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AN EMPIRICAL ASSESSMENT OF THE FACTOR PROPORTIONS EXPLANATION OF MULTINATIONAL SALES

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Abstract

This paper provides empirical evidence that challenges the factor proportions explanation of multinational activity. The same tests on intra-industry ratios and total volumes that were used to demonstrate that a substantial part of trade is explained by factor proportions and income similarities rather than differences are applied to affiliate sales with surprisingly similar results. Some support for the factor proportions hypothesis is derived by comparing affiliate production destined for export to the parent's market, which is the category of activity most likely to be motivated by factor proportions considerations, with that destined for sale in the local market. Affiliate production destined for export home is moderately more responsive to factor proportions differences. However, the two types of activity differ more in their responses to transport costs and destination market income. Overall, the evidence suggests that only a small part of multinational activity into and out of the US in the late 1980s can be explained by factor proportions differences.

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*The author takes sole responsibility for the use and interpretation of the data, and for any errors therein.

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I. Introduction

The imperfect competition models of the early 1980s provided an explanation for trade based on similarities between countries rather than differences. They also provided a more natural framework for treating multinational enterprises. Although these models diminished the importance of factor proportions in explaining trade flows, consistent with empirical evidence, they maintained the primacy of factor proportions in explaining multinational activities. Yet in recent years, this explanation appears increasingly at odds with observed patterns of foreign direct investment (FDI) and multinational activities. A large and growing share of multinational activity involves industrialized nations as both the source and destination markets, rather than flowing from North to South. Between 1961 and 1988, over half of all direct investment outflows generated by G-5 countries was absorbed by other G-5 countries; this share had risen to nearly 70 percent by 1988 (Julius, 1990).

This paper provides empirical evidence that challenges the factor proportions explanation of multinational activity. The same tests on intra-industry ratios and total volumes that were used to demonstrate that a substantial part of trade is explained by factor and income similarities rather than differences are applied to affiliate sales with surprisingly similar results. The predictions of the factor proportions hypothesis for multinational sales is further investigated by distinguishing between affiliate production destined for sale in the local market and that destined for export to the parent's market. Together, the evidence suggests that only a small part of multinational activity into and out of the US in the late 1980s can be explained by factor proportions differences.

The factor proportions explanation for the location of multinational activity focuses on vertical expansion characteristic of North-South flows (Markusen, 1984; Helpman, 1984; Helpman and Krugman, 1985; Ethier and Horn, 1990; Ethier and Horn, 1991). A factor proportions model with differentiated products predicts that when factor proportions are identical, the differential in GDP shares of the source and destination countries and their joint income should be the only determinants of trade volumes, and there should be no multinational activities. However, this paper finds that equations using only the differential in GDP shares and joint income explain roughly the same share of variation in the volume of multinational sales as in the volume of trade, and the coefficients have similar signs and significance. This finding is inconsistent with a factor proportions explanation of multinationals.

The factor proportions model further predicts that the intra-industry share of trade flows should be decreasing in factor proportions differences, while multinational activities should arise only in a single direction between countries with large factor proportions differences. Although intra-industry ratios of affiliate sales are lower than those of trade on average, they are still significant, which is strongly counter to the factor proportions explanation, and they are positively correlated with intra-industry ratios of trade. Further, tests reported below on intra-industry ratios of trade and affiliate sales find that both are inversely related to factor proportions differences, and that a greater share of the variation in intra-industry ratios of affiliate sales than of trade is explained by similarities in factor proportions and transport costs.

The alternative to the factor proportions hypothesis formulates location advantages in terms of proximity to customers or specialized suppliers, which motivate horizontal expansion across borders at the expense of reduced scale (Krugman, 1983; Horstman, Markusen, 1992; Brainard, 1992). Proximity-concentration models predict multinational activities will arise between countries with high transport costs and trade barriers in industries with low plant scale economies, and involve increasing two-way activity the more similar are factor proportions. The tests on the total volumes and intra-industry ratios of trade and affiliate sales are roughly consistent with these predictions, both for income and factor differences and for transport costs. The tests find that freight factors have a strong negative effect on trade flows and a negligible or weakly positive effect on affiliate sales.

The paper further evaluates the factor proportions explanation of multinational activity by comparing affiliate production destined for sale in the local market with that destined for export back to the parent market. The factor proportions model predicts that all varieties of a final good produced by a foreign affiliate should be exported back to the headquarters market, while the proximity-concentration hypothesis predicts that multinationals will substitute overseas production for trade in final goods, so that flows of final goods back to the parent market will be zero. With a multistage production process, the factor proportions model further predicts that multinationals will generate one-way trade in intermediates, while the proximity-concentration model predicts they will generate two-way trade in intermediates. The amount of affiliate sales exported back home is small in both directions: on aggregate, foreign affiliates owned by US multinationals export 13 percent of their overseas production to the US, while the US affiliates of foreign multinationals export 2 percent of their US production to their parents. Tests that compare the share of total affiliate production destined for export back home with the share destined for local sale confirm that the two types of activity differ moderately in their relation to factor proportions differences in a way that is roughly consistent with a factor proportions explanation for the share exported home. However, they differ more in their responses to transport costs and destination market income.

The tests use data on bilateral flows of trade and affiliate sales in both directions between the US and 27 of its trading partners at the 3-digit SIC level, as well as direct measures of transportation costs. The analysis focuses on bilateral flows rather than multilateral flows as would be suggested by theory, due to data limitations. In addition, a cross-section approach is taken because most of the independent variables vary at intervals longer than that for which the data on affiliate sales is available.

II. Two Models

Guided primarily by findings from case study research, the managerial literature has developed a conceptual framework explaining the decision to produce abroad rather than export as optimal in markets characterized by the conjuncture of internalization, ownership, and location advantages. In recent years, trade theorists have incorporated these insights into general equilibrium models. Broadly, two types of models have emerged to explain the location decision. Both focus on the choice between exporting and investing across borders starting from the premise that firms benefit from internalization due to multi-plant economies of scale. I briefly contrast their predictions for the patterns of trade and of multinational sales.

i. Factor Proportions

Markusen, Helpman (1984), Helpman and Krugman, and Ethier and Horn (1990) explain vertical expansion across borders in terms of relative factor endowments and technological parameters.[1] [2] The Helpman and Helpman, Krugman model incorporates multinationals into a differentiated products, factor proportions model

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[1] Ethier and Horn are somewhat more concerned with organizational questions against the background of a factor proportions motivation for overseas production; they model firm configurations as trading off economies of scope against increased costs of managerial control and coordination.

[2] In the Markusen model, factor endowments are symmetric, but sector-specific capital plays a key role in explaining multinational production.

of trade by assuming that the production process in the differentiated products sector can be separated into multiple stages, and there are multi-plant economies of scale associated with a firm-specific input which has a public goods character.

I briefly review the main predictions of the pure trade model here, which will be familiar to most readers, and then go on to discuss the extension to multi-plant firms.[3] Consider a two-sector, two factor, two-country world, where countries are distinguished only by their relative factor proportions differences and their relative incomes. Tastes are homothetic and identical, and there is a constant-returns-to-scale, homogeneous goods sector, and a differentiated products sector characterized by Chamberlinian monopolistic competition and increasing returns. In such a world, there is intra-industry trade in differentiated products motivated by a taste for variety and one-way trade in the homogeneous product, and the net factor content of trade reflects the relative factor endowments of the countries. Then, if either there is specialization in the production of homogeneous products, or if all trade is in differentiated products, the total volume of trade is a decreasing function of the relative size differential of the trading partners. More generally, the share of intra-industry trade in total trade is a decreasing function of factor proportions differentials.

When the production process in the differentiated products sector is separable, so that firms can place headquarters activities in one market and manufacture in either market, the pattern of production will depend on the factor intensities of each stage of the production process and the relative factor endowments of the two economies. If headquarters activities and production activities have different factor intensities, single-plant multinationals will arise to exploit potential factor cost differentials, for large factor proportions differences.

When factor endowments are sufficiently similar that factor price equalization obtains in the trade equilibrium, there is no incentive for cross-border investment, and the pure trade equilibrium results. Assume headquarters activities are relatively more capital-intensive. When factor prices are not equalized under trade, some of the firms in the differentiated sector locate their headquarters in the relatively capital-abundant economy and production in the relatively labor-abundant economy, and export back to the headquarters market. In general equilibrium, the ability to geographically separate firms' activities in the differentiated sector leads to an enlargement

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[3] These predictions are derived in Helpman, Krugman, 1985.

of the factor price equalization set. Because cross-border investment is motivated solely by factor price differentials, multinational activities arise only in a single direction within an industry, in single-plant firms, between economies with strong factor proportions differences. With a two-stage production process, the existence of multinationals generates interindustry trade of final goods, and one would expect to see multinational activities arising in a single direction between countries with different factor proportions. With additional stages of production, multinationals may generate interindustry trade of both final goods and intermediates, but again in one direction within an industry at each vertical stage.

The empirical implications of this framework are quite strong. First, it predicts that multinationals will arise only in one direction between countries in an industry and only between economies that have sufficiently different factor proportions that factor price equalization would not result under trade. Second, if factor proportions are sufficiently different that firms have an incentive to move their plants abroad, the creation of multinationals diminishes the share of intra-industry trade. With an additional stage of production, MNEs may generate interindustry trade of intermediate goods in one direction and of final goods in the reverse direction. Third, an increasing role for MNEs weakens the link between country size dispersion and the total volume of trade. Similarly, it may weaken the link between factor proportions differences and the share of intra-industry trade. With a two-stage production process, the intra-industry share of trade will be positively related to factor proportions differentials if the headquarters market is a net importer of the final differentiated goods, and negatively related otherwise. With an additional production stage, the intra-industry share tends to decrease with increasing factor proportions differentials because the additional trade in intermediates is inter-industry.

ii. <u>Proximity-concentration Tradeoff</u>

Another group of papers uses the same differentiated products framework to explain horizontal expansion across borders motivated by considerations of access to the destination market at the expense of production scale economies (Krugman; Brainard, 1992). Consider the same two-sector, two-country world, but assume that factor proportions are identical, and firms in the differentiated products sector choose between exporting and cross-border expansion as alternative modes of foreign market penetration. The differentiated sector is again characterized by increasing returns at the firm level due to some input, such as R&D, that can be spread among any number of production facilities with undiminished value, but now there are scale economies at the plant level, such that concentrating production lowers unit costs, and a variable transport cost that rises with distance. Here, the decision whether to expand abroad via trade or via investment hinges on a trade-off between proximity advantages and scale advantages from concentrating production in a single location.

In the absence of factor proportions differences between the two economies, the magnitude of variable transport costs and the size of scale economies at the plant level relative to the firm level will determine the location and configuration of production chosen by firms. Suppose there is a simple fixed cost associated with each plant of F; exporting costs of e^{T+D} per unit, which incorporates both freight factors associated with distance, D, and tariff barriers, T; per unit variable costs, V(w,r), that are declining in the amount of the firm-specific input, r, and increasing in local wages, w; and costs associated with production of the input C(w,r). Then, with n_m firms in each market, firms will adopt multinational configurations with plants in both markets if the increase in variable profits associated with producing close to consumers in both markets outweighs the additional plant fixed cost. Combining the no-defection condition with free entry yields the equilibrium condition:

$$(1) \qquad \frac{F(w)}{C^r(w,r)} < \frac{(1-e^{(T+D)(1-\sigma)})}{2e^{(T+D)(1-\sigma)}}$$

which simplifies by assuming that firms do not take into account the effect of their potential deviation on the market price index (which is increasingly accurate as the number of firms increases)[4]. Comparative statics establish that a multinational equilibrium, where all firms have production facilities in both markets, is more likely the smaller is the fixed production cost relative to the corporate fixed cost, and the higher are transport costs and trade barriers. Here, as the corporate cost goes to 0, an equilibrium with multi-plant firms is never sustainable. In addition, for a fixed number of firms, the dual-plant equilibrium is more likely to hold the larger is the foreign market. In such an equilibrium, multinational production completely supplants trade in final goods, there is trade only in "invisible" corporate services, and there is two-way multinational activity in the same industry.

An equilibrium characterized by single-plant, national firms arises under reverse conditions. Firms

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[4] Brainard (1992) gives equilibrium conditions taking into account the effect on the market price index.

maintain a single-plant production configuration as long as the increase in fixed costs to open a second plant in the foreign market outweighs the associated increase in variable profits. With free entry, the equilibrium conditions are characterized by the exact reverse conditions as in equation (1). The single-plant equilibrium is more likely to prevail the higher is the fixed plant cost relative to the corporate fixed cost and the lower are the transport cost and the distance between the markets. Here, there is two-way trade in final goods in the differentiated sector, and, if factor proportions are equal, all trade is intra-industry, as would be predicted by a differentiated products model of trade.

In the intermediate range of parameter values, there is a third equilibrium in which multinational firms coexist with national firms. In the mixed equilibrium, some fraction, α, of firms in each market has a single production facility and exports, and the remaining fraction has production facilities in both markets. For a given number of firms, the proportion with a single plant rises the smaller are transport costs and trade barriers, the greater is the fixed plant cost, the smaller are the savings in variable costs from additional R&D investment, the larger is the corporate cost for the two-plant configuration relative to the single-plant configuration, and the smaller is the size of each market. In the mixed equilibrium, there is both two-way trade in final goods, and two-way multinational production. The share accounted for by multinational production rises with distance and trade barriers, and declines with production fixed costs.

Thus, this model explains horizontal expansion across borders motivated by market access: multinational activity can arise in the absence of factor proportion differences and in two directions in the same industry, and is undertaken by multi-plant firms.

Of course, the two models are not mutually exclusive. When factor proportion differences and a proximity-concentration tradeoff are combined, firms make the decision whether to produce abroad based on both considerations. As Brainard (1992) shows in a hybrid model, this implies that vertical single-plant multinationals will emerge for sufficient factor proportions differences, when concentration advantages are sufficiently strong relative to proximity advantages that national firms would prevail in the absence of factor proportions differences. Single-plant vertical multinationals may also emerge for strong factor proportions differences when proximity advantages are sufficiently strong that horizontal multinationals would form in the absence of factor price differentials. Thus, the addition of factor proportions differences increases the likelihood of concentrating production in a single location, leading to the coexistence of single-plant multinationals with either multi-plant multinationals or single-plant national firms. With a three-stage production process, when factor proportions considerations dominate, multinationals arise in a single direction between countries and generate interindustry trade in intermediate and final goods, while when considerations of proximity dominate, multinational sales supplant two-way trade in final goods of unequal magnitudes and may generate intra-industry trade in intermediates. Generalizing to a multi-country context, one would expect to see a preponderance of one-way multinational sales between countries that are dissimilar and a preponderance of two-way activity between countries with similar endowment ratios.

III. Related Literature

This paper is the first to investigate the empirical validity of differentiated products, factor proportions models of multinationals. The empirical research on multinationals has focused mainly on foreign direct investment flows, and much of it has been preoccupied with responses to differentials in corporate income taxation. Much of the older research on non-tax determinants focused on hypotheses based on factor proportion differences, where foreign direct investment is conceived in terms of physical capital. These empirical efforts were not successful at explaining the location of multinational activity.[5]

This literature missed two critical characteristics of multinational activity.[6] First, the comparison between foreign direct investment and trade flows is a conceptual mismatch. When multinational activities are considered as a substitute for trade in the presence of trade barriers, for instance, the relevant comparison should be between trade flows and multinational sales rather than investment. Although trade and investment are connected through the current account, and this is an interesting connection from a macroeconomic perspective, FDI is not a good measure of the extent and location of overseas production. Second, by their very nature, multinationals cannot

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[5] See Caves (1982) for a survey.

[6] With the notable exceptions of Swedenborg (1979) Blomstrom et. al. (1985) and Lipsey and Weiss (1981) and Grubert and Mutti (1991).

adequately be incorporated into perfect competition trade models. The literature has so far not directly addressed the predictions of imperfect competition, general equilibrium models for multinationals.

There are, however, several empirical findings that are relevant. Kravis and Lipsey (1982) find that payroll per worker ratios of US parents and their affiliates are inversely correlated, which is consistent with a factor proportions account, but capital-labor ratios are uncorrelated. Using cross-section and time series firm-level data for Swedish multinationals, Swedenborg (1984) finds that affiliate sales are increasing in wage differentials while exports are uncorrelated, and both increase in the natural resource intensity of the industry. She also finds that neither is related to per capita income, which has been used to proxy capital-labor differentials in the empirical trade literature.

There is a large body of empirical research investigating factor proportions and differentiated products explanations of trade. Several researchers have found that the strength of the HOS theoretical framework has exceeded its empirical predictive power.[7] The predictions of a factor proportions framework elaborated to include differentiated products have met with more success (Helpman, 1987), but more recently Hummels and Levinsohn (1993) have questioned the robustness of the results and their interpretation. None of this work distinguishes trade mediated by multinationals from arms-length trade.

IV. Data

As is well known in the field of empirical trade, limitations due to incomparability of trade data across countries are daunting. Limitations on multinational sales data are even worse. The US Bureau of Economic Analysis (BEA) compiles the most complete set of data disaggregated by industry, but it covers only bilateral activity between the US and its trading partners. In order to fully exploit this data set, the analysis below is confined to two-way bilateral relationships. Ideally, of course, a single equation would be used to test a full set of multilateral relationships. The analysis focuses on a cross-section of industry-country pairs for 1989.

[7] See Deardorff (1984) for a survey, and Bowen, Leamer, Sveikauskas (1987) for the most complete test of the HOS hypothesis.

i. Trade flows and affiliate sales

The data includes trade and multinational sales for 27 countries in total. The countries were selected to maximize diversity in geographical coverage, income, and production structure, and minimize missing data. They include: Argentina, Australia, Austria, Belgium, Brazil, Canada, Columbia, Denmark, France, Germany, Hong Kong, Ireland, Italy, Japan, Mexico, Netherlands, New Zealand, Norway, Philippines, Singapore, South Korea, Spain, Sweden, Switzerland, Taiwan, United Kingdom, and Venezuela. Data on both bilateral imports and exports at the 3-digit SIC level was obtained from the Census Bureau. Data on affiliate sales was compiled at the lowest level of aggregation available, which is between the 3-digit and 2-digit SIC levels. Industries for which over 50 percent of revenues are accounted for by services, including finance and utilities, were excluded, along with wholesale and retail trade, because the "nontradeable" nature of these activities requires a local presence. Matching the two sets of classifications yielded data on 64 industries, covering manufacturing and primary industries (BEA categories 150 and 292 were dropped because I did not have matching trade data). The data on multinational sales in manufacturing probably understates the true values because some proportion is allocated to wholesale trade. The data includes all US affiliates on the inward side but only majority-owned foreign affiliates on the outward side. Because the multinational data is less familiar than the trade data, I will describe it in some detail here.

For the industries included in the analysis, which will be termed "tradeables", gross trade flows are positively correlated with gross affiliate sales in both directions, but the correlation is much stronger for outward sales and exports (60 percent) than for inward sales and imports (20 percent). The total level of outward sales for the 27 countries and 64 industries included in the sample is $ 542 billion, well above that for inward sales of $ 393 billion. The reverse is true of trade flows: imports total $ 380 billion, exceeding exports totalling $269 billion. The share of both imports and exports accounted for by intra-firm transfers is roughly equal at one quarter.[8] When imports and exports to and from unrelated parties are included as well as those to and from affiliated parties, the

[8] There may be some double counting in the two-way estimates, since some US affiliates are classified both as US parents and foreign-owned affiliates, but for intra-firm trade it should be very small.

ratio of trade mediated by affiliates is 32 percent on the import side, and 37 percent on the export side.[9] These comparisons must be taken as rough approximations, however, as the BEA data on firm trade is classified by the industry of affiliate sales, while the trade data are classified by the actual product. On average, $1 of sales by foreign affiliates owned by US parents generates $0.13 of US exports, and $0.15 of US imports, while $1 of sales by foreign-owned affiliates in the US generates $0.08 of US exports and $0.11 of US imports.

Table 1A breaks the data down by country. It shows the level of inward and outward affiliate sales, the ratios of sales to trade in each direction, and aggregate intra-industry ratios for affiliate sales and trade separately. Table 1B gives the same statistics for an industry breakdown. Descriptions of the BEA industry codes are listed in the appendix. In both cases, trade mediated by affiliates is subtracted from the trade and affiliate sales variables to minimize the overlap between the two (although, as noted above, the match is imperfect).

Comparing countries, 22 percent of outward sales are to Canada, with the UK, Germany, France, and the Netherlands accounting for an additional 43 percent of the total. Canada similarly accounts for 21 percent of exports, with Japan a close second at 16 percent, and Mexico, the UK, and Germany together accounting for an additional 22 percent. The ratio of affiliate sales to exports is 2.5 on average, and is particularly high for Ireland, the UK, Norway, Germany, and Brazil. On the inward side, the UK accounts for 25 percent of affiliate sales, Canada accounts for 14 percent, and Germany, Japan, and the Netherlands together account for an additional 33 percent. The order is somewhat different for imports - with Japan accounting for 24 percent, Canada accounting for 22 percent, and Mexico, Taiwan, and Germany accounting for 19 percent. The ratio of affiliate sales to imports is lower than that on the outward side, but is extremely high for particular countries, such as the Netherlands, Switzerland, and the UK.

The last two columns of Table 1A report Grubel-Lloyd indices of intra-industry ratios of trade and similar indices for affiliate sales. The ratios are aggregated across industries by country as follows:

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[9] Estimates of the share of trade mediated by multinationals seem to vary widely. The estimates here do not include trade between US parents and foreigners other than affiliates, or between foreign parents and unaffiliated parties in the US. For 1989, the ratio of merchandise exports shipped by US parents to foreigners other than affiliates (excluded) to exports shipped to foreign affiliates (included) is 1.3; the analogous ratio for imports is 1.1.

(2)
$$IIX_c = \frac{\sum_{j=1}^{64} Min(X_{cj}^O, X_{cj}^I)}{\sum_{j=1}^{64} (X_{cj}^O + X_{cj}^I)}$$

where X_{cj}^I and X_{cj}^O are inward affiliate sales in industry j from country c and outward affiliate sales to country c respectively for the affiliate sales ratio, and total imports and exports respectively for the trade ratio (net of trade mediated by affiliates). Table 1B reports ratios averaged by industry, which are calculated analogously by aggregating over countries within industries. In both cases, the average ratio is higher for trade than it is for affiliate sales. The intra-industry ratio of affiliate sales exceeds 30 percent for 5 countries (UK, France, Germany, Japan, and Canada) while that for trade exceeds 30 percent for 18 countries, with Mexico, France, the UK, and Ireland exceeding 50 percent. There is a 17 percent correlation between the two indices.

ii. Transport Costs

Two types of variables have been used to proxy for freight factors in past research. Most of the work on gravity equations uses measurements of physical land and sea distances between national "economic centers" to proxy for transport costs (Bergstrand, 1986, 1989), following the procedure outlined in Linneman (1966). At the industry level, a more accurate measure of transport costs should reflect specific product characteristics, as well as geographical factors. Harrigan (1993) approximates variations in freight factors by product, by using the ratio between OECD import values reported on a cif basis by the importing country, and the associated value reported on a fob basis by the exporting country. The results are disappointing, however, with freight factors for some industries exceeding 500 percent, which Harrigan attributes in part to inconsistent reporting procedures.

Below I use an alternative formulation of freight factors, which uses data on freight and insurance charges reported by importers to the US Census Bureau. The freight factors are calculated as the ratio of charges to import values. Since no comparable data is available from exporters, and there is no reason to expect systematic differences in charges for transporting the same goods between the same locations based on the direction of transport, these values are used in the outward equations for all industry/country pairs for which there is intra-industry trade (95 percent of all industry-country pairs), as well as in the inward equations for all industries. The resulting series appears more accurate than either of its two predecessors, yielding values between 0 and 100 percent in 99.8 percent of the industry-country pairs for which freight factors are reported. It has a mean of 8 percent, as compared with a mean ranging between 140 and 270 percent for different methods of correcting the OECD-based series. The series also seems reasonable, with high average values for countries such as Philippines and Singapore, and for industries such as iron ore and concrete, asbestos, and cut stone, and low average values for countries such as Canada and Mexico, and for industries such as electronic components and scientific instruments.

iii. Country Variables

Data on national income and per capita income are taken from the IMF Financial Statistics.

Detailed factor endowments data is constructed using the methodology outlined by Bowen (1982), and capital-labor ratios and per worker GDP ratios are constructed using data from the Penn Mark V World Tables following Hummels and Levinsohn.

V. Empirical Estimates

Both the proximity-concentration and factor proportions explanations of multinational activities are embedded in differentiated products models. However, the first predicts that multinational sales behave like differentiated products trade with respect to factor proportions differences and income - arising in two directions in the same industry and increasing in the similarity between the markets - and differently with respect to proximity and concentration advantages. In contrast, the factor proportions explanation predicts that multinational sales look more like inter-industry trade - arising in a single direction and increasing in factor proportion differences. To distinguish them, I first apply the tests that have been used to assess the differentiated products model of trade to multinational sales. I then exploit the distinction between multinational sales destined for the local market and those destined for export back to the home market in an attempt to evaluate a factor proportions explanation of multinational activity.

i. Comparing the Total Volume of Trade with the Total Volume of Affiliate Sales (Table 3)

Helpman (1987) develops two tests of differentiated products models of trade and applies them to a sample of 14 OECD countries. More recently, these have been replicated and extended to a sample of non-OECD countries by Hummels and Levinsohn. The first assumes that all trade is in differentiated products. In the absence of factor proportions differences, the theory would predict that the volume of trade is determined by the relative size of trading partners. This yields an equation explaining the total volume of trade between countries u and i:

$$\frac{V_{ui}}{Y_u+Y_i}=\frac{Y_u+Y_i}{Y_w}\left(1-\frac{Y_i^2+Y_u^2}{(Y_i+Y_u)^2}\right) \tag{3}$$

where V_{ui} is the bilateral volume of trade, Y_i is income in country i and Y_w is world income. The volume of bilateral trade is greater the smaller is the difference in size of the two countries and the greater is their size in relation to world income. This equation is tested either for trade among a group of countries or for a set of country pairs over time. A similar equation should apply to the total volume of multinational sales in a proximity-concentration, differentiated products mode, but it would not explain multinational sales motivated by factor proportions differences.

Figure 1 shows the distribution of total volumes of affiliate sales and trade and compares them to income. Figure 1a shows the distribution by income. Both multinational activity and trade are skewed towards the countries whose incomes are most similar to the US, but the bias is more extreme for affiliate sales. Figure 1b shows the distribution by per capita income. Both affiliate sales and trade are greater for countries with similar per capita incomes and disproportionately so relative to income. The difference between affiliate sales and trade is more complicated here, since there is disproportionate trade with the 5 countries with the highest per capita incomes but also with the half with the lowest incomes.

Below I modify equation (3) so that it explains the bilateral volume of trade in particular products, by relying on the assumption that preferences are identical and homothetic. In the differentiated products model, there is a uniform elasticity of demand among different varieties of a product and constant expenditure shares, so that the demand for imported varieties within an industry should depend similarly on relative country sizes. I allow for differences in industry elasticities by including dummies. In addition, I include freight factors, which can easily be incorporated into a pure differentiated products model of trade (Helpman, Krugman). The equation to be estimated for affiliate sales is:

(4) $$MTOT_i^j = \sigma_1 TGDP_i + \sigma_2 SHDIF_i + \sigma_3 FF_i^j + \sum_1^{64} \sigma_{3+j} D^j + e_{ij}$$

where $MTOT_i^j$ is the log of total affiliate sales (net of imports) between country i and the US of product j, $TGDP_i$ is the log of the total income of country i and the US, $SHDIF_i$ is the log of 1 minus the sum of the squared income shares of country i and the US, and D^j is a variable specific to industry j.[10] Past research on trade volumes constrained the coefficients on TGDP and SHDIF to be equal. Below I report results for the case where the coefficients are constrained and where they are allowed to differ. The same equation is then used to explain the total volume of trade (net of trade mediated by affiliates), $TTOT_i^j$. When all activity is in differentiated products sectors, a proximity model would predict a rising volume of trade and multinational sales as the income of the trading partners becomes increasingly similar and as their joint GDP rises and a declining volume of trade as transport costs rise, while a factor proportions model would predict only a rising volume of trade as relative income shares converge.

The data suggests a strong similarity between the volumes of trade and affiliate sales: the volumes of gross affiliate sales and gross trade flows have a correlation of 56 percent, although netting out trade mediated by affiliates reduces the correlation to 33 percent. Columns 1 through 3 of Table 3 report estimates of the volume of affiliate sales net of trade using equation (4). Column 1 reports an estimate of the equation with $\sigma_1=\sigma_2$ and $\sigma_3=\sigma_4=0$. The coefficient on RELSH, which is the product of TGDP and SHDIF, is highly significant, as would be predicted by a differentiated products model, and the elasticity is close to 1. Column 2 permits the coefficients on TGDP and SHDIF to differ. The explanatory power of the equation remains constant, but all of the significance resides in the share differential variable, with the elasticity slightly larger than on the scaled share differential in the first equation. This result probably reflects collinearity between the SHDIF and TGDP variables. Column 3 adds freight factors and industry dummies. The fit of the equation improves markedly, and the elasticity on the share differential rises to unity. The coefficient on the freight factor is significant at -0.35.

Columns 4 through 6 of Table 3 report analogous estimates of trade volumes net of internal transactions.

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[10] Trade flows mediated by affiliates are netted from both the affiliate sales and trade flows to avoid overlap. As explained above, however, the trade mediated by affiliates includes products from other industries. The results are not sensitive to the use of net versus gross flows.

In column 4, the coefficient on the product of the share differential and joint GDP, RELSH, is significant and of the same size as in the affiliate sales equation, and the fit of the equation is nearly identical. Allowing the coefficients to differ in column 5 does not improve the fit of the equation. In contrast to the affiliate sales equation, both variables retain significance, and the elasticity on the TGDP is over twice that on SHDIF, but again the results probably reflect collinearity. The addition of freight factors and industry dummies in column 6 improves the fit of the trade equation even more than the affiliate sales equation. The elasticity of trade volumes with respect to the freight factor is nearly twice that of affiliate sales and is highly significant.

In sum, the relative share variable performs as would be predicted by a differentiated products model of trade in explaining both the volumes of trade and of affiliate sales. The finding that the responses of trade and affiliate sales to the relative share variable are nearly identical suggests either that the predictions of a differentiated products model absent factor proportions differences or with specialization in the homogeneous product sector for trade apply equally well to affiliate sales, or that the positive relationship between relative income shares and cross-border transactions is better explained by a different model. Similar to the findings in Hummels, Levinsohn, the relative share variable performs almost too well, considering that the group of countries includes those for whom factor proportions are sufficiently different from the US that one would expect inter-industry trade and one-way multinational activity to prevail. In addition, although the volume of both affiliate sales and trade contracts with increasing transport costs, the elasticity of the trade response is nearly twice that of affiliate sales, weakly consistent with the proximity hypothesis.

ii. Comparing Intra-Industry Ratios for Trade and Affiliate Sales (Table 4)

I next turn to the second test developed by Helpman, which allows for the co-existence of differentiated products trade and factor proportions trade. The differentiated products model in a factor proportions framework predicts that the share of two-way trade in total bilateral trade should increase with factor proportions similarities, holding relative country size constant, and affiliate activity should arise only in a single direction within an industry and decrease with factor proportions similarities.

Figure 2a plots the Grubel-Lloyd index of intra-industry trade against a similar index of intra-industry affiliate sales averaged across industries by country, which is defined in equation (2). There is a clear positive correlation between the two indices. Figures 2b and 2c plot each of the indices against income-per-worker ratios by country, as a rough proxy of factor proportions differences. In both cases, there is a clear negative relationship, but it is somewhat stronger for affiliate sales. Although this is precisely what would be predicted by a differentiated products-factor proportions model for trade, the existence of intra-industry affiliate sales and their negative relationship with per worker income are strongly counter to the predictions of this model. Figures 3a and 3b plot the analogous intra-industry indices averaged across countries by industry against average industry freight factors. The figures suggest that freight factors have little to no influence on intra-industry ratios of affiliate sales and a negative relationship on intra-industry ratios of trade. This is roughly consistent with the predictions of the proximity-concentration hypothesis.

Helpman and Hummels, Levinsohn test the relationship between factor proportions differences and intra-industry ratios of trade for a multilateral sample of country pairs over time. Here I first modify their equations to fit the bilateral and industry-specific nature of the data and then present results for the country aggregates. In both cases, I stick with cross-section analysis and expand the equations to include freight factors. The first estimating equation for multinational sales is:

$$MINTRA_i^j = \pi_1 CAP_i + \pi_2 LAB1_i + \pi_3 LAB2_i + \pi_4 LAB3_i + \pi_5 LAND_i + \pi_6 MINGDP_i + \pi_7 MAXGDP_i + \pi_8 FF_i^j + \sum_1^{64} \pi_{8+j} D^j + \mu_i^j \qquad (5)$$

$MINTRA_i^j$ is the ratio of two-way affiliate sales to total affiliate sales (net of exports) in both directions in industry j between the US and country i: $MINTRA_i^j = 2*\min(NOUT_i^j, NIN_i^j)/(NOUT_i^j + NIN_i^j)$. $MINGDP_i$ is the minimum of US GDP and GDP in country i and $MAXGDP_i$ is the reverse. Since the US is the country with the highest GDP in the sample, MINGDP is simply the trading partners' GDP, and MAXGDP takes the place of the constant. CAP is the absolute value of the differential between per capita capital ratios between country i and the US, LAB1 is the differential in per capita endowments of high-skill workers, LAB2 measures per capita unskilled, literate labor differentials, LAB3 measures per capita illiterate labor differentials, and LAND measures per capita arable land differentials. In addition, I allow for differences in industry responses by including industry-specific variables, D^j, as well as freight factors. Analogous equations are used to estimate $TINTRA_i^j$, the ratio of two-way trade flows to total trade flows (net of internal transactions) in both directions in industry j between the US and country i.

The first three columns of the upper panel of Table 4 report estimates of intra-industry shares of affiliate sales, MINTRA. Column 1 reports an estimate of equation (5). Intra-industry ratios of affiliate sales are decreasing in differences in the relative abundance of skilled labor and of illiterate labor, weakly decreasing in differences in literate, unskilled labor, and increasing in arable land ratio differentials. They are also decreasing in differences in income levels, but the coefficient on MAXGDP is insignificant. Relative capital endowments are insignificant. The coefficient on the freight factor is negative but insignificant. Following Hummels, Levinsohn, column 2 replaces the factor proportions variables with a single measure of the per worker income differential, DGPL, and column 3 uses the capital-labor ratio differential, DKL. In both cases, the fit of the equation falls moderately, but the coefficients on the factor proportion differential proxies are negative and significant, as would be predicted for trade by a factor proportions, differentiated products model. The coefficients on MINGDP are both positive and significant, as predicted for trade, but those on MAXGDP are positive and significant in the equation with DKL, which is contrary to prediction. The coefficient on freight factors remains negative, but is significant only in the equation with the per worker income differential.

Columns 4 through 6 of the upper panel of Table 4 report analogous estimates of intra-industry ratios of trade. The signs and magnitudes of the coefficients on the factor proportions differentials are similar to the affiliate sales equations, but the significance of the coefficient on literate, unskilled labor is greater and that on high skilled labor is lower. Compared to the affiliate sales results, a smaller fraction of the variation in intra-industry trade ratios is explained. Column 5 replaces the factor proportions differentials with the per worker income differential, DGPL, and column 6 replaces them with the capital-labor ratio differential, DKL. Similar to the affiliate sales equation, the coefficients on the factor proportions differential variables are negative and significant, consistent with a differentiated products model, but the magnitude of the response is half that of affiliate sales in both cases. In all three equations, the coefficient on MINGDP is positive and significant, as predicted, and the magnitude of the coefficient is less than half that in the corresponding equation for affiliate sales. The coefficient on MAXGDP has the wrong sign in the equations with DKL and DGPL and is significant in the equation with DKL. In all three equations, the coefficient on freight factors is negative and significant and much larger than that in the parallel affiliate sales equations.

Roughly similar results obtain for the signs and significance of the coefficients when a tobit specification is used instead, so I do not report them here. Overall, the results of both equations are consistent with the predictions of a differentiated products, factor proportions model for trade, modified to incorporate transport costs, but the affiliate sales equation is squarely at odds with the predictions of the same model for affiliate sales. Moreover, there is a surprising similarity between the responses of the shares of intra-industry affiliate sales and that of trade to differences in particular factor proportions. Indeed, intra-industry shares of affiliate sales and trade appear to differ most in their responses to freight factors and income differences.

The lower panel of Table 4 reports estimates comparable to those in Helpman and Hummels, Levinsohn, which use as the dependent variable the Grubel-Lloyd country aggregate intra-industry ratio. Both sets of authors find that the intra-industry index of trade had the predicted negative relationship to variables measuring factor proportions differences two decades ago, but conclude that the relationship has since deteriorated. In addition, Hummels, Levinsohn find that when country pair effects are controlled for, the relationship becomes positive, contrary to theory. The intra-industry index for each country aggregates the volume of intra-industry trade across industries within a country and scales by the total volume of trade, as in equation (2).

Columns 1 through 3 of the lower panel of Table 4 report results for the aggregate intra-industry ratio of multinational sales, CMINTRA, and columns 4 through 6 repeat the same tests for trade, CTINTRA. Columns 1 and 4 use the full set of factor differentials, while columns 2 and 5 include only the per worker income differential, and columns 3 and 6 include only the capital-labor ratio differential. Each equation includes a country freight factor, which is averaged across industries.[11]

Similar to the industry-level results, the coefficients on both types of literate labor are significantly negative in the affiliate sales equation in column 1. The coefficient on the capital differential is insignificant, but this may be attributable to collinearity with other factor variables, similar to the industry equations. In addition, the sign of MINGDP is as predicted and significant, while those on MAXGDP and FF are positive but insignificant. The fit of the equation is very good - around 78. Replacing the list of factor differentials with a single income per worker

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[11] I experimented with both weighted and simple averaging; the results are not sensitive so I report only the weighted average.

differential, DGPL, in column 2, and a capital labor differential, DKL, in column 3 yields surprisingly similar results, with some sacrifice in fit. Similar results are also obtained using per capita income differentials, so I do not report them here.

The estimates of the intra-industry shares of trade in columns 7 through 9 are very similar to the Hummels, Levinsohn findings (with the exception of the freight factor). In all three equations, the coefficients on the factor differentials are largely insignificant, with the exception of unskilled, literate labor (which is marginally negative) and arable land (which is positive). Surprisingly, the MINGDP and MAXGDP variables do not fare much better. However, the coefficient on the freight factor is negative and significant, as would be expected. These results are robust to the use of per capita income differentials.

The results of the intra-industry share equations together with the total volume equations make a strong case that a significant part of multinational activity is motivated by similarities in income and proportions of certain types of factors, rather than differences, which is inconsistent with a factor proportions account. Indeed, the estimates of country-wide intra-industry ratios suggest that the predictions of the differentiated products model for trade fits affiliate sales better than it does trade. The roles of relative incomes and income shares in determining affiliate sales and trade flows are fairly similar, even after controlling for trade mediated by affiliates, which may in part explain their complementarity. The similarity breaks down in the responses to increases in freight factors, however. While both total flows and intra-industry ratios of trade diminish significantly with increasing transport costs, affiliate sales diminish by a much smaller magnitude, and intra-industry ratios are essentially unaffected.

iii. Comparing Affiliate Production for Export and Local Sale (Tables 5 and 6)

The two tests above do not rule out a factor proportions explanation of multinationals; they simply establish that it does not account for a significant amount of multinational activity. Ideally, the role of factor proportions differences would be tested using data from input-output matrices and factor endowments, along the lines of the careful test of the HOS hypothesis for trade in Bowen, Leamer, and Sveikauskas (1987). Unfortunately, the industry categories do not permit the degree of vertical separation that would be necessary for such a rigorous test, which would require factor intensities data not only for individual products, but also for separate activities within each product's business system. However, some light can be shed on this issue by distinguishing between affiliate activities based on whether their primary market is local or export-oriented, which corresponds roughly to a distinction between horizontal activity motivated by proximity advantages and vertical activity motivated by factor cost differences. Below I exploit this distinction in an attempt to evaluate the factor proportions hypothesis.

Recall a factor proportions explanation of multinational activity predicts that all varieties of a final good produced abroad are exported back to the headquarters market, and such activity arises between countries with significantly different factor proportions. A proximity-concentration explanation predicts that overseas production substitutes for trade in final goods, so that exports back to the home market should be zero. Both explanations could be consistent with overseas production destined for export to third markets, so I focus on affiliate sales destined for export home as the category most likely to reflect factor proportions considerations and contrast it with local sales as the least likely category.

Table 5 reports the shares of affiliate production destined for the local market and for export back to the parent market for inward and outward sales, averaged by country and by industry. A simple glance at the aggregate ratios suggests that for the US, multinational sales are destined primarily for the destination market in both directions, but particularly on the inward side. On the outward side, local sales account for 64 percent of total affiliate sales on aggregate, while exports back to the US account for only 13 percent. On the inward side, local sales account for 92 percent of total affiliate sales on aggregate, while exports to the foreign parent account for only 2 percent. Broken down by country, the ratio of sales destined for sale back home is highest for Singapore, Hong Kong, Canada, Taiwan, and Mexico on the outward side, which fits a factor proportions explanation fairly well, with the exception of Canada. On the inward side, only Taiwanese and Brazilian affiliates export more than 5 percent of their production to their parents. The industries with the greatest ratios of exports to the home market are iron ores, nonmetallic nonfuel minerals, lumber and wood products, and other transportation equipment on the outward side, and iron ore on the inward side. Many of these industries are resource intensive.

Figure 4a plots the share of inward affiliate sales exported to the parent against the difference in the ratio of illiterate labor to unskilled literate labor in the source market relative to the US ratio, and 4b plots the share of inward affiliate sales sold locally against the same factor proportions differential. The share exported to the parent market exhibits a clear positive relationship to the factor proportion differential, while the local share has a negative relationship. Similarly, figure 4c plots the share of outward affiliate sales exported to the US against the difference in the ratio of unskilled literate labor to skilled labor in the destination market relative to the US ratio, and 4d plots the share sold locally. Again, the share exported home is increasing in factor proportions differences, while here the share sold locally appears uncorrelated.

I next present equations that examine these relationships more rigorously. The equations compare the importance of factor proportions differentials in determining affiliate sales destined for export to the home market with their importance in determining affiliate sales sold locally:

$$(6) \qquad OXSH_i^j = \lambda_1 CAP_i + \lambda_2 LAB1_i + \lambda_3 LAB2_i + \lambda_4 LAB3_i + \lambda_5 LAND_i + \lambda_6 GDP_i + \lambda_7 USGDP + \lambda_8 FF_i^j + e_i^j$$

where all the independent variables are in logs, and OXSH is the share of total outward sales comprised of exports back to the US. A similar equation explains the share of outward sales destined for the local market, OLSH.[12]

Table 6 reports estimates for equation (6) for the share of outward sales destined for the local market in column 1 and the share of sales destined for export back to the US in column 2, using a tobit specification. The share accounted for by local sales decreases in differences in per capita endowments of capital, skilled labor, and arable land, while it increases in differences in endowments of literate unskilled and illiterate labor. In contrast, the share accounted for by exports back to the US increases in differences in per capita endowments of capital and illiterate labor, and decreases in differences in unskilled, literate labor. In addition, local sales are a larger share of activity the greater is destination market income and the greater are transport costs, consistent with a proximity-concentration hypothesis, while sales for export are unaffected by income levels and fall with increases in transport costs.

Estimates of the levels of each type of sales suggest that the difference in responses to factor proportions differences is one of degree rather than kind. Column 3 reports an estimate of the log of the level of outward sales destined for the local market, OUTL, using equation (6), and column 4 reports the same equation for the log of the level of outward sales destined for export to the US, OUTX. Compared to the share estimates, the coefficient on capital differentials becomes insignificant in the local sales equation, and the coefficient on unskilled literate labor

[12] Gross flows are used in this section.

differentials becomes insignificant in the export sales equation. The two flows differ most in the magnitude of their responses to destination market income and to freight factors, with local sales three times more responsive to income, and export sales three times more responsive to freight factors.

Comparable estimates for inward sales are reported in columns 5 through 8 of Table 6. Column 5 reports a tobit estimate of the share of inward sales destined for sale in the US, INLSH, based on equation (6), and column 6 reports an estimate of the share destined for export back to the parent, INXSH. The shares differ in their response to increases in unskilled, literate labor differentials, with local sales falling and export sales rising. Since the US is moderately abundant in unskilled literate labor, this implies that affiliate production in the US is more likely to be destined for export back to the parent the poorer is the parent's market in this resource. The results on the freight factor are consistent with the results on outward sales above and with a proximity hypothesis for local sales: the share destined for local sale increases with the freight factor, while the share destined for export home falls. The coefficients on income are inconsistent, however: the share exported to the source country increases with the size of the home country market, while the share sold locally actually decreases. The fit of the export share equation is particularly poor, however. The level equations for inward local sales, INL, in column 7, and for inward export sales, INX, in column 8 provide little additional insight. The levels of both types of sales are decreasing in the illiterate labor differential; given the relative scarcity of this resource in the US, this implies that countries which are relatively abundant in illiterate labor are not fertile ground for corporate headquarters. The coefficient on GDP is significantly positive in both equations, and that on freight factors is significantly negative, although smaller in the local sales equation.

A few inferences can be drawn from the two sets of estimates. Outward sales of both types are decreasing in high-skill labor differentials (to countries scarce in high-skill labor) and increasing in illiterate labor differentials (to countries abundant in illiterate labor). Outward sales destined for export back to the US differ from those destined for local sale in that they are increasing in capital and arable land differentials (to countries with either extreme scarcity or abundance of capital and scarce in arable land) and decreasing in unskilled, literate labor differentials (to countries scarce in unskilled, literate labor). Inward sales of both types are weakly decreasing in illiterate labor differentials (from countries abundant in illiterate labor) and weakly increasing in arable land differentials (from countries scarce in arable land). Inward sales destined for export back to the parent differ from those destined for local sale in that they are increasing in unskilled, literate labor differentials (from countries scarce in this resource). This implies US multinationals use countries that are relatively abundant in illiterate labor and relatively poor in capital, arable land, and unskilled, literate labor as offshore production bases. Foreign multinationals that use the US as a base for exports back home tend to be relatively poor in unskilled, literate labor (perhaps suggesting they are locating a different part of the production process in the US compared to US affiliates abroad). Further, the US has a net surplus of sales with countries relatively abundant in illiterate labor and a net deficit with countries relatively poor in arable land.

The results provide some evidence that affiliate production destined for export back home differs from that destined for local sales. They provide support for the factor proportions hypothesis in explaining the share exported back home, while local sales appear to be decreasing in factor proportions differences. The tests also support the predictions of the proximity hypothesis for local sales, while affiliate sales destined for export home are more similar to trade in their response to freight factors. The share of both inward and outward sales destined for the local market increases in freight factors, while the export shares decreases. And the coefficients on income in the outward equations support the hypothesis that the income level of the destination market is a more important determinant of local sales than of export sales, but this result is not robust in the inward equations.

VI. Conclusion

The data clearly rejects a pure factor proportions explanation of multinational activities, although factor proportions appear to explain some portion of these activities. Total volumes of affiliate sales (net of internal trade) are strongly increasing in similarities in relative income shares, as would be predicted for trade in a model with identical factor proportions, and this variable together with transport costs explains over 40 percent of the variation in affiliate sales. Further, although intra-industry ratios of multinational sales are lower on average than those for trade, they are still significant, and the variation in intra-industry ratios of multinational sales is better explained by factor proportion similarities and relative incomes than is that of trade. Both findings are inconsistent with a pure factor proportions explanation of multinationals, and suggest that a substantial part of multinational activities is motivated by similarities rather than differences in factor proportions and incomes. Some evidence for the factor proportions account is derived by distinguishing affiliate production destined for sale in the parent's home market: foreign affiliate production destined for export back to the US is highest in markets scarce in capital, arable land, and unskilled, literate labor, and abundant in illiterate labor, while US affiliate production destined for export back to the foreign parent is highest for countries that are scarce in unskilled, literate labor.

Interestingly, both the tests on intra-industry ratios and total volumes confirm that freight factors have a strong dampening effect on trade flows, and a much smaller or insignificant effect on affiliate sales. In addition, distinguishing affiliate production destined for export from that destined for local sale reveals an important difference in their responses to transport costs: while export sales diminish as freight factors rise, local sales are either unaffected or increase.

Taken together, these results provide only weak evidence of factor proportions motivations for multinational activity. Factor proportion differences are strongest in explaining the portion of affiliate sales that is destined for export back home, which accounts for 13 percent of foreign affiliate production and between 2 and 8 percent of US affiliate production, while local affiliate sales are decreasing in differences in capital and skilled labor endowments. In addition, the results on transport costs shed some light on findings in a companion paper testing the proximity-concentration hypothesis (Brainard, 1993). That paper finds that the share of total flows accounted for by affiliate sales is increasing in freight factors and both the share and level of trade are decreasing, consistent with the proximity-concentration hypothesis. However, the effect of freight factors on the level of affiliate sales is not robust. This finding may be partially explained by the presence of some vertical affiliate activity, which would be consistent with the negative relationship between transport costs and affiliate sales destined for export to the home market documented above.

Table 1A: Affiliate Sales and Trade Flows, by Country
Net of Trade Mediated by Affiliates*
64 Tradeables Industries
1989, $ Millions

COUNTRY	OUTWARD SALES	OUTWARD SALES/ EXPORTS	INWARD SALES	INWARD SALES/ IMPORTS	INTRA INDUSTRY AFFIL SALES	INTRA INDUSTRY TRADE
arg	3187	3.62	1	0.00	0.00	0.22
aul	19600	2.98	8487	2.37	0.18	0.24
aus	1887	2.49	574	0.58	0.11	0.46
bel	15600	2.11	5524	1.35	0.15	0.38
bra	22000	5.76	43	0.01	0.00	0.24
can	85800	2.69	53100	0.67	0.29	0.41
col	(d)	(d)	1	0.00	0.00	0.15
den	1275	1.34	223	0.15	0.17	0.35
fra	38700	4.09	30000	2.88	0.39	0.66
ger	76800	5.76	39800	2.03	0.34	0.46
hko	3161	0.56	(d)	(d)	0.20	0.37
ire	(d)	(d)	4240	2.85	0.08	0.54
ita	22500	3.76	3978	0.35	0.14	0.39
jap	20800	0.52	34600	0.42	0.30	0.30
mex	13000	0.58	1264	0.05	0.02	0.66
net	24400	2.65	41300	11.74	0.16	0.40
nor	4369	4.58	1077	0.58	0.07	0.19
nze	1221	1.21	3323	2.83	0.02	0.19
phi	1508	0.79	(d)	(d)	0.01	0.37
sin	5976	1.08	120	0.01	0.03	0.34
sko	1163	0.09	928	0.05	0.05	0.29
spa	17200	4.36	188	0.06	0.01	0.26
swe	3270	1.17	9109	2.34	0.18	0.45
swi	2233	0.59	30700	10.98	0.07	0.46
tai	4438	0.43	(d)	(d)	0.05	0.31
uki	83200	5.51	94300	6.79	0.40	0.59
ven	1707	0.61	861	0.13	0.01	0.08
AVERAGE		2.46		1.83	0.13	0.36
TOTAL	485431	2.18	365477	1.03	0.86	0.77

* Net of all US exports to foreign affiliates on outward side, and of imports by US affiliates from foreign parent group on inward side

Table 1B: Affiliate Sales and Trade Flows, by Industry
Net of Trade Mediated by Affiliates*
27 Countries, 1989, $ Millions

BEA	OUTWARD SALES	OUTWARD SALES/ EXPORTS	INWARD SALES	INWARD SALES/ IMPORTS	INTRA INDUSTRY AFFIL SALES	INTRA INDUSTRY TRADE
10	300	0.02	1046	0.28	0.24	0.29
20	98	0.14	634	0.53	0.17	0.31
80	(d)	(d)	10	0.05	0.00	0.45
90	(d)	(d)	271	0.10	0.07	0.21
101	(d)	(d)	594	1.34	0.85	0.56
102	797	1.09	3666	15.94	0.33	0.14
107	65	0.17	111	0.31	0.01	0.21
120	580	0.15	1331	15.54	0.04	0.01
133	19800	43.08	823	0.05	0.04	0.04
140	(d)	(d)	2481	3.64	0.30	0.42
201	905	0.22	1117	0.47	0.09	0.12
202	2402	7.11	6189	9.86	0.07	0.05
203	4575	3.50	(d)	(d)	0.17	0.31
204	11000	8.56	(d)	(d)	0.10	0.21
205	2545	81.40	3547	12.00	0.41	0.18
208	8822	11.83	5399	1.70	0.44	0.20
209	16800	7.08	13700	5.43	0.25	0.53
210	(d)	(d)	(d)	(d)	0.58	0.01
220	1808	0.89	3304	0.68	0.51	0.44
230	2862	2.35	1589	0.11	0.53	0.16
240	(d)	(d)	1003	0.20	0.14	0.25
250	1376	1.75	436	0.09	0.30	0.28
262	5808	1.07	1857	0.19	0.17	0.19
265	10700	14.13	5146	4.29	0.21	0.43
271	91	0.23	1608	48.38	0.00	0.15
272	2618	2.50	6865	6.72	0.41	0.64
275	938	0.99	4808	8.14	0.28	0.57
281	36700	2.23	56400	6.30	0.47	0.50
283	20000	8.63	15100	7.10	0.23	0.63
284	17000	17.54	12700	12.95	0.28	0.49
287	1498	0.65	332	0.22	0.16	0.55
289	9500	7.01	1754	3.00	0.28	0.52
291	26900	8.00	43600	5.61	0.12	0.29
299	216	0.43	703	5.45	0.08	0.39
305	7256	6.51	7098	1.51	0.37	0.28
308	5656	2.45	3982	1.38	0.55	0.60
310	178	0.18	(d)	(d)	0.15	0.17
321	2991	3.04	3770	2.63	0.16	0.62
329	(d)	(d)	12100	3.56	0.25	0.41
331	1126	0.46	8781	0.92	0.16	0.37
335	3213	0.41	12100	1.17	0.35	0.56
341	3938	2.68	8858	8.39	0.30	0.28
342	2407	1.72	559	0.17	0.28	0.48
343	1749	2.15	2091	2.70	0.51	0.69
349	5681	1.63	10300	1.96	0.28	0.70
351	2053	0.80	(d)	(d)	0.01	0.46
352	(d)	(d)	799	0.34	0.27	0.49
353	(d)	(d)	9843	2.36	0.24	0.63
354	(d)	(d)	1180	0.21	0.20	0.47
355	3357	0.88	4714	0.94	0.53	0.51
356	3109	0.73	2356	0.49	0.34	0.61
357	58100	3.84	6107	0.30	0.19	0.44
358	3921	1.71	2055	0.99	0.25	0.45
359	(d)	(d)	(d)	(d)	0.48	0.59
363	(d)	(d)	(d)	(d)	0.12	0.44
366	(d)	(d)	12100	0.67	0.28	0.32
367	13000	1.11	5941	0.38	0.58	0.63
369	6590	0.81	(d)	(d)	0.49	0.60
371	86800	13.23	7098	0.10	0.07	0.14
379	3088	0.12	3107	0.26	0.07	0.59
381	3629	0.50	3732	0.69	0.37	0.73
384	5621	1.51	2462	0.71	0.46	0.74
386	8974	6.02	331	0.06	0.05	0.37
390	3192	0.75	2675	0.21	0.51	0.44
AVERAGE		4.85		5.70	0.27	0.40

Variable Definitions

MTOT	Sum of affiliate sales (net of trade mediated by affiliates)
TTOT	Sum of trade flows (net of mediated by affiliates)
MINTRA	Intra-industry ratio of affiliate sales (net of mediated trade)
TINTRA	Intra-industry ratio of trade (net of mediated trade)
FF	Freight factor: transport cost as percent of value
TGDP	Total GDP of trade partners
SHDIF	Income share differential
RELSH	TGDP*SHDIF
DPCY	Differential in per capita income
DKL	Differential in capital/labour ratio
CAP	Differential in per capita capital endowment
LAB1	Differential in per capita endowment of skilled labour
LAB2	Differential in per capita endowment of literate, unskilled labour
LAB3	Differential in per capita endowment of illiterate labour
LAND	Differential in per capita endowment of arable land
OUTX	Outward affiliate sales destined for export back to US
OUTL	Outward affiliate sales destined for local sale
OUTXSH	OUTX/OUT
OUTLSH	OUTL/OUT
INX	Inward affiliate sales destined for export back to parent
INL	Inward affiliate sales destined for local sale
INXSH	INX/IN
INLSH	INL/IN

Table 2A: Correlations

Inward
(obs=1731)

	in	im	nin
im	0.2023		
nin	0.9945	0.1380	
nim	0.1660	0.9958	0.1082

Outward
(obs=1731)

	out	ex	nout
ex	0.6392		
nout	0.9397	0.4553	
nex	0.1803	0.6884	0.2102

Factor Proportions Differentials and Country Variables
(obs=1711)

	dpcy	cap	lab1	lab2	lab3	land	gdp
cap	0.6749						
lab1	0.8223	0.6555					
lab2	0.7393	0.4399	0.7046				
lab3	0.7638	0.6826	0.7943	0.7591			
land	0.0608	0.1650	0.2350	0.2850	0.2687		
gdp	-0.3725	-0.3713	-0.2011	-0.0793	-0.2378	0.1540	
dist	0.1340	0.2119	0.1901	-0.1264	0.2298	-0.3756	-0.0261

Table 2B: Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
mintra	1154	.1569205	.2750482	0	.9977354
tintra	1704	.3886493	.3228418	0	.9998716
mtot	1731	491659	1779576	0	2.87e+07
ttot	1731	333850	1200208	0	2.73e+07
out	700	313084	1469733	0	3.97e+07
outx	822	42225	576674	0	2.29e+07
outl	725	199360	830912	0	1.67e+07
in	1174	227170	1212308	0	2.37e+07
inx	1125	4885	34548	0	906871
inl	1291	208275	1114694	0	2.07e+07

Table 3: Total Volume of Trade and Affiliate Sales

A. Affiliate Sales

$$MTOT_i^j = \sigma_1 TGDP_i + \sigma_2 SHDIF_i + \sigma_3 FF_i^j + \sum_1^{64} \sigma_{3+j} D^j + \mu_{ij}$$

B. Trade

$$TTOT_i^j = \theta_1 TGDP_i + \theta_2 SHDIF_i + \theta_3 FF_i^j + \sum_1^{64} \theta_{3+j} D^j + \epsilon_{ij}$$

DEP VAR	mvol	mvol	mvol	tvol	tvol	tvol
relsh	0.8248			0.7953		
	14.7870			17.9610		
tgdp		0.2562	0.3170		2.3277	3.5538
		0.2450	0.3620		2.6210	5.9740
shdif		0.8690	0.9742		0.6858	0.4875
		8.8190	11.5660		8.8740	9.2000
ff			-0.3532			-0.6728
			-5.0910			-15.3690
const	6.5752	11.5961	6.9350	6.2371	-7.2721	-22.9824
	19.0480	1.2570	0.8880	23.7730	-0.9300	-4.3550
Observ.	1152	1152	1132	1704	1704	1620
Adj. R-sq	0.1590	0.1585	0.4255	0.1588	0.1598	0.5799

Table 4: Intra-industry Ratios of Trade and Affiliate Sales Industry Ratios

A. Affiliate Sales

$$MINTRA_i^j = \pi_1 CAP_i + \pi_2 LAB1_i + \pi_3 LAB2_i + \pi_4 LAB3_i + \pi_5 LAND_i + \pi_6 MINGDP_i + \pi_7 MAXGDP_i + \pi_8 FF_i^j + \sum_1^{64} \pi_{8+j} D^j + \mu_i^j$$

B. Trade

$$TINTRA_i^j = \rho_1 CAP_i + \rho_2 LAB1_i + \rho_3 LAB2_i + \rho_4 LAB3_i + \rho\gamma_5 LAND_i + \rho_6 MINGDP_i + \rho_7 MAXGDP_i + \rho_8 FF_i^j + \sum_1^{64} \rho_{8+j} D^j + e_i^j$$

DEP VAR	mintra	mintra	mintra	tintra	tintra	tintra
cap	0.0050			0.0094		
	0.623			1.210		
lab1	-0.0263			-0.0203		
	-2.055			-1.548		
lab2	-0.0171			-0.0209		
	-1.519			-1.987		
lab3	-0.0262			-0.0126		
	-3.383			-1.679		
land3	0.0198			0.0404		
	2.618			5.352		
dgpl		-0.0357			-0.0179	
		-4.305			-2.173	
dkl			-0.0827			-0.0475
			-6.625			-3.732
mingdp	0.0585	0.0607	0.0635	0.0201	0.0257	0.0244
	8.518	8.229	9.672	3.011	3.597	3.718
maxgdp	-0.0126	0.0234	0.0723	-0.0413	0.0036	0.0383
	-0.596	1.122	3.185	-2.446	0.228	1.988
ff	-0.0134	-0.0302	-0.0095	-0.0439	-0.0570	-0.0481
	-1.380	-3.083	-0.934	-4.657	-6.077	-4.993
Observ.	1132	1132	1132	1620	1620	1620
Adj. R-sq	0.2400	0.1785	0.1973	0.1824	0.1560	0.1610

Table 4: Intra-industry Ratios of Trade and Affiliate Sales
Country Aggregates

DEP VAR	cmintra	cmintra	cmintra	ctintra	ctintra	ctintra
cap	-0.0102			0.0218		
	-0.841			1.000		
lab1	-0.0421			-0.0009		
	-2.043			-0.025		
lab2	-0.0646			-0.0454		
	-3.901			-1.540		
lab3	0.0084			-0.0116		
	0.705			-0.552		
land3	0.0202			0.0380		
	1.660			1.700		
dgpl		-0.0588			0.0122	
		-1.937			0.320	
dkl			-0.0397			-0.0103
			-2.114			-0.435
mingdp	0.0466	0.0575	0.0507	0.0189	0.0268	0.0195
	4.450	3.769	3.108	1.016	1.380	0.939
maxgdp	0.0170	0.0464	0.0220	-0.0589	-0.0590	-0.0286
	0.803	1.082	0.757	-1.553	-1.083	-0.782
ff	0.0012	0.0054	-0.0175	-0.1509	-0.2018	-0.1974
	0.044	0.139	-0.478	-3.009	-4.032	-4.167
Observ.	27	27	27	27	27	27
Adj. R-sq	0.7798	0.5033	0.5163	0.4952	0.4394	0.4415

Table 5: Share of Affiliate Sales Sold Locally and Exported Home
64 Tradeables Industries, 27 Countries, 1989

COUNTRY	OUTWARD LOCAL RATIO	OUTWARD EXPORT HOME RATIO	INWARD LOCAL RATIO	INWARD EXPORT HOME RATIO
TOTAL	0.64	0.13	0.92	0.02
arg	0.76	0.04	1.00	0.00
aul	0.81	0.04	0.96	0.00
aus	0.51	(d)	0.90	0.02
bel	0.30	0.04	0.96	0.01
bra	0.83	0.09	0.72	0.11
can	0.65	0.32	0.91	0.02
col	0.77	0.12	1.00	0.00
den	0.51	0.12	0.91	0.02
fra	0.70	0.03	0.85	0.02
ger	0.60	0.03	0.88	0.04
hko	0.31	0.40	0.94	0.00
ire	0.25	0.08	0.96	0.00
ita	0.73	0.11	0.92	0.01
jap	0.83	0.09	0.90	0.04
mex	0.66	(d)	0.98	0.01
net	0.32	0.06	0.96	0.02
nor	0.30	(d)	0.92	0.03
nze	0.94	0.03	0.78	(d)
phi	0.65	0.15	1.00	0.00
sin	0.13	0.55	0.89	0.03
sko	0.61	0.30	0.94	0.03
spa	0.70	0.04	1.00	0.00
swe	(d)	(d)	0.91	0.02
swi	0.69	0.06	0.94	0.02
tai	0.54	0.30	0.83	0.13
uki	0.71	0.07	0.94	0.02
ven	0.99	0.01	0.94	0.01
AVGE	0.61	0.14	0.92	0.02

BEA	OUTWARD LOCAL RATIO	OUTWARD EXPORT HOME RATIO	INWARD LOCAL RATIO	INWARD EXPORT HOME RATIO
10	0.79	0.01	0.98	0.00
20	0.80	0.01	0.93	0.00
80	1.00	0.00	1.00	0.00
90	1.00	0.00	0.56	0.07
101	0.21	0.46	0.67	0.32
102	0.41	0.21	0.85	0.04
107	0.26	0.10	0.91	0.09
120	0.13	0.06	0.85	0.11
133	0.64	0.18	1.00	0.00
140	0.53	0.44	0.92	0.02
201	0.86	0.06	0.87	0.00
202	0.74	0.00	0.99	0.00
203	0.89	0.04	0.97	0.01
204	0.82	0.01	0.96	0.00
205	0.92	0.01	1.00	0.00
208	0.79	0.02	0.98	0.01
209	0.76	0.03	0.95	0.03
210	0.85	0.02	0.91	0.03
220	0.64	0.04	0.94	0.01
230	0.55	0.29	0.96	0.04
240	0.40	0.44	0.83	0.05
250	0.74	0.15	0.83	0.16
262	0.40	0.36	0.79	0.12
265	0.83	0.06	0.96	0.01
271	0.48	0.03	1.00	0.00
272	0.86	0.01	0.97	0.00
275	0.81	0.09	1.00	0.00
281	0.53	0.06	0.87	0.03
283	0.73	0.03	0.95	0.02
284	0.87	0.00	0.98	0.00
287	0.72	0.05	0.55	0.03
289	0.66	0.05	0.94	0.01
291	0.90	(d)	0.98	0.01
299	0.88	0.02	0.94	0.00
305	0.74	0.07	0.95	0.01
308	0.76	0.03	0.96	0.02
310	0.95	0.05	0.97	0.01
321	0.69	0.06	0.93	0.01
329	0.78	0.06	0.98	0.00
331	0.53	0.07	0.97	0.01
335	0.54	0.22	0.93	0.04
341	0.66	0.08	0.94	0.00
342	0.73	0.04	0.94	0.02
343	0.72	0.09	0.96	0.00
349	0.70	0.07	0.91	0.01
351	0.50	0.07	0.72	0.00
352	0.39	0.23	0.95	0.02
353	0.53	0.14	0.86	0.01
354	0.61	0.07	0.91	0.04
355	0.57	0.09	0.88	0.04
356	0.60	0.08	0.92	0.05
357	0.55	0.23	0.82	0.06
358	0.56	0.07	0.96	0.01
359	0.67	0.10	0.90	0.01
363	0.82	0.08	0.92	0.02
366	0.56	0.16	0.72	0.04
367	0.47	0.25	0.86	0.05
369	0.65	0.09	0.89	0.05
371	0.54	0.24	0.96	0.01
379	0.34	0.39	0.82	0.02
381	0.66	0.10	0.84	0.03
384	0.63	0.07	0.89	0.04
386	0.57	0.08	0.91	0.00
390	0.74	0.06	0.92	0.02
AVGE	0.66	0.11	0.90	0.03

(d) Suppressed

Table 6: Factor Proportions and Local and Export Affiliate Sales

A. Outward, Levels and Shares

$$OLSH_i^j = \omega_1 CAP_i + \omega_2 LAB1_i + \omega_3 LAB2_i + \omega_4 LAB3_i + \omega_5 LAND_i + \omega_6 GDP_i + \omega_7 USGDP + \omega_8 FF_i^j + \mu_i^j$$

$$OXSH_i^j = \lambda_1 CAP_i + \lambda_2 LAB1_i + \lambda_3 LAB2_i + \lambda_4 LAB3_i + \lambda_5 LAND_i + \lambda_6 GDP_i + \lambda_7 USGDP + \lambda_8 FF_i^j + \epsilon_i^j$$

B. Inward, Levels and Shares

$$ILSH_i^j = \kappa_1 CAP_i + \kappa_2 LAB1_i + \kappa_3 LAB2_i + \kappa_4 LAB3_i + \kappa_5 LAND_i + \kappa_6 GDP_i + \kappa_7 USGDP + \kappa_8 FF_i^j + \mu_i^j$$

$$IXSH_i^j = \tau_1 CAP_i + \tau_2 LAB1_i + \tau_3 LAB2_i + \tau_4 LAB3_i + \tau_5 LAND_i + \tau_6 GDP_i + \tau_7 USGDP + \tau_8 FF_i^j + \epsilon_i^j$$

	TOBIT	TOBIT	OLS	OLS	TOBIT	TOBIT	OLS	OLS
DEP VAR	outlsh	outxsh	outl	outx	ilsh	ixsh	inl	inx
cap	-0.0210	0.0169	0.0886	0.3025	-0.0032	-0.0008	0.0872	0.0629
	-1.740	2.098	1.180	2.398	-0.311	-0.161	0.804	0.453
lab1	-0.0379	-0.0093	-0.3719	-0.5606	0.0079	-0.0001	-0.1031	0.1534
	-2.024	-0.762	-3.152	-3.134	0.523	-0.019	-0.639	0.756
lab2	0.0534	-0.0362	-0.2002	-0.1693	-0.0490	0.0141	0.1928	0.3724
	3.289	-3.430	-1.935	-1.064	-2.950	1.844	1.107	1.600
lab3	0.0517	0.0280	0.2412	0.2289	0.0035	0.0049	-0.5310	-0.3875
	4.579	3.811	3.347	2.085	0.311	0.919	-4.446	-2.392
land	-0.0896	0.0119	-0.2053	0.2710	0.0096	-0.0022	0.0056	0.3714
	-8.305	1.647	-3.044	2.485	0.948	-0.467	0.053	2.476
gdp	0.0544	0.0058	0.7746	0.2087	-0.0259	0.0174	0.6086	0.5309
	5.546	0.911	12.673	2.183	-2.778	4.078	6.193	4.186
usgdp	0.0177	-0.0620	0.9502	0.1179	0.0319	-0.0167	0.7015	-0.2163
	1.575	-8.509	7.561	0.587	3.316	-3.761	3.483	-0.810
ff	1.2310	-0.3163	-0.3241	-0.9720	1.2947	-0.1819	-0.2032	-0.3276
	7.131	-2.768	-4.649	-9.145	7.874	-2.388	-2.007	-2.339
Observ.	1017	1017	994	694	596	596	590	370
Adj. R-sq	0.1329	0.3521	0.2110	0.1694	0.1780	0.1228	0.1683	0.1069
Log like	-416.9	-110.5			-64.185	174.61		

Appendix: BEA Industry Definitions

010	Crops
020	Livestock, animal specialties
080	Forestry
090	Fishing, hunting, trapping
101	Iron ore
102	Copper, lead, zinc, gold, silver
107	Other metallic ores
120	Coal
133	Crude petrol extraction, natural gas
140	Nonmetallic minerals, except fuels
201	Meat products
202	Dairy products
203	Preserved fruits and vegetables
204	Grain mill products
205	Bakery products
208	Beverages
209	Other food and kindred
210	Tobacco products
220	Textile mill products
230	Apparel and other textile products
240	Lumber and wood products
250	Furniture and fixtures
262	Pulp, paper, board mill products
265	Other paper and allied products
271	Newspapers
272	Miscellaneous publishing
275	Commercial printing and services
281	Industrial chemicals and synthetics
283	Drugs
284	Soap, cleaners, toilet goods
287	Agricultural chemicals
289	Chemical products, nec
291	Integrated petroleum refining and extraction
299	Petroleum and coal products, nec
305	Rubber products
308	Miscellaneous plastics products
310	Leather and leather products
321	Glass products
329	Stone, clay, concrete, gypsum, other nonmetallic mineral products
331	Primary metal products, ferrous
335	Primary metal products, nonferrous
341	Metal cans, forgings, stampings
342	Cutlery, hardware, screw products
343	Heating equipment, plumbing fixtures, structural metal products
349	Metal services; ordnance; fabricated metal products, nec
351	Engines, turbines
352	Farm and garden machinery
353	Construction, mining, and materials handling machinery
354	Metalworking machinery
355	Special industrial machinery
356	General industrial machinery
357	Computer and office equipment
358	Refrigeration and service industry machinery
359	Industrial and commercial machinery, nec
363	Household appliances
366	Household audio, video, communications equipment
367	Electronic components and accessories
369	Electrical machinery, nec
371	Motor vehicles and equipment
379	Aircraft, motorcycles, bikes, spacecraft, railroad
381	Measuring, scientific, optical instruments
384	Medical and ophthalmic instruments and supplies
386	Photographic equipment and supplies
390	Miscellaneous manufacturing

DISTRIBUTION OF US TRADE & AFFILIATE SALES BY PARTNER'S GDP RANK

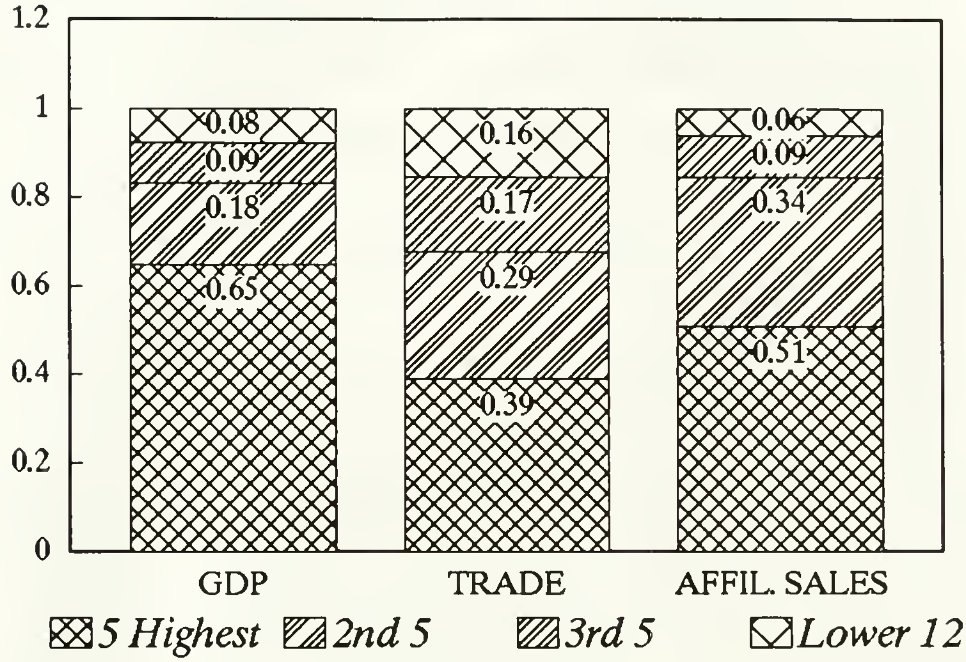

Figure 1a

DISTRIBUTION OF US TRADE & AFFILIATE SALES BY PARTNER'S PER CAPITA INCOME RANK

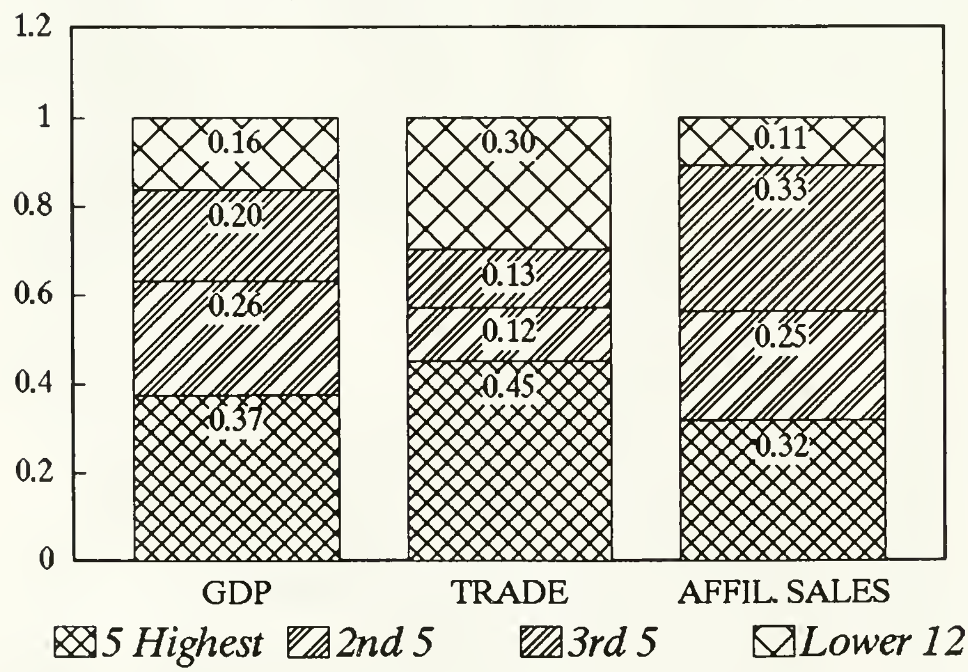

Figure 1b

INTRA – INDUSTRY RATIOS OF TRADE AND AFFILIATE SALES

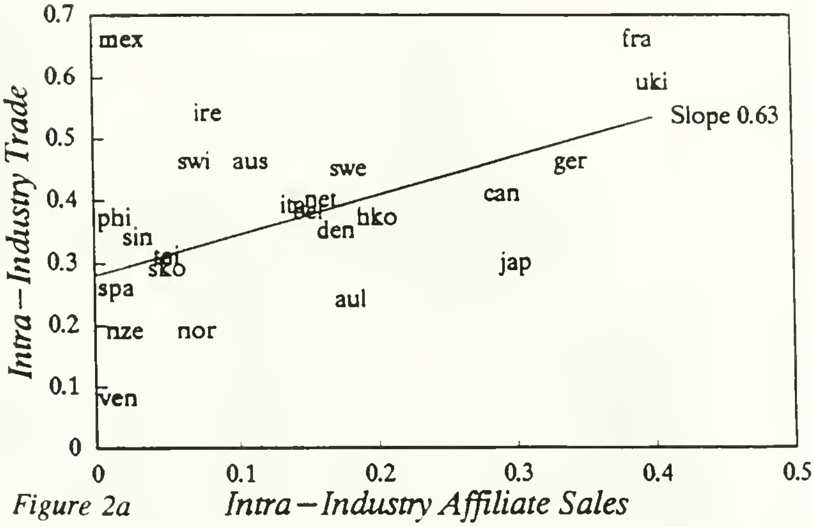

Figure 2a

INTRA – INDUSTRY AFFILIATE SALES RATIOS By Country, 1989

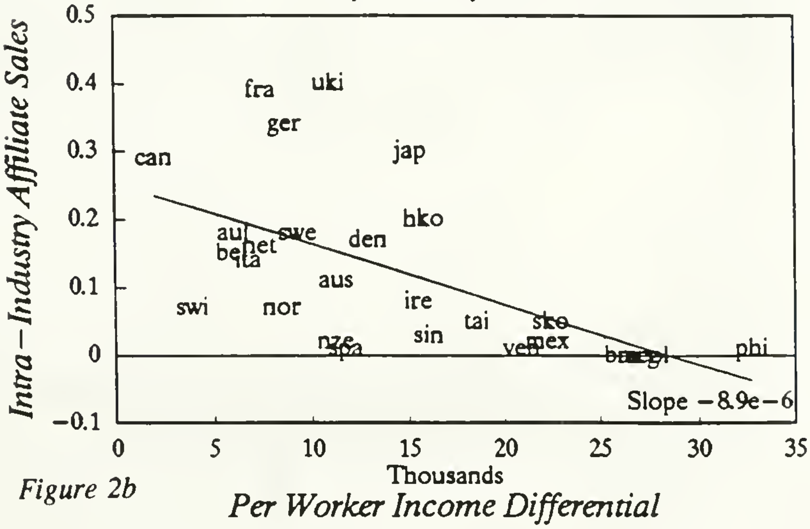

Figure 2b

INTRA – INDUSTRY TRADE RATIOS By Country, 1989

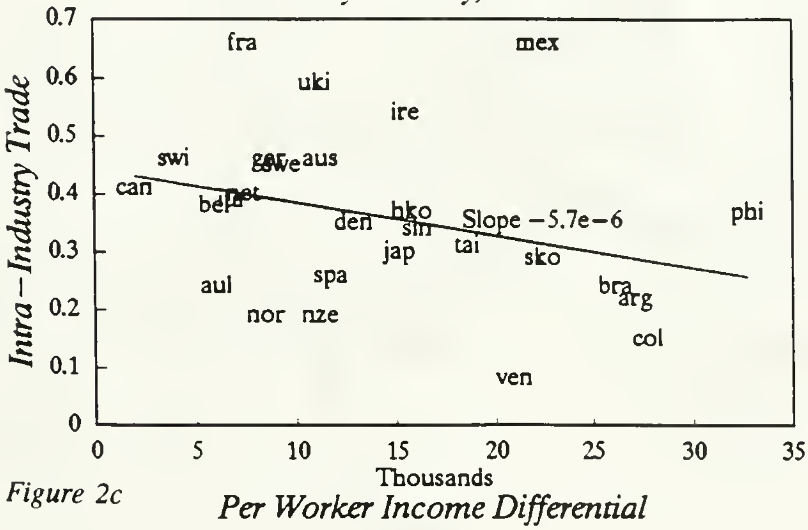

Figure 2c

TWO-WAY TRADE RATIOS BY INDUSTRY AVERAGED OVER COUNTRIES

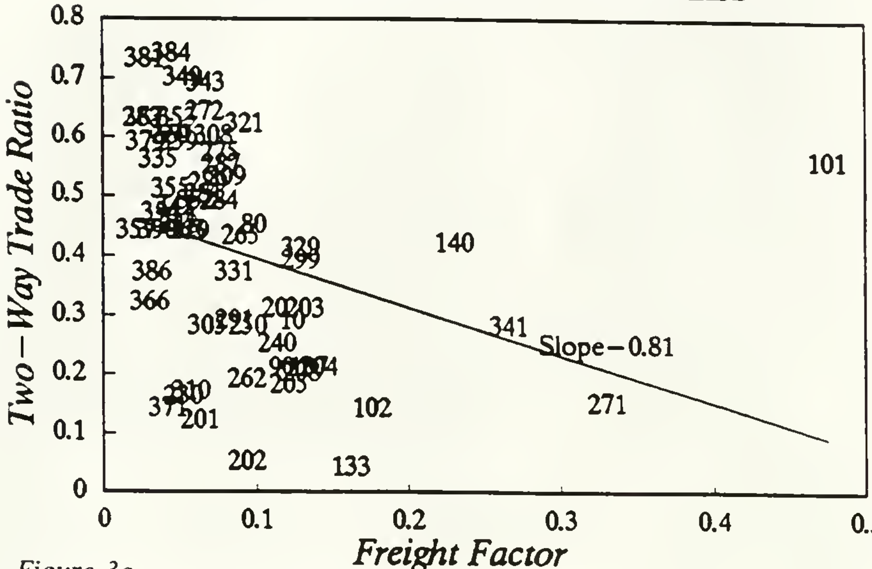

Figure 3a

2-WAY AFFILIATE SALES RATIOS BY INDUSTRY AVERAGED OVER COUNTRIES

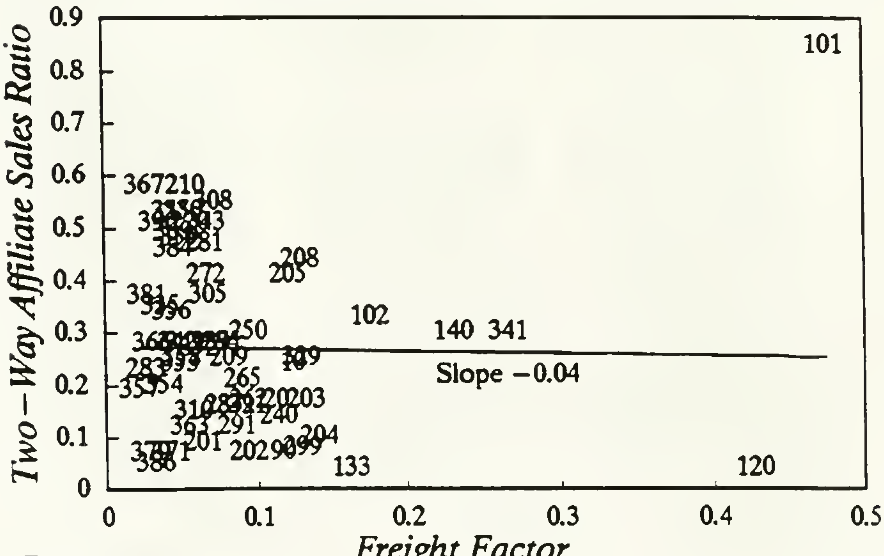

Figure 3b

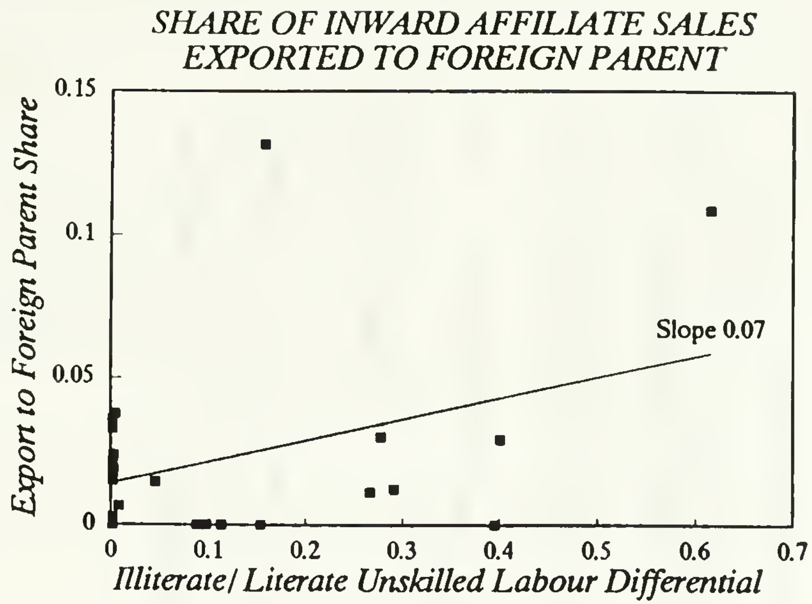

Figure 4a

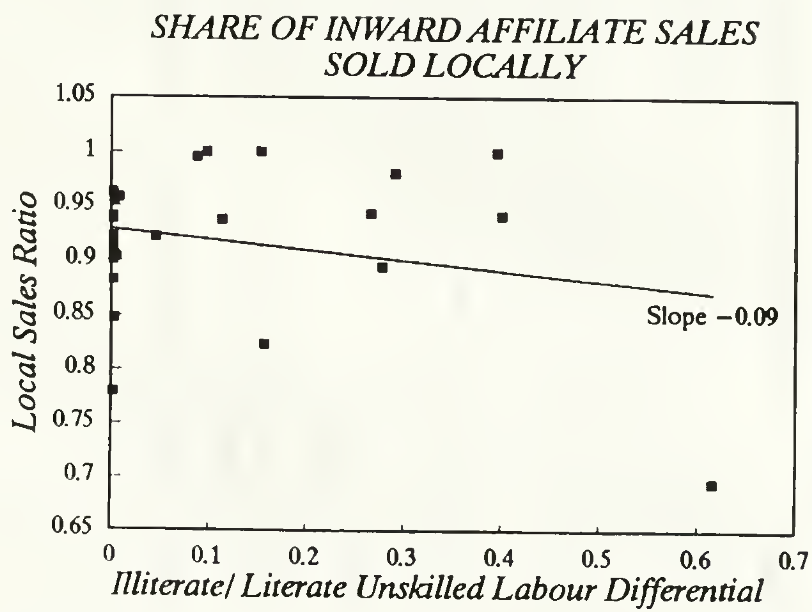

Figure 4b

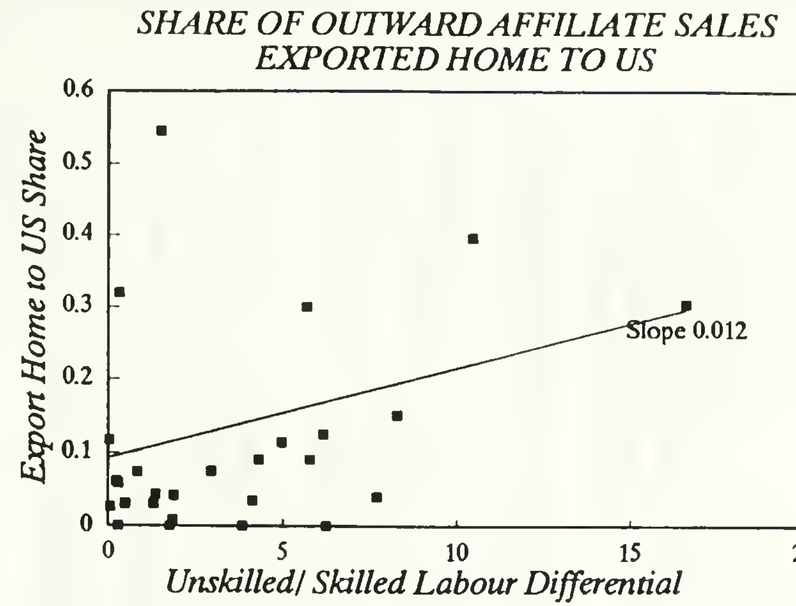

Figure 4c

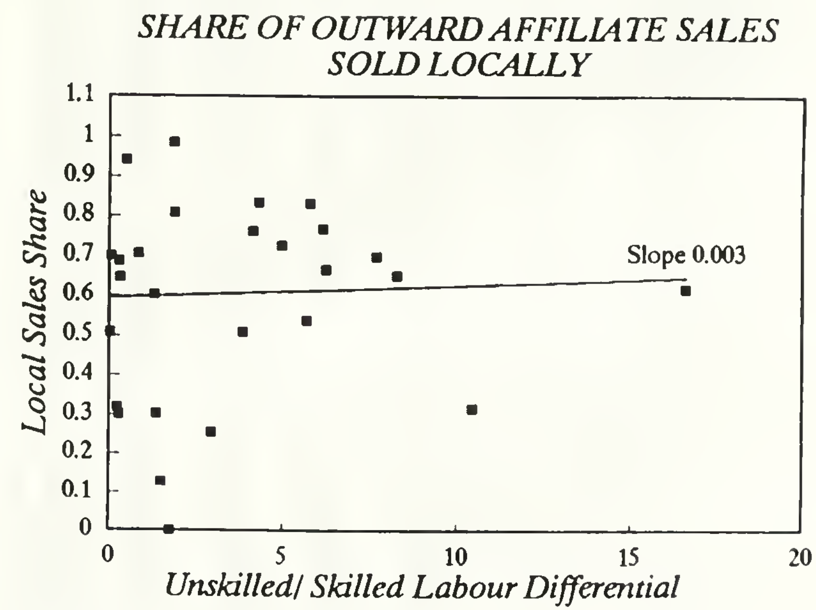

Figure 4d

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