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6 Do Multinational Firms Adapt Factor Proportions to Relative Factor Prices?

Robert E. Lipsey, Irving B. Kravis, and Romualdo A. Roldan

6.1 Introduction

A major issue in the discussion of the effects of multinational firms' operations on host country employment has been whether these firms use "inappropriately" capital-intensive methods of production and are therefore responsible in some degree for underutilization of the presumably abundant labor, or unskilled labor, resources of less developed countries. There are many aspects to this issue; here we consider one: whether multinational firms respond to differences in labor costs by using more labor-intensive methods of production where labor costs are low. In contrast to the case studies that have examined this question in individual countries or industries, our work investigates the pattern that emerges from an analysis of the main manufacturing industries across many countries. We make particular use of data on multinational firms collected by the Bureau of Economic Analysis (BEA) of the United States Department of Commerce for 1966 and 1970 and similar data for Swedish-based multinational firms collected by the Industriens Utredningsinstitut of Stockholm for 1970 and 1974.

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We are indebted to Dennis Bushe and Linda O'Connor, helped in the late stages by Stanley Lewis, for statistical calculations and programming, and to Arnold Gilbert and Michael Liliestedt for programming and advice on United States Department of Commerce data. Anne O. Krueger, Hal B. Lary, and several referees read the paper carefully and made valuable comments on it. The Industriens Utredningsinstitut provided hospitality in Stockholm and information and calculations on Swedish multinational firms from its surveys, and Birgitta Swedenborg guided us in using the Swedish data and supervised the Swedish calculations. We are grateful also to the City University of New York for a grant of computer time.

The question of degree of adaptation to factor costs has received considerable attention. Unfortunately there are many possible definitions of adaptation, and a good deal of effort has been spent, often unprofitably, we believe, in attempting to distinguish one from another.

A question frequently raised is whether any observed differences between production methods in developed countries and those in LDCs are the result of factor substitution within a single technology (along a single production function), as in figure 6.1, or the result of the use of a more labor-intensive technology in LDCs: one that would be more labor-intensive under any set of factor price ratios, as in figure 6.2. Observed differences in factor input ratios could be a combination of substitution between and within technologies, as in figure 6.3. Courtney and Leipziger (1975), for example, assume two technologies in each industry—one for developed country affiliates of each firm and one for affiliates in LDCs. They fit production functions accordingly and attempt to divide the observed differences between DC and LDC factor use ratios (k_1 and k_3 in fig. 6.3) into the unobserved differences between k_1 and k_2 (ex ante substitution in their terms) and the unobserved differences between k_2 and k_3 (ex post substitution). "By ex ante factor substitution we refer to choices of plant design and by ex post factor substitution, we refer to the way in which the plant is run" (Courtney and Leipziger 1975, p. 297).

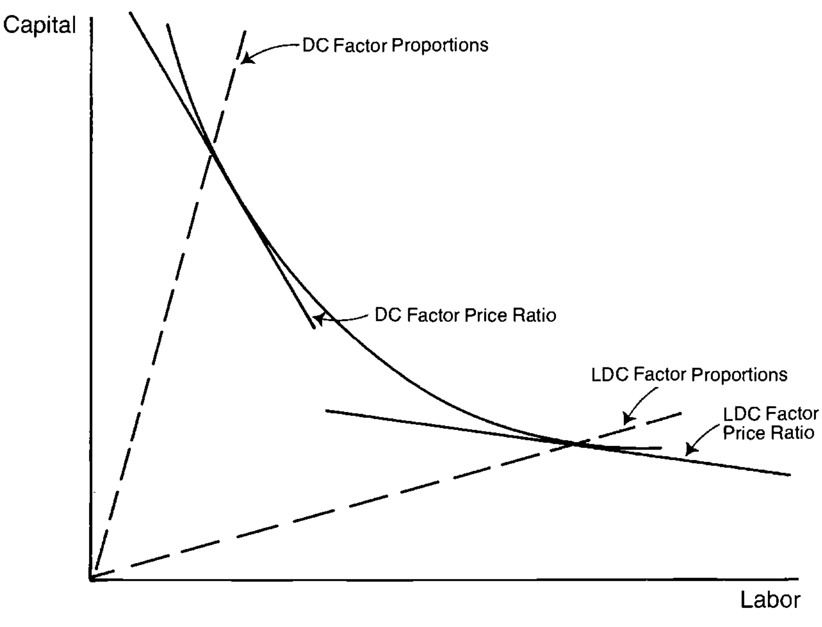


Fig. 6.1 Substitution of capital for labor within a single technology.

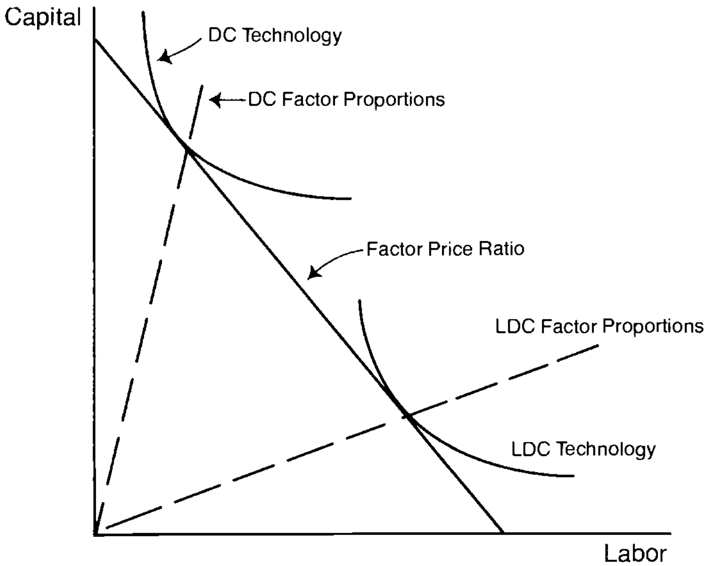


Fig. 6.2 Substitution of labor-intensive technology for capital-intensive technology.

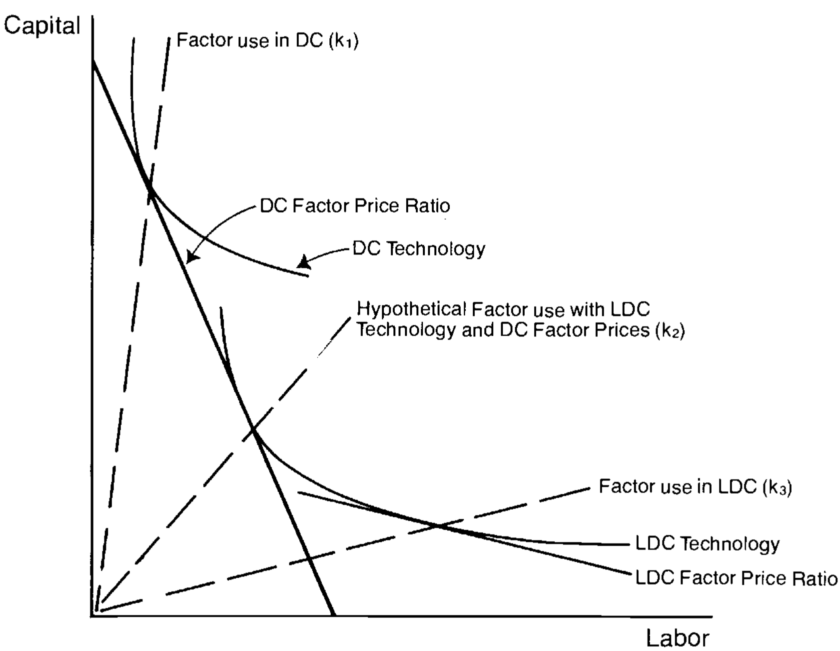


Fig. 6.3 Substitution of labor for capital between and within technologies.

In our study we have not only compared parent companies, DC affiliates, and LDC affiliates as groups, but also compared affiliates in an industry across all countries, treating individual affiliates or the aggregate of affiliates in a country as the units of observation. The parent firm is viewed as having a technology set consisting of a variety of ways of producing that differ in their capital intensity. The question is whether the parent firm's choices from this technology set for use in different countries reflect differences in factor costs. Of course this picture of a single technology set is a simplification, more appropriate for a single product than for the heterogeneous industries distinguished in any available collection of data.

We concentrate on the observed differences in factor proportions (the difference between k_1 and k_3 in fig. 6.3) and relate them to differences in factor prices. We examine the relationships taking as our units of observation for a country, in turn, manufacturing as a whole, broad industries, and individual firms. We ask what adaptation there is to host country factor prices, how much of it takes place through the selection of industries (labor-intensive industries producing in low-wage countries), how much takes place through the selection of firms within each industry (labor-intensive firms in each industry producing in low-wage countries), and, finally, how much takes place through the choice of factor proportions within industries or firms.

At the most aggregative level, among broad industries such as textiles or chemicals, adaptation by selection of industries means that labor-intensive industries based in high-wage countries establish affiliate production in low-wage countries more frequently, or at a higher level relative to home output, than do capital-intensive industries from high-wage countries. In other words, if there is adaptation by industry selection, the share of labor-intensive industries will be higher among affiliates in low-wage countries than among home-country industries or affiliates in high-wage countries. Such selection could be represented by figure 6.2 if we relabeled DC and LDC technology and factor proportions as instead referring to industry A (noninvestor or investor in high-wage countries) and industry B (investor in low-wage countries).

Virtually all industries defined by statistical classifications are heterogeneous in the sense that they include more and less labor-intensive firms. The more labor-intensive firms within each industry might choose to relocate their production to foreign countries with low wage levels, while more capital-intensive firms did not invest abroad at all or chose locations with high wage levels. That would be adaptation by selection of firms within an industry. Again, such selection could be represented in figure 6.2 by substituting firm A and firm B technology and factor proportions for those of DCs and LDCs.

In the cases of selection of investing industries and investing firms there are, of course, influences other than the price of labor on the extent and location of foreign operations. It has been suggested, in fact, that the typical advantage of United States firms, which enables them to compete effectively in foreign markets with host country firms and other foreign firms, is technological skill. If high technology is associated with high capital intensity there will be a tendency for capital-intensive firms and industries to locate abroad. For firms in a home country with high labor costs, such a tendency will operate in the opposite direction from the influence of labor costs on the selection of industries and firms to operate abroad. Also operating against the influence of labor costs would be high capital intensity in industries based on natural resource availability if the natural resources were concentrated in countries with low labor costs.

Even within the firm there could be differences in the type of output produced in different countries. Since the typical firm produces more than one final or intermediate output and can supply one market by production from another market, it will have an incentive to produce the labor-intensive product in LDCs and the capital-intensive product in developed countries or at home. This phenomenon would appear in the statistical data as substitution of labor for capital in LDCs even if each product were produced in exactly the same way at home and abroad. Since most large firms' home country operations extend over several industries, the selection of products within the firm may be a selection not only among the products of a single industry but also among the industries of the parent. Once again we could represent the selection using figure 6.2, with products A and B, produced in high-wage and low-wage countries respectively, substituted for DC and LDC technology and factor proportions.

Thus there are three types of adaptation to low wages in LDCs that involve selection rather than the adaptation of production processes. One is the greater tendency of labor-intensive industries, compared with capital-intensive industries, to move production to low-wage countries. The second is the same tendency for labor-intensive firms within any industry. The third is, for a given firm, the same tendency to select among products or production processes. Of course the division between adaptation by selection among industries and adaptation by selection within industries depends on the fineness of the industry classification. The broader the industry groups, the more apparent adaptation within industries; the narrower the industries, the more important industry selection appears.

Also embedded in factor proportions comparisons among countries may be differences in capital intensity due to differences in scale of production, if the production function is not homothetic. This possibility

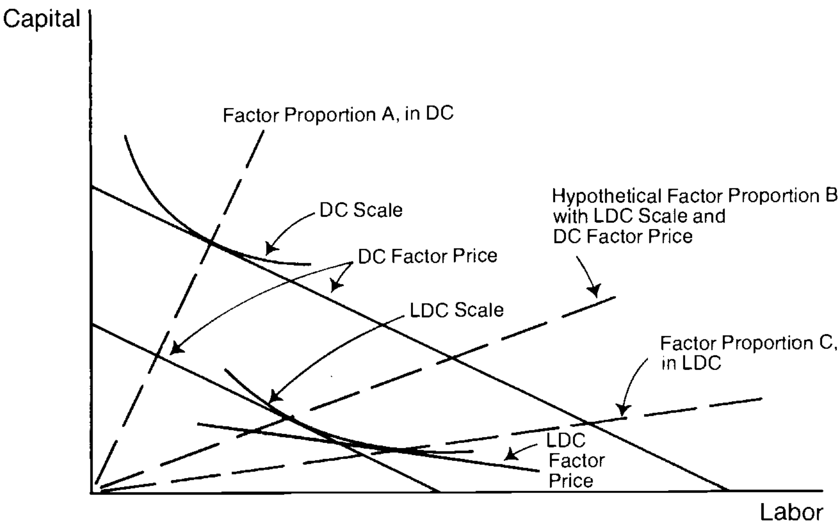


Fig. 6.4 Effect of scale of production on factor proportions: one technology, two production levels, two factor prices.

would be obscured if a single production function were fitted to all countries, assuming homotheticity. Differences in factor proportions that were really related to scale of production would then be attributed to factor prices, since these are, among countries, generally related to scale of production, the least developed countries having both low labor costs and small plants. In figure 6.4, for example, the existence of some indivisibilities in plant or capital equipment means that capital-intensive methods of production (DC scale) would be used only in developed countries, resulting in factor proportion A. Labor-intensive methods would be used in LDCs, resulting in factor proportion C. If the production function were assumed to be homothetic, the entire difference between A and C would be attributed to factor price differences, even though at LDC scale DC factor prices would bring about a capital intensity only as high as B.

In our direct comparisons of capital intensities between developed countries and LDCs we are, in effect, treating low capital intensities that result from small-scale operations in LDCs as one more form of adaptation to low labor costs. Although the differences in capital intensities between LDC affiliates and parents or DC affiliates in such a case do not represent substitution along an isoquant, they may still be a consequence of differences in factor costs. Low labor costs in LDCs may make economical the operation of small labor-intensive plants that would be hopelessly uneconomical at high labor costs.

A more fundamental difficulty plagues attempts to measure scale effects from production functions fitted to data across countries. Typically no physical output data are available, and output is measured by value added. This practice biases the result toward obscuring economies of scale, if they exist. Presumably, plants of uneconomically small size, perhaps in markets too small to sustain plants of optimal size, can survive only if they are afforded high protection or subsidies. The level of protection must be high enough to provide standard levels of wages for the workers and profits sufficient to attract and retain capital. Each worker enters the production function on the right-hand side, and his wage enters on the left, in value added. Each unit of capital is also entered on both sides of the function because the investment (on the right-hand side) will not be made unless the level of protection or subsidy is sufficient to provide a standard return, which enters the equation on the left-hand side.

Within a single economy the presumption is that all producers must sell at the same price, since they are in competition with each other. Any inefficiently small plant with too many workers per unit of output would have the high wage bill included in its value added; but, since it is selling in competition with, and at the same price as, efficient plants, the inefficiency will be reflected in a low or even negative return on capital, and a low or negative value added, which will truly reflect net output. The same would happen in the case of a plant with too much capital per unit of output. What is different in a comparison across countries is that prices need not be the same if there are trade barriers and plants in one country that do not compete freely with those in another. The value added by inefficient plants is inflated in segregated, protected markets. The results in studies across countries are thus biased toward proportionality between inputs and outputs: that is, constant returns to scale.[1] This analysis assumes, of course, that the degree of protection is that needed for survival by inefficient plants rather than that achieved by politically powerful firms or industries seeking high profits.

6.2 Data

The basic data for our analysis came from two sources: surveys of the foreign operations of United States firms by the Bureau of Economic Analysis (BEA), formerly the Office of Business Economics (OBE) of the United States Department of Commerce, and surveys of foreign operations of Swedish firms by the Industriens Utredningsinstitut of Stockholm. The United States surveys took place in 1966 (a complete census) and 1970, and the Swedish surveys, believed to have virtually complete coverage, took place in 1970 and 1974. The United States data are described in United States Department of Commerce (1972, 1975), and the 1970 Swedish data in Swedenborg (1973, 1979). The Swedish data for 1974 had not yet been published at the time these calculations were done and are therefore referred to below as unpublished data.

Although the United States and Swedish survey questionnaires are very similar, there are differences that are reflected in the way they are used below. The United States data give more detailed balance-sheet information, including net and gross book values for property, plant, and equipment. The Swedish data provide a breakdown of products and industries for both parents and overseas subsidiaries and also, in addition to book value, the value of property, plant, and equipment based on fire insurance values, an approximation to current gross market value. Although the fire insurance valuation presumably does not include revaluations of land, we are inclined to the view that it is better than book value as an estimate of the amount of capital in market values. The United States data, on the other hand, characterize each parent and each affiliate only by its single most important industry affiliation and provide only book values of assets.

6.3 Factor Proportions of Domestic Industry, Parent Companies, and Foreign Affiliates: Aggregate Data

The basic facts about capital intensity for all manufacturing in multinationals' home countries, home country operations of parent companies, and foreign affiliates are set out in table 6.1. In every case for which we have data to make a comparison, capital intensity in home country domestic manufacturing as a whole and in parent companies' domestic operations was higher than in foreign affiliates, even those in other developed countries. And capital intensities of affiliate operations in other developed countries were consistently higher than those of operations in less developed countries. The comparisons clearly indicate that some form of adaptation to differences in wage levels does take place and that the adaptation, or the sum of all the different types of adaptation, was large. Capital intensities of affiliates in less developed countries were typically 40 percent or more below those of parents or home countries.

As we mentioned earlier, there are many possible reasons for such differences. One is that we are observing only industry selection. The more labor-intensive industries might choose to go abroad to benefit from lower wage levels, particularly in less developed countries, but might produce abroad exactly as at home. A test for this possibility is to make comparisons of capital intensity within industries, as in tables 6.2 and 6.3. If all the differences in table 6.1 were accounted for by industry selection there would be no differences within industries. If industry selection were unimportant, the differences in tables 6.2 and 6.3 would be as large as those in table 6.1.

Table 6.1 **Capital Intensity (Capital per Employee) in Manufacturing, United States and Swedish Domestic Industry, Parents, and Foreign Affiliates**

		Value per Employee			
				Foreign Affiliates	
Capital Stock Measure		Domestic Industry	Parents	Developed Countries	Less Developed Countries
			Thousands of Dollars		
United States					
Total assets	1966	n.a.	22.1[a]	17.0	14.8
	1970	n.a.	29.3	20.8	16.2
Net property, plant, and equipment, book value	1966	11.7[b]	8.6[a]	6.7	5.7
	1970	14.6[c]	12.0	8.0	6.0
			Thousands of Kronor		
Sweden					
Total assets	1960	n.a.	n.a.	37.9[d]	27.7
	1965	n.a.	n.a.	57.8[d]	38.7
	1970	117.6	n.a.	91.9[d]	59.0
	1974	176.0	n.a.		
Net property, plant, and equipment, book value	1970	31.9	n.a.	25.7	19.4
	1974	40.2	n.a.	35.1	22.6
Gross property, plant and equipment, fire insurance value	1970	108.0	n.a.	50.8	29.2
	1974	177.5	206.8	73.2	43.9

SOURCES: United States Department of Commerce (1972), Sweden, Statistiska Centralbyrån (1972*a*, *b*, 1976*a*, *b*), Swedenborg (1973), and unpublished data of the Industriens Utredningsinstitut.

[a]Includes only those parents reporting in 1970.

[b]Gross property plant and equipment for 1967; 1966 not available.

[c]Gross property, plant, and equipment.

[c]Includes Europe, North America, Australia, New Zealand, and South Africa. No Japanese manufacturing subsidiaries are reported.

It is clear that, even within broad industry groups, home production is most capital-intensive, production in developed country affiliates next, and production in LDC affiliates least capital-intensive. In the case of the United States (table 6.2), twenty-two out of twenty-four possible comparisons between parents and developed country affiliates show parent production more capital-intensive. All sixteen possible comparisons between developed country affiliates and those in LDCs show that the former are more capital-intensive, and all sixteen possible comparisons show parent production more capital-intensive than affiliate production in LDCs. Adaptation, in other words, is visible within industries, at least within industry groups as broad as these. That impression is strengthened by the averages. The averages of the industry relatives of affiliate to parent capital intensity show at least as much relation to the type of host country as do the aggregates, and possibly more in the case of LDCs.

The adaptation in capital intensity shown by manufacturing industry as a whole in table 6.1, put in index form in the "all manufacturing" rows of table 6.2, can be divided into two parts. One is the adaptation within industries, and the other is adaptation by selection among broad indus-

Table 6.2 Capital Intensity (Capital per Employee) in Manufacturing Industry Groups, United States Parents and Foreign Affiliates (Unit: Thousand Dollars per Employee)

Manufacturing Industry Group	1970			1966[a]		
		Affiliates in			Affiliates in	
	Parents	Developed Countries	LDCs	Parents	Developed Countries	LDCs
	Total Assets per Employee					
Food products	28.27	20.17	14.44	21.62	17.42	13.26
Chemicals and allied products	35.95	37.77	20.46	29.94	28.27	17.27
Primary and fabricated metals	33.71	21.31	—	26.11	21.33	—
Machinery	24.25	18.02	12.08	16.28	13.54	12.26
Transport equipment	30.01	19.07	—	22.04	17.30	—
Other	29.69	21.26	16.31	23.75	15.99	13.94
	Total Assets per Employee (Parent Ratio = 100)					
All manufacturing	100.0	70.9	55.2	100.0	76.6	66.8
Average of industry relatives[b]	100.0	74.8	53.0	100.0	80.4	63.6
	Net Property, Plant, and Equipment per Employee					
Food products	11.17	7.72	4.18	8.33	6.55	4.68
Chemicals and allied products	17.67	17.37	8.28	14.78	13.24	7.33
Primary and fabricated metals	18.28	7.52	—	13.04	7.79	—
Machinery	9.86	5.84	3.60	6.38	4.52	3.51
Transport equipment	8.09	7.78	—	5.75	6.97	—
Other	13.12	8.05	7.24	9.62	6.55	6.15
	Net Property, Plant, and Equipment per Employee (Parent Ratio = 100)					
All manufacturing	100.0	67.2	50.3	100.0	78.6	66.3
Average of industry relatives[b]	100.0	72.3	44.1	100.0	81.9	60.5

SOURCE: United States Department of Commerce (1972).
[a]Includes only those parents reporting in 1970.
[b]Weighted by parent employment in each industry.

tries, discussed earlier. Adaptation within industries is shown in the individual industry rows of table 6.2 and summarized in the "average of industry relatives" rows. It is calculated by putting each industry row into relative form (parent capital intensity = 100) and averaging across industries with parent employment as weights. If within-industry adaptation were the only type that took place, the "all manufacturing" entries and the "average of industry relatives" entries would be identical. If there were, in addition, some selection by choice of industries, in the sense that labor-intensive industries had a larger share of overseas activity than of home country activity, it would tend to make the "all manufacturing" relatives lower than the "average of industry relatives." Such selection does appear to have taken place in the case of affiliates in developed countries. Labor-intensive industries are more important than in the home countries. However, the opposite seems to be true for less developed countries. The industry selection seems to lean toward capital-intensive industries there and offsets, to a small degree, the effect of adaptation within industries. Thus, not only does selection of industries play a small role in the total extent of adaptation for manufacturing as a whole, but it even plays a role apparently opposite to that of labor cost in LDCs, for reasons suggested earlier. The major adaptation to labor costs takes place within these broad industries.

The Swedish data in table 6.3 point to roughly the same conclusions. In the overwhelming majority of cases the capital intensities in Swedish industries were higher than those in developed country affiliates (fifteen out of seventeen) and those in LDC affiliates (nine out of eleven). The capital intensities in Swedish parent companies were higher than those in developed country affiliates in fifteen out of eighteen cases and higher than those of LDC affiliates in all twelve comparisons we could make. By far the largest part of the difference in capital intensity between companies in Sweden and foreign affiliates in developed countries and between affiliates in developed countries and those in LDCs is accounted for by differences within broad industries. Comparing the aggregate ratios with the averages of industry ratios for fire insurance values, we find for LDCs that the aggregate is a bit lower, indicating some selection of labor-intensive industries for production in LDCs. However, the effects of that selection were again, as in the United States, minor compared with the use in LDCs of relatively labor-intensive production methods within industries.

We conclude from these aggregate data that the large differences in capital intensity, especially between LDCs and the DC affiliates of United States and Swedish companies and between DC affiliate and parent or home country capital intensity, are not primarily expressions of industry mix, at least among the broadly defined manufacturing industries we consider, but reflect differences within industries.

Table 6.3 Capital Intensity (Capital per Employee) in Manufacturing Industry Groups, Swedish Domestic Industry, Parent Companies, and Foreign Affiliates (Unit: Thousand Kronor per Employee)

Manufacturing Industry Group	1970 Swedish Industry	1970 Parent Companies	1970 Affiliates in Developed Countries	1970 Affiliates in LDCs	1974 Swedish Industry	1974 Parent Companies	1974 Affiliates in Developed Countries	1974 Affiliates in LDCs
	Fire Insurance Value of Gross Property, Plant, and Equipment per Employee							
Food, drink, and tobacco	108.6	142.4	76.6	—	186.6[d]	252.6	120.4	—
Textiles and apparel	57.8[c]	62.7	12.2	—	91.7[d]	114.8	16.5	—
Pulp, paper, and printing	182.2	n.a.	108.1	71.0	338.1	325.4	193.7	110.6
Pulp and paper	341.6[d]	234.2	156.7	—	589.4[d]	365.0	233.1	—
Paper products and printing	73.2[d]	118.0	66.0	71.0	109.3[d]	125.8	137.7	110.6
Chemicals and plastics	164.0[e]	92.6	94.0	31.9	258.4[d]	165.3	170.7	95.1
Metal products[a]	65.7[d]	117.1	67.1	35.2	113.6[d]	172.1	88.3	36.7
	100.3							
Machinery			48.3	27.4	118.3	128.5	57.7	35.9
Nonelectrical	82.7[d]	106.7	54.7	28.6	122.2[d]	125.2	71.6	17.7
Electrical	77.6[d]	78.0	29.8	24.1	100.1[d]	130.9	40.0	32.4
Transport equipment[f]	107.9[d]	108.6	43.7	22.5	139.8[d]	128.8	126.8	51.6
	Fire Insurance Value of Gross Property, Plant, and Equipment per Employee (Swedish ratio = 100)							
All manufacturing	100.0		53.6	26.2	100.0		47.5	24.7
Average of industry relatives[b]	100.0		55.6	32.6	100.0		52.6	31.9

SOURCES: For industries, Sweden, Statistiska Centralbyrån (1972*a*, *b*, 1976*a*, *b*), except as indicated. For companies, directly from Industriens Utredningsinstitut.

[a]Published industry figures include primary metals, excluded from company data. This is a very capital-intensive industry and tends to distort the comparisons. We have therefore used the figure for metal products alone, from the Industriens Utredningsinstitut.
[b]Weighted by industry employment.
[c]Including rubber products.
[d]Estimates from Industriens Utredningsinstitut.
[e]Excluding rubber products.
[f]Excluding shipping industry.

6.4 Measures of the Price of Labor and Capital Intensity

The theoretical determinant of capital-intensity decisions, if scale of production is not a factor, is the relative prices of labor and capital. In examining factor choices within the firm we have assumed that the prices of capital are identical for the firm in all locations, and that ratios of the price of labor to the price of capital are therefore proportional to the price of labor (wage rates) alone. The price of capital may be considered to consist of two elements, one the opportunity cost to the firm of tying up assets in a particular form, and the other the price of a physical capital good. If there were no restrictions on transferring profits or repatriating capital, and if risks and tax rates were the same among countries, capital costs in the first sense could be taken to be the same for a given firm all over the world. That might not be a bad assumption for comparisons among developed countries. In at least some developing countries it would be far from accurate, and in extreme cases restrictions on repatriation might make capital for reinvestment almost free to an affiliate. Such circumstances would tend to produce high capital intensities in low-income countries and limit or obscure adaptation to factor prices.

With respect to physical capital, the assumption of equal prices in all countries is clearly not valid. This is particularly true for construction costs, which are strongly affected by wage or real income levels. It is not quite such a bad assumption for equipment, which tends to have more of a world market. Price indexes for construction costs in 1970, relative to those in the United States, ranged from 37 and 26 percent in the poorest and next-poorest group of countries to 62 percent in the highest-income countries, while those for producer durables ranged from 91 percent in the middle group of countries up to 106 percent in the poorest group (Kravis, Heston, and Summers 1978*a*, p. 120). Thus the price relationships for the two groups have somewhat offsetting effects.

The high level of producer durable prices in low-income countries reflects, to some extent, the degree of protection to domestic production of these products. The effective protection rates vary widely, but quite a few are over 100 percent.[2]

It would be desirable to take account of these differences in capital costs if the price comparisons were available. Since construction costs and wage rates are positively correlated, we exaggerate the differences between countries in relative factor prices and underestimate elasticities of substitution by using wage rates alone to measure factor price ratios.

The price of labor we would like to measure is that for completely unskilled labor or for labor of a given quality. Lacking any such price measure, we have used several approximations, or proxies. These include real GDP per capita, the average wage paid by all United States manufacturing affiliates in a country, the average wage paid by a particular affiliate, and the latter two deflated by an index of the average quality of labor.

Real GDP per capita is of course not a measure of the price of labor. It was used as a proxy under the assumption that the higher the real GDP per capita, the higher the standard of living and the higher the cost of unskilled labor. The estimates, which are from Kravis, Heston, and Summers (1978*b*), are based on data from the United Nations International Comparison Project and are not subject to the usual problems of comparisons via exchange rates (see Kravis, Kenessey, Heston, and Summers 1975; Kravis, Heston, and Summers 1978*a*).

Average wages, converted into dollars at current exchange rates, come closer to measures of the price of labor, but they obviously reflect differences in quality as well as differences in price. To remove the effect of quality differences, we have devised a rough index of labor quality for about fifty countries from various measures calculated by others, including Denison (1967), Harbison and Myers (1964), and Krueger (1968). In using the quality index to deflate money wages for a specific industry, for example, we in effect assume that each company within a country hires workers of average quality and that any deviation of a company's wage or an industry's wage from the average wage represents a higher cost rather than higher quality. Where we use average country wages without distinguishing companies or industries, however, we are making a very different assumption—namely, that all companies and industries in a country face the same price of labor and that any variation in average wages among companies or industries represents differences in quality.

Measures of capital intensity raise at least as many problems. We have experimented with assets per worker, book and replacement values of property, plant, and equipment per worker, value added, and nonwage value added per worker. Assets per worker have the advantage of being comprehensive. If one thinks of inventories, bank accounts, and loans as being production inputs, that comprehensiveness seems desirable. However, there is no assurance that the financial assets of a subsidiary are held entirely to assist production in that subsidiary's host country. It is quite conceivable that a parent company might arrange to have the subsidiary hold assets for the use of the parent or of other affiliates, and it would then be improper to treat those financial assets as necessarily contributing to host country output. Similarly, the parent might hold financial assets for the use of all its affiliates, in which case we might be understating the amount of capital involved in a given affiliate's production.

We have, for these reasons, leaned toward fixed assets, or property, plant, and equipment per worker. Most of the data are for net property, plant, and equipment, with all the associated problems of depreciation rates, valuation of assets purchased in the past, and so on. However, for Swedish affiliates and their parents and for Swedish domestic firms in each industry we also have data on the valuation of gross property, plant, and equipment for fire insurance, which should come closer to current replacement cost.

It would be desirable to have a measure of the flow of capital services instead of the stock of capital, since that would be the appropriate measure of the contribution of capital to production. We do not have adequate measures, however, and the proxies that have been suggested, such as value added or nonwage value added per worker (see, for example, Lary 1968), do not seem satisfactory, especially for comparisons within firms. The problem centers on the ability of the firm to manipulate the location of profits, presumably to minimize taxes or to evade other host country or home country regulations. The result is that there are large numbers of affiliates with negative or zero value added and others in which value added has been inflated for similar reasons. To the extent that companies kept subsidiary books in local currencies and translated into dollars or kronor via current exchange rates in answering questionnaires, there may be a bias from under- or overvaluation of currencies that enters the value of capital (part of the dependent variable) and the wage rate (one of the independent variables) in the same direction. As a check on such bias we have run equations using real GDP per capita as a wage-cost proxy, since that measure, while it may be subject to error as a wage proxy, is free of currency translation bias because it does not depend on exchange rate conversions.

We should have liked to investigate differences in skill mix and prices of skilled labor, but the data are poor for this purpose. The United States survey forms included questions on the breakdown of the labor force and payrolls by type of worker, but the answers were considered unsatisfactory by BEA and were not used. We could not treat differences among countries in average wages as representing skill differences, as one might within a country. The average wage of each country, deflated by average labor quality, is our measure of the price of standard labor, though it can incorporate skill differences as well. To the extent that it does, the relationship between the price of labor and capital intensity is blurred.[3]

The Swedish affiliate data did include a usable distinction between production workers and others. We have made some use of the proportion of nonproduction workers as a measure of skill intensity. It is a crude measure, but the fact that nonproduction workers have higher earnings per worker than the production workers suggests that they are of higher average skill.

6.5 Labor Costs and Factor Proportions in Individual Countries and Industries

We begin our analysis of the effect of labor costs on capital intensity with a series of regressions across countries, using data on the characteristics of United States and Swedish multinationals' affiliates in different countries.

In the first set of regressions, summarized in table 6.4, each observation is for the sum of all United States–owned manufacturing affiliates in a country. The equations, which are in double-log form, show that capital intensity responds significantly to country differences in the price of labor. Equations 5 and 6, which make use of what we consider our best measures of the price of labor (the average affiliate wage divided by our measure of average labor quality in each country, described earlier), show strongly significant coefficients for the price of labor of about 0.7 (with property, plant, and equipment as the capital measure) and 0.8 (for all capital). If we assume that the production functions are CES and that capital costs do not differ among countries, these coefficients are measures of the elasticity of substitution between capital and labor. Comparing equations 1 and 2 with equations 3 and 4 indicates that adding more countries to the thirty-eight covered by our labor quality index would tend to raise the coefficients, their significance, and the $\bar{r}^2$ but would not change the main findings.

Real GDP per capita, which we expected to be a good proxy for the price of labor, performed poorly, explaining very little of the variation in capital intensity. To check whether the greater explanatory power of the wage rates might be spurious, stemming from a common price level effect on both wage rates and the capital intensity measure, we ran equations 7 and 8 with price level as the explanatory variable. Price level had no apparent explanatory power, and the coefficients were not statistically significant. However, the fact that the coefficients were positive and fairly large does raise the possibility that the elasticity of substitution we calculate may be somewhat exaggerated by spurious price effects.

The Swedish data of table 6.5, like the United States data, show strong effects of wage levels on capital intensity. The coefficients for average wage and for quality-adjusted average wage range from 0.75 to 0.87, somewhat above those in the United States equations. What is different about the Swedish results is that both price level and real GDP are related to capital intensity. The high price level coefficient hints at some exaggeration of the calculated substitution elasticities, but the considerable explanatory power of real GDP, the labor price proxy most clearly cleansed of price effects, shows that the price of labor is an influential factor.

The results summarized in tables 6.4 and 6.5 indicate that factor proportions do respond in a significant way to differences in wage levels.

We ask next whether the response involves only the choice of industries for investment (labor-intensive industries in low-wage countries) or includes choices among companies or production methods within industries. We can get some notion of the answer to this question from tables

Table 6.4 **Relation of Capital Intensity of Production to the Price of Labor, United States–Owned Affiliates, by Country (All Manufacturing Combined, 1966)**

$$\ln\left(\frac{K}{L}\right) = a + b \ln w$$

Equation Number[a]	Number of Observations (Countries)[b]	Capital Intensity Measure	Labor Price Measure	Coefficients: Labor Price[c]	Coefficients: Constant Term	$\bar{r}^2$
1[d]	66	PPE	Average affiliate wage	0.72 (4.73)	2.97 (2.55)	.25
2[d]	66	Assets	Average affiliate wage	0.68 (5.55)	4.28 (4.53)	.31
3	38	PPE	Average affiliate wage	0.60 (2.80)	3.96 (2.38)	.16
4	38	Assets	Average affiliate wage	0.62 (3.26)	4.76 (3.21)	.21
5	38	PPE	$\frac{\text{Average affiliate wage}}{\text{Average quality}}$	0.73 (3.10)	6.29 (8.31)	.19
6	38	Assets	$\frac{\text{Average affiliate wage}}{\text{Average quality}}$	0.79 (3.84)	7.07 (10.73)	.27
7	38	PPE	Price level	.26 (.76)	7.57 (5.49)	.00
8	38	Assets	Price level	.31 (1.01)	8.32 (6.62)	.00

NOTE:
PPE = Gross property, plant, and equipment per worker, in $ thousand.
Assets = Total assets per worker, in $ thousand.
Average affiliate wage = Average wage in United States manufacturing affiliates.
Average quality = Index of average quality of the labor force.
Price level = Money GDP, translated into dollars by exchange rate, divided by real GDP.
[a]Each equation is in double-log form, with capital intensity as the dependent variable and the price of labor as the independent variable.
[b]Each observation is for all affiliates of United States manufacturing companies in a foreign country.
[c]Assuming the production function is CES and that capital costs do not differ across countries for an individual firm, this coefficient is a measure of the elasticity of substitution.
[d]Equations 1 and 2 are based on all observations for which average affiliate wage is available. The other equations are confined to countries for which the labor quality measure could be constructed.

Table 6.5 **Relation of Capital Intensity of Production[a] to the Price of Labor, Swedish-Owned Affiliates, by Country (All Manufacturing Combined, 1970 and 1974)**

$$\ln\left(\frac{K}{L}\right) = a + b \ln w$$

Equation Number[b]	Number of Observations (Countries)[c]	Year	Labor Price Measure or Proxy	Coefficients: Labor Price	Coefficients: Constant Term	$\bar{r}^2$
1	27	1970	Average affiliate wage[d]	0.75 (3.29)	1.16 (1.41)	.27
2	25	1974	Average affiliate wage[d]	0.80 (2.53)	1.31 (1.12)	.18
3	27	1970	Average wage[d] / Average quality	0.84 (3.22)	4.69 (6.71)	.27
4	25	1974	Average wage[d] / Average quality	0.87 (2.30)	5.05 (13.82)	.15
5	28	1970	Real GDP	0.46 (3.71)	2.23 (4.98)	.32
6	26	1974	Real GDP	0.49 (3.07)	2.40 (3.94)	.25
7	28	1970	Price level	0.89 (2.92)	0.18 (0.14)	.22
8	26	1974	Price level	0.98 (2.87)	0.14 (0.10)	.22

NOTE: For definitions of labor price measure see table 6.4.

[a]Fire insurance value of property, plant, and equipment per worker.

[b]Each equation is in double-log form, with capital intensity as the dependent variable and the price of labor as the independent variable.

[c]Each observation is for all affiliates of Swedish manufacturing companies in a country other than Sweden.

[d]Average wages in United States affiliates.

6.6 and 6.7, which show the same relationships within broad industry groups for both United States and Swedish affiliates.

The United States equations for aggregate manufacturing (table 6.4) and for pooled individual industries (table 6.6) are very similar, except that the latter imply lower elasticities of substitution, 0.50–0.55 instead of 0.6–0.7. In other words, the substitution between labor and capital in the manufacturing aggregates of table 6.4 owes a little to the choice of industries but mostly takes place within the broad industry groupings found in the table. There is some tendency for labor-intensive industries to be more heavily represented in lower-income countries, in contrast to our earlier results from treating all LDCs as a group, but it accounts for only a small part of the apparent substitution of labor for capital there.

The equations for individual United States industries almost all show significant labor price coefficients, implying substitution of labor for capital in low-wage countries. The exception was transport equipment, for which the number of observations was very small. The largest coefficient, suggesting an elasticity of substitution above one, was for the chemicals industry.

In every industry, whether property, plant, and equipment or total assets was used as the capital measure, the response to differences in wages adjusted for labor quality was somewhat stronger than that to the unadjusted wage differences. The same was true in the pooled industry data, as can be seen in the comparison between equation 2 and equation 3. The higher coefficients for quality-adjusted wage levels are apparently not simply a characteristic of the smaller group of countries for which we have the labor quality data; these countries and the whole set produce almost identical equations, as can be seen by comparing equations 1 and 2.

A similar analysis of Swedish affiliates is made in table 6.7. Since we had no wage data by country for Swedish affiliates, the elasticities were estimated using average wages paid in each country by United States affiliates: the same wage variable as in tables 6.4 and 6.5. Both 1970 and 1974 equations indicated strong response to labor prices, as measured by average wages or by quality-deflated average wages, and the degree of response was virtually the same as in the corresponding country aggregates of table 6.5. Industry mix, in other words, contributed very little, if anything, to the appearance of response to wage differences. Both real GDP and price level were also related to capital intensity and, in fact, explained it better than did the presumably more appropriate wage variable.

Although there were not enough observations to calculate an equation for each industry among Swedish affiliates, there did seem to be some industry differences large enough to affect the elasticity measure. When we distinguished two industries, which seemed to be outliers, paper products and printing and metal products, from the others, we found them to have somewhat higher capital intensities, and the explanatory power of the equation increased greatly.

On the whole, the Swedish affiliates appeared to respond to prices of labor as the United States affiliates did, and perhaps to a greater degree, with elasticities of substitution mainly over 0.7. Little of this apparent response in either country is attributable to selection of industries. Almost all the response took place within industries.

Table 6.6 **Relation of Capital Intensity of Production to the Price of Labor, United States Affiliates Aggregated by Industry Group within Each Country (Five Industry Groups, Separately and Pooled, 1966)**

$$\ln\left(\frac{K}{L}\right) = a + b \ln w$$

Equation Number[a]	Industry Group	Number of Observations[b]	Capital Intensity Measure	Labor Price Measure[c]	Coefficients: Labor Price	Coefficients: Constant Term	$\bar{r}^2$
1	All manufacturing industry groups, pooled	179	PPE[d]	Average wage	0.50 (4.97)	−5.28 (6.82)	.12
2		128[e]	PPE[d]	Average wage	0.51 (4.30)	−5.32 (5.76)	.12
3		128	PPE[d]	Average wage / Average quality	0.55 (4.18)	−3.12 (7.36)	.11
4	Food manufacturing	45	PPE	Average wage	0.40 (3.66)	5.33 (6.48)	.22
5		31	PPE	Average wage / Average quality	0.56 (4.35)	6.68 (16.70)	.37
6		45	Assets	Average wage	0.53 (5.17)	5.21 (6.70)	.37
7		31	Assets	Average wage / Average quality	0.61 (5.57)	7.45 (21.78)	.50
8	Chemicals	52	PPE	Average wage	1.07 (4.70)	0.26 (0.14)	.29
9		33	PPE	Average wage / Average quality	1.20 (3.60)	4.80 (4.31)	.27

10		52	Assets	Average wage	0.73 (5.02)	4.06 (3.56)	.32
11		33	Assets	Average wage / Average quality	0.78 (3.25)	7.24 (9.01)	.23
12	Metals	29	PPE	Average wage	0.54 (1.91)	4.45 (1.99)	.09
13		23	PPE	Average wage / Average quality	0.81 (1.96)	5.97 (4.34)	.11
14		29	Assets	Average wage	0.55 (2.73)	5.40 (3.43)	.19
15		23	Assets	Average wage / Average quality	0.66 (2.20)	7.49 (7.50)	.15
16	Machinery	38	PPE	Average wage	0.49 (3.80)	4.22 (4.27)	.27
17		28	PPE	Average wage / Average quality	0.51 (2.82)	6.42 (11.18)	.20
18		38	Assets	Average wage	0.56 (5.65)	5.02 (6.64)	.46
19		28	Assets	Average wage / Average quality	0.62 (4.42)	7.40 (16.71)	.41
20	Transport equipment	15	PPE	Average wage	0.44 (1.12)	4.71 (1.51)	.02
21		13	PPE	Average wage / Average quality	0.64 (1.33)	6.12 (3.82)	.06

Table 6.6 (continued)

Equation Number[a]	Industry Group	Number of Observa-tions[b]	Capital Intensity Measure	Labor Price Measure[c]	Coefficients: Labor Price	Coefficients: Constant Term	$\bar{r}^2$
22		15	Assets	Average wage	0.30 (1.20)	7.10 (3.57)	.03
23		13	Assets	$\frac{\text{Average wage}}{\text{Average quality}}$	0.40 (1.32)	8.15 (7.91)	.06

[a]Each equation is in double-log form with capital intensity as the dependent variable and the price of labor as the independent variable.
[b]Each observation is the sum of all United States affiliates in an industry group in a country.
[c]Average wage paid by all United States-owned affiliates in an industry in a country.
[d]In pooled equations the capital intensity (gross property, plant, and equipment per worker) of United States affiliates is taken as a percentage of the capital intensity in the corresponding United States industry.
[e]Equation 2 is the same as equation 1 but is run only over those countries for which labor quality data are available. Thus equation 2 is comparable in country coverage to equation 3.

6.6 Labor Costs and Factor Proportions within United States Firms

The next question we address is whether the degree of adaptation we have found to exist within industries might be a matter of selection, either among subindustries or among companies within each industry, with each company producing in the same way at home and abroad and in each foreign location. We cannot work with much finer industry classifications than those of table 6.6, for lack of data or of sufficient numbers of observations, but we can, for both the United States and Sweden, use information for individual companies and their affiliates to look for adaptation within companies. The within-company adaptation might be within a given technology (fig. 6.1), between technologies (fig.6.2), some combination of these (fig.6.3), or some selection of processes for LDC production. In addition, the capital/labor ratio may reflect the effects of scale economies or diseconomies within the firm (fig.6.4).

Table 6.7 **Relation of Capital Intensity of Production[a] to the Price of Labor, Swedish Affiliates Aggregated by Country within Industry (Manufacturing Industries, Pooled, 1970 and 1974)**

$$\ln\left(\frac{K}{L}\right) = a + b\,D + c \ln w$$

Equation Number	Year	Labor Price Measure	Coefficients: Labor Price or Proxy	Constant Term	Dummy Variable for two Industries[b]	Number of Observations	$\bar{R}^2$
1	1970	Average wage[c]	.68 (3.83)	−3.44 (5.25)	.61 (4.19)	106	.25
2	1974	Average wage	.77 (3.79)	−3.75 (4.92)	.58 (3.95)	96	.22
3	1970	Average wage[c]/ quality	.74 (3.54)	−1.95 (6.67)	.62 (4.25)	106	.24
4	1974	Average wage[c]/ quality	.79 (3.25)	−2.02 (5.58)	.58 (3.91)	96	.19
5	1970	Real GDP	.45 (4.69)	−2.64 (7.18)	.62 (4.45)	108	.30
6	1974	Real GDP	.53 (4.95)	−2.95 (6.94)	.56 (4.15)	100	.28
7	1970	Price level	.91 (4.34)	−4.77 (5.40)	.62 (4.36)	108	.28
8	1974	Price level	1.00 (4.64)	−5.13 (5.58)	.54 (3.92)	100	.27

[a]Fire-insurance value of property, plant, and equipment per worker relative to that of the same industry in Sweden.
[b]Paper products and metal products.
[c]Average wage in manufacturing affiliates of United States companies.

A sampling of United States results for all industries in 1966 and 1970 is given in table 6.8. Since we are using individual affiliates as the units of observation here, we can include, in addition to the price of labor in the host country, the scale of operations for the affiliate itself as an explanatory variable.

The data for 1966 have some advantages and some drawbacks compared with those from the 1970 survey. The main advantage is that they are from a complete census of foreign direct investment, and the number of observations is therefore much greater. Second, the 1966 questionnaire was much more detailed than the later one, a fact that permits us to measure more and different variables. On the other hand, the 1966 census did not include as much parent data as in 1970. Therefore the capital-intensity variables for 1966 could not be calculated relative to those of parents because we lack parent data. The result is that some selection of parents may be mixed in with the adaptation by individual companies.

The wage level coefficients in equations 2 and 3 are close to, but a little smaller than, those of table 6.6 where we used country aggregates of affiliates. We can therefore say that most of the response to wage level within industries takes place within individual companies, but there is also a tendency for firms with low capital intensity to operate in low-wage countries, reinforcing the effects of intrafirm adaptation.

The scale variable proves to be highly significant and in the expected direction for capital intensity as measured by physical plant and equipment. That is, larger scale is associated with more capital-intensive methods of production. But this was not true where capital intensity was measured by total assets per worker (equations 7, 8, and 9). By that measure, larger size had no relation, or even a negative relation, to capital intensity.

The measure of the price of labor used here (except in equations 3, 6, and 9) is different for each affiliate. It is the affiliate's average wage per worker or average wage deflated by the average labor quality of the country in which the affiliate is located. Use of the individual firm average wage as a measure of the price of labor implies that, within a country, higher wages represent a higher price for standard labor rather than higher labor quality. If this is not the case (if internal labor markets are competitive, for example) the price of labor might be better measured by the average manufacturing affiliate wage for the country as a whole. Equations 3, 6, and 9 of table 6.8 use this wage level measure, but the results are not consistently higher or lower labor price coefficients than those of the equations using the affiliate wage levels.

The pooling of observations from all industries implies that labor price and scale effects are identical among them, an assumption in which we have no great confidence. Coefficients from equations for the individual manufacturing industries are given in table 6.9 and 6.10, the former showing those for the price of labor and the latter those for scale of production, for both 1966 and 1970. The equations for 1966 differ from those for 1970 in several respects. As mentioned earlier, affiliate capital intensity is not calculated relative to that of the parent for 1966, and we have omitted the equations for net property, plant, and equipment per worker because they are similar to those for gross PPE but show slightly lower elasticities and $\bar{R}^2$s.

Within industries, physical capital intensity is clearly responsive to differences in the price of labor (table 6.9). The variable is significant in eleven out of fourteen equations for 1970 and twelve out of fourteen for 1966, not counting groups such as chemicals for which we also have subgroup equations. The mean and median of the statistically significant wage level coefficients is 0.45 for 1970, when each affiliate is compared with its parent, and 0.50 for 1966, both a little lower than the coefficient of 0.55 from the country aggregates for the same year in table 6.6. Apparently, most all of the response to wage level differences we have observed takes place within, rather than between, individual firms.

Somewhat surprisingly, in view of the doubts we expressed earlier about assets as a capital measure for individual affiliates, we are able to explain variation in total capital per worker better than variation in physical capital per worker. The levels of the $\bar{R}^2$ and the average labor price coefficients are substantially above those for physical capital. The coefficients are higher than those in the equations of table 6.8 using pooled industry data. Apparently industries with affiliates having high total assets per worker tend to locate in low-wage countries. Such a selection of industries would run counter to what we would expect from adaptation to wage levels through selection of industries, and it therefore implies that industry selection is not the reason for the labor price response we observe.

Scale is significant in only three of the fourteen individual industry equations, excluding duplicated groups, for 1970, when capital intensity was measured by net PPE assets. However, the coefficient is positive, as expected, where it is significant (table 6.10). For 1966, with many more observations, a gross PPE measure, but no comparison with parents, scale was significant in eight of the industries. The absence of scale effects in many industries, particularly for 1970 when capital intensity was measured relative to parents, suggests that in the pooled data of table 6.8 we might have been observing an interindustry effect rather than a true effect of scale on capital intensity within industries. That is, industries with small-scale operations tended to have affiliates that were labor-intensive relative to their parents, but within most industries there was little relation between scale and capital intensity of individual affiliates. That possibility of industry effects is also suggested by the fact that two of

Table 6.8 **Relation of Capital Intensity of Production to the Price of Labor: Individual United States Affiliates (All Manufacturing Industries, Pooled, 1966 and 1970)**

$$\ln\left(\frac{K}{L}\right) = a + b \ln w + c \ln NS$$

Equation Number[a]	Year	Number of Observations (Affiliates)	Capital Intensity Measure[b]	Labor Price Measure	Coefficients: Labor Price	Coefficients: Scale[c]	Coefficients: Constant	$\bar{R}^2$
1	1966	4,502	Gross PPE[d]	Average affiliate wage	0.44 (14.29)	0.13 (11.54)	8.88 (98.51)	.08
2	1966	4,336[f]	Gross PPE	Average affiliate wage / Average quality	0.47 (13.18)	0.14 (12.27)	−9.73 (101.40)	.08
3	1966	4,336	Gross PPE	Average country wage / Average quality	0.34 (7.96)	0.15 (13.06)	−9.62 (96.18)	.06
4	1970	2,305	Net PPE[e]	Average affiliate wage	0.45 (9.89)	0.08 (4.53)	−2.18 (14.30)	.06

5	1970	2,256	Net PPE	Average affiliate wage / Average quality	0.45 (8.98)	0.09 (4.86)	−2.23 (14.20)	.06
6	1970	2,213	Net PPE	Average country wage / Average quality	0.62 (9.20)	0.09 (5.12)	−2.55 (15.15)	.06
7	1970	2,315	Assets[e]	Average affiliate wage	0.60 (20.05)	−0.02 (1.95)	−1.11 (11.28)	.15
8	1970	2,266	Assets	Average affiliate wage / Average quality	0.60 (18.38)	−0.02 (1.39)	−1.17 (11.47)	.13
9	1970	2,223	Assets	Average country wage / Average quality	0.59 (13.08)	0.00 (0.27)	−1.37 (12.12)	.07

[a]Each equation is in double-log form with capital intensity as the dependent variable and labor price as the independent variable.
[b]Gross PPE = Gross property, plant, and equipment per worker.
Net PPE = Net property, plant and equipment per worker.
Assets = Assets per worker.
[c]Scale (SC) = Net sales of affiliate (total sales less imports from the United States).
[d]Affiliate relative to United States industry.
[e]Affiliate relative to parent.
[f]Equation 2 is the same as equation 1 but is run only over those countries for which labor quality data are available. Thus equation 2 is comparable in country coverage to equation 3.

Table 6.9 Coefficients for Labor Price in Equations Relating Physical and Total Capital Intensity to the Price of Labor[a] and Scale of Production[b] (Individual United States Affiliates, by Industry, 1966 and 1970)

$$\ln\left(\frac{K}{L}\right) = a + b \ln w + c \ln NS$$

	Coefficients in Equations for			
	Physical Capital Intensity[c]		Total Capital Intensity[d]	
Industry	1970	1966	1970	1966
Food processing	0.45	0.53	0.91	0.85
Paper and allied products	0.44	0.70	0.40	0.71
Chemicals	0.55	0.67	0.64	0.78
Drugs	0.41	0.29	0.37	0.58
Other chemicals	0.58	0.75	0.76	0.82
Rubber and plastics	0.19[e]	0.50	0.27	0.68
Primary and fabricated metals	0.44	0.45	0.59	0.62
Non-electrical machinery	0.52	0.39	0.60	0.69
Computers and office machinery	1.04	0.70	0.78	0.78
Other nonelectrical machinery	0.32	0.25	0.56	0.63
Electrical machinery	0.54	0.57	0.82	0.85
Radio, television, and electronics	0.47	0.70	0.90	0.92
Household appliances	1.28	0.41	1.00	0.65
Other electrical machinery	0.33[e]	0.47	0.58	0.83
Transport equipment	0.54	0.28	0.29	0.67
Motor vehicles	0.59	0.22[e]	0.30[e]	0.60
Other transport equipment	−0.43[e]	0.65[e]	−0.19[e]	1.04
Other manufacturing	0.38	0.47	0.49	0.81

[a]Average wage per worker in each affiliate, deflated by average labor quality in the country in which the affiliate is located.
[b]Net sales of an affiliate (total sales less imports from the United States).
[c]For 1970, affiliate net property, plant, and equipment per worker relative to the same measure for the parent company; for 1966, affiliate gross property, plant, and equipment per worker.
[d]For 1970, affiliate total assets per worker relative to the same measure for the parent company; for 1966, affiliate total assets per worker.
[e]Not significant at the 5 percent level.

the three significant scale effects on physical capital intensity in 1970 are for combinations of industries: other chemicals, and other nonelectrical machinery.

When we did measure capital intensity by total, rather than physical, assets per worker, the coefficient for scale, while it is statistically significant in only a minority of cases, is negative in all of these. That is, the larger the affiliate, the lower the total assets per worker even though some of the same industries' equations showed that the larger the affiliate, the higher the gross property, plant, and equipment per worker.

These negative scale coefficients are a surprise. There is virtually no relationship between size of affiliate and assets per worker in simple regressions within industries, and the few significant coefficients are split between positive and negative ones. However, there is a strong relationship between affiliate size and gross property, plant, and equipment per worker, and all the statistically significant coefficients are positive. These results suggest that indivisibilities in machinery and equipment are responsible for the relationship with physical capital intensity and that the effect of these is offset in other types of assets.

6.7 Labor Costs and Factor Proportions within Swedish Firms

The data for Swedish firms and their foreign affiliates differ from the United States data in several respects. One of the chief advantages of the Swedish data is that they give production, by industry, for each parent and affiliate. We can thus distinguish industry-mix choices even within the firm from choices of factor proportions within an industry in a way that is impossible with the United States data, in which each parent and each affiliate is characterized as being in a single industry. We calculate, for each Swedish parent and affiliate, capital intensities at Swedish industry coefficients. Any difference between the capital intensities of parents and affiliates at Swedish industry coefficients then represents a choice of industry mix, while the differences between the actual capital intensity of an affiliate and its calculated capital intensity at Swedish industry coefficients represents a choice of production methods or product mix within industries. Thus we can calculate the affiliate's capital input at Swedish coefficients as

$$AK^{sw} = \sum_{i=1}^{m} Aq_i \frac{K_i^{sw}}{q_i^{sw}}$$

and its labor input at Swedish coefficients as

$$AL^{sw} = \sum_{i=1}^{m} Aq_i \frac{L_i^{sw}}{q_i^{sw}},$$

where AK_i^{sw} and AL_i^{sw} are affiliate capital and labor inputs at Swedish industry coefficients, Aq_i is the affiliate's production in industry i, and K_i^{sw}, L_i^{sw}, and q_i^{sw} are capital input, labor input, and output in the domestic Swedish industry i. We can similarly calculate parent capital and labor inputs at Swedish industry ratios, PK^{sw} and PL^{sw}, and we can compare all of these with actual affiliate and parent inputs, AK, AL, PK, and PL.

Table 6.10 Coefficients for Scale Variable in Equations Relating Physical and Total Capital Intensity to the Price of Labor[a] and Scale of Production[b] (Individual United States Affiliates, by Industry, 1966 and 1970)

$$\ln\left(\frac{K}{L}\right) = a + b \ln w + c \ln NS$$

Industry	Coefficients in Equations for: Physical Capital Intensity[c] 1970	Physical Capital Intensity[c] 1966	Total Capital Intensity[d] 1970	Total Capital Intensity[d] 1966
Food processing	0.10**	0.06**	−0.10**	−0.06**
Paper and allied products	0.09*	0.06*	0.02	−0.06*
Chemicals	0.15**	0.21**	0.02	0.01
Drugs	0.10*	0.26**	0.08*	0.03*
Other chemicals	0.15**	0.19**	−0.00	0.00
Rubber and plastics	0.03	0.13**	−0.01	−0.04*
Primary and fabricated metals	−0.06	0.09**	−0.07*	−0.04**
Non-electrical machinery	0.12**	0.11**	0.01	−0.02*
Computers and office machinery	0.02	0.32**	−0.07**	0.05*
Other nonelectrical machinery	0.12**	0.07**	0.04*	−0.02*
Electrical machinery	−0.05	0.02	−0.11**	−0.09**
Radio, television, and electronics	−0.03	0.02	−0.17**	−0.06**
Household appliances	−0.11	0.04	−0.08*	−0.17**
Other electrical machinery	−0.06	0.03	−0.08*	−0.10**
Transport equipment	−0.01	0.05*	0.02	−0.04*
Motor vehicles	−0.01	0.06**	0.02	−0.02
Other transport equipment	0.04	−0.08	0.01	−0.02*
Other manufacturing	0.08*	0.03*	−0.02	−0.09**

[a]Average wage per worker in each affiliate, deflated by average labor quality in the country in which the affiliate is located.
[b]Net sales of an affiliate (total sales less imports from the United States).
[c]For 1970, affiliate net property, plant, and equipment per worker relative to the same measure for the parent company; for 1966, affiliate gross property, plant, and equipment per worker.
[d]For 1970, affiliate total assets per worker relative to the same measure for the parent company; for 1966, affiliate total assets per worker.
** = $t \geq 1.96$.
* = $1.00 \leq t < 1.96$.

Another advantage of these data is that both numbers and payroll are given separately for wage and salaried workers, enabling us to calculate average earnings for each. The wage per wage worker, while not standardized for quality, may be a little less subject to wide differences in mix than the average wage in the United States figures, which lump wage and salaried workers together.

One way to use the Swedish affiliate data is to compare affiliates in the aggregate with their parents and with Swedish industry, taking advantage of the information on industry composition instead of relying on the single-industry designations as in the earlier comparisons of aggregates in tables 6.1 and 6.3. For example, we can calculate the average ratios of affiliate industry/parent industry capital intensities and skill intensities at Swedish industry coefficients in 1974

$$\frac{AK^{sw}}{AL^{sw}} \Big/ \frac{PK^{sw}}{PL^{sw}} = 1.06$$

$$\frac{ALS^{sw}}{AL^{sw}} \Big/ \frac{PLS^{sw}}{PL^{sw}} = 1.01,$$

where AK^{sw} is the amount of capital, AL^{sw} the number of workers, and ALS^{sw} the number of salaried workers an affiliate would have if it used the Swedish industry ratio of capital, all workers, and salaried workers to output and the figures for parents are analogous.

The actual capital intensities of the affiliates and parents can be compared with Swedish and parent levels for the same industries as follows:

$$\text{Average} \frac{AK}{AL} \Big/ \frac{AK^{sw}}{AL^{sw}} = .81$$

$$\text{Average} \frac{\frac{AK}{AL} \Big/ \frac{AK^{sw}}{AL^{sw}}}{\frac{PK}{PL} \Big/ \frac{PK^{sw}}{PL^{sw}}} = .79.$$

We can interpret these ratios in the light of the fact that Swedish wages were high in comparison with those in affiliates' host countries. Adjusted for labor quality or not, Swedish wage levels in 1966 and 1970 were higher, by all our measures of the price of labor, than those of every country except the United States and Canada.

If we take Swedish capital intensities in parent company industries (PK^{sw}/PL^{sw}) as 100, the capital intensities for aggregates of parents and affiliates were:

Affiliate industry mix relative to parents $\left(\frac{AK^{sw}}{AL^{sw}} \Big/ \frac{PK^{sw}}{PL^{sw}}\right)$	106
Parent capital intensity relative to all Swedish firms in same industries $\left(\frac{PK}{PL} \Big/ \frac{PK^{sw}}{PL^{sw}}\right)$	102

Affiliate capital intensity relative to Swedish industry in parent industries $\left(\frac{AK}{AL} \Big/ \frac{PK^{sw}}{PL^{sw}}\right)$ 86

Affiliate capital intensity was 14 percent below that of Swedish companies in the industries of parents. We can divide that difference into two elements. The actual capital intensity of affiliate production was almost 20 percent below what would have been expected (difference between 106 and 86), given the industry composition of affiliate activities and Swedish capital intensity. The 20 percent could reflect the degree of adaptation by affiliates, within industries, to lower prices of labor outside Sweden. That lower capital intensity within industries was partly offset by the fact that the affiliates were in industries that were 6 percent more capital-intensive than those of the affiliates' parent companies. Thus there was no adaptation to wage level differences in the selection of affiliate industry mix as compared with parent company industry mix. Furthermore, parent companies tended to be slightly more capital-intensive than the corresponding Swedish industries, and there was thus no indication of adaptation through selection of labor-intensive parents within industries.

With respect to our indicator of skill intensity, the only calculation we made shows that affiilates are in industries with substantially the same skill requirements (as measured by the importance of salaried workers) as those of their parents' industries.

Using the data for individual affiliates and individual countries, we test first for adaptation by choice of industry mix. Do affiliates in labor-intensive industries tend to be in low-wage countries? For this purpose we related the capital intensity of each affiliate's parent and of each affiliate itself, at Swedish factor coefficients (AK^{sw}/AL^{sw} and PK^{sw}/PL^{sw}), to measures of wage levels, as in equations (1) through (3).

(1) $\ln \frac{AK^{sw}}{AL^{sw}} = 4.83 + .09 \ln w_c$ $\bar{R}^2 = .00$
Number of observations = 428

(2) $\ln \frac{PK^{sw}}{PL^{sw}} = 5.08 + .16^{*} \ln w_c$ $\bar{R}^2 = .01$
Number of observations = 424

(2) $\ln \frac{PK^{sw}}{PL^{sw}} = 5.09 + .15 \ln w_a$ $\bar{R}^2 = .02$
Number of observations = 402

*Statistically significant at the 5 percent level. The calculations performed for us on the Swedish data did not include t-statistics for the coefficients.

w_c is the average wage in all Swedish affiliates in a country, and w_a is the average wage in a particular affiliate, both divided by the average quality of labor, estimated from data on the educational level of the population, as described earlier. There is only a very faint tendency for affiliates with parents in labor-intensive industries to be in countries where wage levels are low.

Our measure of adaptation to factor costs within industries by individual firms is the ratio of affiliate factor proportions to what they would have been if there had been no adaptation. The factor proportions that represent no adaptation within an industry are those of Swedish parents or of a Swedish industry in the aggregate in each industry. Thus the factor input ratios AK^{sw}/AL^{sw} and AK^{p}/AL^{p} represent no adaptation to factor prices outside Sweden, and we compare the actual factor ratio of each affiliate, AK/AL, with that at Swedish or parent coefficients, in table 6.11. When we use affiliate wage, either adjusted for average labor quality in each country as in equations 3 and 4, or unadjusted, but compared with Swedish or parent wages (assuming an industry or company hires the same quality of labor abroad as in Sweden), as in equations 5 and 6, the labor cost coefficients are statistically significant and range between 0.47 and 0.55. However, only a small part of the variation in capital intensities is explained. If we substitute average wages in Swedish affiliates in a country for the individual affiliate wages, as in equations 1 and 2, the wage level coefficient rises substantially, to about 0.75. We might guess from this change that the apparent variation in the price of labor among affiliates within a country may be spurious, representing mainly quality differences rather than price differences.

If we aggregate not only wage levels but also capital intensities within host countries, as in table 6.12, the sensitivity to wage level differences is much greater. The wage level coefficients are 0.90 or above, and the equations explain much more of the variation in capital intensities, up to 40 percent. The variation in capital intensities is adjusted for differences in industry mix and is the closest we can come to within-industry substitution between capital and labor. If we accept the results from these country aggregates, we would conclude that Swedish firms respond even more strongly to wage level differences than do United States firms.

Since the Swedish data contain information on aggregate wages, aggregate salaries, and numbers of wage and salary workers, we can calculate the average wage and average salary for each parent, affiliate, and Swedish industry. If each group of workers is assumed to be homogeneous—clearly a risky assumption—we can calculate prices for wages and salary and also amounts of input (employment) of each group. We have calculated a relative price of skilled labor for each affiliate as the ratio of the average salary to the average wage divided by the ratio of average Swedish or parent salary to average Swedish or parent wage,

Table 6.11 **Relation of Physical Capital Intensity to the Price of Labor (Individual Swedish Affiliates, 1974)**

$$\ln\left(\frac{K}{L}\right) = a + \ln w$$

Equation Number	Dependent (Capital Intensity) Variable	Labor Cost Variables	Coefficients: Labor Price	Coefficients: Constant Term	Number of Observations	$\bar{R}^2$
1	$\frac{AK}{AL} / \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_c}{Q_c}$	.74*	.30	334	.09
2	$\frac{AK}{AL} / \frac{AK^{p}}{AL^{p}}$	$\frac{w_c}{Q_c}$	.79*	.31	334	.10
3	$\frac{AK}{AL} / \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_a}{Q_c}$	.48*	−.02	326	.06
4	$\frac{AK}{AL} / \frac{AK^{p}}{AL^{p}}$	$\frac{w_a}{Q_c}$	.47*	−.08	326	.06
5	$\frac{AK}{AL} / \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_a}{w_s}$	.55*	−.55	353	.09
6	$\frac{AK}{AL} / \frac{AK^{p}}{AL^{p}}$	$\frac{w_a}{w_p}$	.48*	−.50	349	.08

NOTE:
AK = Fire insurance value of affiliate plant and equipment.
AL = Number of workers in affiliate.
AK^{sw} = Fire insurance value of affiliate plant and equipment if affiliate had the same ratio of plant and equipment to sales in each industry as Swedish industry.
AL^{sw} = Number of workers in affiliate if affiliate had the same ratio of employment to sales in each industry as Swedish industry.
AK^{p} = Fire insurance value of affiliate plant and equipment if affiliate had the same ratio of plant and equipment to sales as among Swedish parents in each industry.
AL^{p} = Number of workers in affiliate if affiliate had the same ratio of workers to sales as among Swedish parents in each industry.
w_c = Average wage in Swedish manufacturing affiliates in a country.
w_a = Average wage in a Swedish affiliate.
w_s = Average wage in Sweden in affiliate industries.
w_p = Average wage in parent firm.
Q_c = Average quality of labor in a country as estimated from data on education.
* = Statistically significant at the 5 percent level.

weighted by the affiliate's mix of industries. We thus measure the relative price of skill adjusted for industry mix, and the same ratio is aggregated over Swedish affiliates to produce country measures of the relative price of skilled, as compared with unskilled, labor.

The skill input measure is the ratio of salaried to wage workers, again adjusted for the industry composition of the affiliate's output. The skill input measure can be related to the relative price of skill across affiliates and across countries.

Table 6.12 **Relation of Physical Capital Intensity to the Price of Labor (Swedish Affiliates Aggregated by Country, 1974)**

$$\ln\left(\frac{K}{L}\right) = a + \ln w$$

Equation Number	Dependent (Capital Intensity) Variable	Labor Cost Variable	Coefficients: Labor Price	Coefficients: Constant Term	Number of Observations	$\bar{R}^2$
1	$\frac{AK}{AL} \Big/ \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_c}{Q_c}$	.94*	.65	30	.41
2	$\frac{AK}{AL} \Big/ \frac{AK^{p}}{AL^{p}}$	$\frac{w_c}{Q_c}$	.95*	.55	30	.41
3	$\frac{AK}{AL} \Big/ \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_c}{w_s}$	1.04*	−.37	35	.40
4	$\frac{AK}{AL} \Big/ \frac{AK^{sw}}{AL^{sw}}$	$\frac{w_c}{w_p}$	.95*	−.20	35	.30
5	$\frac{AK}{AL} \Big/ \frac{AK^{p}}{AL^{p}}$	$\frac{w_c}{w_s}$	.98*	−.48	35	.36
6	$\frac{AK}{AL} \Big/ \frac{AK^{p}}{AL^{p}}$	$\frac{w_c}{w_p}$	.89*	−.32	35	.27

NOTE: For definitions of terms see notes to table 6.11.
* = Statistically significant at the 5 percent level.

An attempt is made in the equations of table 6.13 to test for response to relative prices of skilled (salaried) and unskilled (wage) labor. Although little of the variation in skill ratios was explained by the relative price variable, there was a statistically significant response in the expected direction. In affiliates where the price of skilled labor was high, the proportion of skilled workers, adjusted for the industry mix of the affiliate's production, tended to be low (equations 1 and 2). The relationship was stronger among countries (equations 3 and 4). In countries where the price of skilled labor was relatively high, the proportion used was low. Whatever this crude "skill" ratio measures, whether it is truly skill or education, or perhaps the distinction between white-collar and blue-collar workers, Swedish firms did appear to respond to differences in relative prices among countries by adjusting the proportions of the two types of labor.

6.8 Results of Other Studies

The study most similar to ours was that of Courtney and Leipziger (1975), who used the same data on United States affiliates abroad. As

Table 6.13 **Relation of Skill Intensity to Price of Skilled Labor (Individual Swedish Affiliates and Affiliates Aggregated by Country, 1974)**

$$\ln\left(\frac{L_{sal}}{L_{wage}}\right) = a + \ln \frac{w_{sal}}{w_{wage}}$$

			Coefficients			
Equation Number	Skill Intensity (Dependent) Variable	Skilled Labor Price Variable	Skilled Labor Price	Constant Term	Number of Observations	$\bar{R}^2$
1	$\frac{L_{sal}}{L_{wage}} \Big/ \frac{L^{sw}_{sal}}{L^{sw}_{wage}}$	$\frac{w_{sal}}{w_{wage}} \Big/ \frac{w^{sw}_{sal}}{w^{sw}_{wage}}$	−.27*	.15	427	.04
2	$\frac{L_{sal}}{L_{wage}} \Big/ \frac{L^{p}_{sal}}{L^{p}_{wage}}$	$\frac{w_{sal}}{w_{wage}} \Big/ \frac{w^{p}_{sal}}{w^{p}_{wage}}$	−.32*	−.01	423	.07
3	$\left(\frac{L_{sal}}{L_{wage}} \Big/ \frac{L^{sw}_{sal}}{L^{sw}_{wage}}\right)_c$	$\left(\frac{w_{sal}}{w_{wage}} \Big/ \frac{w^{sw}_{sal}}{w^{sw}_{wage}}\right)_c$	−.42*	.19	31	.08
4	$\left(\frac{L_{sal}}{L_{wage}} \Big/ \frac{L^{p}_{sal}}{L^{p}_{wage}}\right)_c$	$\left(\frac{w_{sal}}{w_{wage}} \Big/ \frac{w^{p}_{sal}}{w^{p}_{wage}}\right)_c$	−.46*	.03	31	.12

NOTE:

L_{sal} and L_{wage} = Number of salaried and wage workers.

L^{sw}_{sal} and L^{sw}_{wage} = Number of salaried and wage workers that would be employed by an affiliate at Swedish industry ratios of salaried and wage workers to output.

L^{p}_{sal} and L^{p}_{wage} = Number of salaried and wage workers that would be employed by an affiliate at parent ratios of salaried and wage workers to output.

w_{sal} and w_{wage} = Average salary per salaried worker and wage per wage worker.

w^{sw}_{sal} and w^{sw}_{wage} = Average salary per salaried worker and average wage per wage worker that affiliate would have given at affiliate industry. mix and Swedish salary levels.

w^{p}_{sal} and w^{p}_{wage} = Average salary per salaried worker and average wage per wage worker in parent companies.

c = Country aggregates.

* = Statistically significant at the 5 percent level.

already noted, their study concentrated on separating observed differences in capital intensity between affiliates in developed countries and those in LDCs (k_1 and k_3 in figure 6.3) into the unobserved differences in the choice of technology (k_1 and k_2), or "ex ante substitution" in their terms, and the unobserved substitution within the chosen technology (k_2 and k_3), or "ex post substitution." Courtney and Leipziger assumed two technologies in each industry, one for developed country affiliates and one for affiliates in LDCs.

Their results contained some puzzling findings. They found significant differences in technology between affiliates in developed countries and those in LDCs in six out of eleven industries, and in three of these it was the affiliates in LDCs that were using the more capital-intensive technology: that is, they were using, by the authors' interpretation, more capital-intensive plant designs. However, the response to wage levels being lower in LDCs than in developed countries was so large that even industries using more capital-intensive technologies in LDCs ended up with comparatively labor-intensive production there. Since the most capital-intensive technologies in LDCs, relative to developed countries, were associated with the highest elasticities of substitution, there is a question whether the authors were really successful in separating the choice of technology or plant design from the response to factor prices.

Other studies of factor use in multinational firms' operations in LDCs have been mainly case studies of particular industries or groups of plants. On the whole, the results have been inconclusive, with some reporting extensive adaptation and others reporting virtually none. Since adaptation is not always clearly defined, or the definitions differ among studies, and since most studies refer to narrow segments of industry, it is not certain whether they contradict each other or simply observe actual differences in behavior among industries or countries.

A study by Morley and Smith (1974) examined the choice of technology by multinational firms in Brazil, largely on the basis of interviews and the authors' views rather than any substantial statistical evidence on the operation of plants. Their main conclusion was that there were very large differences in technology between the United States firms at home and their affiliates in Brazil. However, they explained the difference as an adaptation to differences in the scale of production rather than in relative factor prices. They argued that the production function is not homothetic and that at any factor prices small-scale production would be relatively labor-intensive and large-scale production capital-intensive.

It is worth mentioning again in this connection that a major role for scale in determining factor proportions does not preclude a role for factor costs in adaptation even if there is no response to factor prices at a given level of production. It may be only the cheapness of labor in LDCs that permits the existence of small, labor-intensive plants that could not survive in the high labor cost environment of the developed countries. The amount of protection required to sustain small-scale, labor-intensive production may be much less in LDC, with low wages, than in a developed country with its high wage levels. The adaptation by multinational firms may thus be attributable to both the smallness of LDC markets and the low labor costs.

Examples of adaptation in the sense of both selection of stages of production and selection of production techniques were found in a study by Finan (1975) of United States direct investment and technology transfer in the semiconductor industry. American firms tended to place the labor-intensive assembly stage of production in low-wage foreign countries while confining the more capital-intensive and technology-intensive wafer fabrication stage to the United States and to affiliates in developed countries. However, within the assembly stage, production was more capital-intensive in the United States than abroad. A substantial number of automated assembly lines were in operation in the United States, but there were none in foreign operations.

Cohen (1975), in a study of foreign-owned and locally owned plants in Taiwan, South Korea, and Singapore, not identified by industry, mentions that National Semiconductor and Texas Instruments were producing integrated circuits using highly automated techniques in these countries, a fact he interprets as lack of adaptation, though he presents no comparison with home country methods of production.

6.9 Conclusions

The purpose of our investigation was to learn whether multinational firms responded to differences among countries in the price of labor by using more labor-intensive methods of production in low-wage countries, either by selecting labor-intensive subindustries, selecting labor-intensive processes within industries, selecting small-scale operations for which only labor-intensive methods were available, or operating in a labor-intensive way whatever technologies were selected. We found that, for both Swedish and United States multinational firms, parent company or home country capital intensities of production, as measured by total assets per worker or by fixed assets alone, were higher than those of affiliates in developed countries, and that these in turn were higher than those of affiliates in less developed countries. These differences were not primarily the result of industry selection, at least among the broad industry groups used here: in fact, in some cases it was capital-intensive industries that tended to invest abroad, particularly in less developed countries.

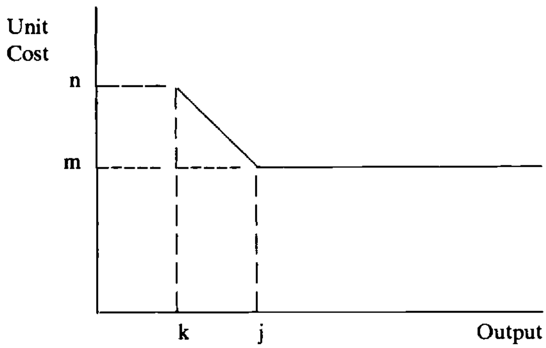
Among countries in which affiliates were located, a higher price of labor was associated with higher capital intensities of affiliates in the aggregate for all manufacturing and within manufacturing industries. Some of the relation for manufacturing as a group represented a tendency for affiliates in labor-intensive industries to settle in low-wage countries, but the main element was the relation of capital intensity to wage levels within industries.

Within individual companies there is again a strong effect of wage levels on capital intensity. Some of the intraindustry effect noted above could have been the result of selection among companies, more labor-intensive companies being more attracted to low-wage countries. However, the main intraindustry effect was the result of adaptation within companies, whether by selection among products or processes or by adaptation of particular production processes. We also found, in the data for individual companies, a strong effect of scale of operations on capital intensity when that was defined as property, plant, and equipment per worker. Scale had very little effect, and sometimes a negative effect, on capital intensity measured by total assets per worker.

While the United States data, even for individual firms in an industry, could contain some industry-mix effects, because some firms and even affiliates produce in several industries and could vary the industry mix from country to country, we could reduce that effect in the Swedish data, for which we know the industry mix of each affiliate's production. The results there seem to show even stronger indications that firms respond to low wage rates by producing in a labor-intensive way.

Notes

1. We can see this relationship most clearly in a very simple example, abstracting from transport costs, differences in factor costs and factor prices, and the possible existence of intermediate products. If there are decreasing costs up to some level of output, *j*, perhaps the level at which some indivisible unit of capital is fully utilized, and constant costs above *j*, we have the type of unit cost function shown in the accompanying diagram.



A producer in a small country, operating at output *k*, could not compete in his own market with large producers unless he had a protective tariff of 50 percent. Such a tariff would inflate both the value of his output and his value added. If output is then measured by value added in a production function fitted across countries, the inefficiency of the small producer is concealed, different scales of production appear to be equally efficient, and the estimated production function implies constant returns to scale.

2. Among the seven countries included in the two poorest groups above, four were studied in NBER's project on foreign trade regimes and economic development. The effective rates of protection for years closest to 1970, as calculated in the NBER studies or taken from other publications, were as follows:

	Nonelectrical Machinery		Electrical Machinery
Colombia (1970)	33		57
India (1968–69)	88		120
Philippines (1965)		112[a]	
		103[b]	
South Korea (1968)		44[a]	
		30[b]	

[a]Balassa measure.
[b]Corden measure.

Data are from Bhagwati and Srinivasan (1975), p. 179, Balassa (1971), p. 279, Díaz-Alejandro (1976), p. 60), and Frank, Kim, and Westphal (1975, pp. 198–99).

3. A possibility that might be worth exploring is to measure the price of labor by average wage for the country as a whole deflated by the average labor quality index and to measure skill intensity for a given affiliate or group of affiliates by the ratio of average wage paid to the average national wage.

References

Balassa, Bela, and Associates. 1971. *The structure of protection in developing countries*. Baltimore and London: Johns Hopkins University Press for the International Bank for Reconstruction and Development and the Inter-American Development Bank.

Bhagwati, Jagdish N., and Srinivasan, T. N. 1975. *Foreign trade regimes and economic development: India*. New York: National Bureau of Economic Research.

Cohen, Benjamin I. 1975. *Multinational firms and Asian exports*. New Haven and London: Yale University Press.

Courtney, William H., and Leipziger, Danny M. 1975. Multinational corporations in LDCs: The choice of technology. *Oxford Bulletin of Economics and Statistics* 57:297–303.

Denison, Edward. 1967. *Why growth rates differ*. Washington, D.C.: Brookings Institution.

Díaz-Alejandro, Carlos F. 1976. *Foreign trade regimes and economic development: Colombia*. New York: National Bureau of Economic Research.

Finan, William. 1975. The international transfer of semiconductor technology through U.S.-based firms. NBER Working Paper no. 118. Xeroxed.

Frank, Charles R., Jr.; Kim, Kwang Suk; and Westphal, Larry E. 1975. *Foreign trade regimes and economic development: South Korea*. New York: National Bureau of Economic Research.

Harbison, Frederick, and Myers, Charles A. 1964. *Education, manpower, and economic growth*. New York: Macmillan.

Kravis, Irving B.; Heston, Alan W.; and Summers, Robert. 1978*a*. *United Nations international comparison project: Phase II; International comparisons of real product and purchasing power*. Baltimore and London: Johns Hopkins University Press.

———. 1978*b*. Real GDP per capita for more than one hundred countries. *Economic Journal* 88:215–42.

Kravis, Irving B.; Kenessey, Zoltan; Heston, Alan; and Summers, Robert. 1975. *A system of international comparisons of gross product and purchasing power*. Baltimore and London: Johns Hopkins University Press.

Krueger, Anne O. 1968. Factor endowments and per capita income differences among countries. *Economic Journal* 78:641–59.

Lary, Hal B. 1968. *Imports of manufactures from less developed countries*. New York: National Bureau of Economic Research.

Leipziger, Danny M. 1976. Production characteristics in foreign enclave and domestic manufacturing: The case of India. *World Development* 4:321–25.

Morley, Samuel A., and Smith, Gordon W. 1974. The choice of technology: Multinational firms in Brazil. Paper no. 58 (fall), Rice University Program of Development Studies.

Sweden, Statistiska Centralbyrån. 1972*a*. Företagen 1970. Ekonomisk redovisning.

———. 1972*b*. Industri 1970. Del. 1. Data fördelade enligt standard för svensk näringsgrensindelning (SNI).

———. 1976*a*. Företagen 1974. Ekonomisk redovisning.

———. 1976*b*. Industri 1974. Del. 1. Data fördelade enligt standard för svensk näringsgrensindelning (SNI).

Swedenborg, Birgitta, 1973. *Den svenska industrins investeringar i utlandet*. Stockholm: Industriens Utredningsinstitut.

———. 1979. *The multinational operations of Swedish firms*. Stockholm: Industriens Utredningsinstitut.

United States Department of Commerce. 1972. *Special survey of U.S. multinational companies, 1970*. Washington, D.C.: Bureau of Economic Analysis.

———. 1975. *U.S. direct investment abroad, 1966: Final data*. Washington, D.C.: Bureau of Economic Analysis.

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