefulness of the Ricardian emphasis on differences in relative productivity levels by industry, although some serious data problems are present. For example, it is difficult to match the employment data with the output data in volume terms. Thus, the 1937 data are not adjusted for purchases from other industries or employment in the supplying industries. The 1950 employment data again relate only to the specific industry, but in practice intermediate inputs are not always deducted.

Bhagwati raises a number of problems about these studies in his survey. He tested the relationship between labor productivity ratios and export price ratios and between unit labor cost ratios and export price ratios. In all cases the signs of the relationship were consistent with the Ricardian expectations, but the degrees of relationship were uniformly low (as measured by the r^2 's) except for the arithmetic MacDougall sample for 1937.³²

I would like to put forth an hypothesis in explanation of this result (as it seems to have been an important influence on Bhagwati's rather negative appraisal of the testing of the Ricardian theory). Rostas' 1937 data on productivity levels in the two countries were largely built up on actual physical measures of output in the individual industries, with no allowance for the use of purchased materials by those industries. This is conceptually a measure of the gross output of an industry

³⁰ *Ibid.*, December 1951, p. 712.

³¹ Robert M. Stern, "British and American Productivity and Comparative Costs in International Trade," *Oxford Economic Papers*, October 1962, pp. 275–296; Donald MacDougall, Monica Dowley, Pauline Fox, and Senta Pugh, "British and American Productivity, Prices and Exports: An Addendum," *Oxford Economic Papers*, October 1962, pp. 297–304.

³² Bhagwati, "Pure Theory," pp. 170–171.

measured in real terms. However, the 1950 data from Paige and Bombach tried to take account of the purchases of intermediate products from other industries. This is conceptually a measure of the net value added in an industry in real terms, and is equivalent to the use of the Geary double deflation approach (designed to measure changes in real output of individual industries over time) for intercountry comparisons. Because of the problems they encountered with this approach, they sometimes ended up using output measures with no allowance for differences in inputs from other industries.

The export price ratios used in all the studies are unit values (based on trade statistics) of individual commodities. These are conceptually closer to the measures of gross output (such as were developed by Rostas for 1937) than to the measures of net value added (which were derived by Paige and Bombach for 1950). If this interpretation is on the right track, the close correlation between export price ratios and labor productivity ratios for 1937 and the absence of a significant correlation in 1950 are not surprising. One would get a close correlation between prices and *net* value added only if the commodity and industry definitions were the same *and* the relationships between output and material purchases from other industries were the same between the two countries. I would be very surprised if these conditions were met.

There is indirect evidence *against* the assumption of similar relationships between value added and intermediate products by industry. The recent discussion of tariffs and commercial policy has been enriched by the literature on effective tariff rates, which is based on the importance of intermediate inputs as a factor in costs and differences in the levels of tariff rates at various stages of processing. The theoretical literature and empirical evidence suggest significant dispersions for individual countries between nominal and effective rates for individual industries.³³ A necessary (but not a sufficient) condition for a close

³³ W. M. Corden, "The Structure of a Tariff System and the Effective Protective Rate," *Journal of Political Economy*, June 1966; Georgio Basevi, "The U.S. Tariff Structure: Estimates of Effective Rates of Protection of U.S. Industries and Industrial Labor," *Review of Economics and Statistics*, May 1966; Bela Balassa, "Tariff Protection in Industrial Countries: An Evaluation," *Journal of Political Economy*, December 1965; and James R. Melvin and Bruce W. Wilkinson, *Effective Protection in the Canadian Economy*, Economic Council of Canada, Special Study No. 9, Ottawa, The Queen's Printer, 1968, and additional references cited therein. Denison

relationship between relative export prices and relative labor productivities on a net value added basis would be a close relationship between nominal and effective tariff rates. The evidence for a number of countries suggests that such a close relationship does not exist.

The preceding discussion of the productivity ratios for the United States and United Kingdom has concentrated on the numerator in the data. Problems are also encountered in the employment data by industry. In both the 1937 and 1950 comparisons the employment data relate to direct employment in the industry specified. The data are conceptually consistent with the measures of net output used in 1950, but not with the measures of gross output used for 1937, as they do not include employment in the material-supplying industries. The problems in obtaining measures of both output and employment that are conceptually comparable are thus very real.

This argument suggests that the absence of correlation between export price ratios and labor productivity ratios, which Bhagwati found, can reflect conceptual and statistical lack of comparability in the data rather than strong evidence against the Ricardian hypothesis. The other concern of Bhagwati, about the need for an explanation of the difference in the productivity ratios, will be considered in the discussion of the Canada-United States data.

Heckscher-Ohlin Analysis

Work along the Heckscher-Ohlin lines accepts the differing structure of relative prices in different countries, but emphasizes differing influences as underlying causal factors. Two key assumptions are the existence of similar production conditions in the several countries, and constant returns to scale. The differing relative use of the various factors of production in different industries, and differing relative supplies of factors in the various countries are regarded as crucial in explaining the differing structure of relative prices. International specialization would then emerge as a result of specialization by each of the various countries in those industries that involved more intensive

has pointed out that if the pattern of effective tariff rate structures were similar for the same industries in different countries, this would not be a sufficient condition for productivity differences between countries. The evidence on this point has not yet been explored.

use of the factors that were relatively more abundant (and thereby relatively less expensive) in that country.

The origin of this development in theory goes back to a Swedish essay by Heckscher in 1919 and Ohlin's book in 1935.³⁴ In subsequent development it was applied to the effects of tariffs on income distribution, factor price equalization, terms of trade, and many other topics.³⁵ Corden comments that "the dominating development in pure theory during the period under consideration has been the elaboration and filling-out of the Heckscher-Ohlin trade model."³⁶ However, much of this literature has been devoted to the development of a wide range of conclusions and implications from a number of initial assumptions. The degree of empirical testing of the main conclusions and the real-world relevance of these ideas have been much more limited.

It seems important to point out that both Samuelson and Ohlin have been acutely aware of the problems in applying the results of this framework of theory to the real world. Samuelson discussed this in his 1948 paper on factor price equalization.

There remains a third, and perhaps more fundamental, reason why factor prices need not be equalized: the Ohlin proportions-of-the-factors analysis of international trade has fundamental inadequacies and limitations.

The Ohlin analysis explains much; but there is much that it fails to explain; and if adhered to inflexibly, there is much that it can obscure. Its two central tenets are open to grave doubt: Is it reasonable and useful to set up the hypothesis that production functions are the same the world over? Is it possible to find reasonably homogeneous and commensurable factors of production in diverse parts of the world, so that relative proportions can be defined and compared?

Certainly no strong affirmative answers to these two questions can be given—as Ohlin himself has pointed out in a number of places. . . .

Space does not permit further elaboration on this important topic. We may conclude by saying that factor proportions explain only part of the facts of international economics. We must still set up hypotheses of differences in

³⁴ Eli Heckscher, "The Effect of Foreign Trade on the Distribution of Income," *Ekonomisk Tidskrift*, 1919, translated and printed in Ellis and Metzler, eds., *Readings*, pp. 272-300; and Bertil Ohlin, *Interregional and International Trade*, rev. ed., Cambridge, Mass., Harvard University Press, 1967.

³⁵ Fuller and fairly recent discussion is contained in the discussions by Caves, Haberler, Corden, Bhagwati, and Chipman referred to earlier.

³⁶ Corden, *Recent Developments*, p. 24.

international production and productivity, differences in effectiveness which are to be accepted as empirical facts even if not simply explainable.³⁷

In the second edition of *Interregional and International Trade*, Ohlin expressed concern at the degree to which some elements of his initial work had been pushed by subsequent discussion. In Appendix II, "Reflections on Contemporary International Trade Theories," he discussed the factor proportions model and showed "the need for its extension to include the advantages of large-scale operations and different production functions."³⁸

An understanding of this [i.e., using instead a model that permits different production functions in different countries] would constitute some protection against exaggerating the importance of the model in question. . . . It is because of these conditions and the importance of taxes, social costs, transport costs, etc., that I have found the intensive preoccupation with the factor proportions model after World War II—which started with Paul Samuelson's penetrating article "International Trade and the Equalization of Factor Prices" (*Economic Journal*, 1948)—to have a gradually declining "marginal utility" compared to the results that could be obtained with the same acumen, intelligence, and work if it were directed, e.g., toward a study of transportation costs and taxation in their relation to international trade.³⁹

The number of efforts to test the empirical applicability of the Heckscher-Ohlin model has been much more limited than the number of theoretical studies. Several important empirical investigations have created considerable discussion. The remarks here will concentrate on comments made that are pertinent to the assumption that production functions in different countries are similar.

In a famous study, Leontief used the material from his input-output work on the American economy to study the capital and labor requirements in exports and imports. To explain the paradoxical results he obtained, he abandoned the assumption of similar production functions in different countries.

Let us, however, reject the simple but tenuous postulate of comparative technological parity and make the plausible alternative assumption that in

³⁷ P. A. Samuelson, "International Trade and Equalization of Factor Prices," *Economic Journal*, June 1948, pp. 181-183, reprinted in J. E. Stiglitz, ed., *The Collected Scientific Papers of P. A. Samuelson*, Cambridge, Mass., MIT Press, 1966, Vol. II, pp. 865-867.

³⁸ Ohlin, *Interregional and International Trade*, p. 311.

³⁹ *Ibid.*, p. 310. See also his comments on the papers by Bhagwati and Harry Johnson in Harrod and Hague, eds., *International Trade Theory*, pp. 398 and 420.

any combination with a given quantity of capital, one man-year of American labor is equivalent to, say, three man-years of foreign labor. . . .

Thus, without denying that capital can be substituted for labor, we must still look for some other reason in explaining the high productivity of labor in America as compared with the labor employed by similar industries abroad. Entrepreneurship and superior organization have often been mentioned in this connection. . . . To explain the comparative surplus of labor which our figures unmistakably reveal we must, however, also infer that entrepreneurship, superior organization, and favorable environment must have increased—in comparison with other countries—the productivity of American labor much more than they have raised the efficiency of American capital.⁴⁰

In the article in which Arrow, Chenery, Minhas, and Solow introduced the constant elasticity of substitution production function, their data raised questions about the similarity of production conditions in different countries. In their conclusion they stated:

Although we began our empirical work on the naive hypothesis that observations within a given industry but for different countries at about the same time can be taken as coming from a common production function, we find subsequently that this hypothesis cannot be maintained. But we get reasonably good results when we replace it by the weaker, but still meaningful, assumption that international differences in efficiency are approximately neutral in their incidence on capital and labor. A closer analysis of international differences in efficiency leads us to suggest that this factor may have much to do with the pattern of comparative advantage in international trade.⁴¹

In a much larger study, Minhas considered also the rates of return to capital and labor in different industries in a number of countries, as well as differences in efficiency levels. A number of key conclusions are worth quoting here.

The realization of relatively low rates of return on industrial capital in the poor countries in spite of extremely low capital-labor ratios most likely is due to low levels of efficiency in the use of factors of production. These low levels of efficiency may result from a combination of a large number of factors like the lack of "third" factors, the presence of pronounced external effects,

⁴⁰ W. W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-examined," in Bhagwati, ed., *International Trade*, pp. 127 and 130.

⁴¹ Arrow et al., "Capital-Labor Substitution," August 1961, p. 246.

or low rates of investment which inhibit the adoption of advanced technology, etc. One should not expect these factors to have a uniform impact on all the industries; their impact is quite varied. Nevertheless, in these differences in the levels of efficiency of factor use lies an important clue to many problems of economic development in underdeveloped areas. . . .

We have argued that the evidence on returns may be consistent with an aggregate production function, which is not strictly invariant across countries but admits differences in efficiency levels that are neutral in their impact on capital and labor returns.⁴²

In conclusion, the empirical studies touched on here all raise serious questions about the appropriateness to real-world situations of the assumptions of similar production functions in different countries. This is in line with the studies on economic growth mentioned earlier. In the Denison and Poullier study, for example, of a difference of 41.0 percentage points in national income per person employed between northwest Europe and the United States, 29.7 percentage points reflected differences in output per unit of input, and only 11.3 percentage points, differences in factor inputs per employed person.⁴³ For this to be true for the economy as a whole, it must also be true in a majority of the individual industries. This point is developed further in the context of Canadian-U.S. comparisons in the next section.

The general conclusion from the summary of empirical work on international trade is that the overall evidence is uniformly inconsistent with the Heckscher-Ohlin hypothesis of similar production functions in different countries. It is ironic that the much earlier ideas of Ricardo continue to have a great deal of current applicability. Still missing in that tradition, however, is some interpretation of *why* production conditions in different countries are different for the same industries, and how this affects the structure of relative prices.

These questions will be explored further in the next section, on Canada-U.S. comparisons. The quantitative data and discussion explore some of the unresolved questions touched on in earlier pages that may have applicability beyond the North American continent from which they have been primarily derived.

⁴² B. S. Minhas, *An International Comparison of Factor Costs and Factor Use*, Amsterdam, North-Holland, 1963, pp. 90 and 96.

⁴³ Denison, *Why Growth Rates Differ*, p. 332.

CANADA—UNITED STATES COMPARISONS

During the latter half of the 1960's, a series of studies has been completed that provides much more quantitative data on comparisons between Canada and the United States. Much of this material has been brought together into a conceptual framework that uses Denison's work on United States and European growth for comparisons between United States and Canada. Some studies incorporate differences in the structure of tariff rates into estimates of effective tariff rates for Canada, while other investigations have applied the work of Alchian and Hirshleifer on cost and supply at the level of the firm to the differences in costs and productivity between Canada and the United States. In this section, this material is brought together and cast into the framework of a test of international trade theory for these two countries.

The Canadian tariff permits the firm to obtain higher prices for manufactured products; productivity levels can, therefore, be lower than in the United States, while profit levels stay about the same. Thus, the productivity levels in Canada adjust to the tariff-influenced structure of relative prices. Recent work on costs at the level of the firm provide a rationale for productivity differences between Canada and the United States, even with common technological knowledge and similar quantities of capital per worker. Further on, this material will be related to the discussion of international trade theory.

Introduction

Canada is physically close to the United States. A very large proportion of the Canadian population is located within a hundred miles of the United States border. There are many cultural similarities between the two countries apart from the important French-Canadian part of Canada. American television, news, advertising, magazines, and radio all provide many similarities in background, values, attitudes, and products.

The ready flow of basic ideas on knowledge and technology, the flow both ways across the border of technologists, teachers, and scholars, the membership in and attendance at conferences of North American professional associations promote awareness of new products and ideas

in Canada. This awareness is also facilitated by the high proportion of United States ownership and control of commodity-producing industries within Canada. The United States is the most important market for Canadian exports, and the most important source of Canadian imports. From the United States point of view, Canada is the largest market for exports and the most important source of imports, but it does not play the critically large role in total U.S. trade that the United States does in Canadian trade.

Differences in Tastes

Linder⁴⁴ has emphasized the role of differences in tastes as a factor in international trade between countries. However, differences in tastes do not seem to be an important factor in trade between Canada and the United States. Differences in the distribution of consumer expenditures in real terms between the two countries do exist, of course. For example, per capita expenditures on cars, consumer durables, and other manufactured products are lower in Canada than in the United States. However, these differences primarily reflect the lower levels of real income, and the relatively higher prices of manufactured products in Canada than in the United States. Basic differences in tastes do not seem to play an important role. Under these circumstances, the major attention will be given to differences in supply and production conditions between the two countries, with some perspective being provided initially for the economy as a whole.

Differences in Overall Inputs and Outputs

The work by Dorothy Walters provides some relevant basic information for the economy as a whole.⁴⁵ Since there is a significant difference

⁴⁴ S. Linder, *An Essay on Trade and Transformation*, New York, Wiley, 1961. However, it is not really clear what the effect of taste differences on relative prices would be. If the same items were being produced in both countries under similar production conditions and constant returns to scale, it is not clear that taste differences could affect relative prices at all. The inclusion of the Alchian-Hirshleifer emphasis on length of run as a factor in costs would facilitate the introduction of taste differences into a more complete interpretation. For a further discussion of the need for more clarification of the Linder hypothesis on the pattern of trade, see W. M. Corden, "Comment," in J. MacDougall et al., eds., *Studies in International Economics*, Amsterdam, North-Holland, 1970, pp. 52-54.

⁴⁵ Walters, *Canadian Income Levels*. For a fuller discussion of concepts, see Denison, *Why Growth Rates Differ*.

in the relative size of the two economies (the U.S. population and labor force being about ten times as large), the comparisons will be made on a per employed person basis. This also has the advantage of setting out the relative scope for differences in factor supplies on the one hand and productivity differences on the other for the two economies at the aggregate level.

For additional detail on the assumptions, methodology, and basic data, the reader should refer to the basic studies. At this stage, several key points in the statistical methods should be noted as a background for subsequent discussion. The comparisons are built on the official national accounts estimates for the two countries (with adjustments to go to net national income with depreciation valued at replacement cost). A crucial but difficult step in the calculations is to take account of price differences between the two countries. The results of the statistical work indicate that the levels of real income per person employed in Canada were about 15 to 20 per cent lower than in the United States, a difference that has varied within this general range throughout the current century. This difference in real income is about two percentage points less if United States price weights are used instead of Canadian ones.

The next key step in the process is to assess the degree to which this difference in real income per employed person might have reflected differences in the quantities of other productive factors used by the average employed person in the two countries. The basic methodology follows the approach developed in Denison's earlier book on the United States.⁴⁶ In a discussion of *Why Growth Rates Differ*, I have summarized these key steps:

Basic to his method in analyzing economic growth over time is the distinction between total inputs and output in relation to total factor input. The individual inputs follow the classical distinction between labor, capital and land, and time series are developed for each of the individual inputs. The measure of labor input takes account of changes in the age and sex composition of the labor force and hours worked. It also takes account of changes in the quality of the labor force in so far as it is influenced by the levels of formal education of those in the labor force. The measures of capital input are based on the stock of capital in the form of housing and inventories in

⁴⁶ Denison, *Sources of Economic Growth*.

addition to non-residential structures and equipment. The input of land is based on measures of non-residential site land, agricultural land and the rental portion of mineral land. When an over-all measure of these three major inputs (with subcategories for each of the major inputs) is to be prepared, some system of weights to combine them into a comprehensive index of inputs is necessary. For this, Denison uses the distribution of national income. This involves some assumptions about the relationships between the contribution of inputs to output and the related distribution of income, and the effects of substitution between factors. Denison uses differences in income as weights for the individual age, sex and education categories in building up the major input measures.⁴⁷

In using this framework for comparisons of differences in levels of real national income per person employed, a comparison of the levels of total factor input per person employed and total output per person employed gives a measure of differences in output per unit of input. Denison explores these differences, including such factors as differences in the allocation of resources, economies of scale, and any differences in pressure of demand or irregularities in farm output. These results are summarized in Table 6.

Table 7 shows the contribution of each factor to the difference in national income per person employed in the two countries. It indicates that Canada has a level of factor inputs per employed person almost the same as that of the United States, but a level of output in relation to inputs that is appreciably lower.

How do these data throw light on the earlier Ricardo and Heckscher-Ohlin discussion? The quantitative size of the differences in output per unit of input suggests important differences in production relations between the two countries—a result for the economy as a whole much more in line with Ricardo than Heckscher-Ohlin assumptions about production relations in different countries. The differences in the availability of agricultural land and mineral resources per person employed between Canada and the United States point up the continued importance of natural resources in Canada.⁴⁸ For this sector,

⁴⁷ D. J. Daly, "Why Growth Rates Differ—A Summary and Appraisal," *International Review of Income and Wealth*, March 1968, pp. 76-77.

⁴⁸ The amount of agricultural land per person employed in Canada is almost double that in the United States, while the value of mineral resources (as measured by output) is about 70 per cent larger. However, when the weight for these two categories is only about one-fourth of the land income share, and less than 1 per

TABLE 6
 Importance of Factors Affecting National Income Level,
 Canada Compared with the United States, 1960
 (United States = 100)

	Canada
Net national income per person employed	81.7
Input per person employed	98.9
Labor quality	100.1
Hours worked "	103.8
Age-sex composition "	102.2
Education "	94.3
Capital	90.5
Dwellings	94.5
Foreign investments	-241.2
Nonresidential structures and equipment	107.3
Inventories	107.8
Land	124.0
Output per unit of input	82.6

SOURCE: Walters, *Canadian Income Levels*, p. 109 (see Table 3, footnote *a*, above). Subsequent revisions in the Canadian national accounts would reduce these differences slightly, and also some of those in Table 7.

" After adjustment for zero-quality difference in "no productivity difference" sectors.

the Heckscher-Ohlin emphasis on resource availability continues to be important in the Canada-U.S. comparison.

Some orders of magnitude of the differences in productivity from one industry to another in comparisons between the United States and Canada can be seen in Table 8. The variations in productivity are very large, much larger than the differences in wage rates. The degree of relationship between wage rates and output per worker is not significant.⁴⁹

cent of national income, its measured contribution can only be small in relation to the total income difference.

⁴⁹ r^2 is 0.035, and the standard error of the slope is 0.35, compared to 0.47 for the regression coefficient.

The data is subject to all the statistical problems mentioned previously in the

TABLE 7

U.S. Contribution to Differences Between Canadian and
 U.S. National Income per Person Employed, 1960
 (differences are in percentage points in U.S.
 prices; net national income is on
 base U.S. = 100)

	Canada
Net national income per person employed	81.7
U.S. contribution to difference	18.3
Breakdown of contribution	
<i>Factor input per person employed</i>	0.7
Labor	-
Hours worked	-2.8
Age-sex composition	-1.6
Education	4.4
Capital	1.3
Housing	0.2
Foreign investments	2.0
Nonresidential structures and equipment	-0.7
Inventories	-0.2
Land	-0.6
<i>Output per unit of input</i>	17.6
Resource allocation	
Agricultural inputs	1.5
Nonfarm self-employment	-0.6
Economies of scale	
National market	4.6
Local markets	0.6
Shift work	NA
Difference in pressure of demand	1.4
Difference in agricultural output	0.0
Residual productivity	10.1

SOURCE: Walters, *Canadian Income Levels*, p. 170 (see Table 3, footnote a, above).

TABLE 8

United States-Canada Ratios of Output
per Worker and Wage Ratio, 1947

	U.S.-Canada Ratios		
	Output per Worker	Wage Rate	Wage per Unit of Output
Cotton textiles	0.33	1.27	3.85
Fertilizers	0.72	0.90	1.25
Cement	0.76	1.11	1.46
Lime	0.80	1.10	1.38
Primary aluminum	0.94	1.40	1.49
Flour	0.96	1.35	1.41
Macaroni	0.97	1.44	1.48
Pulp and paper	0.98	1.00	1.02
Meatpacking	1.06	1.38	1.30
Leather footwear	1.12	1.02	0.91
Bread and biscuits	1.25	1.58	1.26
Automobiles and parts	1.33	1.24	0.93
Primary iron and steel	1.35	1.10	0.82
Bricks	1.40	1.17	0.84
Hosiery	1.45	1.16	0.80
Petroleum refining	1.52	1.65	1.09
Rubber tires	1.52	1.42	0.93
Brewing	1.69	0.64	0.38
Tobacco products	1.74	1.56	0.90
Coke	1.88	1.37	0.73
Chewing gum	1.99	1.67	0.84

SOURCE: Output per worker index ratio from J. H. Young, "Some Aspects of Canadian Economic Development," Ph.D. dissertation, Cambridge University, England, 1955, p. 61. Wage rate ratio from Mordechai E. Kreinin, "The Theory of Comparative Cost—Further Empirical Evidence," *Economia Internazionale*, November 1969, p. 10.

One interesting result from Dorothy Walters' work is that the capital stock of equipment per person employed in manufacturing is about the same in Canada as in the United States and the construction stock was

United States-United Kingdom comparison. Some later unpublished work by Craig West of the staff of the Economic Council of Canada would give quite different results for the same industries covered earlier by Young.

even higher in Canada on the same basis. This is a striking result, bearing in mind the significant differences in factor prices in the two countries. Some evidence on such prices is given in Table 9.

How is it that about the same quantity of machinery and equipment per person employed was used in both countries, whereas prices of machinery in Canada at that time were about one-fourth higher and hourly earnings about one-fifth lower? One possibility is that there are differences in the degree of capital intensity that only appear at a finer level of industrial detail, with certain resource-processing industries using more capital in Canada, while other areas of secondary manufacturing use less. Another possibility is that the costs of developing special machinery for Canada that would take account of lower wages there would be more expensive for the small Canadian market than would producing or importing the United States designs, which had been developed for a different pattern of factor prices. This latter view is relevant to an explanation for the use of United States- and European-designed machinery in manufacturing in some of the developing countries of Asia, Africa, and South America.

Thus far, the evidence for the economy as a whole is much more in line with the Ricardian view, which emphasizes differences in production relations, than with the Heckscher-Ohlin emphasis on differences in factor supplies and factor prices. The next section will look at the pattern of relative prices and relative productivities in Canada and

TABLE 9
Comparative Material and Factor Prices,
Canada and the United States, 1965
(United States = 100)

Average hourly earnings in manufacturing	81
Machinery and equipment prices	125.6
Long-term corporate bond prices	123.2
Selected materials prices	120

SOURCE: D. J. Daly, B. A. Keys, and E. J. Spence, *Scale and Specialization in Canadian Manufacturing*, Economic Council of Canada Staff Study No. 21, Ottawa, The Queen's Printer, 1968, p. 29.

the United States, with more emphasis on the commodity-producing industries.

Differences in Relative Prices and Productivity

The structure of Canadian merchandise trade has traditionally been based on the export of a relatively limited number of natural resource products, and the import of a wide range of manufactured products, industrial materials, and components, and a variety of tropical fruits, spices, etc. During this century exports have included metals, lumber and forest products, petroleum, and grain.⁵⁰ During the latter part of the 1960's the range of exports has widened to include a markedly greater number of manufactured products, which have increased to about 30 per cent of total exports. The United States dominates the country composition of Canadian trade, with exports to the United States now amounting to about 60 per cent of total exports, and the share of imports from the United States amounting to 70 per cent of total imports.

Because of the high proportion of Canadian trade with the United States, the geographic proximity of the two countries, and the relatively easy transportation connections, there is inevitably a close tie-in between the prices of individual items in Canada and the comparable product in the United States. However, the structure of relative prices in the two countries is far from identical. The presence of tariffs in the two countries and of transportation and other costs contribute to important price differences between them.⁵¹ These price differences permit and encourage different responses by producers and consumers.

The presence of tariffs in both the United States and Canada has an important influence on the price differences for individual commodities. For products in which Canada is an exporter, the upper limit on those prices would be the price in the United States *less the United States tariff* (together with any allowance for transport costs from the

⁵⁰ David W. Slater, "Changes in the Structure of Canada's International Trade," *Canadian Journal of Economics and Political Science*, February 1955, pp. 1-19; and B. W. Wilkinson, *Canada's International Trade: An Analysis of Recent Trends and Patterns*, Montreal, Private Planning Association of Canada, 1968, especially Chaps. 2 and 3.

⁵¹ W. P. Travis, *The Theory of Trade and Protection*, Cambridge, Harvard University Press, 1964, develops the general analysis of how tariffs influence the applicability of international trade theory to contemporary economies.

Canadian producer to the United States market).⁵² However, for products in which Canada is an importer (or where imports *could* develop even though domestic production was currently important), the upper limit on domestic prices in Canada would be the price in the United States *plus the Canadian tariff* (together with any allowance for transport and other costs to the Canadian market).⁵³ Thus, the presence of tariffs in the two countries affects the structure of relative price within Canada—with prices of industrial materials for export being relatively lower, and the prices of manufactured products being relatively higher, than in the absence of tariffs.⁵⁴

Given the effect of tariffs on the structure of relative prices in the two countries, the idea of the effective tariff rate should be introduced. A brief statement can illustrate the idea.

The basic argument of the effective protection concept is that nominal tariff rates give an inaccurate indication of the extent to which the tariff structure protects the value added in a given industry. A nominal tariff on the final output of the industry permits the producer to raise the price at which he sells his product domestically while still remaining competitive with imports. But if there are tariffs on his inputs of material and components as well, these tariffs in turn raise the cost of the inputs to him regardless of whether he imports them or buys them domestically. If he buys domestically, the supplier of them can charge up to the foreign price plus the tariff on imports. The net effect of the nominal tariff structure on the price the producer can charge for his output domestically relative to the prices he must pay for his intermediate inputs—hence the effect upon his value added—is called the “effective protection” that [the] producer enjoys.⁵⁵

⁵² To simplify the exposition in the text, no reference to the exchange rate between the Canadian and United States dollar has been introduced. A reference to the exchange rate could be made in relation to price differences between the two countries on both the export and import side, but it would not affect the overall point being developed in the text.

⁵³ For a development of these points, see H. C. Eastman and S. Stykolt, *The Tariff and Competition in Canada*, Toronto, Macmillan, 1967, pp. 22–25.

⁵⁴ Tariffs can also affect relative prices in the United States, but in light of the lesser importance of international trade in relation to the domestic economy, the quantitative effect is not expected to be as great as in Canada. This is in line with the smaller relative effect of tariffs on the U.S. economy found by the Wonnacotts.

⁵⁵ James R. Melvin and Bruce W. Wilkinson, *Effective Protection in the Canadian Economy*, Economic Council of Canada, Special Study No. 9, Ottawa, The Queen's Printer, 1968, p. 4. For further discussion see Corden “Structure of a Tariff System,” pp. 221–237; Balassa, “Tariff Protection,” pp. 573–594; Basevi, “The U.S. Tariff Structure,” and additional references in the bibliography of the Melvin-Wilkinson study.

Three features of the Canadian economy make the effective tariff notion particularly relevant. One is the extent of imports of a wide range of industrial materials, machinery, and equipment into Canada, especially from the United States. A second aspect is the widespread practice of setting prices of manufactured products within Canada on the basis of the duty-paid value of the comparable item if it were to be imported.⁵⁶ This is one of the assumptions now commonly made in the literature on effective tariffs.⁵⁷ A third feature is the typically higher tariff rate on the more highly processed stages of manufacture compared to the primary and intermediate stages. This feature is found in the tariff structure of most industrialized countries.

Two important conclusions emerge from the calculation of effective tariff rates for Canada. One is that the effective rates are substantially higher than the nominal rates. Another is that there is a significantly larger dispersion around the average tariff rate for effective rates than nominal rates. Both of these points emerge in Table 10.

How does this discussion of tariffs and effective tariff rates affect the differences in prices of manufactured products in Canada and the United States? The differences in tariff rates and the tendency for prices of export items to be close to world prices introduces important differences in the price structure from what would prevail in the absence of tariffs. A high tariff rate permits a Canadian producer to produce in Canada at prices above the U.S. domestic price. For other reasons, he can hire labor at wages well below the U.S. level. The output per worker can be well below the level in the same industry in the United States, even with the same amount of capital and other inputs. When the effective tariff results are introduced, the net difference in price between the intermediate input price and the finished goods price becomes even greater. There is also a wider deviation from one

⁵⁶ A number of interviews were made by the Economic Council of Canada on this point in preparing material for the Third Annual Review. However, it is also apparent that a number of Canadian manufacturers did not initially increase their prices, at the time of the devaluation of the Canadian dollar in 1962, to the full extent of the devaluation.

⁵⁷ The Melvin-Wilkinson study for Canada assumes "that domestic producers all price at world price plus the tariff: hence pre-tariff price is assumed to be the observed post-tariff price less the tariff" (p. 9). They discuss the reasonableness of this assumption for Canada on pages 49-50.

TABLE 10

Weighted Means, Standard Deviations, and Rank Correlation Coefficients for Nominal and Effective Tariffs for 133 Canadian Industries, 1963

	Weighted Mean	Standard Deviation	Rank Correlation with Nominal Rates
Nominal rates	13.1	8.0	
Effective rates			
Calculation 1	21.0	19.4	.86
Calculation 2	24.4	20.5	.83

SOURCE: James R. Melvin and Bruce W. Wilkinson, *Effective Protection in the Canadian Economy*, Economic Council of Canada Special Study No. 9, Ottawa, The Queen's Printer, 1968, p. 29. The two alternative calculations of effective rates are based on different assumed rates for intermediate inputs where insufficient detail is provided in the Census of Manufactures.

product to the other in the levels of effective tariff rates than in nominal rates.

The general argument developed here would regard the differences in the productivity ratios in manufacturing between the two countries as a response to the pattern of effective tariff rates in Canada. In products with a high effective tariff rate, the gap in productivity between the two countries can be very wide and still permit Canadian production of the items. The protected Canadian producer is not driven out of business by foreign competition. However, profits are not especially high, nor is output as efficient as it might be. On the other hand, on items with a low effective tariff rate, or where Canadian producers were exporting to the United States market, the productivity gap would have to be much less. These productivity differences could persist as long as the structure of tariff rates in the two countries remained unchanged, even though there was full knowledge of the basic technology used in the United States, and Canadian workers had capital facilities comparable to those being used in the United States.

In light of the emphasis on the effects of tariffs on the Canadian price structure and levels of productivity, it might be noted that a recent

estimate of the costs of tariffs would put them at about 10.5 per cent of Canadian GNP in 1958.⁵⁸ This is considerably higher than the range of estimates usually made for other countries. Most estimates of the costs of the tariff are based on the effects of tariffs in the country concerned on prices to consumers. This procedure was followed in an earlier study of the Canadian tariff by J. H. Young.⁵⁹ The Wonnacotts' study extended this estimate in two directions. They included an estimate of the U.S. tariff on Canadian GNP and also included the effect of tariffs on production as well as consumption. Many of the estimates of the effects of tariffs in other countries assume constant returns to scale and similar production conditions in the countries concerned. This assumption rules out many of the factors that have been found to be critical for Canada.⁶⁰

A more explicit discussion of how the tariff can contribute to persistent productivity differentials seems desirable, as the literature on international trade has given insufficient attention to this area. In a broad review of international trade theory, Corden states, "Some of the considerations that have not been emphasized in the models [of customs unions] are also those which have been neglected in ordinary tariff theory—economies of scale, the effects of free trade or protection on efficiency, and the effects of growth."⁶¹ A key element in the differences in costs per unit of output in manufactured products between the two countries is the typical short production runs in Canada. Recent developments in the theory of production and costs of the firm throw new light on this important area.

Alchian and Hirshleifer have developed the rationale of how the

⁵⁸ Ronald J. Wonnacott and Paul Wonnacott, *Free Trade Between the United States and Canada: The Potential Economic Effects*, Cambridge, Harvard University Press, 1967.

⁵⁹ J. H. Young, *Canadian Commercial Policy*, Ottawa, The Queen's Printer, 1967; and J. H. Young, "Some Aspects of Canadian Economic Development," Ph.D. dissertation, Cambridge University, England, 1955.

⁶⁰ D. J. Daly, B. A. Keys, and E. J. Spence, *Scale and Specialization in Canadian Manufacturing*, Economic Council of Canada, Staff Study No. 21, Ottawa, The Queen's Printer, 1968; H. E. English, *Industrial Structure in Canada's International Competitive Position*, Montreal, Private Planning Association, 1964; H. C. Eastman and S. Stykolt, *The Tariff and Competition in Canada*, Toronto, Macmillan, 1967; John Dales, *The Protective Tariff in Canada's Development*, Toronto, University of Toronto Press, 1967.

⁶¹ Corden, *Recent Developments*, p. 55.

volume of accumulated past output affects the level of costs per unit in the current period. A central point is that marginal cost *increases* with the rate of output per unit of time, but *declines* with a higher volume of output. This basic distinction is illustrated with examples from costs for book printing, airframes, telegraph companies, electric power, airlines, hotels, quantity discounts and size of shipments.⁶² There is considerable evidence that the tariff in Canada permits short runs of a wide range of manufactured products, with a resultant higher price and lower level of productivity in Canada than in the comparable industry in the United States. The existence of the tariff and the relatively easy entry into manufacturing production in Canada has led to the establishment of a larger number of firms and plants in Canada than in the United States, with each plant producing a wider range of products than a U.S. plant of the same size.

Implications for International Trade Theory

The key point in this brief review of the evidence on Canada-United States differences in prices and productivity raises serious questions about the applicability of the Heckscher-Ohlin theory to Canada-United States trade. Crucial to the latter formulation was the assumption of constant returns to scale and of similar production conditions in the countries concerned. The assumptions usually also exclude transport costs and tariffs. Much of the international trade literature of recent years has been devoted to a spelling out of the logical implications of the assumptions under a variety of conditions. In almost all of the tests of that theory, questions about the applicability of the assumptions of similarity of production conditions or production relations have come up. The data for Canada suggest to me that the assumptions which emphasize differences in the productivity ratios (or production relations) between countries have more applicability than the assumption of similar production conditions. Furthermore,

⁶² A. Alchian, "Costs and Outputs," in M. Abramovitz and others, *The Allocation of Economic Resources: Essays in Honor of B. F. Haley*, Stanford, Stanford University Press, 1959; Jack Hirshleifer, "The Firm's Cost Function: A Successful Reconstruction?" *Journal of Business*, July 1962, pp. 235-255. For additional references to the related literature on learning by doing and progress cost functions, see Daly, Keys, and Spence, *Scale and Specialization in Canadian Manufacturing*, pp. 41-47.

the extent of differences in production conditions is probably even more important in most other intercountry comparisons than in the Canada-United States comparisons. The discussion has introduced the Alchian-Hirshleifer emphasis on length of run explicitly into international trade, and built on the theory of effective tariff rates. Although some discussions of customs unions, economic integration, and income differences have recognized the role of length of run, I have not been able to find any explicit references to the Alchian-Hirshleifer articles in discussions of international trade.

However, there are two aspects of the Heckscher-Ohlin line of approach that are relevant to the Canadian-United States discussion. One is the relative supply of industrial raw materials in Canada, which has been mentioned before, to which the availability and price of particular factors of production are still relevant and appropriate. However, even for Canada this is an increasingly small part of the total economy. Another pertinent feature is the Stolper-Samuelson theorem on the effects of tariffs on the distribution of income. This grew out of the discussion of the Australian tariff, in which labor was regarded as the relatively scarce factor, whose share was increased by the existence of the tariff.⁶³ In Canada, there is considerable evidence that trained management is the scarce factor, reflecting a lower level of education in the Canadian labor force compared to the United States, and the larger number of plants and firms encouraged by the tariff.⁶⁴ Insofar as this is true, the costs of the tariff fall on the Canadian consumer and industrial worker. However, there is a degree of income redistribution associated with the tariff that gives a relatively higher rate of return to management in Canadian manufacturing than would prevail under free trade. However, with the limited supply of trained people, the tariff has probably permitted a lower level of management to persist behind the tariff than under free trade conditions. Some pragmatic integration of the Ricardian emphasis on the one hand

⁶³ W. F. Stolper and Paul A. Samuelson, "Protection and Real Wages," *Review of Economics and Statistics*, 1941, pp. 58-73, reprinted in Ellis and Metzler, eds., *Readings*, and in Bhagwati, ed., *International Trade*; and Jagdish Bhagwati, "Protection, Real Wages and Real Incomes," *Economic Journal*, 1959, pp. 733-744, reprinted in Bhagwati, ed., *International Trade*.

⁶⁴ D. J. Daly, "The Changing Environment for Management in Canada," paper presented to the Canadian Association of the Schools of Business at York University, June 1969.

with the Heckscher-Ohlin-Stolper-Samuelson ideas on the other may be necessary as part of a complete and balanced story.

COMMENT

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Professor Daly's purpose has been to survey recent work on international price and cost comparisons. In so doing, he has also ventured into the discussion of particular issues in international trade theory. Needless to say, a survey of this sort can hardly be carried out in depth in the confines of a single article. This fact in part explains certain deficiencies of the paper, such as the cursory treatment of several topics, the omission of a few important contributions, and the reliance on obiter dicta at various points of the argument. In the following, I will consider some of the issues raised by Daly.

ECONOMIC GROWTH AND INTERNATIONAL COMPARISONS OF PRICE AND REAL INCOME

Among empirical studies on international comparisons of income levels and economic growth, Daly cites contributions by Colin Clark and Simon Kuznets, the Arrow-Chenery-Minhas-Solow paper on the CES production function, and Denison's *Why Growth Rates Differ*. A surprising omission is Chenery's attempt to derive patterns of industrial growth by the use of regression analysis of cross-sectional data of a large number of countries. This has been continued and extended by the United Nations and again by Chenery and Taylor.¹ The latter study has also utilized time series data as well as a combination of time series and cross-sectional observations.

There is further need to distinguish between problems of measurement and the sources of economic growth. As regards the first, Daly notes the fundamental similarity of intertemporal and interspatial

¹ Hollis B. Chenery, "Patterns of Industrial Growth," *American Economic Review*, September 1960, pp. 624-54; U.N. Department of Economic and Social Affairs, *A Study of Industrial Growth*, New York, 1967; and Hollis B. Chenery and Lance Taylor, "Development Patterns: Among Countries and Over Time," *Review of Economics and Statistics*, November 1968, pp. 391-416.

comparisons. An additional consideration is the choice between using the country's own prices or those of other countries in measuring the rate of economic growth in a particular country. While at first sight "borrowing" the prices of other countries for the calculations may seem to make little economic sense, the usefulness of such calculations becomes apparent for countries where prices are greatly distorted by the application of protective measures.

For simplicity's sake, let us first take the case of the proverbial small country of international trade theory that can affect neither the prices of its exports nor of its imports. Infant industry considerations apart, welfare maximization would require the country to specialize in conformity with price relations on the world market that express the choices open to it. Rates of economic growth, then, should be properly evaluated at world market prices. In turn, in the case of countries that can affect their terms of trade, the evaluation should take place at the world market prices that would obtain in a free trade situation.

Estimation at world market prices results in substantial reductions in measured growth rates in the case of countries where the highly protected manufacturing sector has been growing more rapidly than the rest of the economy, since in such countries domestic prices overstate the contribution of manufacturing to national income. This was the case, for example, in Hungary where the adjusted growth rate was 3.5 per cent in 1960-65 as compared to an unadjusted rate of 4.5 per cent. Among developing countries, unadjusted and adjusted growth rates were 2.6 and 2.2 per cent for Argentina in the period 1953-63 and 3.8 and 3.3 per cent for Pakistan in the period 1950-67.²

The second problem is to explain intercountry differences in growth rates, measured in an appropriate fashion. Here we have several studies predating Denison, including comparisons of the sources of economic growth in the Soviet Union and in Western industrial countries that involved estimating increases in total factor productivity.³ More re-

² Bela Balassa, "Growth Strategies in Semi-Industrial Countries," *Quarterly Journal of Economics*, February 1970, p. 44; and Bela Balassa and Associates, *The Structure of Protection in Developing Countries*, Baltimore, Johns Hopkins University Press, 1970, Chap. 2. In the latter volume some of the qualifications of the estimates are also discussed.

³ Cf. e.g., A. Bergson, "National Income" in *Economic Trends in the Soviet Union*, A. Bergson and S. Kuznets, eds., Cambridge, Mass., Harvard University

cently, in comparing the growth performance of selected eastern and western European countries, estimates of total factor productivity have been adjusted for economies of scale and improvements in the quality of labor and capital.⁴

TESTING INTERNATIONAL TRADE THEORY

Turning to writings "on the real and positive aspects of international trade," Daly claims that "much of the literature is theoretical . . . [and] the extent of testing of these conclusions against the real world has been much more limited . . ." (see *Testing International Trade Theory*). He further asserts that ". . . all the pure theories of international trade emphasize that trade takes place between countries because . . . differences exist in relative prices between the countries concerned. . . . The major differences among trade theorists emerge from differing emphases on the *reasons* for the differences in relative prices" (*loc. cit.*; emphasis Daly's).

In making these statements, Daly ignores a substantial body of the literature on international trade that has assumed importance over the last decade. The origins of these developments can be traced back to an article by Irving Kravis, who put forward the view that "availability" is an important determinant of international exchange. Availability, in turn, is conditioned by a country's natural resource endowment, its level of technological sophistication, and the importance of product differentiation in modern industry.⁵

Kravis's contribution has been followed by theoretical and empirical work on the product-cycle hypothesis by Vernon and his collaborators, by studies on the effects of research and development expenditures on

Press, 1963, pp. 1-37; Evsey D. Domar et al., "Economic Growth and Productivity in the United States, Canada, United Kingdom, Germany and Japan in the Postwar Period," *Review of Economics and Statistics*, February 1964, pp. 33-40; and Bela Balassa, "The Dynamic Efficiency of the Soviet Economy," *American Economic Review, Papers and Proceedings*, May 1964, pp. 490-505.

⁴ Bela Balassa and Trent Bertrand, "Growth Performance of Eastern European Economies and Comparable Western European Countries," *American Economic Review, Papers and Proceedings*, May 1970, pp. 314-20.

⁵ Irving B. Kravis, "'Availability' and Other Influences on the Commodity Composition of Trade," *Journal of Political Economy*, April 1956, pp. 143-55. The article is cited in a different context in Daly's study (footnote 25), but no reference is made to Kravis's discussion of the role of nonprice factors in determining international specialization, which is the central issue in the article.

international specialization, and by investigations of the interrelationships of foreign investment and trade.⁶ The hallmark of this literature, ably summarized by Harry Johnson,⁷ is indeed its emphasis on the nonprice factors affecting trade flows as well as an intertwining of theoretical and empirical research.

DIFFERENCES IN THE STRUCTURE OF RELATIVE PRICES

Next, Daly turns to the problem of differences in relative prices among countries that affect international comparisons of real incomes. He submits that such differences are "quantitatively much more important in comparisons between countries than between different points of time within a particular country" (Differences in the Structure of Relative Prices). This conjecture may apply in some situations, but not in others; indeed no a priori statement can be made as to the possible magnitude of these differences. Thus, while relative prices may differ little between adjacent countries with similar living standards and a large volume of trade among them, in countries undergoing structural transformation relative prices may change to a considerable extent in two or three decades. In this connection, reference can be made to the so-called Gerschenkron effect which pertains to the over- (under-) estimation of growth rates in such countries by the use of the Laspeyres (Paasche) formula.

Daly further considers relative prices of consumption categories in major industrial countries in 1950, and suggests that the large differences shown in these ratios are explained by the substantial barriers to trade existing at the time. In presenting the data, however, he lumps together goods and services, although the latter do not enter international trade, and service prices are not equalized even under free trade. Rather, the relative prices of services are a function of

⁶ On these points, see Raymond Vernon, "International Investment and International Trade in the Product Cycle," *Quarterly Journal of Economics*, May 1966, pp. 190-207; G. L. Hufbauer, *Synthetic Materials and the Theory of International Trade*, Cambridge, Mass., Harvard University Press, 1966; D. B. Keesing, "The Impact of Research and Development on United States Trade," *Journal of Political Economy*, February 1967, pp. 38-48; and W. Gruber, D. Mehta, and R. Vernon, "The R & D Factor in International Trade and International Investment of United States Industries," *ibid.*, February 1967, pp. 20-37.

⁷ H. G. Johnson, *Comparative Cost and Commercial Policy Theory in a Developing World Economy*, Stockholm, Alqvist and Wiksell, 1968.

differences in per capita incomes which in turn reflect intercountry differences in productivity.⁸ Indeed, in the classification scheme used in Daly's Table 1 most services have low prices in European countries relative to the United States.⁹ And if we consider the somewhat broader consumption categories for which data are given in absolute terms, the exclusion of services reduces the ratio of the highest and the lowest price relatives between the United States and the United Kingdom from 4.5 to 3.1; between the United States and France, from 5.8 to 4.3; between the United States and Germany, from 6.2 to 5.5; and between the United States and Italy, from 11.3 to 3.7.¹⁰ As expected, the exclusion of services makes the greatest difference in U.S.-Italian comparisons, where income and productivity differences are the largest.

TESTING RICARDO

Daly next turns to Professor Bhagwati's criticism of the conclusions I earlier derived from an empirical testing of the Ricardian explanation of international specialization.¹¹ Since Bhagwati is the other appointed critic of Daly's paper, I will refrain from discussing Daly's objections to his argument. I will use the occasion, however, to put forward my own objections to it.

Bhagwati takes issue with the method originally used by MacDougall¹² which involved testing the Ricardian theory in regard to U.S. and U.K. exports by relating ratios of export sales of various commodity categories in third markets to ratios of labor productivities

⁸ Bela Balassa, "The Purchasing-Power Parity Doctrine: A Reappraisal," *Journal of Political Economy*, December 1964, pp. 584-96.

⁹ Milton Gilbert and Irving B. Kravis, *An International Comparison of National Products and the Purchasing Power of Currencies*, Paris, OEEC, 1954, Tables 21-24, pp. 53-56.

¹⁰ Milton Gilbert and Associates, *Comparative National Products and Price Levels: A Study of Western Europe and the United States*, Paris, OEEC, 1958, Table 27, p. 80. I have excluded from the calculations alcoholic beverages and tobacco on which the incidence of excise taxes varies greatly from country to country.

¹¹ Bela Balassa, "An Empirical Demonstration of Classical Comparative Cost Theory," *Review of Economics and Statistics*, August 1963, pp. 231-38.

¹² G. D. A. MacDougall, "British and American Exports: A Study Suggested by the Theory of Comparative Costs," *Economic Journal*, December 1951, pp. 697-724 and September 1952, pp. 487-521. See also Robert B. Stern, "British and American Productivity and Comparative Costs in International Trade," *Oxford Economic Papers*, October 1962, pp. 275-96.

in these same categories. It will be recalled that my calculations showed a high correlation between productivity ratios and export ratios and that this result has been interpreted as evidence for the validity of Ricardo's hypothesis.

Bhagwati suggests that this interpretation would be valid only if there was also a high correlation between productivity ratios and price ratios, since it is via prices that productivity is related to exports, if at all.¹³ He finds that "regressions of export price ratios on labour productivity ratios are almost entirely hopeless"¹⁴ and submits that "these results . . . cast sufficient doubt on the usefulness of the Ricardian approach (as generally understood). Contrary, therefore, to the general impression (based on the MacDougall, Balassa, and Stern results) there is as yet no evidence in favour of the Ricardian hypotheses."¹⁵

The conclusions suggested by Bhagwati do not stand up to scrutiny, however, as his approach rests on the incorrect identification of prices and unit values. In the article, Bhagwati speaks of export prices throughout, although the available data are unit values rather than prices. Now, since with two or three exceptions the commodity categories used in the investigation are heterogeneous, ratios of unit values do not appropriately represent price ratios.

At the same time, in the case of heterogeneous commodity categories, the observed correlation between productivity ratios and export ratios can be explained if we consider that higher productivity levels, calculated in value terms, can be translated into lower prices or higher quality. While both of these tend to improve a country's export performance, the former would lead to lower and the latter to higher unit values.¹⁶ Correspondingly, if the effects of productivity on prices

¹³ Jagdish Bhagwati, "The Pure Theory of International Trade," *Economic Journal*, March 1964, pp. 9-11.

¹⁴ *Ibid.*, p. 15.

¹⁵ *Ibid.*, p. 16.

¹⁶ Also, Bhagwati does not find "plausible" the possibility that "labour productivities approximate the *pre-trade* prices but that trade leads to boosted profits in the export industries . . ." (p. 10n), in which case productivity ratios could be related to export ratios without being correlated with price ratios. Clearly, we need empirical data to test this proposition, but the finding that productivity ratios are better correlated with export ratios than are rates of unit costs may be interpreted as partial evidence for the above proposition (cf. Balassa, "An Empirical Demonstration," p. 237).

and quality are randomly distributed, we cannot expect a high correlation between ratios of productivity and unit values; consequently, a low correlation between the two variables in no way affects the validity of testing the Ricardian hypothesis by relating productivity and export ratios.

I come now to Bhagwati's contention that we cannot expect to find a close relationship between productivity ratios and export ratios, since substitution elasticities differ among commodities.¹⁷ The answer simply is that the proof of the pudding is in the eating: such differences do not appear to be substantial enough to have materially affected the results. In other words, a high correlation is observed despite possible interindustry differences in substitution elasticities.

But how are we to explain the observed interindustry differences in productivity ratios that appear to be correlated with export ratios? Bhagwati claims that "the reliance of the prediction on labour productivity unaccompanied by any explanation of why the labour productivity is what it is . . . restricts the utility of the prediction."¹⁸ The answer to this question was given in my article, where I stated that the Ricardian hypothesis "presupposes the existence of intercountry differences in production functions";¹⁹ productivity differences, then, are taken as a proxy for differences in production functions.

One last point should be noted. According to Bhagwati, "the results would surely be more in conformity with the spirit of the Ricardian approach if the *indirect* labour productivities were also computed"²⁰ in addition to direct productivities. This statement is open to criticism. While Ricardo dealt with the case of commodities that use only primary factors (or a single factor), an extension of his argument to commodities utilizing intermediate inputs would lead to the conclusion that, as long as intermediate inputs are traded, labor productivity incorporated in their manufacture is irrelevant for comparative advantage and international specialization.²¹

¹⁷ "Pure Theory," p. 11.

¹⁸ *Ibid.*, p. 17.

¹⁹ Balassa, "An Empirical Demonstration," p. 231.

²⁰ "Pure Theory," p. 14.

²¹ On this point, cf. Bela Balassa, Stephen Guisinger, and Daniel Schydlosky, "The Effective Rates of Protection and the Question of Labor Protection in the United States: A Comment," *Journal of Political Economy*, September-October 1970.

HECKSCHER-OHLIN ANALYSIS

Daly further suggests "the overall evidence is uniformly inconsistent with the Heckscher-Ohlin hypothesis of similar production functions in different countries" (Heckscher-Ohlin Analysis). I have no quarrel with this proposition; no international economist would. It seems to me, however, that some of the evidence presented by Daly is not quite to the point.

In reference to Leontief's well-known study on U.S. trade patterns, Daly contends that "to explain the paradoxical results he obtained, [Leontief] abandoned the assumption of similar production functions in different countries" (Heckscher-Ohlin Analysis). This interpretation is hardly correct. As Daly himself notes, Leontief has raised the possibility that "one man-year of American labor is equivalent to, say, three man-years of foreign labor."²² Such an assumption does not involve differences in production functions; we have only to express American and foreign labor in equivalent units.

It may be added that the empirical testing of the Heckscher-Ohlin hypothesis would still be quite easy if we accepted the contention of the originators of the CES production function that "the evidence on returns may be consistent with an aggregate production function, which is not strictly invariant among countries but admits differences in efficiency levels that are neutral in their impact on capital and labor returns."²³ Finally, economies of scale and "learning by doing" are not inconsistent with the hypothesis of identical production functions among countries. Such considerations can be introduced by making costs depend on relative factor prices, the level of output (economies of scale) and cumulated output (learning by doing).

Daly puts considerable emphasis on learning by doing. He claims to have introduced new concepts in his paper, among other things, by

²² W. W. Leontief, "Domestic Production and Foreign Trade: The American Capital Position Re-examined," *Economia Internazionale*, February 1954, pp. 9-45, reprinted in Richard E. Caves and H. G. Johnson, eds., *Readings in International Economics*, Homewood, Ill., Irwin, 1968, pp. 503-527.

²³ B. S. Minhas, *An International Comparison of Factor Costs and Factor Use*, Amsterdam, North-Holland, 1963, p. 96. The efficiency term has been estimated in U.S.-Peruvian comparisons in Christopher Clague, "An International Comparison of Industrial Efficiency: Peru and the United States," *Review of Economics and Statistics*, November 1967, pp. 487-93.

relating the recent theoretical formulations by Alchian and Hirschleifer on the length of the production run to specialization in international trade (p. 86). He also suggests that differences in the length of the production run largely explain differences in U.S. and Canadian productivity levels (*Differences in Relative Prices and Productivity*).

The importance of learning by doing for international specialization has been known for some time. In U.S.-Canadian relationships, the point was made fifteen years ago by J. H. Young.²⁴ The problem is discussed in considerable detail in some of my own writings where a number of relevant papers are also cited.²⁵ Furthermore, Arrow's path-breaking contribution to the theoretical implications of learning-by-doing has spawned a number of articles on the subject.²⁶ Nevertheless, further empirical research would be necessary in order to judge the relative importance of the length of the production run in explaining productivity differentials between the United States and Canada or between any other pair of countries.

All in all, the survey on "Uses of International Price and Output Data" leaves this reader rather unsatisfied. In extending his attention to international trade theory Daly has used a broad palette, with the result that few topics have been adequately discussed. A more judicious choice of topics and material would have brought greater returns.

JAGDISH N. BHAGWATI

Daly's paper is a worthwhile survey of a number of topics which have one common denominator: They all involve the use of interna-

²⁴ Cf. his "Some Aspects of Canadian Economic Development," Ph.D. dissertation, Cambridge University, England, 1955; and his "Comparative Economic Development and the United States," *American Economic Review, Papers and Proceedings*, May 1955, pp. 80-97.

²⁵ See Bela Balassa, *The Theory of Economic Integration*, Homewood, Ill., Irwin, 1961, Chap. 6; and Balassa, *Trade Liberalization among Industrial Countries: Objectives and Alternatives*, New York, McGraw-Hill, 1967, Chap. 5.

²⁶ Cf., e.g., K. J. Arrow, "The Economic Implications of Learning by Doing," *Review of Economic Studies*, 1962, pp. 154-74; E. Sheshinski, "Optimal Accumulation with Learning by Doing," section 6 in Karl Shell, ed., *Essays on the Theory of Optimal Economic Growth*, Cambridge, Mass., MIT Press, 1967; S. Clemhout and H. Y. Wan, "Learning-by-Doing and Infant Industry Protection," *Review of Economic Studies*, January 1970, pp. 33-56.

tional data on prices, outputs, incomes, etc. This inevitably makes my task as a discussant very difficult, however, as I will have to select a few topics for detailed comment, while neglecting the rest. Following the theory of comparative advantage, I shall concentrate on the areas where my competence is greatest.

A

Let me begin with the important question of measuring growth rates, on which Balassa touched. He has already shown how the measured growth rates may differ, depending on whether goods are evaluated at domestic or foreign prices. The problem here, however, is not entirely one of measurement but also of concept. Why do we wish to use foreign prices at all? If we correctly answer that question, we should also know *which* foreign prices to use, and what the limitations of such calculations would be. Clearly, the use of international prices in evaluating income and its growth has been advocated, for some years now, by a number of theorists of international trade and also of cost-benefit analysis (e.g., Little, Scott, Scitovsky, Usher, among others), entirely because international prices are taken to represent "true opportunity costs." However, all the usual qualifications to which the theory of international prices as true opportunity costs is subject must apply as well to any methods of income evaluation based upon it. These qualifications arise particularly because a country may have a less than infinitely elastic demand for its exports or supply of its imports; and the choice of technology (including the pattern of trade) may have also to be determined in the context of *growth-theoretic* second-best considerations (such as that the savings of the economy may be a function of market-imputed incomes, and intertemporal utility maximization for any stated time horizon may then require that the pattern of trade be other than that dictated by current international prices). Note further that, even if we were to apply the *static* efficiency theory and use international prices as true opportunity costs, assuming unrealistically that the country has no monopoly power in trade (and hence introducing errors in our calculations on that account), we would have to worry about two difficult problems:

1. We would have to take international prices *not* in terms of U.S. prices for Argentine calculations, as indicated in Balassa's example in

his discussion, but rather in terms of the c.i.f. values of imports (from the cheapest source) and f.o.b. values of exports (to the highest-priced destination) for the country in question, for it is *these* prices that would represent the true opportunity costs and *not* the domestic prices of goods abroad; and these prices may well be difficult to come by with accuracy.

2. Further, in a world with transport costs, we do not have one unique vector of international prices. In principle, there are f.o.b. prices and c.i.f. prices on every good, and there are a number of goods which are not traded and whose prices, at any equilibrium solution, lie between their c.i.f. and f.o.b. values. Hence, we would have to be able to classify each good we wished to evaluate at its "true" international price as an exportable, or an importable, or a nontraded good, and this could not be done until we knew the optimal equilibrium exchange rate and the overall solution to the general equilibrium model. Only if we knew that would we be able in principle to categorize each good correctly.

Once these problems are fully understood, it should be possible to avoid the haste shown by several estimators, who drew adverse quantitative inferences about the economic performance of a country only because a crude estimate of growth rates measured in the prices of some foreign country (such as the United States) turned out to be lower than the growth rate measured in domestic prices. It also becomes obvious then that a *range* of estimates of incomes and growth rates at international prices, instead of a single estimate, must be provided, using a sensitivity analysis approach, to emphasize that the calculations require heroic conceptual and measurement assumptions.

B

The next point I wish to make relates to the Ricardian theory of comparative advantage and to tests of it. I am grateful that Daly has deemed it useful to refer to my review of these tests (undertaken by MacDougall, Stern, and Balassa) and to offer to explain why my negative review of these tests, and of the predictive ability of Ricardian theory interpreted as a labor productivity theory, may not be warranted. Professor Balassa has also touched upon this question, offering yet another, and more sweeping, rejection of my negative findings. I

am, unhappily, afraid that Daly's doubts and Balassa's firm rejection are both ill-taken and that there is cause to reject the MacDougall-Stern-Balassa findings until further empirical evidence is found along lines which I suggested in my review.

Before I do that, let me first say that I still think the correct way to look at Ricardian theory in a multifactor world is, as Minhas and I have indicated earlier, to think of the trade pattern as reflecting international differences among production functions of a Hicks-neutral variety. In fact, the Arrow-Chenery-Minhas-Solow (ACMS) findings support the view that this might be the case in the real world.

However, the approach to Ricardian theory in the literature on the empirical patterns of trade has been to seek correlations of one kind or another between labor productivity ratios and the pattern of trade (frequently export performance of two exporters in third markets). In the first place, I find this approach totally arbitrary. Why take labor productivity and not capital productivity, for example, if one factor has to be chosen? In fact, as Hal Lary has emphasized in his recent work, skilled labor's returns could be taken out of the wage data and treated as returns to human capital; and most land rents could be treated again as returns to capital inputs into "natural" land; so we could end up thinking that capital is the most important factor, rather than labor. In either case, the choice of the single factor in terms of which productivity is to be defined would be quite arbitrary; hence the basic unattractiveness of any empirical investigation which proceeds to show simple correlations between productivity in this sense and export performance. But let us grant that the correlation is established empirically; what does it really mean?

In answering this question, I said that the most it could mean was that higher labor productivity meant lower prices and greater competitiveness and hence superior export performance. Therefore, I proceeded to use the data from the MacDougall-Balassa-Stern literature to see if any correlation between labor productivity and prices could be established. I naturally had to take unit values, which alone were available for this purpose, and I cited a number of qualifications in this regard. It was surprising to find that the relationship between labor productivity and price was extremely poor; hence I argued that we had to withhold judgment on whether the Ricardian theory "explained"

the pattern of trade, even if we were willing to buy this "arbitrary-factor-productivity" approach. And I called for more systematic empirical analysis, using better and more appropriate data, to see if labor productivity or labor costs correlated well with prices.

Balassa does *not* offer this exercise; nevertheless, we are asked to accept his correlation between export performance and labor productivity. He reasons that higher labor productivity may result not merely in lower prices but also in better quality. True; and this too was a question I raised in discussing the meaningfulness of the MacDougall-Balassa type of work on comparative export performance on a cross-sectional basis among different industries when the product differentiation among the two trading countries' different industries may vary widely. The answer to Balassa is straightforward: If the tendency to take higher productivity in better quality rather than lower price is evenly distributed and therefore is similar among different industries, then there is no bias from this complication. He produces no theoretical argument to suggest that there should be a bias on this account; hence his belated defense of the failure to investigate whether labor productivity differences had anything to do with the ability to compete via price advantage (in the widest sense) is not persuasive. If he is still interested in convincing us that labor productivity differences significantly determine the pattern of trade, he has to show first that they are correlated significantly with competitive price advantage (in the widest sense). If the birth rate in China has a high correlation with the death rate in India, I am afraid that I would still refuse to accept a Chinese-birth-rate "theory" of the Indian death rate, unless it was shown to me that it made theoretical *and* statistical sense outside of the correlation itself! That this analogy is far from being inappropriate is readily understood when it is realized that (among other deficiencies noted in my earlier review) there is really little reason from a theoretical point of view to expect such a correlation between the Balassa measure of labor productivity and export performance: The labor productivity measured for these exercises is *direct* labor productivity whereas export performance must depend on gross output competitiveness which must clearly reflect direct *and* indirect cost considerations. Hence, at best, we should expect the correlation to hold, in theory, between export performance and

direct plus indirect labor productivity underlying the exports in question. This takes me directly into Daly's critique.

He asks whether we should not correlate prices with the value-added productivity of labor rather than with its gross output productivity. He thinks that where the former concept was used, my relationship between prices and labor productivity was not too weak. Since I used the 1950 data from Paige and Bombach which apparently applied the net value-added concept in defining labor productivity, and I used the Rostas data for 1937 for gross output productivity, my results were presumably weaker for 1950. However, I find this suggestion difficult to accept. It seems to me that the correct approach has to be the estimation of direct and indirect labor productivity to see whether this "true" labor productivity really accounts for the price of the gross output. Until we have done this, we cannot really develop any basis for thinking that the labor productivity approach is meaningful even in the limited sense of establishing a plausible correlation between competitiveness and labor productivity in industries. I might finally add that Kravis has expressed strong doubt to me concerning whether the Paige-Bombach data are truly on a net value-added basis: if they, too, are substantially on a gross output basis, then Daly's explanation of the findings of my tests is also statistically weak.

C

Let me finally touch on the question of the empirical relevance of the Heckscher-Ohlin theory. Without a doubt, Daly is quite right in thinking that we ought to change this theory in the generalized Ricardian direction, by allowing for international differences in production functions. The ACMS work, quite aside from the Denison-type work on Canada which he refers to, would support this view. Indeed, there is a fair amount of trade-theoretic work which explores precisely the question of trade among countries which are in a Ricardo-Heckscher-Ohlin world.

At the same time, it is worth noting that the early disillusion with the utility of the Heckscher-Ohlin approach, which stemmed from the paradoxical findings of Leontief for the U.S. pattern of trade, has steadily been eroded. Work has proceeded quite intensively along two different lines: The early pioneering and brilliant work of Minhas,

which seemed to establish the empirical reality of factor-intensity reversals, has generated a massive empirical literature which reverses these findings, thus underlining the empirical realism of the Heckscher-Ohlin assumption that factor intensities are nonreversible; and work on human capital has tended to support the view that adjusting the paradoxical trade pattern findings by separating out returns to human capital may sometimes work in the direction of re-establishing the empirical relevance of the Heckscher-Ohlin theory.

REPLY BY DALY

My two discussants were selected on the basis of their previous writing and experience in the field of international trade and economic development, particularly as my paper raised a number of questions on the applicability to the real world of some of the major emphases in trade theory of recent years. One of those attending jokingly commented that I couldn't be accused of selecting them on the basis of sympathy to the themes of my paper!

A few sentences of restatement of my aims might be in order. As many of the papers planned for the conference were quite specific and deliberately narrow in focus, a more comprehensive paper to put parts of the field in a broader context seemed desirable. Some of my own recent work has been on comparisons between Canada and the United States, using the conceptual framework developed by Denison. This involved quantitative data on comparisons of real income per employed person in the two countries and a quantitative distribution of the main sources of income differences. On the basis of the research work completed thus far, two points emerged that were emphasized in the paper for this conference. One was that there were very significant differences in output in relation to total factor input in the two countries. A second was that the particularly large differences in secondary manufacturing could be explained by the emphasis on length of run developed by Alchian and Hirshleifer. An initial study of a fairly large body of literature on international trade and intercountry comparisons suggested that these points had *not* been discussed fully.

in the literature. Furthermore, these points were applicable to a much wider range of countries than just Canada and the United States.

Let me restate what seems to be the response to these points by Bhagwati and Balassa.

1. The empirical relevance of Heckscher-Ohlin: The main theme of the discussion in the paper is that the evidence suggests there are significant differences in production conditions between countries, even after allowing for measurable differences in factor inputs (including adjustments for quality of labor as measured by educational differences, differences in capital, and natural resource differences as they are reflected in rent). Balassa has no quarrel with this proposition, and his earlier work has consistently put more emphasis on the Ricardian stream of theory. Bhagwati states: "Professor Daly is undoubtedly right in thinking that we ought to change this theory in the generalized Ricardian direction, by allowing for international differences in production functions." I regard this and the tone in his concluding paragraphs as reflecting an important shift away from his emphasis on the Heckscher-Ohlin theory in his 1964 *Economic Journal* article. In that survey he did not, in my opinion, test the Heckscher-Ohlin theory as carefully and critically as the Ricardian one. It is to be hoped that future theoretical and applied work in international trade will include even more systematically and explicitly the significant differences in production conditions that most recent empirical work has been emphasizing.

2. Alchian-Hirshleifer in relation to international trade: One of the points emphasized in my paper is that length of run should be explicitly considered as a variable in production conditions, and that this is frequently empirically relevant for international trade. I am disappointed that Bhagwati did not deal with this point at all. Balassa accepts the empirical importance of this point, and has touched on it in several of his own studies. In discussing the theoretical underpinnings of specialization in *Theory of Economic Integration and Economic Development and Integration* he refers to Allyn Young's 1928 article and Stigler's 1951 article.¹ In his *Trade Liberalization Among*

¹ B. Balassa, *Theory of Economic Integration*, Homewood, Ill., Irwin, 1961, pp. 156-159; and *Economic Development and Integration*, Mexico, Centro de Estudios Monetarios Latinamericanos, 1965, pp. 149-153.

Industrial Countries he expresses concern about the limited attention to dynamic effects of trade liberalization associated with economies of scale and improvement in production methods from intensified competition:

These sources of gain have received relatively little attention in the trade literature, and static considerations also predominate in the traditional theory of customs unions. Economies of scale have apparently been regarded as an unimportant complication for customs union theory, and little consideration has been given to the impact of increased competition on the methods of production.²

I have been unable to find any explicit reference to the Alchian-Hirshleifer articles (which give the most complete and systematic discussions of this in the literature of production and cost theory of the firm) in Balassa's large contribution to the international trade literature, and he apparently doesn't consider it important enough to refer to it. Neither discussant has referred to any previous literature applying the Alchian-Hirshleifer concepts to international trade.

Although both Balassa and I would emphasize the importance of differences in production conditions in manufacturing between countries, we would put quite a difference in emphasis on the empirical importance of the product cycle hypothesis on the one hand and product diversity and length of run on the other. It is to be hoped that future theoretical and applied work in international trade will explicitly include a discussion of product diversity and length of run as factors in domestic production and in international trade in manufactured products.

Scale and Specialization in Canadian Manufacturing contains empirical evidence on the length of the production run in explaining productivity differentials between Canada and the United States in ten manufacturing industries, and other studies emphasizing the same points have also been published before and since. Differences in the length of production run have been more important than other factors such as differences in education, capital, plant size, or knowledge of production techniques. In the light of the importance of differences

² B. Balassa, *Trade Liberalization Among Industrial Countries: Objectives and Alternatives*, New York, McGraw-Hill, 1967, p. 95. Pages 95-101 cover some features of market size, economies of scale, and standardized products.

in the length of production run in explaining productivity, it would be useful to study these factors in other countries as well.

3. Testing Ricardo: In commenting on this topic, my two discussants have had an opportunity to return to an area on which they have expressed differing views before. All three of us would agree that we do not have enough data at the industry level on productivity differences, price differences, and international trade for different countries, to test fully the Ricardian assumptions in relation to domestic production and trade, even for the United States and the United Kingdom where the published data are better than for any other pair of countries that I know of. Both discussants have tended to restate their earlier positions, without much consideration of later and relevant data on the United States and the United Kingdom. On the basis of the data we do have, it seems to me that the evidence provides relatively more support for significant differences in production conditions for the two economies as a whole, and for significant differences at the individual industry level within manufacturing. The United Kingdom also has less physical and human capital per employed person than the United States, but the differences in inputs are less important than the differences in output in relation to overall inputs. When the data by industry are limited and costly, we cannot afford to ignore the implications of the evidence for the total economy.

Bhagwati would dismiss comparisons of labor productivity ratios as totally arbitrary. He wonders why labor productivity and not capital productivity is selected. My response would be that labor is such a very important factor, as measured by shares of national income, that it *should* be emphasized. Data on this point are included in my paper, in Table 3, and Bhagwati apparently overlooked this and the related discussion in making his comments. The importance of such additional factors as physical capital, education, and land rents on overall productivity differences can also be studied. Tables 6 and 7 in my paper show such data for Canada and the United States. Similar data for the United Kingdom and six other countries in northwestern Europe are also available. The key importance of differences in output per unit of input, and the relative unimportance of differences in other factor inputs per employed person, suggest that the primary emphasis on labor productivity is much less arbitrary than an emphasis on physical

and/or human capital, on the basis of the evidence for about ten developed countries.

4. Prices and quantity indexes: My paper dealt briefly with the effects of using domestic or foreign prices in intercountry comparisons of prices and real product. The large differences in comparisons of level at a point in time were emphasized. Both Bhagwati and Balassa went on to discuss a different, but related, point on the use of domestic and foreign prices for analyzing differences in growth rates over time.

My comment that the differences in relative prices between countries at a point in time were typically larger than changes in relative prices over time within a particular country was an empirical generalization and not an a priori statement. The importance of this point was made at the conference in the Bergson and Grunwald-Salazar papers, and in the discussion of Afriat's paper. A number of studies of the effects of Paasche and Laspeyres formulas in measuring price and volume changes over time in industrialized countries indicate negligible differences in the alternative measures of price and volume changes, even over extended periods.

Both discussants have added to the conference and the volume by the range of their comments and their additional references to the literature. Both of them commented from the point of view of specialists in international trade and economic development, and commented on certain topics in detail. However, most of those attending the conference were more familiar with national income concepts and data than international trade, and the purpose of the paper was to build some bridges between these two fields. The discussion confirmed my earlier thinking that some bridges needed to be built and indicated the part of the landscape where they might do the most good. However, more complete foundations and surfacing seem necessary before the professionals will be willing to go back and forth with any assurance and enthusiasm.

