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U.S. MULTINATIONALS AND COMPETITION FROM LOW WAGE COUNTRIES

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ABSTRACT

It is often argued that the globalization of production places workers in industrialized countries in competition with their counterparts in low wage countries. We examine a firm-level panel of foreign manufacturing affiliates owned by U.S. multinationals between 1983 and 1992 and find evidence to the contrary. Affiliate activities in developing countries appear to be complementary to rather than substituting for affiliate activities in industrialized countries. Workers do compete across affiliates, but the competition is between affiliates in countries with similar workforce skill levels. The results suggest that multinationals with affiliates in countries at different stages of development decompose production across borders into complementary stages that differ by skill intensity. The implied complementarity of traded intermediate inputs has important implications for the empirical debate over trade, employment, and wages.

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I. Introduction

Reductions in the costs of international trade have reportedly set off an exodus of low skill, labor-intensive manufacturing to developing countries. The removal of trade barriers, declining transport costs, and advances in communications technology have made it possible to divide production into component stages, locate these production stages in separate countries, and then trade the resulting intermediate goods across borders. Some observers claim that these developments have led to a diminishing demand for less skilled workers in industrialized countries, as multinational firms substitute toward workers in developing countries in what has been memorably termed the "great sucking sound."

The globalization of production at the firm level is an important and underresearched issue in the current debate over the impact of trade on relative wages and the location of manufacturing employment across countries.[1] The stylized facts that over half of total trade is in intermediate goods (Markusen, 1989) and that the majority of international trade is controlled by multinational enterprises (Rugman, 1988) motivate a close empirical examination of these enterprises. With access to the proprietary technologies, financing and markets of their U.S. parents, foreign affiliates may either compete with each other as alternative suppliers of the same set of final products or complement each other by supplying different components of the same final goods.

At first glance, the relative aggregate employment growth of U.S.-owned multinationals across their foreign affiliates between 1983 and 1992 appears to support concerns that increased overseas production is the result of a wage competition with less developed countries. The employment of U.S.-owned multinationals increased by 11 percent in developing countries, decreased by 3.5% in industrialized countries outside the United States, and decreased by 12.5% in the United States. During the same time, wages in industrialized countries have grown 20 percent relative to those paid in

[1] For a review of the trade and wages literature, see Deardorff and Hakura (1994).

developing countries, starting from a higher initial base.

However, the aggregate numbers misrepresent firm-level realities. Only a third of U.S.-owned multinational firms has any production activities in developing countries. And of the subset of firms that has employees in developing countries, employment in industrialized country affiliates actually *increased* 13 percent between 1983 and 1992, compared to the above-mentioned 11 percent employment growth in developing country affiliates and a marginal decline in parent employment of only 3 percent. Although the global scale of production of these multinational firms has fluctuated over time, the *proportions* of employment located at industrialized and developing country affiliates has remained relatively fixed.

Anecdotal descriptions of multinationals as well as more formal evidence suggest that these fixed proportions reflect a vertical decomposition of production across borders to exploit international factor price and skill differences.[2] Skill-intensive production stages are located in industrialized countries, while labor-intensive activities such as assembly are located in developing countries.

Using a large firm-level panel dataset from the Bureau of Economic Analysis (BEA), we examine the pattern of production across affiliates as reflected in the firm's employment in each location and its sensitivity to fluctuations in relative wages. The dataset reports the production and employment of U.S.-owned multinationals in each of 90 countries from 1983 to 1992. The evidence confirms a significant cross-border relationship at the firm-level between relative wages and employment shares; however, the North-South relationship is one of complementarity rather than competition. Cross-wage elasticities of labor demand are *positive* and statistically significant among affiliates in countries at similar stages of development (i.e., North-North and South-South), indicating that workers at similar locations produce goods which are substitutes through trade. In contrast, cross-

[2] For example, Flamm (1984) examines the practice of vertically decomposing production of multinationals in the semi-conductor industry.

wage elasticities of labor demand are *negative* between affiliates in industrialized and developing countries (i.e., North-South), indicating that workers at locations with different levels of development are likely engaged in complementary activities, such as parts production and assembly.[3] This evidence runs contrary to the zero-sum claim that multinationals are "exporting" U.S. jobs to low wage countries.

We also estimate labor demand relationships separately for a number of manufacturing industries. There is evidence of North-South complementarity in the electronic components, food products, plastic products, glass products, service industry machinery, apparel, photo equipment, and medical instruments industries. In addition, there is a high South-South wage elasticity in the first four of these industries. On the other hand, the labor demands of affiliates in resource-intensive chemical industries do not appear to be linked internationally, i.e., the location of employment is not sensitive to variation in relative labor costs across countries.

In earlier work that looks at employment relationships across parents and affiliates using a translog estimation approach, Brainard and Riker (1995) similarly find that strong substitution relationships characterize employment at alternative developing country affiliates, while there is weak substitution between parents and affiliates and often complementarity between affiliate locations at different stages of development.

In a related literature, Feenstra and Hanson (1995a) find that outsourcing, more broadly defined as all imported intermediate or final goods that are used in U.S. production, has a positive effect on the relative demand for skilled workers in the United States. This result is consistent with the model and findings of our study, though we do not focus upon the relative demands for more skilled and less skilled workers within countries due to data constraints. In a companion paper,

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[3]Markusen (1989) and Lopez-de-Silanes, Markusen and Rutherford (1994) model the theoretical implications for trade policy when there is trade in complementary intermediate goods. They emphasize that complementarity reverses conventional results.

Feenstra and Hanson (1995b) find that foreign direct investment in Mexico increased the relative demand for skilled workers in that country. This result is similarly consistent with our model and results (the less skill-intensive production or assembly processes that multinationals locate in developing countries may well be skill-intensive relative to indigenous production activities).

II. Conceptual Framework

Consider a firm producing manufactures in a number of countries. The firm chooses a geographical configuration of production and employment with respect to the location of product demand and the set of relative factor prices. Labor demand in each affiliate is derived from the international trade in intermediate and final goods that links the firm's production locations.

Multinational producers typically sell a differentiated product or range of products in a number of national product markets. Each firm is assumed to face the following downward-sloping demand curve for final product Q in market I:

$$Q_i = Y_i - P_i$$

where Y_i is aggregate demand in country I and P_i is the price in the national market. The firm's market power reflects ownership of a proprietary non-rival asset in production, such as a unique and protected technology, an established distribution network, or brand recognition.

Production requires both highly skilled and less skilled workers. Labor markets are segmented by legal and cultural barriers to international migration. National labor markets are assumed to be competitive, and therefore the wage of less skilled workers in country i, W_i, is taken as given by each individual firm. The cost of highly skilled workers in country i, $(W_i/E_i)(1+m)$, is increasing in the wage of the less skilled, decreasing in educational attainment, E_i, and increasing in

the wage premium paid to skilled workers, m, which is assumed to be constant across countries. The effect of formal education on the cost of skilled workers can be interpreted either as a direct increase in productivity from skills learned in school or alternatively as an indirect reduction in the costs of further training workers in firm-specific technologies.

The firm's final product encompasses two vertical production stages: basic production, which is denoted B, and assembly, denoted A. Assembly requires only less skilled workers, L_l. Basic production is more sophisticated, requiring highly skilled workers, L_h and less skilled workers. For the sake of a simple, illustrative model, we assume the following two-stage, fixed proportions production technology:

$$Q = \min[A,B], \quad A = L_l, \quad B = \min[L_h, L_l]$$

The assumption of fixed proportions is extreme, but it is probably a reasonable description of the technological relationship between parts and assembly.[4] This assumption highlights the more general point that substitution between different vertical stages of production is low relative to the case where A and B are non-differentiated stages.

If production is vertically decomposed across different countries, there is international trade in intermediate goods.[5] Assume the firm faces costs to shipping goods across borders. Following Dornbusch, Fischer and Samuelson (1977), we assume these trade costs to be of the "iceberg" variety: G goods shipped across borders results in tG goods received, where $t < 1$. This "melting" of exports represents a variety of barriers to trade as well as freight charges.

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[4] While this assumption of low substitution *between production stages* is crucial to the results, fixed proportions in *factor requirements* is only a simplifying assumption.

[5] Helpman and Krugman (1985) provides a general equilibrium trade model of multinational production in the factor proportions tradition. In contrast, the model above does not endogenize wage determination, though the wage of unskilled workers might be determined by productivity in a constant returns (in labor) agricultural sector that is open to the world market, for example.

Define the amount of assembled output produced in location i and used in location j as a_{ij}, where $A_i = \sum_j a_{ij}$, and similarly for unassembled parts, b_{ij}. The fixed proportions technology implies that the quantity of domestic output of either production stage net of exports is equal to the sum of the domestic output of the second stage and any imports:

$$(1) \qquad Q_i = M_i - \sum_{c \neq i} m_{ic} = N_i + \sum_{c \neq i} t\, n_{ci} \quad \forall \text{ country } i$$

where $m=a$ if the affiliate in country i is a net exporter of assembly services, $n=b$ if the affiliate is a net exporter of parts, and vice versa.

A firm that can feasibly decompose production across borders therefore maximizes the following global profit objective, which is the sum of revenues across its various locations of production net of production costs:

$$\Pi = \sum_i \left([\, Y_i \,][\, Q_i \,] - [\, Q_i \,]^2 - [W_i \,]\, A_i - \left[\frac{W_i(1+m+E_i)}{E_i} \right] B_i \right)$$

subject to the production technology and the set of trade flow relationships in equation (1). The optimal labor demand of firm f in each country responds to what might be called a *relative product wage*: the multinational's reduced-form labor demand for a given affiliate location i is a weighted sum of labor cost (W) and aggregate demand (Y) conditions across its set of affiliate locations. This labor demand relationship can be represented in the following reduced-form:

$$(2) \qquad L_i^f = \alpha_i^f + \beta_0 W_i + \gamma_0 Y_i + \sum_{c \neq i} [\beta_{ic}\, W_c + \gamma_{ic}\, Y_c]$$

Total labor demand of firm f in location i, $L^f{}_i$, is divided between less skilled and highly skilled workers in fixed proportion, by the assumed technology. In the empirical work below, we do not

distinguish between workers by skill level because this distinction is not observed in available data; however, we have done so in this model in order to rationalize vertical decomposition of production activities and the corresponding relationship of total labor demands across countries within the firm. If the vertical organization of production across countries were directly observed, then testing the hypothesis of vertical decomposition would be trivial.

Instead, restricted versions of these β weights are the focus of our empirical analysis. These cross-elasticities of labor demand[6] depend on whether production is in fact decomposed across affiliate locations into component stages of production, which in turn depends on relative costs of training, relative wages, relative skills, and the costs of trade. Notice that the difference between levels of educational attainment in countries i and c is implicit in the cross-elasticities β_{ic} through its effect on the location of different production stages. We illustrate this relationship with a simple two-country example of a firm with production facilities in the North and South, denoted by subscripts n and s respectively.

Under the assumed linear production technology, the location of production stages depends on the international relative wages and relative skill levels of workers if trade barriers are not prohibitive. Assembly is produced in the low wage location if there is intra-firm trade, and in both countries otherwise. The cost of producing skill-intensive parts in country c is $[(W_c / E_c)(1+m+E_c)]$. Therefore, parts are produced in the North if $t(W_N/E_N)(1+m+E_N) < (W_S/E_S)(1+m+E_S)$ and in the South if $t(W_S/E_S)(1+m+E_S) < (W_N/E_N)(1+m+E_N)$. These inequalities define regions in the space of these relative country characteristics that are illustrated in Figure 1. If North-South trade were completely liberalized (i.e., $t=1$), the model would collapse to only two inequalities.

The pattern of multinational production and the corresponding pattern of intra-firm trade is determined by the relative country characteristics and the size of transport costs. There are four

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[6] The coefficients are elasticities if equation (2) is log-linear in the variables.

empirically relevant regions, which are numbered in Figure 1, while the remainder is shaded gray. In region I, all assembly is located in the South, while parts production is located in both the North and the South due to costs of trade that exceed the relative production cost advantages of the North. There is technological diffusion in the sense that the skill-intensive technology employed in parts production in the North is also used in the South. In region II, differences in educational attainment in excess of transportation cost differences lead to complete specialization in assembly: all assembly is located in the South but skill-intensive production is located in both hemispheres. In region III, international differences in wages and education levels are overwhelmed by transportation costs. Production is horizontally rather than vertically decomposed, and multinationality is motivated solely by proximity to product markets.[7] In region IV, skill-intensive production is concentrated in the North, while assembly is located in both hemispheres to avoid the costs of re-exporting assembled parts. Notice that in regions I, II, and IV, the firm chooses a vertical decomposition of production to optimize over relative wages and skills, leading to complementarity in labor demands between locations.

In this simple two-country case, the firm's labor demand in each location can be expressed as:

$$(3) \qquad L_i^f = \alpha_i^f + \beta_0 W_i + \beta W_j + \gamma_0 Y_i + \gamma_{ij} Y_j$$

Within regions I, II, and IV, the firm's labor demand in each location exhibits the following qualitative characteristics: it is (i) decreasing in the wage in that location, $\beta_0 < 0$; (ii) decreasing in W_j, the wage in the other location, $\beta < 0$; (iii) increasing in local aggregate demand, $\gamma_0 > 0$; (iv) increasing in foreign aggregate demand, $\gamma_{ij} > 0$; and (v) decreasing in the costs of globally-hired factors, $\delta < 0$. On the other hand, if production is not vertically decomposed, as in region III, then $\beta \geq 0$.

[7] Region III applies to the large fraction (40 percent) of affiliates of U.S-owned multinationals located in Europe. Brainard (1993) empirically investigates horizontal multinationals.

A *ceteris paribus* drop in Southern wages **within** regions I, II, or IV, due for example to a devaluation of the Southern currency, reduces the cost of assembly in the South without causing substitution from assembly workers in the North, and therefore results in an unambiguous *increase* in the demand for labor in the North. On the other hand, wage changes that move the economies *across* the region boundaries typically lead to international labor substitution, as a stage of production is relocated across hemispheres. Therefore, the effect of a decline in Southern wages depends both on the initial position in Figure 1 and the size of the innovation. Within region III, wage changes do not have international effects because production in each affiliate is not linked by trade.

In regions I, II, and IV, there is complementarity in labor demands between affiliates in the North and affiliates in the South even between identically skilled workers. This complementarity is driven by the vertical relationship between the production processes in which the workers are engaged, rather than by skill differences. Managers and skilled production workers are complements to less skilled assembly workers, but so are the less skilled production workers whose activities are integral to the skill-intensive production process.

The linear model is simple, but the corner solutions that it imposes are likely unrealistic. The model can be generalized to allow for multiple affiliates engaged in the same production stage and linked by intra-firm trade, by allowing for convex costs of trade or costs of adjusting production capacity that limit North-North and South-South labor substitution. Such capacity constraints no doubt bound the labor substitution observed between affiliates in developing countries that function as "export platforms" (Brainard and Riker, 1995). For firms that are horizontally rather than vertically integrated across affiliates, capacity constraints and trade costs limit substitution but cannot explain North-South complementarity.

To make estimation tractable, the labor demand specification in equation (3) can be extended to the case of multiple affiliates (in both industrialized and developing countries) by constructing

composite measures of wages for affiliates in countries with similar skill endowments to replace the single country wage measures of equation (3). Define for affiliate i the composite measure of affiliate wages in countries with similar skill endowments as W_{is} and the composite measure of affiliate wages in countries with different skill endowments as W_{id}:

$$W_{is} = [\sum_j \omega_j^f W_j], \quad W_{id} = [\sum_k \omega_k^f W_k]$$

where j indexes other affiliates in countries with a similar average skill level as i, and k indexes other affiliates in countries at different skill levels. The ω_c^f are firm-specific weights for each country c related to the firm's production capacity in that location. In the econometrics below we use measures of the firm's lagged employment in each country as weights on these "other affiliate" wages. The general form of equation (3) extended to include multiple affiliates in developing and industrialized countries is therefore:

$$(4) \quad L_{it}^f = \alpha_i^f + \beta_i(E_i) W_{it} + \beta_s(E_s) W_{ist} + \beta_d(E_d) W_{idt} + \gamma Y_{it} + \gamma'(\sum_j Y_{jt})$$

Notice that the simplifying assumption that γ_{ic} is constant for all $i \neq j$ implies that $\gamma = \gamma_0 - \gamma'$ and the term $\gamma' \sum_j Y_j$, the size of the global product market, is captured by time fixed effects. Vertical decomposition to take advantage of skill endowment differences implies that $\beta_s > 0$ and $\beta_d < 0$.

III. Data

We base our empirical analysis on firm-level data from the *Annual Survey of U.S. Direct Investment Abroad*, which is administered on a mandatory basis and audited by the Bureau of Economic Analysis. The dataset is a three-dimensional panel in which the production activities of each

firm's affiliates in up to ninety countries are tracked over a ten-year period ending in 1992, summing to approximately 60,000 firm-country-year observations. We include all firms in manufacturing industries. Our operational definition of *firms* is based on both ownership and industry-of-sales criteria: it is a grouping of affiliates that share a common U.S. parent whose sales are classified in the same three-digit ISI manufacturing industry. We choose this definition in order to group production sites that can plausibly serve as alternative supply sources either for the same differentiated final product or for intermediate goods that are components of the same final product. Because the data does not consistently group related intermediate and final goods in the same three-digit product category, our definition of the firm no doubt imperfectly achieves this objective. By this definition, many of the firms do not have observation for employment in the United States, because the U.S. parent is classified in a different industry. U.S. parents are generally diversified across industries, making an industry-specific employment comparison with foreign affiliates difficult. Therefore, we exclude U.S. parent employment from the empirical analysis that follows and focus instead upon the interrelation of labor demands of foreign affiliates.

This firm-level panel has not been previously analyzed in econometric studies, with the exception of Brainard and Riker (1995), though Lipsey, Kravis, and Roldan (1982) examines a cross-section in a study of the relative factor proportions of affiliates. In addition, we use aggregate private consumption of each country from the *World Tables* as a measure of aggregate demand. Measures of national average educational attainment from Barro and Lee (1993) are used in grouping countries as a proxy for national average skill levels.

Table 1 reports the distribution of employment across affiliate locations.[8] We group countries into seven geographical regions and two educational attainment classifications (based on the 1985

[8]The data are geographically disaggregated at the country-level, and therefore throughout the paper the term *locations* refers to countries.

Barro-Lee numbers) that define the rows and columns of the Table. In each cell we report aggregate affiliate employment in each geographical region in 1992, each region's share of global affiliate employment in 1992 (which does not include parent employment in the United States), and the rate of growth in the region's employment between 1983 and 1992.[9] By educational level, nearly two thirds of affiliate employment was located in countries with high average educational attainment, primarily in Europe. However, employment is shifting towards countries with lower educational attainment: affiliates in countries with low educational attainment grew 13 percent over the decade, while affiliate employment in countries with high educational attainment contracted by 12 percent. By region, the greatest concentration of employment was in Europe, with 41 percent of the total, followed by North America, which accounted for one quarter of total affiliate employment. Within North America, affiliate employment has grown 45 percent in Mexico (shown in the low educational attainment column) while contracting 18 percent in Canada (shown in the high educational attainment column) over the sample period. Declines in Europe, South America, and Africa were offset by job creation in the less educated countries of Asia, where affiliate employment has boomed from low initial levels, and in the highly educated countries of Northeast Asia.

Table 2 reports the average dollar-denominated compensation per affiliate employee for the same country groups.[10] Large differences across countries by level of educational attainment (in excess of a multiple of 3) are reported for North America and Northeast Asia, with smaller though still substantial differences (a multiple of 2) for Southeast Asia and the Near East. Although the wage gap between China (reported in the low educational attainment Northeast Asia cell) and Japan (reported in the high educational attainment Northeast Asia cell) remains considerable, Table 1 indicates that most

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[9] *Countries with Low Educational Attainment* are defined as countries whose national average schooling in 1985 was less than six years according to the calculations of Barro and Lee.

[10]Throughout Section III, we refer to these constructed measures of labor costs as *wages*.

affiliate employment has remained in Japan and the Asian NICs (reported in the low educational attainment Southeast Asia cell), no doubt reflecting non-wage deterrents to direct investment in China during the 1983-1992 survey period.

Figure 2 displays the evolution of average wages relative to U.S. parent wages over the sample period for affiliates in high educational attainment countries, termed "industrialized," and low educational attainment countries, termed "developing." Relative wages of affiliates in industrialized countries have risen considerably to 90 percent of parent wages, reflecting the depreciation of the dollar between 1985 and 1992. Average wages of affiliates in developing countries, on the other hand, have increased only slightly, remaining below 40 percent of parent wages.[11]

Table 3 disaggregates the multinationals' global employment by three-digit industry classifications. The first column reports the 1992 share of industry employment in countries with low average educational attainment, developing countries. The second column reports the change in the industry's share of employment in developing countries between 1983 and 1992, and the third column reports the industry's global employment in 1992 (which includes parent employment in the United States). With 35 percent and 24 percent of employment in developing countries respectively, other foods and glass have both the highest concentrations of workers in developing countries and the fastest growth in the developing country share. Electronic components similarly has a large concentration, 20 percent, of employment in developing countries, but that share declined slightly over the 1980s. With 1.6 million workers, the motor vehicles industry is by far the largest employer abroad, more than twice the size of the next largest beverage, industrial chemical, electronic component and office equipment industries.

In summary, though the vast majority of foreign affiliate employment is located in

[11] Wages in individual countries within the groupings have fluctuated considerably more than these averages.

industrialized countries with developed product markets and rising relative wages, approximately a third of the firms simultaneously maintain affiliate production facilities (within the same three digit industry) in developing countries. The latter group is the focus of the labor demand analysis reported below. The geographical dispersion of production within the firm suggests that at least some of the firms decompose production into differentiated stages to take advantage of wage and skill differences across countries. Moreover, affiliate employment shifted from more developed to less developed countries over the sample period, at the same time that average wages rose in the more developed countries relative to the less developed countries.

IV. Estimation

In estimating the multinationals' labor demands, we focus on the subset of firms that have affiliates in both developing and industrialized countries, as these are the expected boundaries of

$$(5) \qquad \ln L_{it}^{f} = \alpha_i^{f} + \beta_0 \ln W_{it} + \beta_s \ln W_{ist} + \beta_d \ln W_{idt} + \gamma \ln Y_{it} + \gamma' \sum_j Y_{jt} + \varepsilon_{it}^{f}$$

vertical decomposition. We estimate a log-linear version of equation (4) using ordinary least squares:[12] Equation (5) includes affiliate dummy variables (firm-country-industry fixed effects) to remove the influence of affiliate characteristics, α_i^f, that are fixed at the affiliate or any broader level (e.g., the firm or industry-level) but are not observed in the data.[13] In addition, we control for year and firm

[12] We correct for heteroskedasticity in the error term. The error term may predominantly reflect firm optimization errors or omitted factors that are observed by the firm but not recorded in the survey. We assume these unobservables are uncorrelated with wages and GDP of the affiliate locations, and are not serially correlated. Otherwise, there would be a simultaneity bias from using lagged employment as weights in the wage composites. The coefficients were also estimated with unweighted wage composites, and the qualitative results were robust. In addition, a Durbin-Watson test did not reject the null hypothesis of no serial correlation in the error terms.

[13] Within estimation should go part way toward controlling for physical plant that is firm-location-specific, approximately fixed over time, but not reported in the dataset.

effects, in order to control respectively for global demand innovations as well as firm-specific costs of global factors such as managers, internationally mobile capital and traded raw materials.

An alternative form of heterogeneity in the multinational labor demand relationship involves allowing the "slope" terms β and γ to vary across the sample (i.e., relaxing the pooling restrictions). Accordingly, we estimate the model of labor demand separately for affiliates in countries with high and low educational attainment and for industry sub-pools of affiliates.

The compensation-per-employee measure, constructed at the affiliate level, may reflect the firm's demand shocks thus leading to biased estimates of the coefficients in equation (5). To avoid potential bias, we construct a country-year wage that is the average of compensation per employee paid by all *other* U.S. multinational manufacturing affiliates in the same country and year.[14] [15]

The wage composites separate countries into two groups by average educational attainment, with the cutoff at an average of six years of education. If instead we averaged all affiliate wages into a single regressor, the larger, more numerous affiliates in industrialized countries would dominate, leading to the spurious finding that workers are substitutes among *all* affiliate locations, rather than only among locations at the same level of educational attainment. The data rejects this restriction.

We also separated the wage composite by location as well as education to consider whether affiliate employment is more sensitive to wage changes in neighboring countries than in locations on different continents. The data did not reject the null hypothesis that there is no difference in sensitivity.

In addition, we control for the size of the local product market by including measures of

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[14] The functional form used in aggregating the wage measures across affiliates is a geometric weighted average, with one-year-lagged firm employment shares as weights.

[15] An alternative approach would use a separately calculated measure of manufacturing wages in each country. However, international wage measures available from the Bureau of Labor Statistics do not cover many of the developing countries that are crucial to our analysis. The correlation between our constructed measures and BLS wages (for countries for which the data are available) is 0.9.

aggregate private consumption in the labor demand regression. Both wages and demand are measured in dollars and are deflated using a U.S. producer price deflator (for intertemporal comparisons).

If trade costs were prohibitive, as would be the case with a high local content requirement, labor demand would be entirely local and could be represented as the standard neoclassical function of the local product wage.[16] Purely local labor demand implies zero restrictions on the coefficients β_s and β_d that measure the effects of foreign wage innovations. On the other hand, if production were horizontally- rather than vertically-integrated across borders and trade costs were not prohibitive, labor in different countries would serve as substitutes, implying $\beta_s = \beta_d > 0$. These are the alternative hypotheses to the prediction of $\beta_s > 0$ and $\beta_d < 0$ associated with vertically integrated production.

The results from fitting equation (5) to the full sample of manufacturing firms are reported in Table 4, pooled separately for affiliates in industrialized and developing countries.[17] The estimated coefficients indicate statistically significant North-South complementarity in labor demands. In the first column, a ten percent decline in wages in developing country affiliates results in an *increase* in employment in industrialized countries by 1.9 percent, while the same decline in affiliate wages in industrialized countries *decreases* employment in alternative industrialized country affiliates by 1.5 percent. On the other hand, employment appears to be more "footloose" between affiliates located in developing countries: the elasticity of labor demand to wage changes in affiliates at the same level of educational attainment is greater for affiliates in developing countries (shown in the second column).[18]

Moreover, for industrialized country affiliates, ten percent growth in local aggregate demand

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[16]This local model also applies in the absence of trade costs if products are customized for each product market and customization requires de-centralized production.

[17] The standard errors reported in Table 4 are robust to heteroskedasticity that varies by country-year grouping.

[18] A similar finding is reported in Brainard and Riker (1995) using a different econometric approach.

increases local affiliate employment by 8.3 percent. Comparing across the two columns, affiliate employment in industrialized countries is much more sensitive to local product market demand that in developing countries.

The fundamental empirical result is that the labor demand of U.S. multinationals is linked internationally *at the firm level*, presumably through trade in intermediate and final goods, and this link results in complementarity rather than competition between employees in industrialized and developing countries. For the manufacturing pool overall, the null hypothesis of local labor demand is strongly rejected, in favor of the alternative hypothesis that labor demand in a particular location is significantly related to composites of wages in other affiliate locations. Moreover, we reject the hypothesis that cross-wage elasticities are the same across affiliates regardless of educational attainment in favor of the pattern of complements and substitutes implied by a vertical decomposition of production.

We next estimate equation (5) separately for a number of industries within the manufacturing sector. Separately pooled by development level of countries - results are qualitatively though not quantitatively similar, and failed a test of the pooling restrictions necessary for combining the two sets. The results are reported in Table 5. There is evidence of North-South complementarity for the electronic components, food products, plastic products, glass products, service industry machinery, apparel, photo equipment, and medical instruments industries. The first four of these industries also exhibit high South-South substitution. In contrast, although the motor vehicle and construction machinery industries exhibit significant cross-border labor demand linkages, the pattern of elasticities does not match the prediction of the model. The industrial chemical, drug, soap and other chemical products industries do not show a significant cross-border relationship in labor demands. For this set of industries, we cannot reject the hypothesis that the affiliates' labor demands are local. This suggests that labor demand is localized in industries where production is not "footloose" because of specialized

resource requirements.

A potential limitation of the estimation approach is that it captures marginal shifts in labor allocation rather than discrete changes associated with plant shutdowns and startups, which have been the focus of much of the popular debate over offshore production. Limitations of the dataset make it difficult to test these discrete changes directly.[19] Nonetheless, we go part way in investigating this question by allowing for a separate coefficient on wage changes corresponding to affiliate start-ups to capture the possibility that these innovations correspond to shifts in the configuration of production. In Figure 1 above, such shifts are represented by movements across rather than within regions. The estimation suggests changes in start-up wages have the same qualitative effects (i.e., $\beta_s > 0$, $\beta_d < 0$) as wage changes at existing affiliates, though they have quantitatively larger effects.

Moreover, multinationals that establish new affiliates in developing countries typically do so in the context of a global expansion of employment across the affiliates of the firm. The correlation between the magnitude of start-up employment and the change in employment in the firm's affiliates in industrialized countries is positive and small, estimated to be 0.15.

V. Conclusions and Implications

This paper establishes two important empirical results. First, within multinationals, labor demand in each affiliate is related to the cost and demand conditions of other affiliates owned by the same firm. Moreover, between affiliates in developing and industrialized countries, this relationship takes the form of a vertical decomposition of complementary stages of production. For instance, in the electronic components industry, a 10 percent decline in affiliate wages in a developing country leads to a 1.9 percent *increase* in affiliate employment in industrialized countries and a 3.7 percent increase in

[19] The dataset only covers affiliates with sales above $15 million annually. Thus, it is not clear when an affiliate appears (or disappears) in the dataset whether it is starting up (or exiting) or its sales have simply crossed the $15 million threshold.

local affiliate employment in that country, while reducing affiliate employment in other developing countries by 6.3 percent. Specialization in complementary stages of production implies that affiliate employees in industrialized countries need not fear the multinationals' search for ever-cheaper assembly sites; rather, they benefit from an increase in employment in developing country affiliates. Indeed, the real competition is from affiliates in other industrialized countries.

Concerns about the effects of offshore production on employment in industrialized countries rest on the counterfactual that multinational firms would have located these jobs in industrialized countries if wages in less-developed countries were on par with those in industrialized countries, i.e., that changes in the multinational's global employment are zero-sum. In general, this counterfactual is difficult to either prove or disprove. However, by restricting our empirical analysis to multinational firms that maintain employment in both industrialized and developing countries, we are measuring the marginal relocation of employment to wage fluctuations in a setting where the counterfactual international distributions of employment, as well as the total levels of employment, are well-defined in the data.

Our empirical analysis of the microeconomic relationship between trade and labor demands within firms derives several advantages from the use of micro-level data. It allows the use of a fixed effects specification to accommodate some forms of heterogeneity in labor demands across firms and countries. Moreover, looking at affiliates of the same firm (with sales classified in the same industry) enables us to identify interrelated production activities and factor demands more accurately than would be possible with industry-level trade data. On the other hand, intra-firm transactions within multinational corporations represent only a subset of the broader phenomenon known as outsourcing, which includes arm's-length trade as well.

The methodology of this paper should be applicable to a broader examination of the effect of trade on U.S. wages and employment, such as that undertaken in Revenga (1992), for example. The

results obtained above suggest there is a critical distinction between imports of substitute final goods and of complementary intermediate goods, since the two forms of trade have opposite effects on domestic labor demand. If this distinction is not made, the effects of trade in substitutes and complements may offset each other in the data, leading to a spurious finding that international trade has no discernible effect on U.S. labor markets.

Grossman (1982) makes an important contribution along these lines when he estimates the effects of import prices from developed and developing countries on import demand separately. Grossman interprets the finding of low North-South substitutability of imports in terms of specialization across countries in the production of final goods within the same broad product category. Although the interpretation is slightly different (and Grossman does not directly relate the two types of trade to factor markets), our multinational labor demand estimates provide a firm-level counterpart to this result.

The complementarity results suggest that any simple predictions about the effect of trade liberalization on employment may be misleading. For instance, NAFTA sparked a heated debate over job loss in U.S. manufacturing multinationals. In fact, there is no single straightforward prediction, as illustrated in the simple model above. In the case of North-South complementarity of labor demands observed in the data, the net effect of trade liberalization on affiliate employment in the North is ambiguous.[20] There could be a net job loss if the North loses less-skilled labor intensive operations that previously had been protected. On the other hand, there could be a net job gain if trade liberalization permits affiliates in the North to increase exports of the skill-intensive final product. The crucial issue is whether the less skilled workers in the North are engaged in activities that are integral to skilled production--in which case they benefit from trade liberalization--or whether they are engaged

[20] The net employment effect is ambiguous even in the partial equilibrium model of Section II, which does not consider possibilities for reemployment in other sectors of the economy.

in less skill-intensive activities that can be geographically relocated to the South--in which case they lose out.

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TABLE 1: EMPLOYMENT OF AFFILIATES BY GEOGRAPHICAL REGION AND NATIONAL AVERAGE EDUCATIONAL ATTAINMENT

		Countries with High Educational Attainment	Countries with Low Educational Attainment	Total
North America				
	Employment	404,950	476,613	881,563
	Share	10.5%	12.3%	22.8%
	Growth	-17.9%	44.6%	7.1%
South America				
	Employment	60,098	424,235	484,333
	Share	1.6%	11.0%	12.5%
	Growth	-23.1%	-0.7%	-4.1%
Europe				
	Employment	1,448,046	117,140	1,565,186
	Share	37.5%	3.0%	40.5%
	Growth	-12.8%	-3.5%	-12.2%
Northeast Asia				
	Employment	349,771	19,911	369,682
	Share	9.1%	0.5%	9.6%
	Growth	7.4%	1784.0%	13.1%
Southeast Asia				
	Employment	229,601	196,790	426,391
	Share	5.9%	5.1%	11.0%
	Growth	-13.8%	62.6%	10.1%
Near East				
	Employment	5,977	64,017	69,994
	Share	0.2%	1.7%	1.8%
	Growth	482.2%	-32.5%	-27.0%
Africa				
	Employment	0	64,663	64,663
	Share	0.0%	1.7%	1.7%
	Growth	0.0%	-44.6%	-44.6%
Total				
	Employment	2,498,443	1,363,369	3,861,812
	Share	64.7%	35.3%	100.0%
	Growth	-11.6%	12.5%	-4.3%

Note: Each cell reports:

* Aggregate employment per group across the sample in 1992
* The group's share of global affiliate employment in 1992
* Percentage change in employment between 1983 and 1992

TABLE 2: AVERAGE COMPENSATION PER EMPLOYEE BY GEOGRAPHICAL REGION AND AVERAGE EDUCATIONAL ATTAINMENT
1989 Cross-Section

	Countries with High Educational Attainment	Countries with Low Educational Attainment	Average by Region
North America	$32,328	$8,703	$19,555
South America	$12,819	$12,375	$12,430
Europe	$32,252	$27,104	$31,867
Northeast Asia	$32,252	$8,554	$30,976
Southeast Asia	$23,671	$11,666	$18,130
Near East	$23,415	$12,693	$13,609
Africa		$10,822	$10,822
Average by Educational Attainment	$30,987	$12,140	
Parent Wages	$37,828		

Note: Reported wages are averages weighted by affiliate employment.

TABLE 3: THE SHARE OF GLOBAL EMPLOYMENT IN DEVELOPING COUNTRIES BY INDUSTRY

Industries	**Employment Share in Developing Countries** (1992)	**Change in Share in Developing Countries** (1983-1992)	**Affiliate Employment Worldwide** (1992)
Other Foods	.353	+.198	247,384
Glass	.236	+.137	145,091
Tobacco	.173	+.060	207,330
Apparel	.091	+.053	268,599
Lumber and Wood	.061	+.004	73,385
Grain	.078	-.013	288,003
Preserved Fruits	.096	-.033	151,693
Beverages	.086	-.050	608,418
Pulp and Paper	.023	-.039	228,593
Print	.008	-.015	415,015
Industrial Chemicals	.081	-.002	672,758
Drugs	.113	-.032	554,681
Soap	.139	+.044	343,061
Chemical Products	.102	+.015	174,927
Rubber	.164	-.023	228,857

Note: The set of products in each of these industries is defined in U.S. Department of Commerce, Bureau of Economic Analysis. *U.S. Direct Investment Abroad, 1989 Benchmark Survey*. Washington, D.C.: Government Printing Office, October 1992.

TABLE 3 (cont.): THE SHARE OF GLOBAL EMPLOYMENT IN DEVELOPING COUNTRIES BY INDUSTRY

Industries	**Employment Share in Developing Countries** (1992)	**Change in Share in Developing Countries** (1983-1992)	**Affiliate Employment Worldwide** (1992)
Structural Metals	.073	+.020	100,217
Fabricated Metals	.098	+.034	147,497
Construction Machinery	.119	+.008	187,737
General Indust. Machinery	.046	-.013	171,779
Computers, Office Equip.	.092	+.070	713,777
Service Industry Machinery	.125	+.068	147,819
Electronic Components	.222	-.007	635,317
Electrical Machinery	.145	+.060	324,138
Motor Vehicles	.154	+.068	1,593,850
Scientific and Optical Equipment	.008	-.021	420,201
Medical Instruments	.074	-.020	191,684
Photo Equipment	.061	+.045	230,731
Plastics	.094	-.044	142,089

Note: The set of products in each of these industries is defined in U.S. Department of Commerce, Bureau of Economic Analysis. *U.S. Direct Investment Abroad, 1989 Benchmark Survey*. Washington, D.C.: Government Printing Office, October 1992.

TABLE 4: THE LABOR DEMAND EQUATION

REGRESSAND: Employment, L^f_{ct} (of firm f in country c in year t)

	Countries with High Educational Attainment	Countries with Low Educational Attainment
REGRESSORS:		
Local wage	-.755 (.120)	-.366 (.100)
Wage of other affiliates in industrialized countries	.154 (.057)	-.225 (.080)
Wage of other affiliates in developing countries	-.185 (.049)	.170 (.075)
Local aggregate demand	.828 (.073)	.426 (.028)
Constant	.044 (.011)	.020 (.030)
R^2	.462	.2099
Number of observations	9,174	3,677
F-Tests		
Prob [$b_s = b_d$]	.0002	.0045
Prob [affiliate (fc) dummies = 0]	.0000	.0000

Note: Estimates are for a pool of all affiliates in manufacturing industries. Estimation is based on equation (5), including affiliate (firm-country) fixed effects. Standard errors, which are reported in parentheses, are robust to country-year heteroskedasticity in the error terms.

TABLE 5: INDUSTRY-LEVEL LABOR DEMAND EQUATIONS

Industries	Country type	b_o	b_s	b_d	g	obs.
Electronic Components	Ind.	-.896	.362	-.224	.649	420
		(.266)	(.163)	(.160)	(.039)	
	Dev.	-.368	.629	-.187	.212	157
		(.128)	(.161)	(.288)	(.064)	
Other Food Products	Ind.	-.933	.472	-.295	.757	282
		(.188)	(.342)	(.249)	(.064)	
	Dev.	-.540	.982	-.637	.834	175
		(.149)	(.219)	(.344)	(.130)	
Plastic Products	Ind.	-1.07	1.83	-1.30	.834	146
		(.274)	(.741)	(.609)	(.069)	
	Dev.	-.637	.863	-.459	.238	45
		(.203)	(.304)	(.750)	(.128)	
Glass Products	Ind.	-.198	.404	-.905	.932	103
		(.422)	(.400)	(.525)	(.114)	
	Dev.	-.828	1.33	.206	.531	37
		(.347)	(.395)	(.718)	(.136)	
Service Industry Machinery	Ind.	-.779	.230	-.914	1.39	87
		(.349)	(.261)	(.427)	(.168)	
	Dev.	-.485	1.85	-3.25	.914	28
		(.569)	(1.54)	(1.99)	(.267)	
Apparel	Ind.	-.789	.948	-.379	.729	105
		(.406)	(.698)	(.693)	(.130)	
Medical Instruments	Ind.	-1.50	1.46	-.750	.714	155
		(.377)	(.548)	(.567)	(.112)	
	Dev.	-.592	.060	-.023	.289	53
		(.166)	(.240)	(.406)	(.085)	

Note: The regressions are pooled separately for affiliates in industrialized and developing countries. Standard errors are reported in parentheses.

TABLE 5 (cont.): INDUSTRY-LEVEL LABOR DEMAND EQUATIONS

Industries	Country type	b_o	b_s	b_d	g	obs.
Photo Equipment	Ind.	-2.08	.069	-.006	1.10	149
		(.800)	(.640)	(.594)	(.156)	
	Dev.	-.030	.665	-.152	.286	20
		(.150)	(.320)	(.148)	(.173)	
Motor Vehicles	Ind.	-.135	-.896	-.020	1.06	417
		(.225)	(.345)	(.206)	(.053)	
	Dev.	-.841	.231	-.650	1.32	138
		(.182)	(.260)	(.459)	(.071)	
Construction Machinery	Ind.	-.649	-.037	-.217	.836	327
		(.243)	(.317)	(.238)	(.106)	
	Dev.	-.253	-.064	.561	.487	158
		(.152)	(.249)	(.440)	(.063)	
Industrial Chemicals	Ind.	-.174	-.232	-.393	.866	888
		(.151)	(.271)	(.223)	(.038)	
	Dev.	-.594	-.321	.597	.702	246
		(.135)	(.230)	(.403)	(.150)	
Drugs	Ind.	-.775	.142	.038	.788	1091
		(.100)	(.189)	(.169)	(.025)	
	Dev.	-.463	.122	-.020	.459	598
		(.110)	(.148)	(.106)	(.048)	
Soap Products	Ind.	-.976	-.039	.005	.834	591
		(.095)	(.209)	(.199)	(.297)	
	Dev.	-.396	.330	-.077	.472	377
		(.073)	(.163)	(.195)	(.062)	
Chemical Products	Ind.	-.965	.006	.148	.640	459
		(.240)	(.281)	(.205)	(.046)	
	Dev.	-.115	.170	.047	.377	147
		(.108)	(.120)	(.221)	(.110)	

Note: The regressions are pooled separately for affiliates in industrialized and developing countries. Standard errors are reported in parentheses.

Figure 1: Relative Wages, Education Levels, and Costs of Trade

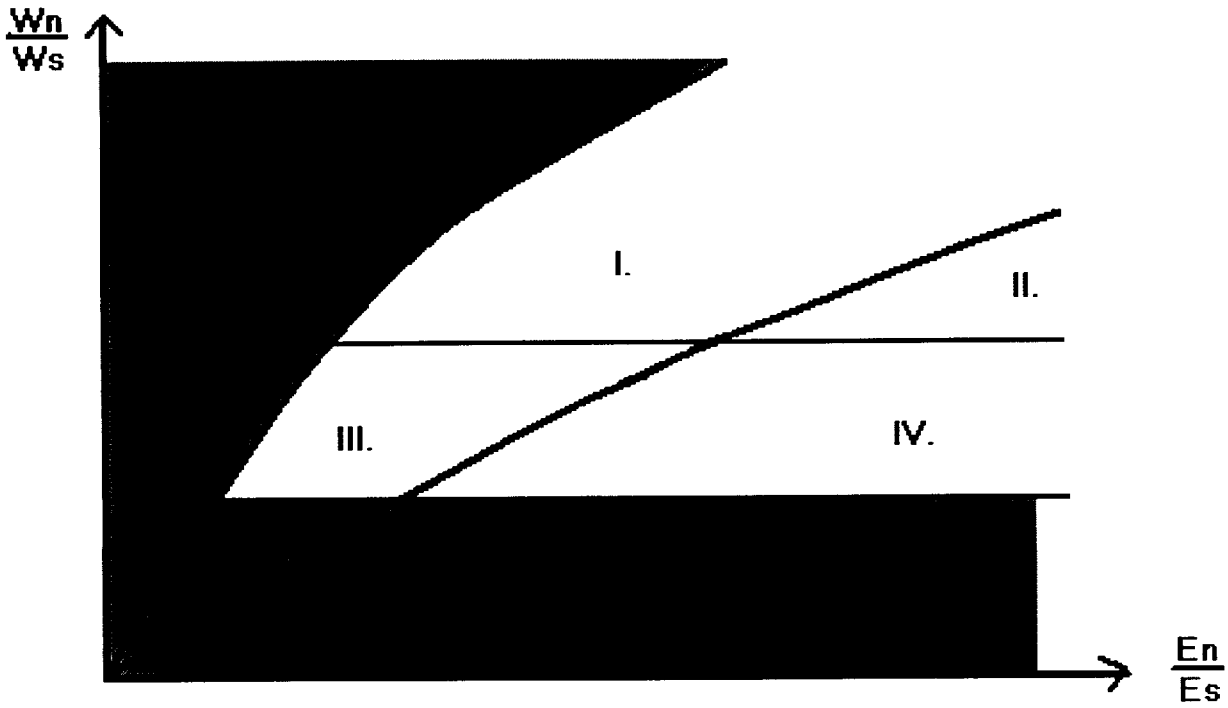

Figure 2