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ARE U.S. MULTINATIONALS EXPORTING U.S. JOBS?

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ABSTRACT

Many allege multinationals are "exporting" U.S. jobs when they expand operations abroad. This paper investigates the extent to which expansion of offshore production by U.S. multinationals reduces labor demand at home and at other offshore locations, using a panel on U.S. multinationals and their foreign affiliates between 1983 and 1992. The results suggest that foreign affiliate employment substitutes modestly at the margins for U.S. parent employment. There is much stronger substitution between workers at affiliates in alternative low wage locations. In contrast, activities performed by affiliates at locations with different workforce skill levels in the same region appear to be complements. The results suggest a vertical division of activities among countries with different workforce skill levels, where workers in developing countries compete with each other to perform the activities most sensitive to labor costs. When wages in developing countries, such as Mexico, fall 10 percent, U.S. parent employment falls 0.17 percent, while affiliates in other developing countries, such as Malaysia, lay off 1.6 percent of their workforce.

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I. Introduction

Several prominent labor organizations undertook an intense political campaign to oppose the North American Free Trade Agreement (NAFTA) on the grounds that it would encourage the relocation of U.S. plants south of the border, substituting cheap Mexican workers for costly U.S. workers. This is only the latest instance of recurring allegations that offshore production is tantamount to exporting U.S. jobs. These allegations receive substantial support from economic theory. The dominant economic models explain multinational expansion as a means of exploiting labor cost differences, predicting that foreign direct investment (FDI) should flow from advanced industrial countries to developing countries. However, this is at odds with casual empiricism -- in recent years more than 80 percent of FDI has been directed at industrialized countries (Graham and Krugman, 1990).[1]

To this point, there has been no attempt to investigate the relationship between offshore production and domestic parent employment directly. This research makes a first attempt. The treatment of multinationals formalized by Caves (1982) and subsequent researchers suggests the firm is the appropriate unit of analysis because of the importance of firm-specific proprietary assets. We use a detailed firm-level panel on U.S. foreign affiliates and parents spanning the period 1983-92 to examine the response of employment within multinationals across different plant locations to changes in relative local wages.

The paper first describes the data set and empirical regularities briefly. We note that employment has increased most in countries where wages have increased most relative to the wages paid by the parent in the United States, contrary to the labor competition story. We also note that casual examination of the data does not provide strong evidence of offsetting employment changes within firms between plants.

We then go on to link the changing distribution of employment within firms to relative labor

costs by estimating elasticities of substitution of multinational labor demand across different plant locations. We jointly estimate the labor demand equations for different plants within a firm that derive from a translog cost function. This estimation strategy in effect allows for the possibilities that each firm has a global production function and that workers in different locations are imperfectly substitutable because of different attributes or adjustment costs.

We employ various aggregations of the affiliate locations to distinguish the level of development, geographic proximity, and industry value added. The analysis confirms that labor employed by affiliates overseas substitutes at the margins for labor employed by parents at home, but the degree of substitution between parents is small. In contrast, there is strong substitution between workers at affiliates in different developing countries, suggesting there is a vertical separation of activities to take advantage of wage differentials, with workers in developing countries performing the activities that are most sensitive to labor costs. The story that U.S. jobs are "exported" to low cost production sites is supplanted by the suggestion that employment shifting takes place predominantly between offshore affiliates in less developed countries. Moreover, the estimates suggest that the activities performed by labor employed in countries at different levels of development within the western hemisphere are complementary, and labor substitution between countries at different levels of development within the eastern hemisphere is weak. This suggests a vertical decomposition of production activities between industrialized and developing country affiliates within each hemisphere.

The pattern of price elasticities reinforces the conclusions drawn from the employment elasticities. Although employment at affiliates in developing countries is very sensitive to wages in other developing countries, parent employment responds very little when foreign affiliate wages fall.

II. Related Literature

Although this paper is the first to estimate the elasticity of substitution within firms between

overseas affiliate employment and U.S. parent employment directly, several papers have investigated related questions. Using data from 1966 and 1970, Kravis, Lipsey, and Roldan (1982) show that the labor intensity of affiliate production exceeds that of parent production and is greatest for affiliates in developing countries. They also show that labor intensity is negatively correlated with the destination market wage. These conclusions are consistent with our finding that employment at affiliates in developing countries appears most sensitive to wage competition from other locations.

Slaughter (1993) compares industry-level affiliate employment to U.S. manufacturing employment in 1977 and 1989 for production and nonproduction workers. The aggregates yield no support to claims that expansion by U.S. multinationals overseas was an important cause of the reduced demand for production workers at home over the 1980s. While total U.S. manufacturing employment shrank 10 percent between 1979 and 89, total overseas affiliate employment shrank 14 percent. Further, while production employment declined 15 percent between 1979 and 89 in the U.S., overseas affiliate employment declined even more -- by 21 percent. Using a similar approach, Lawrence (1994) confirms these findings. In work closely related to ours, Slaughter (1995) uses a translog cost function approach to estimate substitution between total overseas affiliate employment, total industry-wide domestic employment, and an aggregate of U.S. industry-wide capital and overseas affiliate capital for the period 1977 and 1982 to 1989. He finds that domestic industry employment and overseas affiliate employment are complementary, but only weakly related.

III. Conceptual Approach

The growing number and importance of multinational firms suggests an important international link in labor demands related to but conceptually separate from trade. This paper examines whether multinationals' labor demands across locations are related, either through technological synergy (a vertical division of production across locations) or through common product

demand (a horizontal division). To the extent that either of these conditions holds, multinationals would be expected to shift production and employment across borders to minimize costs in response to changes in relative production costs. For example, an appreciation of the dollar would imply an increase in relative U.S. wages and an accompanying shift of production offshore.

Below, we use estimation procedures developed in the literature on multifactor (e.g. capital and labor) demands to estimate the relationship between overseas affiliate employment and U.S. employment by treating them as distinct factors of production. We analyze labor demand within firms across plant locations, by fitting a firm-level global cost function specified in terms of relative wages (which are taken as exogenous). Two aspects of this estimation strategy deserve particular attention. First, each multinational is permitted to have a single production function across all its plant locations. Second, workers employed in different locations are treated as potentially differentiated in skills or quality. This estimation strategy is designed to impose as little structure as possible on the relationship between labor employed by the parent at home and by foreign affiliates in different countries.

We assume the supply of labor is nationally segmented by immigration restrictions and highly elastic (reflecting the conventional assumption of competitive labor markets). In contrast, the demand for labor is linked across countries by firms that produce in a number of countries (as well as by international trade in goods). Foreign investment by multinationals is treated as a flow of firm-specific proprietary advantages across borders, for example in the form of trademarks, product or process designs, or marketing networks.

In the extreme case where labor is perfectly substitutable across plants in different countries, we would expect the cost-minimizing firm to shift all employment and production to the lowest cost location. However, there are a number of frictions that may impede this type of wage-chasing employment reallocation: the distribution of skills might vary across locations, there may be

considerable fixed costs or adjustment costs associated with plant capacity, and there may be proximity considerations that impede trade such as tariffs, local content requirements, or transport costs.

The estimation approach is designed to measure the extent to which labor substitution across locations diverges from the frictionless case. It focuses on wage-induced marginal shifts in labor demand among the firms' existing production locations, taking as given the international configuration of plant capacity.[2] In effect, we treat labor in different countries as separate factors and estimate substitution among them, assuming nationally segmented labor supplies and location-specific plant capacity.

In principle, it would be possible to include a separate equation for the firm's labor demand in each of the countries in which affiliates potentially operate. However, this would be intractable, since there is a daunting multiplicity of possible affiliate configurations with a data set covering 90 countries. Even if it were tractable, it is not clear that estimating a cross-elasticity for every pair of locations would be illuminating. Instead, we aggregate labor across subsets of countries that share certain economic characteristics related to the frictions discussed above.[3]

In aggregating across plant locations, the literature on multinationals suggests the following distinctions are particularly salient:[4]

Geography: There is a clear distinction in the multinational literature between vertical expansion across borders for purposes of access to low cost factors of production and horizontal expansion across borders for purposes of market access (Brainard, 1993a). Multinationals are more likely to expand for purposes of market access when transport costs and trade barriers are high. The less tradeable are intermediate and final goods, the lower is labor substitution between affiliates likely to be. Conversely, production should be more "footloose" among geographically proximate countries

the more distance restricts international trade. We would expect to see more vertical decomposition of activities in markets that are located close to each other, and more horizontal decomposition in markets that are located farther away, all else equal. We therefore distinguish between affiliates that are located close to parents in the western hemisphere (defined as the Americas), and affiliates located in the more distant eastern hemisphere (defined as the rest of the world).[5]

Factor Supplies/Development: Since the distribution of skills and other factors varies across countries, the average attributes of the labor force are likely to differ across locations, reducing the degree of substitution. To the extent that multinationals locate each stage of production in the country with the most favorable relative factor costs, we would expect to see more substitution between countries with similar factor proportions. We differentiate between affiliates located in advanced industrial countries and those located in developing countries as a way of proxying differences in the relative supply of skills.[6] Below, we follow a common tradition in trade estimation of proxying factor proportion differences by per capita income differences.[7]

IV. Data and Empirical Regularities

This study uses 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 (BEA).[8] The data set is a three-dimensional panel, in which each firm's production activities in up to 90 countries are tracked over a ten-year period ending in 1992, yielding approximately 70,000 firm-country-time observations. We include all firms whose parent industry is in the manufacturing sector. The panel includes data on an annual basis for each reported affiliate and parent on employment, employee compensation, exports, sales, location, and a three-digit industry identifier.[9] Because the data are business confidential, this is the first time this panel has been subjected to formal

data are business confidential, this is the first time this panel has been subjected to formal econometric analysis.

To this data set we append economic development rankings of countries from the *World Development Report* (based on per capita income) and measures of average industry wages by country from the Bureau of Labor Statistics (BLS).

Changes in Employment Shares over Time

Before presenting the formal econometric estimates, we first examine a number of simple firm-level relationships between labor allocation and wages across locations. Figure 1 shows how the allocation of employment within U.S. multinationals (averaged across firms) has evolved across locations over time. Employment at affiliates in the eastern hemisphere has expanded from 23 percent of total firm employment in 1983 to 28 percent in 1992. It consistently exceeds employment at affiliates in the western hemisphere, which has risen only marginally to 15 percent in 1992. There is less contrast between the change in employment in developing and advanced industrial countries. The share of employment at affiliates in advanced industrialized countries has expanded over the decade from 21 to 24 percent of total firm employment, while the share at affiliates in developing countries has expanded similarly, rising from 18 to 20 percent of employment.

Over the same time period, the average multinational has reduced the share of total employment at the U.S. parent from 61 to 56 percent. Aggregating across firms, employment by U.S. multinationals in the United States has declined similarly as a share of total U.S. manufacturing employment over the 1980s, from roughly half to 45 percent (not shown). Thus, the popular perception that U.S. multinationals have expanded their overseas employment at the expense of domestic employment is supported by the evidence on average within-firm shares of employment. However, contrary to conventional wisdom, much of the growth abroad has occurred in advanced

industrial countries, especially outside the western hemisphere.

Relative Wage Developments

Corresponding changes in relative wages[10] are portrayed in Figure 2. While the ratio of wages paid by affiliates in developing countries to parent wages has remained remarkably flat at roughly 30 percent over the decade, the ratio of wages in advanced industrial countries has risen substantially, reaching over 90 percent by 1992. Similarly, the relative wage at affiliates in the eastern hemisphere has risen from slightly over half to 80 percent, while the relative wages of affiliates in the western hemisphere have remained relatively flat around 50 percent (mainly reflecting an expansion of employment in developing country affiliates relative to Canada).

Together, Figures 1 and 2 suggest the rather surprising conclusion that employment has expanded most in precisely those areas where the relative wage has also grown the most and is closest to wages in the United States. However, the timing differs somewhat: while most of the relative wage expansion occurred during the period of dollar depreciation, 1985 to 1988, much of the employment expansion occurred in the early and late 1980s. Furthermore, simple correlations between averages of employment shares and relative wages across firms may be misleading because they do not address either the correlation within firms or the multilateral nature of the firms' employment allocation decisions.

Distribution of Employment across Locations

Next we shed some light on substitution among labor employed in different locations by examining the degree to which employment changes at particular locations within multinationals have been offset by opposite changes at other locations. Table 1 examines bilateral employment change offsets within firms. The histogram presented in the first panel compares employment changes at

parent locations with employment changes aggregated across all affiliates within firms. Over one-quarter of the observations entail large, complementary expansions of roughly equal magnitudes by both affiliates and parents. Roughly one-eighth of the observations entail small expansions of affiliate employment offset by small contractions of similar magnitudes at the parent.

The second panel matches employment changes across all affiliates in advanced industrial countries with changes across affiliates in developing countries. Here, roughly one-eighth of the observations evidenced small complementary expansions of roughly equal magnitudes in both types of affiliates, while one-ninth of the observations evidenced complementary expansions with relatively greater expansion across developing country affiliates. Another one-sixth of the observations evidenced small expansions in developing country locations offset by contractions in industrialized country affiliates.

The third panel compares affiliates in the western and eastern hemispheres. Here again, the changes are fairly evenly spread. Over one-fifth of the firms evidenced complementary expansions in the west and the east of equal magnitudes and one-tenth evidenced sizeable contractions in both eastern and western hemispheres; another one-twelfth evidenced small contractions in the east offset by comparable expansion in the west.

Table 1 suggests that most changes have entailed complementary expansions across different types of locations. In addition, a number of firms have experienced small offsetting reallocations of labor from parents to affiliates and within affiliates from the eastern hemisphere to the western hemisphere, and from advanced industrial locations to developing locations.

The conclusion that the degree of one-for-one *quantity shifting* across borders is relatively low at the firm level is consistent with conclusions based on aggregate data (Lawrence, 1994; Slaughter, 1993; Lipsey, 1994). However, it is a big leap to conclude from these quantity movements that the price responsiveness of employment across locations within firms is low. Even when we observe

similar expansion across all sites, there may be considerable *shifting of shares* in response to price movements. Moreover, simple ratios can shed little light on allocations across a multiplicity of potential sites. Such subtleties motivate our estimation of multifactor demand relationships.

V. Methodology

The most widely used methodology for estimating multi-factor demands is to fit the factor demand equations that derive from the cost function.[11] The "translog" form of the cost function initially proposed by Christenson, Jorgenson, and Lau (1973) has been applied extensively in estimating both macro and microeconomic production relationships. It is essentially a second-order log-linear approximation to an unspecified general cost function. Its popularity stems from its generality: the functional form imposes few restrictions on factor substitution.

By Shepard's Lemma, differentiation of the cost functions with respect to the n factor prices yields n factor demands, which are typically converted to the following system of n linear equations (Hamermesh, 1993, and Berndt and Wood, 1978):

$$S_{ft}^{(nx1)} = \alpha^{(nx1)} + \beta^{(nxn)} W_{ft}^{(nx1)} + \Gamma^{(nxn)} K_f^{(nx1)} + \epsilon_{ft}^{(nx1)}$$

S is a vector of cost shares. It is expressed as a linear function of a vector of constants, α, the coefficient matrix, β, multiplied by the (nx1) factor price vector (in logs), a vector of firm fixed effects, K, and a vector of residuals, ϵ, satisfying the standard assumptions for seemingly unrelated estimation (SUR). An output term can also be added on the right hand side to allow for variable returns to scale. The only restriction that is imposed in the estimates below is symmetry of the β matrix, which follows from the assumption of a twice differentiable global cost function.

The size of the system, n, depends on the aggregation of affiliates across countries. The elements of the factor price vector are composed of the log geometric weighted average of compensation per employee (weighting by relative employment) across each subset of locations. In the

estimates below, we report three levels of disaggregation, partitioning the affiliates into one, two, and four subsets along the economic dimensions discussed above.

We take advantage of the multidimensional nature of our panel data to control for firm and year fixed effects. Thus, reported estimates are based on "within firm" estimation. Although firm fixed effects might capture a variety of possible heterogeneities among firms' international production relationships, we have a particular interpretation in mind. This interpretation follows Berndt and Hesse (1986), who propose a variant to the standard translog called a variable or short-run cost function, where the stocks of relatively fixed factors such as physical capital are included in the share equations in lieu of the price of capital. We effectively estimate labor substitution among locations conditional on the capital stock, assuming that capacity adjustment is not an important option during the short time horizons under consideration. This assumes that the relatively fixed configuration of multinational plant capacity across locations could have a significant role in bounding wage-chasing labor substitution across borders. The firm fixed effects are used to capture firm-specific plant configurations.[12] When instead we control for plant capacity directly, using BEA data on plant and equipment expenditures, the results are robust.

We also experimented with various formulations of the wage measure to take into account possible lags in the adjustment of labor across locations (including current wages, one-year lagged wages, 2- and 3-year moving average wages, and predicted wages). The general pattern across coefficients is relatively stable across different formulations. We report results using a two-year moving average wage in the equations below.

From the SUR estimates of the β matrix, we construct Allen partial cross-elasticities of substitution, ES_{ij}, and price elasticities, PE_{ij}, using the following formulae, respectively:

$$\hat{ES}_{ij} = 1+\frac{\hat{\beta}_{ij}}{S_i S_j} \qquad \hat{PE}_{ij} = \frac{\hat{\beta}_{ij}+S_i S_j}{S_i}$$

Although the β are constrained to be constant across the sample by pooling assumptions implicit in the specification, the cost shares vary by firm and over time. We follow the translog estimation approach of Anderson and Thursby (1986) in using the mean shares of the actual data, rather than the fitted shares, a common alternative. For each of the Allen cross partials, we report confidence (half) intervals. We used both Delta Method and bootstrap resampling techniques in estimating the half-intervals.[13] The results were similar, so we report only the bootstrapped estimates.

We also check whether substitution relationships vary with industry value added on the presumption that this might be correlated with the labor intensity of production. We separate the firms into two groups based on the value added of their production.[14] The translog is estimated separately for the high value added and low value added firms; this approach imposes pooling restrictions, whereby the slope terms, β, as well as the intercepts, α, are allowed to vary by industry grouping.

The translog estimation approach effectively imposes the hypothesis that factor demands are linked across borders. If there were no linkage between factor demands, it would not imply a testable set of restrictions on the estimated β matrix, since the left-hand side of the equation system is the cost shares. Therefore, we ran a preliminary set of hypothesis tests, regressing labor demand (in levels rather than shares) in each location or aggregation of locations against "local" and "offshore" wages. We were able to reject the null that factor demands are not linked across borders at a very high level of significance.

The BEA panel data set measures total employment at each location, aggregating across various types of labor, and compensation per employee, averaging across various types of labor.[15] By treating different types of labor as a composite factor of production, we run the risk of finding spurious substitution relationships that actually reflect differences in the composition of labor. For instance, if affiliates add production workers to a fixed core of white collar workers as they expand

production, then employment expansion may lead to a declining composite wage even if the underlying wages for each type of worker do not change.[16] In this case, we would see a negative correlation between employment and firm-level wages for reasons other than labor substitution.

Therefore, we estimated the equations reported below by both substituting BLS industry wages for BEA firm wages directly, and using the BLS industry wages to instrument for BEA firm wages. The estimates based on BLS industry wages yield similar results in terms of the relative size and significance of substitution between various locations, but generally magnify the estimated substitution between parents and affiliates relative to that between affiliates.

VI. Elasticities of Substitution across Affiliates

We next turn to the elasticity estimates. The first panel of Table 2 presents elasticities derived from the simplest formulation of equation (1), which aggregates across all affiliates. The cross-elasticity of substitution between parents and all affiliates, ES_{pa}, is slightly below one, implying that labor abroad substitutes one-for-one for parent labor. When the sample is split into high value added and low value added industries, as in the second and third rows of the first panel, the elasticity does not change. The parent, ES_{pp}, and affiliate, ES_{aa}, own-elasticities are negative as predicted (not reported).

The second panel in Table 2 splits the affiliate locations into two groups based on their level of per capita income, which is used to proxy relative skill endowments. The cross-elasticity between the parents and both the subset of affiliates located in developing countries, ES_{pl}, and the subset located in industrialized countries, ES_{ph}, drops below one. Substitution is markedly higher between affiliates in different countries, ES_{hl}. This suggests that the activities undertaken by affiliates in more and less developed economies are more similar than those undertaken by parents and either type of affiliates.

Separate equations are estimated for firms in low and high value-added industries in the second and third rows. The finding that substitution is much stronger between labor at different affiliates than between parents and either type of affiliate is particularly pronounced for low value added industries. This is consistent with the presumption that the greater less-skilled labor intensity of production activities in low value-added industries makes them more sensitive to labor costs.

The third panel of Table 2 splits the set of affiliates along geographical rather than development lines to reflect proximity differences. Affiliate locations are divided into western and eastern hemispheres. Similar results were obtained using a split between countries adjacent to the United States and other countries.[17]

The results suggest that proximity has little effect on substitution between parents and affiliates. The cross-elasticities of substitution between parents and both types of affiliates are below 1. In addition, the cross-elasticity with eastern hemisphere affiliates, ES_{pe}, is slightly larger than that with affiliates in the same hemisphere, consistent with greater vertical differentiation in the hemisphere closer to the parent. Similar to the development breakdown, the cross-elasticity between affiliates in different hemispheres, ES_{we}, is significantly higher than that between parents and either type of affiliate. This suggests, as above, that affiliates tend to perform activities that are more similar to each other than to parent activities, and that the differentiation is somewhat greater for affiliates located in the same hemisphere.

We next examine the pattern of substitution more closely by further dividing the groups of affiliate locations. In Table 3, we investigate relationships among affiliates in different industrial countries and separately among different developing countries by dividing each development group by location. And similarly, we investigate relationships among affiliates in countries at different levels of development within each hemisphere.

The results in Table 3 suggest that labor substitution is strongest between affiliates at similar

levels of development. The elasticity of substitution between affiliates in different developing countries, ES_{ll}, is particularly high. Substitution is lower among labor in different industrial countries, ES_{hh}, but still above unity.

In contrast, there is complementarity or negligible substitution between locations at different levels of development within the same hemisphere. Within the western hemisphere, the activities performed by labor in industrial countries is complementary to the activities performed by labor in developing countries, $ES_{ww} < 0$, suggesting a vertical separation of activities. And although there is substitution between countries at different levels of development within the eastern hemisphere, ES_{ee}, it is weak (below unity).

The cross-elasticity between parents and all types of affiliates is positive but well below one, suggesting weak substitution. Moreover, similar to Table 2, substitution between parents and affiliates in industrialized countries in the eastern hemisphere, ES_{phe}, is marginally greater than substitution between parents and affiliates in industrialized countries in the western hemisphere, suggesting a greater vertical separation of activities among locations that are proximate to the parent.

The results suggest that the expansion of employment in a developing country in the western hemisphere such as Brazil threatens parent employment in the United States much less than it does labor at affiliates in developing countries in Asia. And it actually raises employment at affiliates in advanced industrial countries in the same hemisphere, such as Canada. Labor at parent locations in the United States competes only on the margins with labor at affiliates in developing countries, suggesting a strong vertical separation of activities and possibly quality differentials. At the same time, there is intense competition between labor employed in different developing countries. In contrast, there appears to be a strong vertical separation of activities, and hence low substitution or even complementarity, between locations at different development levels within each hemisphere.

The cross elasticities of substitution between affiliates in locations at different income levels

across hemispheres, ES_{helw} and ES_{hwle}, are more difficult to interpret. Both are large and statistically significant. This result may simply be an artefact of the aggregation choice. Almost all of the "developing" category in the eastern hemisphere are middle income countries, whereas almost all of the "developing" category in the western hemisphere are low income countries.

Robustness

As described above, we solve the zero demands problem by aggregating across locations into economically meaningful groupings. However, even after aggregating, some firms do not employ workers in more than one location. The equations estimated above cover only those firms that have employment in all included categories. (It is worth noting that a majority of the firms in the sample do not have any affiliates in less developed countries). Thus, for instance, the equations that estimate cross elasticities between affiliates at the same level of development across hemispheres only include firms that have at least one affiliate each in a less developed eastern hemisphere country, a less developed western hemisphere location, an industrialized western hemisphere location, and an industrialized eastern hemisphere location. We checked whether this estimation was robust by running similar equations for the excluded subsets of firms that have no affiliates in one or more of these four categories. Both the size and significance of the cross-elasticities were remarkably similar across firm configurations, so we do not report those results separately.

Following the production function literature, we included controls for scale both at the level of the plant and the firm. In both cases, as long as firm fixed effects are included, the results are essentially unchanged (although the fit of the equations improves), so we do not report the results here. In effect, although there are scale effects, they do not affect the cross-elasticities of substitution in a way not captured by the firm fixed effects.

The BEA data are comprised of a subset of firms that is surveyed every year and a second

subset that is surveyed only in benchmark years and estimated by BEA statisticians in other years. We performed the estimations for both the full sample and the subsample of firms that are surveyed every year to ensure that the sampling techniques do not in some way bias the results. The results were essentially the same, so we report only the full sample results above.

Linear homogeneity of the cost function is often assumed in translog production function estimation. In the equations reported above, imposing this restriction occasionally changes the absolute size of the coefficients moderately, but rarely affects the relative size of the coefficients. Thus, we do not report the results for the linear homogeneity restriction. Moreover, we do not see a compelling economic rationale for imposing such a restriction in this setting.

VII. Conclusion

Our estimates suggest that labor in the United States does compete at the margins with labor abroad via multinational production. But substitution between labor employed by parents in the United States and affiliates abroad is low. Labor substitution is far greater between affiliates in countries at similar levels of development.[18]

The greatest degree of competition is between labor in different developing countries, particularly in low value added industries. Labor at affiliates in industrialized countries similarly competes with labor at affiliates in other industrialized countries, but to a more moderate degree. In contrast, affiliate workers in countries at different levels of development within the western hemisphere appear to be complements, while affiliates at different levels of development within the eastern hemisphere are only weakly related.

The results suggest there is a vertical separation of activities to take advantage of wage differentials, with affiliates in developing countries performing the activities that are most sensitive to labor costs. This supports findings by Lipsey et. al. (1982) that factor intensities vary with relative

wages among locations. The results further suggest that the activities of affiliates in countries at different levels of development may be complementary, especially in the hemisphere closer to the parent. Subsequent research focusing exclusively on affiliates, and using a more general estimation approach, confirms that complementarity characterizes affiliates in countries at different levels of development more broadly, (Riker and Brainard, 1996). In addition, western hemisphere affiliates appear to compete with parent labor somewhat less than do eastern hemisphere affiliates, consistent with greater vertical differentiation within the western hemisphere.

Price elasticities tell a similar story. Although employment at affiliates in developing countries is very sensitive to wage variation in other developing countries, parent employment responds very little to variations in affiliate wages, and affiliate employment actually expands when wages in countries at a different level of development fall. For example, U.S. parent employment falls one-sixth of one percent when wages in developing countries in the western hemisphere, such as Mexico, fall 10 percent. At the same time, affiliates in other developing countries, such as Malaysia, lay off 1.6 percent of their workforce. And affiliates in high income countries in the same hemisphere (Canada) actually expand employment by 0.5 percent.

Table 1: EMPLOYMENT OFFSET HISTOGRAMS

PARENT VS. AFFILIATE OFFSETS

	Parent: Layoffs Over 200	Parent: Layoffs 0-200	Parent: Hires 0-200	Parent: Hires Over 200
Affiliates				
Hires				
Over 150	6.0	7.8	4.9	26.6
0 to 150	3.8	11.5	6.8	4.7
Layoffs				
0 to 150	3.3	6.5	4.0	2.9
Over 150	6.0	1.4	1.1	2.9

INDUSTRIALIZED VS. DEVELOPING COUNTRY AFFILIATE OFFSETS

	Industrialized: Layoffs Over 80	Industrialized: Layoffs 0-80	Industrialized: Hires 0-80	Industrialized: Hires Over 80
Developing				
Hires				
Over 200	6.8	2.5	2.0	9.6
0 to 200	8.9	8.5	12.9	10.6
Layoffs				
0 to 200	6.7	4.6	4.3	5.2
Over 200	9.1	1.8	1.7	5.0

WESTERN VS. EASTERN AFFILIATE OFFSETS

	Western: Layoffs Over 80	Western: Layoffs 0-80	Western: Hires 0-80	Western: Hires Over 80
Eastern				
Hires				
Over 200	4.6	3.1	4.0	10.4
0 to 200	4.7	5.2	12.4	6.5
Layoffs				
0 to 200	5.4	4.4	7.9	4.8
Over 200	11.1	3.2	3.5	7.1

Note: Tables report distribution of offsetting employment changes on average within firms.

Table 2: ELASTICITIES OF SUBSTITUTION

ALL AFFILIATES

Sample	ES(pa)	# Obs.
All firms	0.95 (0.047)	10,435
High value-added industries	0.969 (0.065)	4,642
Low value-added industries	0.955 (0.071)	4,895

AFFILIATES DIVIDED BY DEVELOPMENT

Sample	ES(ph)	ES(pl)	ES(hl)	# Obs.
All firms	0.656 (0.047)	0.863 (0.098)	2.024 (0.267)	4,024
High value-added industries	0.786 (0.063)	1.06 (0.148)	1.56 (0.336)	2,281
Low value-added industries	0.557 (0.080)	0.743 (0.142)	2.53 (0.446)	1,493

AFFILIATES DIVIDED BY REGION

Sample	ES(pw)	ES(pe)	ES(we)	# Obs.
All firms	0.623 (0.060)	0.816 (0.049)	1.910 (0.172)	4,605
High value-added industries	0.788 (0.085)	1.12 (0.066)	2.09 (0.222)	2,492
Low value-added industries	0.421 (0.095)	0.588 (0.789)	1.63 (0.288)	1,794

Note: Tables report Allen cross-partial elasticities of substitution derived from translog cost functions. Firm and year fixed effects are included. Confidence intervals are reported in parentheses. The own elasticities (which are not reported here) are all negative. Notation is as follows: p represents parent; a represents affiliate; h refers to industrialized country affiliates; l refers to less developed country affiliates; w refers to western hemisphere affiliates; and e refers to eastern hemisphere affiliates.

Table 3: ELASTICITIES OF SUBSTITUTION AFFILIATES DIVIDED BY DEVELOPMENT AND REGION (1486 Observations)

CROSS-PARTIAL ELASTICITIES OF SUBSTITUTION

Parent-Affiliate				Between Affiliates					
p/hw	p/he	p/lw	p/le	h/h	w/w	e/e	l/l	hw/le	he/lw
0.303	0.708	0.475	0.532	1.35	-1.73	0.943	5.26	5.73	2.46
(0.142)	(0.105)	(0.174)	(0.604)	(0.428)	(1.30)	(0.590)	(1.72)	(1.72)	(0.553)

PRICE ELASTICITIES OF SUBSTITUTION

Parent Response to Affiliate				Between Affiliates					
p/hw	p/he	p/lw	p/le	hw/he	wh/wl	eh/el	lw/le	hw/le	he/lw
0.011	0.125	0.015	0.009	0.239	-0.053	0.015	0.086	0.093	0.076

Affiliate Response to Parent				Between Affiliates					
hw/p	he/p	lw/p	le/p	he/hw	wl/wh	el/eh	le/lw	le/hw	le/hw
0.224	0.524	0.351	0.393	0.049	-0.063	0.167	0.162	0.210	0.090

NUMBER OF AFFILIATE OBSERVATIONS

total	hw	he	lw	le
66,301	8,349	35,956	12,966	9,030

Note: Tables report Allen cross-partial elasticities of substitution derived from translog cost functions and the associated price elasticities; a price elasticity represented as a/b refers to the elasticity of employment in location a in response to a wage change in location b. Firm and year fixed effects are included. Confidence intervals are reported in parentheses. The own elasticities (which are not reported here) are all negative. Notation is as follows: p represents parent; h refers to industrialized country affiliates; l refers to less developed country affiliates; w refers to western hemisphere affiliates; and e refers to eastern hemisphere affiliates.

Figure 1

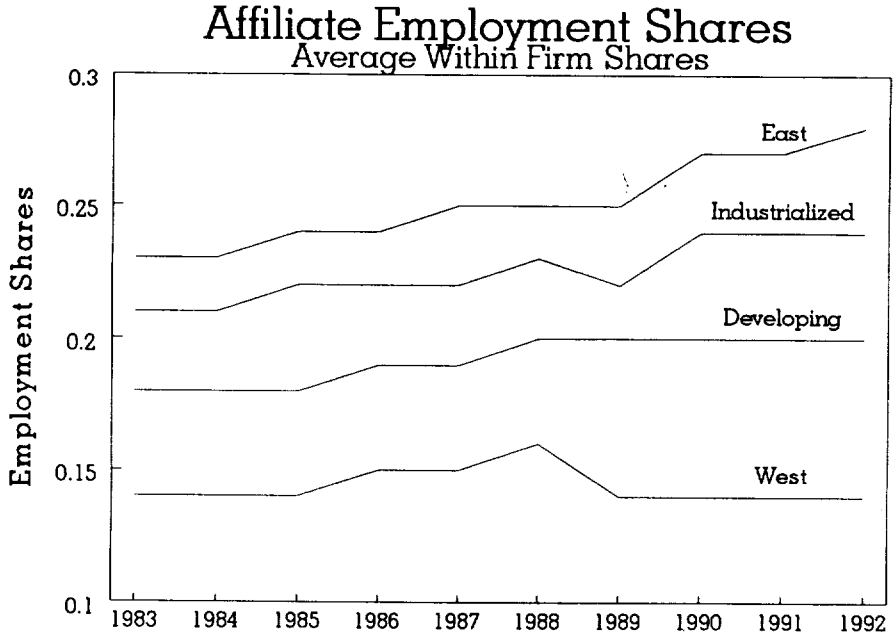
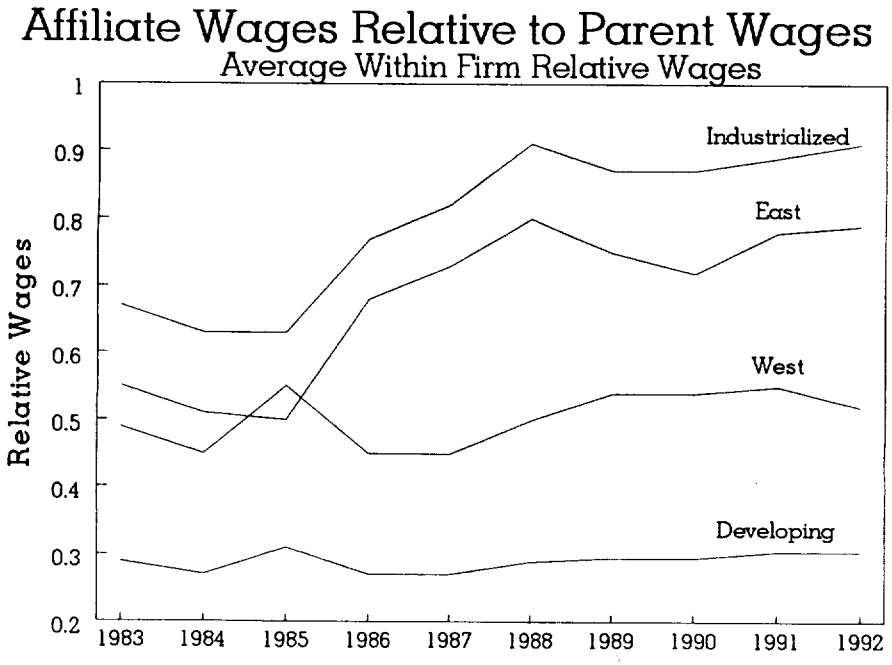


Figure 2



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Endnotes

1. Formal investigations also suggest that multinational activity is more likely between countries the greater are their similarities in factor proportions and per capita income, contrary to both the dominant economic models and popular perceptions (Brainard, 1993b).

2. It is important to note that the dataset permits us only to estimate marginal shifts in employment and production across locations. The establishment of new plants is difficult to discern in the data.

3. Restricting the country dimension of the data transforms the firms' configurations in a way that permits us to pool across firms in fitting a common specification. Otherwise, we would face the problem of "zero demands" that arises in multifactor demand estimation when pooling over a sample of firms that use a different set of factors rather than different quantities of the same set of factors.

4. See Markusen (1995).

5. We experimented with other geographical splits that are described in greater detail below.

6. The country rankings are taken from the *World Development Report*. The "high income" category is taken directly from the *World Development Report*, while our "low income" category combines low and middle-income economies.

7. In subsequent work, Riker and Brainard (1996) instead classify locations according to the average educational attainment of the population, with similar results.

8. Due to the business-confidential status of the firm-level data, the data are not available from the authors of this study.

9. U.S. parents are required to report this data for any affiliates whose sales exceed $15 million.

10. Unless otherwise noted, the term wages refers to the BEA measure of compensation per employee.

11. The cost function approach has several advantages over a production function approach that are detailed in Berndt (1981) and Hamermesh (1993). For a detailed discussion of the literature, see Hamermesh (1993).

12. A fixed effects estimator is preferable to a random effects estimator, since the sample is essentially the entire population, and we do not claim to draw inferences outside the sample (Greene, 1990).

13. Bootstrap estimates were based on one hundred resamplings from the empirical distribution of the fitted residuals. We thank P.O. Gourinchas for suggesting this approach.

14. The categorization is based on a ranking of parent industry value added, defined as the ratio of gross margins to employment.

15. The BEA data distinguish production and nonproduction workers for benchmark survey years (1982, 1989), but this data is unavailable at the firm level.

16. We thank Mike Piore and Steve Pischke for raising these issues.

17. When instead a three-way split between Asia, Europe, and the Western Hemisphere is used, substitution between Asian affiliates and parents looks similar to that between Western Hemisphere affiliates and parents, and larger than that between European affiliates and parents. There is also strong substitution between Asian affiliates and Western hemisphere affiliates, but only weak substitution between the western hemisphere and Europe, and complementarity between Asian and European affiliates. Combining Asia and Europe moderates these relationships because of this distinction.

18. In interpreting these results, it is important to keep in mind that parents employ many more workers than do affiliates in aggregate, and that affiliate employment is heavily concentrated in industrialized countries, particularly in the eastern hemisphere.