International Fragmentation of Production and the Intrafirm Trade of U.S. Multinational Companies

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1. Introduction

An increasingly important feature of global economic integration is trade in intermediate inputs associated with the fragmentation of production across national borders. For some goods, production has become a multinational process in which different stages are carried out in specialized plants around the globe. Materials and components produced in one country may pass through a sequence of other countries that each add value through fabrication, assembly, or other processing before a final product is delivered to consumers. Countries, which specialize in different stages of the production process according to factor-cost or other locational advantages, are thus linked in a vertical chain through trade in intermediate inputs.

The growing role of this vertical trade in the world economy has been documented in a number of recent studies, some of which are surveyed in Feenstra (1998). Estimates by Campa and Goldberg (1997) from input-output tables reveal large increases over the period 1974-95 in the share of imported intermediate inputs in manufacturing industry output for three major industrial countries: the United States, Canada, and the United Kingdom.[1] Strauss-Kahn (2003) constructs similar estimates for French manufacturing industries, which display comparably large increases in imported-input shares. A

[1] For these three countries, the imported-input share of manufacturing output is shown to increase both at the aggregate level and for most individual industries. The authors also estimate the imported-input share for Japan, which decreased over the period. For the United States, see also Feenstra and Hanson (1999), who estimate a large increase in the imported-input share of total nonenergy intermediate inputs used in manufacturing.

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narrower measure of vertical trade–imported intermediate inputs embodied in a country's exports–is examined in Hummels, Rapoport, and Yi (1998) and in Hummels, Ishii, and Yi (2001). In the latter paper, calculations from input-output tables reveal that vertical trade as a share of total exports has increased substantially over time for most of the major OECD countries. Based on these calculations, the authors estimate that the share of vertical trade in worldwide exports increased between 1970 and 1990 by a third, to 24 percent.[2]

Trade in intermediate inputs takes the form of intrafirm transactions when production stages in different countries are performed by vertically integrated units of the multinational company (MNC). In this case, production is fragmented geographically across national boundaries but is integrated organizationally within the boundaries of a common firm. Applying the transactions-cost framework of Coase (1937) and Williamson (1975), international production and trade are expected to be internalized by an MNC when inherent difficulties in enforcing quality-control standards or in preventing spillovers of proprietary knowledge make transactions with foreign unrelated parties excessively costly. Such transaction costs may be particularly acute for the delivery of intermediate inputs that are highly specific in design or require specialized techniques in production.[3]

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[2] A special case of this vertical trade occurs when components or materials are exported for processing abroad and then reimported into the original country. Some countries and customs unions maintain separate records for this trade owing to special tariff provisions that exempt the value of the reimported inputs from customs duties. Several studies based on these data provide additional evidence on increases in vertical trade associated with fragmentation. Examples include Feenstra, Hanson, and Swenson (2000); Gorg (2000); Baldone, Sdogati, and Tajoli (2001); Ruane and Gorg (2001); and Graziani (2001).

[3] An added reason for internalizing international transactions may be the opportunity it affords MNC's to manipulate transfer prices in order to minimize reported income in high-tax countries. See Clausing (2001). Casson (1986), however, concludes from a number of case studies that transfer

For U.S. MNC's, data collected by the U.S. Bureau of Economic Analysis (BEA) indicate that intrafirm trade associated with internationally fragmented production has increased markedly over the past few decades. From 1966 to 1999, the value of intermediate goods shipped by U.S. parent companies to their foreign affiliates for assembly or processing increased fortyfold, from $2.5 billion to $102.6 billion (table 1).[4] Over this period, the share of these exports in total U.S. exports of goods nearly doubled, from about 8 percent in 1966 and 1977 to 15 percent in 1999. Intrafirm exports of intermediate goods used in affiliate production also increased as a share of both the total and intrafirm exports of U.S. parent companies: from 1977 to 1999, the share in total parent exports more than doubled (from 10 percent to 25 percent) and the share in parent exports to affiliates increased two-fold (from 33 percent to 65 percent).

Research to date on intrafirm trade provides general support for the idea that transactions will be internalized for goods that embody specialized or proprietary knowledge: repeated studies have found that intrafirm trade is strongly associated with the research and development (R&D) intensity of industries and firms. Some studies also offer suggestive evidence on factors behind vertical intrafirm trade flows based on specialization between parent companies and their foreign affiliates. In one of the earlier studies of intrafirm trade, Lall (1978) uses data on U.S. MNC trade in 1970 to examine the

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pricing is not the principal motive for establishing intrafirm trade.

[4] These figures are from data reported in BEA's benchmark surveys of U.S. direct investment abroad, which are conducted periodically (currently, at five-year intervals). The intrafirm-trade data collected in benchmark surveys include detail on U.S. parent company exports to their foreign affiliates broken down by intended use (that is, whether for further manufacture by the affiliates, for resale without further manufacture, for use as fixed capital assets, or for other purposes). This detail by intended use is not collected in BEA's less-detailed survey for interim years.

pattern across industries in exports from U.S. parent companies to their foreign affiliates. The share of these intrafirm-trade flows in affiliate sales is found to increase with industry R&D intensity and with an industry indicator of divisible production processes. Siddhathan and Kumar (1990) also work with industry-level data for U.S. MNC's (in this case, for 1982); they find that the share of intrafirm exports in total exports by U.S. parents is positively related to the R&D intensity and average employee skill level of parents.

More-detailed studies of intrafirm trade have been conducted using firm-level data for Swedish MNC's. Zejan (1989) analyzes the variation across Swedish-owned affiliates in the ratio of imports from parents to affiliate sales. For affiliates in both developed and developing countries, he finds that the ratio of intrafirm imports to sales is positively associated with the R&D intensity of MNC sales. In developed countries, the intrafirm-import ratio is found to be negatively related to entry by an affiliate into the MNC through acquisition rather than through greenfield investment. Braunerhjelm (1998) uses firm-level data to analyze intrafirm exports from Swedish parents to their foreign affiliates as a share of parent sales, distinguishing the parents in his sample according to whether they are more inclined toward vertical or horizontal production relationships with their affiliates. For vertically integrated MNC's, the share of intrafirm exports in parent sales displays a positive correlation with the MNC's overall R&D-intensity but a negative correlation with the share of R&D that is undertaken by foreign affiliates, a finding that suggests vertical specialization in terms of technology differences between parents and affiliates.

Focusing on the contrast between intrafirm-trade flows associated with vertical and horizontal integration, Anderson and Fredriksson (2000) utilize information on the intended use of intrafirm

imports by Swedish-owned affiliates to separately examine the determinants of intrafirm imports of intermediate products (which they relate to vertical integration in MNC operations) and intrafirm imports of finished products (which they relate to horizontal integration in MNC operations). The respective shares of these two intrafirm-trade flows in affiliate net production are regressed on variables for the parent company or overall MNC, for the affiliate, and for the host country. For both types of intrafirm trade, the propensity of affiliates to import goods from their parents is found to be positively related to the R&D intensity of parent sales. Other variables, however, are found to have contrasting influences on intrafirm imports of finished or intermediate products. Salient among these findings, the ratio of affiliate imports of intermediate products from their parent companies to affiliate net production is found to increase with the size of the host country and with the share of affiliate output exported either to back to the parent company or to others (variables that are negatively related to intrafirm imports of finished products). The per capita income of the host country is found to be positively related to the propensity of affiliates to import finished goods from parents but unrelated to the propensity to import intermediate goods from parents.

In this paper, we use microdata from BEA's 1994 benchmark survey of U.S. direct investment abroad to analyze the propensity of foreign affiliates to import intermediate goods from their U.S. parent companies. Building on the empirical strategy employed by Anderson and Fredriksson, we relate this propensity to characteristics of the parent company or the overall MNC, of the host country, of the affiliate, and of the affiliate's industry that we hypothesize should influence the volume of intrafirm

trade associated with international fragmentation.[5]

In the following section, we discuss aggregate patterns in our data on foreign affiliates and their intrafirm sourcing behavior, by industry and by host-country income levels. We then discuss the variables we employ to explain the variance across affiliates in intrafirm sourcing behavior and our hypotheses about their expected signs. Section 4 presents the estimation model and section 5 presents the results. The paper concludes with a discussion of the findings.

2. Overview of the Data

The data on foreign affiliates are from BEA's 1994 benchmark survey of United States direct investment abroad. The sample of affiliates examined in this paper consists of 1,444 majority-owned manufacturing affiliates for which a detailed "long form" was required in the benchmark survey. The affiliates in this sample account for 76 percent of the total sales of all majority-owned foreign affiliates in manufacturing in 1994. These affiliates had 374 different U.S. parents and operated in a total of 57 countries. About half of the affiliates in our sample are located in Europe (almost entirely in member countries of the European Union). Affiliates located in Asia and in the two countries bordering the United States (Canada and Mexico) each make up a little less than a fifth of the affiliates in the sample. A more complete description of the data set is available in appendix A.

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[5] In contemporaneous research based on an alternative sample from BEA's 1994 benchmark-survey microdata, Hanson, Mataloni, and Slaughter (2003) employ a translog cost function to estimate an equation for the share of intermediate inputs imported from the United States in total production costs for foreign affiliates of U.S. parent companies. They find that affiliate demand for these imported inputs is higher in host countries that are characterized by lower trade costs, lower wages for less-skilled labor, and lower corporate income tax rates.

In this section, we examine broad patterns in the data on the affiliates' imports of intermediate goods from their parent companies in comparison with the affiliates' sales. The comparisons are made for the affiliates grouped by industry and by income level of the host country. The patterns gleaned from these comparisons provide background and perspective for a more formal analysis of factors that determine the affiliates' propensity to source intermediate goods from their parents.

2.A. By Industry

Table 2 presents statistics on the number of affiliates, their sales, and their intrafirm imports of intermediate goods for the sample affiliates classified by selected two-digit International Surveys Industry (ISI) industry groups.[6] Also shown for each industry is the ratio of intrafirm imports of intermediate goods to affiliate sales (expressed in percent), which shows the relative importance of these intrafirm trade flows in affiliate production.

Among the industries shown, the ratio of intrafirm imports of intermediate goods to affiliate sales is particularly pronounced in electronics (22 percent), transportation equipment (18 percent), instruments (11 percent), and industrial machinery (10 percent). Each of these industries is characterized by production processes that tend to be easily divisible, and, thus, that can be divided into distinct stages that can be performed in different locations. To the extent that the various stages use productive factors in different combinations, a multinational company can move those stages of production that utilize a given factor most intensively to countries that are relatively abundant in that

[6]Foreign affiliates are classified by 2-digit and 3-digit codes under the Bureau of Economic Analysis' ISI codes. As applied to the data for 1994, these codes are closely related to the 2-digit and 3-digit 1987 U.S. Standard Industrial Classification codes.

factor. For example, an MNC can move stages that require low-skilled labor, such as basic assembly, to countries where low-skilled labor is abundant while keeping stages that make intensive use of human or physical capital, such as the production of sophisticated components, in countries that are abundant in those factors. Another common characteristic of these four industries is product differentiation, which can result in a high degree of specificity in the parts and components used by final assemblers. Affiliates in these industries might be expected to source these parts through intrafirm transactions with their parent companies rather than through arm's length transactions with unrelated parties.

The industry with the most intrafirm imports of intermediate goods is transportation equipment, which accounts for 43 percent of the sample data on foreign affiliate imports of intermediate goods from their U.S. parent companies. About three-fourths of these imports are by affiliates located in Canada, reflecting Canada's proximity to the major automobile manufacturing centers in the United States and the legacy of the free-trade regime for producers of motor vehicles and parts that traces its roots to the 1965 United States-Canada Auto Agreement. Most of the remaining imports in this industry are by affiliates located in Mexico, which may also reflect a favorable tariff regime--in this case the tariff exemptions granted to affiliates engaged in the assembly of imported parts for re-export to the United States, under provisions of the maquiladora program that preceded NAFTA.[7] Thus, while the transportation equipment industry accounts for much of the intrafirm trade in intermediate goods, this trade is largely limited to the two border countries and may partly reflect preferential trading arrangements.

[7] The major maquiladora industries in the early 1990's were transportation equipment, electronic and electric equipment, and textiles. See Hummels, Rapoport, and Yi (1998).

Among the other industries shown in table 2, the ratio of intrafirm imports of intermediate goods to affiliate sales is small in the chemical, petroleum, and metal industries. In the chemical industry (which accounts for about a fourth of the affiliates in our sample), the low tendency by affiliates to source intermediate inputs from their parent companies may reflect production processes that are not amenable to being broken up in stages and divided geographically. In petroleum and metals, the low level of intrafirm imports may reflect the homogenous character of the materials used as intermediate inputs in production--these inputs can be procured easily through arm's length transactions on the open market and, thus, need not be supplied by the affiliates' parent companies. In addition, imports from U.S. parent companies may be limited by the fact that the United States is a net importer of some of the natural resources (such as oil or metal ore) that are used in these industries as intermediate inputs.

2.B. By Income Level

Table 3 presents data on affiliates' imports of intermediate goods and sales distributed by per capita income of the host country, which can be treated as a proxy for host-country factor costs. The distribution is across five host-country income levels, as measured in per capita GNP in 1994 dollars: 1) less than $1,000; 2) $1,000 to $5,000; 3) $5,000 to $15,000; 4) $15,000 to $25,000; and 5) above $25,000. As reference points, in 1994 the United States had per capita GNP of $25,880, Canada of $19,510, Taiwan of $11,460, Mexico of $4,180, and Indonesia of $880. The highest income group, therefore, consists of host countries with per capita GNP roughly equal to or greater than that of the United States in 1994. Not surprisingly given the importance of Canada and Europe as locations for the affiliates in the data set, the majority of affiliates are in the $15,000 to $25,000 range,

which includes Canada and much of Europe. There are also a substantial number of affiliates in the $1,000 to $5,000 range, which includes Mexico and several other Latin American countries.

Among the host-country income groups, the ratio of intrafirm imports of intermediate goods to affiliate sales is highest in the $1,000 to $5,000 group (which includes Mexico) and is second highest in the $15,000 to $25,000 group (which includes Canada). Among individual host countries, the ratio is very high for Mexico and Canada, which may partly reflect their status as border economies that have a history of special trading arrangements with the United States.

To eliminate the influence of border-country effects, table 4 presents the distribution with Canada and Mexico omitted. In this table, the ratio of intrafirm imports of intermediate goods to affiliate sales appears to be inversely related to host-country per capita GNP, providing that the host country is not in the lowest income group: the ratio increases from 4 percent in the highest income group (which includes Switzerland, Japan, and Germany) to 9 percent in the second lowest income group (which includes Malaysia, Thailand, and several Latin American countries) before decreasing to 5 percent in the lowest income group. This relation suggests that foreign outsourcing activity within a multinational enterprise is inversely related to host-country factor costs, providing that the host country's level of economic development is above a certain threshold.

3. Determinants of Intrafirm Trade in Intermediate Goods

In the literature, two models of the multinational firm have received the most attention: vertical and horizontal. In a vertically integrated firm, the production process has been divided into separate stages with different units of the firm specializing in particular stages of production. In such an organization,

one unit's output is an intermediate input into the next stage of production. When a multinational enterprise is vertically integrated, different units may be located in different countries, leading to intrafirm trade in intermediate goods. A firm may expand vertically to take advantage of factor cost differentials between countries. In contrast, horizontal integration is the establishment of similar production processes in different locations, and thus, would not be associated with trade in intermediate goods. A firm might expand horizontally to gain market access or because tariffs, transportation costs, or other factors convey an advantage to producers in close proximity to the local market.

Despite the distinction that has been drawn between these two organizational structures, firms usually contain elements of both. For example, a multinational enterprise may have some affiliates that are part of a production chain crossing national borders and other affiliates that are not part of that chain. Therefore, it is often not possible to identify a particular MNC as either vertically or horizontally integrated. However, there are certain characteristics that make it more likely an affiliate is part of a vertically integrated production process.

In what follows, we identify characteristics of the parent company or the overall MNC, of the host country, and of the affiliate that are most indicative of vertical production ties between parents and affiliates, and present hypotheses on the influence of these characteristics on intrafirm trade in intermediate products. Given our focus on the propensity of the affiliate to source inputs from its parent, particular attention will be paid to characteristics that indicate a strong link between the parent and the affiliate. In deciding which characteristics to include, and their expected impact on the affiliate's propensity to source from its parent, we drew on the international trade, foreign direct investment, and industrial organization literature. The characteristics listed below are certainly not exhaustive but are

those that could be quantified with the data available.

In the model employed, we seek to explain the variation across affiliates in a foreign affiliate's propensity to import intermediate goods from its U.S. parent company. Table 5 presents a summary of our explanatory variables and their expected signs. In the next section we discuss the explanatory variables that represent characteristics of either the parent company or the overall multinational enterprise. This is followed by similar sections on variables for the host country and for the affiliate. Finally, industry-level variables are discussed. Each observation in the data set is for an affiliate. Therefore, the affiliate-related variables are unique to each observation. Affiliates of the same U.S. parent will have the parent and enterprise-related variables in common. Affiliates located in the same host country will have the host country-related variables in common.

3.A. Parent and MNC-Related Variables

A characteristic that is widely expected to be associated with the vertical integration of MNC operations is the research and development (R&D) intensity of the parent company's operations. Higher R&D spending on the part of the parent implies that the goods it produces have a higher degree of specificity to the firm's production process. In this case it may be costly or impossible to find an outside supplier to provide the inputs, which would lead the company to internalize their supply. In addition, such inputs may embody proprietary information. Due to the dangers of sharing proprietary information with outside parties, goods with high proprietary content are likely to be traded internally. This is particularly true when the outside party is located abroad. Different countries have different rules regarding the enforcement of intellectual property rights, and some countries may enforce such

rights less stringently than others. In general, contracts involving trading of goods that embody technological know-how are difficult to write and enforce, and, therefore it is expected such goods will tend to be traded internally to the firm. The parent's R&D intensity, measured as the ratio of the parent's R&D expenditures to the parent's sales, is expected to be positively related to the affiliate's propensity to import intermediate goods from the parent.

Another factor likely to influence an affiliate's imports from its parent is the relative importance of foreign operations in the multinational enterprise. When more of the firm's operations are carried out abroad than domestically, the firm exhibits a higher degree of multinationality. Pearce (1982) and Zejan (1989) have argued that a firm that is more multinational will have fewer exports from the parent to a particular affiliate because the parent is relatively less important. In addition, a higher degree of multinationality may promote trade between different foreign affiliates of the firm rather than between the parent and the affiliates. The degree of multinationality, measured as the share of the MNC's total assets that are overseas, is thus expected to be negatively related to the affiliate's propensity to import intermediate goods from its parent.

The model controls for the overall size of the parent company, which we measure as the parent company's value added net of operating profits.[8] Larger parents are expected to export more to their foreign affiliates. However, average parent size is likely to vary across industries. Thus, a relatively large parent in one industry may be relatively small were it in another industry. For example, a large food manufacturer may be relatively small when compared to the average petroleum firm. In order to

[8]We exclude operating profits from this measure because they are subject to large year-to-year fluctuations that may simply reflect changes in market demand.

better control for these differences across industries, the estimation includes dummy variables for each industry interacted with parent size.

Finally, if the parent is capital intensive, it is expected that it would export more intermediate goods to its affiliates. There are two possible reasons for this expectation. First, as Buckley and Casson (1976) have argued, the intensive use of capital is often associated with production processes that require considerable coordination among the different stages of production, giving an incentive to vertically integrate. Second, large sunk costs upstream increase the incentive to vertically integrate in order to capture the return on the firm's assets downstream.

3.B. Host Country Variables

If the affiliate is located in a host country with a small local market, it may be more likely to be part of an internationally integrated production process. Because a small market cannot support a large amount of sales, an affiliate located in such a country is likely to export a substantial portion of its output to other countries, making it more likely that the affiliate is a specialized unit with vertical production ties to other member-firms of the MNC. In contrast, an affiliate located in a large market will be able to sell much of its output locally, and is thus more likely to be a self-contained production unit with horizontal ties to other members of the MNC. The propensity of the affiliate to import inputs from its parent is, thus, expected to be negatively related to the size of the host country, as measured by its gross national product.

Factor price differences between the U.S. and other countries, particularly differences in wage rates, are frequently cited as a reason for locating manufacturing operations abroad. The greater the

difference in the relative price of a given factor between the home and host countries, the more incentive a firm has to locate parts of the production process that use that factor intensively in the country where it is relatively cheaper. U.S. MNC's would be expected to locate labor-intensive stages of production, such as final assembly, in countries with lower unit labor costs. Affiliates engaged in activities such as final assembly are expected to import intermediate inputs more intensively from their parents than affiliates engaged in other types of activities. Therefore, the import propensity is expected to be negatively associated with unit labor costs. Unit labor costs are determined by the wages earned by workers and the workers' productivity. The lower the wage paid, for a given level of productivity, the lower the unit labor cost. Likewise, the higher the productivity, for a given wage level, the lower the unit labor cost. The level of education, skills, and infrastructure in a country affect the productivity of that country's work force. To represent host country factor costs, we use several variables: the income level of the host country measured as GNP per capita; the country's infrastructure measured by commercial energy use (in kilograms of oil equivalent per capita), gross domestic investment (as a percent of GDP), and urbanization (the urban population as a percent of the total population); and the country's human capital measured by the adult illiteracy rate (the percentage of the population 15 years of age and over that are illiterate).[9] It is expected that the import propensity of the affiliate will be negatively correlated with those variables associated with higher unit labor costs (GNP per capita and the adult illiteracy rate) and positively correlated with those measures associated with lower unit labor costs (the infrastructure variables).

[9]The data on illiteracy rates were from 1998 for every country except Hong Kong, Malta, Swaziland, and Trinidad and Tobago for which data from 1997 were used. In using data from 1997 and 1998, it is assumed that the adult illiteracy rate in a country would not change rapidly.

The greater the transportation costs for shipping the intermediate inputs to the affiliate, the less likely it is that the affiliate is vertically integrated with its parent. Distance to the host country is our proxy for transportation costs. However, distance does not capture variations in transportation costs due to differences in the products being shipped, which may vary in bulk and weight relative to value. For example, intermediate inputs in the transportation industry may have significantly higher shipping costs than intermediate inputs in the electronics industry. To capture these differences across industries, interaction terms between the distance measure and industry dummy variables are included.

3.C. Affiliate-Related Variables

We hypothesize that one of the most important aspects of the affiliate that will influence its propensity to source intermediate inputs from its parent is to whom it sells its output. In terms of the geographic location and organizational affiliation of the purchasers, there are six possible destinations for affiliate sales: the host country, the home country (i.e., the United States), and third countries, each distinguished by whether the sales are to affiliated or unaffiliated parties. The destination-of-sales variables will be expressed as the share of a particular destination in the affiliate's total sales. Therefore, all six could not be included in the regression because they sum to one. We decided to drop the sales to affiliated parties in the host country.

Affiliates that sell a relatively large share of their output back to their U.S. parent are likely to be part of a vertically integrated production process in which different stages are performed in different locations. Whether or not this increases the volume of intermediate goods imports the affiliates receive from their parent depends on the affiliates' place in the production chain. If the affiliates are situated

early in the chain, they may provide materials or components into the parent's production process and receive little in the way of inputs from their parent. On the other hand, if the affiliates are situated late in the production chain, it is likely that they receive components from the parent and provide semi-processed or finished goods to the parent. On balance, we expect that manufacturing affiliates that sell a large share of their output to their U.S. parent are likely to be involved in assembly operations at the latter stages of the production chain. We thus expect the affiliate's propensity to import intermediate goods from the parent company to be positively related to the share of affiliate sales shipped to the parent.

We expect affiliates that sell more of their output to unaffiliated parties in the host country to import relatively few intermediate inputs from their parents. A high share of such sales is associated with horizontal investment in which an affiliate has been established to serve the local market rather than as a link in a segmented production process.

Along similar lines, affiliates that sell more to unaffiliated parties in third countries could also be indicative of horizontal investment. In this case, the affiliate was probably established not just to serve the host-country market, but rather to serve an entire region. Such sales are particularly prominent in Europe. We hypothesize that the propensity to source intermediate inputs from the parent is negatively related to the share of affiliate sales directed to unaffiliated parties in third countries.

Affiliates that direct their sales to affiliated parties in third countries may also display a low propensity to import intermediate goods from their parents, as increased trade among the different foreign affiliates of a multinational enterprise tends to dilute the importance of trade with the parent company (as discussed above under multinationality). On the other hand, sales to other foreign affiliates

could be indicative of a chain of production in which one affiliate's output is used in another affiliate's production process. If the first affiliate is situated at a later stage in the production chain relative to the parent, it could receive more imports of intermediate goods from its parent. However, if the affiliate is relatively early in the production chain, it would be expected to receive fewer intrafirm imports of intermediate goods. Thus, the coefficient for this variable could be either positive or negative.

The final destination-of-sales variable we consider is the share of affiliate sales shipped to unaffiliated parties in the United States. Affiliates that sell their output back to the United States but to unaffiliated parties rather than to the parent are probably less likely than other affiliates to receive imports from their parent. If the intermediate goods supplied by a parent to its affiliate embody proprietary information or other firm-specific advantages, it is likely that the parent company would seek to maximize its returns on this information by assuming exclusive control over the distribution of the foreign affiliate's product in the home-country market.

The next variable included in the model is the affiliate's R&D intensity, measured as the affiliate's R&D expenditures over the affiliate's total sales. It is not possible a priori to say what impact greater R&D intensity at the affiliate will have on its propensity to source intermediate goods from its parent. If R&D at the affiliate substitutes for R&D at the parent, we would expect a negative impact on the affiliate's propensity to import intermediate goods from its parent. On the other hand, technical skill at the affiliate might allow it to better utilize technology-laden goods obtained from the parent, having a positive impact.

Finally, two additional dummy variables are included. The first of these variables identifies

affiliates in our data set that used to be wholesale trade affiliates.[10] For several reasons, we expect such affiliates to have higher imports of intermediate goods from their parents. First, according to the life cycle hypothesis of foreign direct investment, wholesale trade affiliates that moved into manufacturing over time are likely to initially manufacture goods previously produced by the parent company with inputs from the parent company. It is also possible that as a wholesale trade affiliate it sold intermediate goods from the parent and has subsequently gone into the business of finishing them. Finally, because as wholesale trade affiliates they received imports from their parents, there are already well established trade channels between the parent and the affiliate. The second dummy variable identifies whether or not the parent and the affiliate are in the same industry. The industries in which parents and affiliates are classified are sufficiently broad to permit a high degree of intra-industry specialization in production. Overall, we expect that parents and affiliates classified in the same industry specialize in different production stages, and thus are more likely to trade intermediate goods.

3.D. Industry Variables

As we saw in the descriptive statistics, certain industries, such as electronics or transportation equipment, displayed relatively high levels of affiliate imports of intermediate goods from their parents, while other industries, such as chemicals, displayed much lower levels. This could be due to the fact

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[10] It is only possible to track the industry of an affiliate back to 1982, when the annual series begins. Because of the ability to track affiliates back to 1982, we attempted to include the age of the affiliate as an explanatory variable. However, it turns out that 69 percent of the affiliates in the data set existed in 1982, and, thus, their exact age could not be determined. Therefore, age of the affiliate was dropped, and the relationship between an affiliate's age and its propensity to import from its parent could not be determined with this data set.

that the production processes of some industries are more amenable to being divided up and spread geographically. A measure of the divisibility of production processes in given industries is constructed using data on imports under Provision 9802 of the Harmonized Tariff Schedule of the United States, which deals with production sharing. Industries that import intensively under this provision are those that are amenable to having their production processes divided between geographical locations.

Under Provision 9802.00.80, articles that are assembled abroad in whole or in part of fabricated U.S. components are dutiable on the full value of the imported article less the cost or value of the U. S. components, as long as the components were exported in condition ready for assembly without further processing; have not lost their physical identity by change in form, shape, or otherwise; and have not been advanced in value or improved in condition abroad, except by being assembled and by operations incidental to the assembly process, such as painting. Provision 9802.00.80 applies only to parts that are to be fitted together with other components and not to raw materials, such as chemical products, food ingredients, or powders, which are mixed. Because of the nature of the activities covered under Provision 9802.00.80, the most important countries and industries involved in the program are developing countries in which labor-intensive stages of production can be located. In 1994, the principal products imported under this provision were apparel from the Caribbean Basin and Mexico; televisions, electronic products, and auto parts from Mexico; electronic components from Asia; and transportation equipment, machinery and equipment, and electronics from Canada. U.S. companies pursue production sharing not only through direct investment in foreign affiliates but also through contracting and licensing agreements. A related provision, 9802.00.60, covers articles of metal (except precious metal) manufactured or processed in the United States, then further processed

abroad, and finally returned for processing in the United States. The two most important source countries for imports under this provision are Canada and Mexico.

To construct a measure of the divisibility of production processes, data on imports under Provision 9802 and total U.S. imports by major product in 1994 were collected. Then a measure equal to the imports of a product under Provision 9802 divided by total imports of that product was calculated.[11] The data by product were then matched to the industries in the data set. (It should be noted that this measure reflects only the divisibility of production processes of U.S. companies; this measure would not reflect the divisibility of production processes in industries that may be exploited by foreign, and not by U.S., companies.) The measure of production sharing by industry is expected to be positively correlated with the propensity of affiliates to import intermediate inputs from their parents.

Finally, to control for other industry effects, industry dummy variables are included in the regressions.

4. Data and Estimation

The dependent variable is the propensity of the foreign affiliate to import intermediate inputs from its parent. It is defined as:

[11]Imports from Canada under Provision 9802 fell from a high of $25.7 billion in 1989 to only $1.7 billion in 1994 although total imports from Canada continued to rise. The drop in imports under Provision 9802 was not the result of a reduction in the volume of imports from Canada incorporating fabricated components from the United States but, rather, was the result of the U.S.-Canada Free Trade agreement, which removed many of the incentives to import under the Provision. To avoid understating the true extent of production sharing, imports from Canada were removed from both the numerator and denominator discussed above.

$$\text{Impprop}_A = \frac{\text{Intimp}_P}{\left(\text{Sales}_A - \text{Intimp}_P - \text{Finimp}_P - \text{Inven}_{93} + \text{Inven}_{94}\right)}$$

where Intimp_P is the imports of intermediate goods from the parent,

Finimp_P is the imports of finished goods from the parent,

Sales_A is the affiliate's total sales, and

$\text{Inven}_{93/94}$ is the affiliate's final inventories in 1993 and 1994 respectively.

The denominator is equal to gross output (sales plus changes in inventories) minus the value of imports of both finished and intermediate goods from the parent company. This term represents the affiliate's production net of imports from its parent.

Because 304 out of the total 1,444 affiliate observations receive no imports from their parents, the sample is left censored. In this case, the appropriate estimation method is the Tobit model. The model can be written as

$y_i = ßx_i + u_i$ if $y_i > 0$

$y_i = 0$ otherwise

where y_i is the propensity of affiliate i to import,

x_i is the vector of independent variables for affiliate i,

ß is the vector of parameters to be estimated, and

u_i are the residuals assumed to be independent and normally distributed with zero mean and constant variance.

The Tobit model maximizes a likelihood function that consists of two parts: 1) for those receiving imports, a traditional OLS regression of the propensity to source intermediate goods from their parent given their values of the independent variables, and 2) for those not receiving imports, the probability of not receiving imports given their values of the independent variables.

5. Results

Table 6 presents the results of the regression equations (industry dummy variables and the interaction terms between the industry dummy variables and distance and between the industry dummy variables and parent size are not shown).

Table 6 shows that of the parent or enterprise-related variables, R&D intensity, the degree of multinationality, and the parent's capital intensity are all significant and of the expected sign. The R&D intensity of the parent is an important driver of the affiliate's intermediate goods imports from its parent. This agrees with previous research which has consistently shown that greater R&D intensity is associated with higher levels of intrafirm trade. Because the multinationality variable is measured as the foreign assets over the entire firm's assets, the larger the parent is relative to the rest of the firm, the lower the value of this variable will be. Thus, the regression results indicate that the larger the parent is relative to the rest of the firm, the greater will be the import propensity of its affiliates. The parent's capital intensity is significant and of the expected sign, lending support to the idea that internationally fragmented production is likely to take place within the MNC for production processes that require

intertemporal coordination. The parent size variable is insignificant, likely due to the inclusion of the interaction terms between the industry dummy variables and parent size.

Of the host-country specific variables, income and the infrastructure variables (commercial energy consumption, gross domestic investment, and urbanization) were all significant and of the expected signs. This result provides support to the idea that firms do divide up the production process and locate different stages to take advantage of relative factor-cost differentials. Meanwhile, the measure of human capital, the illiteracy rate, was not significant. It could be that this measure was not a precise or comprehensive measure of human capital, or that MNC's skim the cream of the crop in hiring, and thus, the MNC's workforce is not representative of the host country's entire work force. The coefficient on the size of the host country market (GNP) is insignificant. Distance had the expected negative sign but was insignificant, possibly due to the inclusion of the interaction terms between the industry dummy variables and distance. Also, distance may be an imperfect proxy for transportation costs.

Of the affiliate-related variables, those specifying to whom the affiliate sells have the expected signs and are all significant. The coefficient on sales back to the U.S. parent is positive, suggesting that affiliates that source inputs from their parents are likely to be performing processing activities for the parents. The coefficient on sales to unrelated parties in the United States is strongly negative, indicating that the parent company generally assumes exclusive control over the home-country distribution of affiliate products that embody inputs supplied by the parent. The sign on sales to affiliated parties in third countries is negative, indicating that trade between affiliates does decrease the intensity with which they use intermediate goods imported from their parents. The sales to unaffiliated local parties has the

expected negative sign and is significant, indicating that affiliates with large local sales are more likely to have horizontal ties to the other members of the MNC than vertical ties.

The other three affiliate-related variables--a dummy for a former wholesale trade affiliate, a dummy for the same industry as the parent, and the affiliate's R&D intensity--were significant. The positive coefficient on the dummy variable for former wholesale trade affiliates suggests that these affiliates do use imports from their parents more intensively than other affiliates. The negative sign on the affiliate's R&D intensity suggests that R&D at the affiliate substitutes for R&D at the parent, and thus reduces imports of intermediate goods from the parent. The positive sign on the same-industry dummy variable suggests a tendency for parents and affiliates to specialize in different stages of the production process within the same industry.

Finally, the measure of the divisibility of the production process indicates that affiliates in industries whose production processes are more amenable to being divided up and spread geographically, as measured by imports under Provision 9802, are significantly more likely to source intermediate inputs from their parents.

In summary, foreign manufacturing affiliates have a greater propensity to source intermediate goods from their U.S. parent:

- if the parent invests intensively in R&D, is large relative to the entire firm, and is capital intensive;
- if the host country has some factor cost advantage but can still provide needed skills and infrastructure to support the affiliate; and
- if the affiliate sells its output back to its U.S. parent; if at one time it was a wholesale trade

affiliate; if it does not invest in its own R&D; and if it is in the same industry as its parent. The results show that MNC's exhibiting characteristics of vertical organization have foreign affiliates with a greater propensity to import intermediate goods from their U.S. parents.

6. Conclusion

Intrafirm trade associated with the production activities of multinational companies is an important aspect of the fragmentation of production across national borders. In this paper, we examined this trade at the firm level in terms of the propensity of foreign affiliates to source intermediate goods from their U.S. parent companies. Relating this sourcing propensity to characteristics of the parent company, the affiliate, and the affiliate's host country and industry, we found general support for a number of hypotheses that link intrafirm trade in intermediate goods to the vertical integration of parent and affiliate operations.

Our results indicate that intrafirm trade in intermediate inputs is associated with parent and affiliate characteristics that favor internalized transactions and the active coordination of different stages of the production process. Consistent with earlier research, the propensity of affiliates to source intermediate inputs from their parent companies is positively related to the R&D intensity of parents, suggesting that the inputs supplied by the parents embody proprietary knowledge. This propensity also increases with parent capital intensity, which has been interpreted as an indicator of multi-stage production processes that require intertemporal coordination. The propensity to source inputs from parents is positively related to affiliate sales to parents, suggesting that affiliate production is closely integrated with that of the parents. In addition, the sourcing of inputs from parents is negatively related

to affiliate sales to unrelated parties in the home country, suggesting that the distribution of the affiliate's product in the home-country market is internalized by the MNC in order to appropriate the gains from intangible assets embodied in the inputs supplied to the affiliate.

The results also underscore the association of intrafirm trade in intermediate inputs with fragmented production processes, and indicate that this trade is most prevalent for affiliates located in countries that offer cost advantages. The propensity to import intermediate inputs from parent companies is most pronounced for affiliates in industries that have divisible production processes and also tends to increase when the affiliate is in the same industry as the parent. In addition, this sourcing behavior tends to be more prominent for affiliates located in host countries with lower quality-adjusted labor costs, as indicated by the negative correlation with per capita GNP and the positive correlation with variables representing host-country infrastructure.

The signs on the regression coefficients for a number of our variables suggest vertical specialization between higher-skilled, or more technologically advanced, activities performed by the parent and lower-skilled, or more rudimentary, activities performed by the affiliate. The affiliate's propensity to source intermediate goods from the parent increases with the R&D intensity of the parent and decreases with the R&D intensity of the affiliate, indicating a higher level of technological sophistication for the value added activities performed by the parent. In addition, this propensity decreases with the host country's per capita income, suggesting that affiliates that receive substantial inputs from their parents tend to perform lower-skilled activities suited to host countries with relatively low labor costs. Finally, the propensity to source intermediate goods from the parent increases with the share of affiliate sales that are shipped back to the parent, suggesting that this behavior is most

pronounced for affiliates that perform basic assembly operations near the end of the value chain. The two-way trade implied by this last relation is consistent with the concept of vertical specialization advanced by Hummels, et al (1998 and 2001), whereby countries link sequentially in a given production process in accordance with their factor cost advantages.

Appendix A: The Data Set

The data are from the 1994 Bureau of Economic Analysis (BEA) benchmark survey of U.S. direct investment abroad. This is a mandatory survey conducted by BEA. The sample of affiliates in the data set was restricted to majority-owned manufacturing affiliates that were reported on the benchmark survey long form, which collects the most detailed data on affiliate operations.[12] All majority-owned affiliates with total assets, sales or gross operating revenues, or net income (or loss) greater than $50 million in 1994 were required to be reported on the long form. The analysis in this paper is based on firm-level reports. Only reported data were used; affiliate reports that were estimated were excluded from the final data set. The data on the U.S. parents were also from the 1994 benchmark survey.[13]

Foreign affiliates are classified by 3-digit International Surveys Industry (ISI) industry codes. If a reporter had more than one business in the same 3-digit ISI industry in a country, the reporter generally consolidated all those businesses into one report. If businesses in the same country but in different 3-digit industries are considered part of one integral production process, then they may also be reported on a consolidated basis. In this case, they were classified in the industry that accounted for the largest share of sales.

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[12]A majority-owned affiliate is defined by BEA to be a foreign affiliate in which the combined direct and indirect ownership interest of all U.S. parents exceeds 50 percent. However, for this paper we used data only for affiliates that were majority-owned by a single U.S. parent.

[13]The U.S. parent is any "person" whose ownership stake exceeds 50 percent in a foreign business enterprise. ("Person" in this definition may be any business enterprise; nonprofit organization; individual; estate or trust; and so on. Most parents are business enterprises.) If the parent is incorporated, the U.S. parent is the fully consolidated U.S. enterprise consisting of 1) the U.S. corporation whose voting securities are not owned more than 50 percent by another U.S. corporation, and 2) proceeding down each ownership chain from that U.S. corporation, any U.S. corporation whose voting securities are more then 50 percent owned by the U.S. corporation above it. A U.S. parent comprises the domestic operations of a U.S. multinational corporation.

For affiliates that were reported on the long form, total imports from their parents were broken out into four possible categories: Goods intended for further processing, assembly, or manufacture by the affiliate before resale to others; goods for resale without further processing, assembly, or manufacture by the affiliate; capital equipment and other goods charged to the affiliate's fixed asset accounts; and other. In the data set, goods for further processing accounted for 80 percent of the total affiliate's imports from their parents. Finished goods accounted for another 19 percent, and capital equipment and other accounted for only 1 percent.

For some affiliates in Mexico, the definition of the dependent variable–the propensity to import intermediate goods from the parent–had to be adjusted to take into account unique reporting pattens. In the benchmark survey report, some affiliates--particularly those engaged in in-bond processing of goods (such as maquiladoras)--did not include imports from the U.S. parent for processing in their sales or expenses.[14] If evidence was found that the affiliate omitted these imports in its reported sales, then the figure for sales was not adjusted to net out imports from the parent in calculating the propensity to source intermediate goods from the parent.[15] The regressions were run both including these observations and excluding them; they made little difference in the final estimates, so they were included in the results shown.

To identify manufacturing affiliates that were previously engaged in wholesale trade, BEA's annual data on U.S. investment abroad going back to 1982 were used. These data were used to

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[14] Overall, these cases are extremely rare--in the 1994 benchmark survey, there were only 67 cases out of a universe of 18,929 nonbank foreign affiliates.

[15]Following the specification of Anderson and Fredriksson as explained in the text, imports from the parent were subtracted from output in constructing the denominator of the import propensity.

identify affiliates that had been classified in wholesale trade in some year prior to 1994.

R&D expenditures were for those activities performed by the parent or by the affiliate and include such activities as basic and applied research in science and engineering and design and development of prototypes and processes.

BEA estimates value added by foreign affiliates as the sum of costs incurred (other than for intermediate inputs) and profits earned in production. Because the measure of size used in the model was value added net of profits, it is the sum of costs incurred in production. Employment is the number of full-time and part-time employees at the end of fiscal year 1994.

The data on host country GNP per capita, population, and infrastructure variables come from two sources. Tables 1, 8, 9, and 13 of the World Bank's *World Development Report* for 1996 provided data on all host countries except Taiwan. The Taiwan data are from the *Statistical Yearbook of the Republic of China for 1999*. Data on the illiteracy rates come from Table 2 of the *World Development Report* for 2000/2001. Data on the distance from Chicago to the host country capital are from Frankel, Stein, and Wei (1995) and Frankel and Wei (unpublished).

The data on imports under Provision 9802 are from the United States International Trade Commission's *Production Sharing: Use of U.S. Components and Materials in Foreign Assembly Operations, 1991-1994.*

Appendix B: Elasticities

In the Tobit model the regression coefficients do not yield the marginal effects on the dependent variable of changes in the independent variables. As McDonald and Moffitt (1980) show, the marginal effects are the combination of two separate elements. The first element is the change for those already above the limit, and the second element is the change in the probability of being above the limit. Thus, in our model, the first element is the change in the import propensity of those already receiving imports from their parents, weighted by the probability of receiving such imports. The second element is the change in the probability of receiving imports, weighted by the expected value of the import propensity of those receiving imports. The marginal effect on the import propensity of an affiliate due to a change in one of the independent variables, i, can be calculated by the following formula:

$$\frac{\partial Y}{\partial X_i} = F\left(\frac{b' X}{s}\right) b_i$$

where Y is the dependent variable (the affiliate's propensity to import from its parent),

F is the cumulative normal distribution function,

ß is the vector of parameter estimates,

X is a vector of independent variables, and

s is the standard deviation of the residuals.

The value of the marginal effect will depend on the value of the independent variables that are used in calculating the above expression. In this case, the means of the independent variables were used. The elasticities were calculated by

$$e_i = \left(\frac{\partial Y}{\partial X_i} \right) * \frac{\bar{x}_i}{\bar{y}}$$

where $\bar{x}_i$ is the mean of the i^{th} independent variable, and

$\bar{y}$ is the mean of the dependent variable.

Table 7 shows the elasticities with respect to the parent-related, affiliate-related, host country-related and industry variables from the regression results presented in table 6.

The infrastructure variables had the largest positive elasticities. These variables, combined with GNP per capita, which had a relatively large negative elasticity, are proxies for the host country's unit labor costs. Taken together, the large elasticities of these variables indicate the importance of factor costs in determining the affiliate's propensity to import from its parent. Being in an industry whose production process is easily divisible across national borders, being in the same industry as its parent, and having a capital intensive parent that invests intensively in research and development all had large positive effects on the affiliate's propensity to import from its parent. In contrast, greater distance from the United States, having a parent with more assets overseas, and the affiliate selling most of its output in the local market or to third countries negatively impacted an affiliate's propensity to import from its parent.

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Table 1: Exports of Goods Shipped by U.S. Parent Companies to Their Foreign Affiliates for Further Manufacture

	1966	1977	1982	1989	1994	1999
Value in millions of dollars	2,483	9,577	22,443	47,689	71,678	102,574
As a percentage of:						
Total U.S. exports of goods	8.5	7.8	10.4	13.1	14.0	14.7
Total exports of goods by U.S. parents	n.a.	10.2	14.6	21.4	22.3	25.2
Total exports of goods by U.S. parents to their foreign affiliates	39.3	32.7	50.6	55.4	54.0	64.7

n.a. Not available

Note: In this table, the data on foreign affiliates of U.S. parent companies are for majority-owned foreign affiliates only.

Table 2: Number of Affiliates, Affiliate Sales, and Intermediate Goods Imports from the U.S. Parent by Industry

Industry	Number of affiliates	Affiliate sales*	Intermediate goods imports from parent*	Imports as a percentage of sales
Manufacturing, total	1,444	527.4	54.9	10.4
Food & kindred products	128	42.3	1.5	3.5
Chemicals & allied products	409	90.6	5.0	5.5
Petroleum manufacturing	22	43.4	0.1	0.2
Primary & fabricated metals	96	12.4	0.8	6.5
Industrial machinery & equipment	171	96.0	9.8	10.2
Electronic & other electric equipment	164	41.8	9.0	21.6
Transportation equipment	110	135.5	23.9	17.6
Instruments & related products	94	19.5	2.2	11.2
Other	250	45.8	2.5	5.5
	Percentage of All-Industries Total			
Manufacturing, total	100.0	100.0	100.0	
Food & kindred products	8.9	8.0	2.8	
Chemicals & allied products	28.3	17.2	9.1	
Petroleum manufacturing	1.5	8.2	0.2	
Primary & fabricated metals	6.6	2.4	1.4	
Industrial machinery & equipment	11.8	18.2	17.9	
Electronic & other electric equipment	11.4	7.9	16.4	
Transportation equipment	7.6	25.7	43.5	
Instruments & related products	6.5	3.7	4.0	
Other	17.3	8.7	4.6	

*Affiliates sales and intrafirm imports are in billions of current dollars.

Table 3: Number of Affiliates, Affiliates Sales, and Intermediate Goods Imports from the U.S. Parent by Host-Country Income Class

Host-country GNP per capita	Number of affiliates	Affiliate sales*	Intermediate goods imports from parent*	Imports as a percentage of sales
Less than $1,000	37	3.7	0.2	5.4
Between $1,000 & $5,000	223	56.6	10.2	18.0
Between $5,000 & $15,000	171	33.3	2.1	6.3
Between $15,000 & $25,000	792	304.3	36.6	12.0
Greater than $25,000	221	129.4	5.8	4.4
	Percentage of All-Countries Total			
Less than $1,000	2.6	0.7	0.4	
Between $1,000 & $5,000	15.4	10.7	18.6	
Between $5,000 & $15,000	11.8	6.3	3.8	
Between $15,000 & $25,000	54.8	57.7	66.6	
Greater than $25,000	15.3	24.5	10.5	

*Affiliates sales and intrafirm imports are in billions of current dollars.

Table 4: By Income Class without Affiliates in Canada and Mexico

Income class	Number of affiliates	Affiliates' sales*	Intermediate goods imports from parent*	Imports as a percentage of sales
Less than $1,000	37	3.7	0.2	5.4
Between $1,000 & $5,000	151	34.3	3.0	8.7
Between $5,000 & $15,000	171	33.3	2.1	6.3
Between $15,000 & $25,000	599	210.1	12.5	6.0
Greater than $25,000	221	129.4	5.8	4.4
	Percentage of All-Countries Total			
Less than $1,000	3.1	0.9	1.0	
Between $1,000 & $5,000	12.8	8.3	12.8	
Between $5,000 & $15,000	14.5	8.1	8.9	
Between $15,000 & $25,000	50.8	51.1	52.9	
Greater than $25,000	18.7	31.5	24.4	

*Affiliates sales and intrafirm imports are in billions of current dollars.

Table 5: List of Explanatory Variables and Their Expected Signs

Variable	Definition	Expected Sign
Parent and MNC-Related Variables		
Parent R&D intensity	R&D expenditures of the parent company as a share of its sales	+
Multinationality	Foreign-affiliate assets as a share of the MNC's total assets	-
Parent size	Parent company's value added net of operating profits (millions of dollars)	+
Parent capital intensity	Net property, plant, and equipment per employee of the parent company (millions of dollars)	+
Host Country-Related Variables		
Country size	GNP in 1994 (billions of dollars)	-
Country income level	GNP per capita in 1994 (thousands of dollars)	-
Distance	Distance of host country capital from Chicago (thousands of kilometers)	-
Commercial energy use	Kilograms of oil equivalent per capita	+
Gross domestic investment	GDI as a percent of GDP	+
Urbanization	Urban population as a percent of total population	+
Education	Percent of people 15 years of age and older who are illiterate	-
Affiliate-Related Variables		
Sales to parent	Sales to the U.S. parent company as a share of the affiliate's total sales	+
Affiliated sales to third countries	Sales to affiliated parties in third countries as a share of the affiliate's total sales	+/-
Unaffiliated sales to third countries	Sales to unaffiliated parties in third countries as a share of the affiliate's total sales	-

Unaffiliated sales to the United States	Sales to unaffiliated parties in the U.S. as a share of the affiliate's total sales	-
Unaffiliated sales to host country	Sales to unaffiliated parties in the host country as a share of the affiliate's total sales	-
Former wholesale trade affiliate	Dummy variable for manufacturing affiliate that had been classified in wholesale trade in any of the years 1982-93	+
Affiliate R&D intensity	R&D expenditures of the affiliate as a share of its sales	+/-
Same industry as the parent	Dummy if the parent and the affiliate are in the same industry	+
Other Variables		
Divisibility of the production process	Imports of products in that industry under provision 9802 over total imports of products in that industry in 1994	+

Table 6: Regression Results

Variable	Coefficient	S.E.
Parent R&D intensity	0.508**	0.213
Multinationality	-0.242***	0.063
Parent size	0.0001	0.001
Parent capital intensity	0.0003**	0.0001
Country size	0.001	0.01
Country income level	-0.005**	0.003
Distance	-0.022	0.020
Commercial energy use	0.00002**	0.000001
Gross domestic investment	0.015***	0.002
Urbanization	0.002***	0.0008
Education	-0.0004	0.002
Sales to parent	0.145*	0.086
Affiliated sales to third countries	-0.240***	0.078
Unaffiliated sales to third countries	-0.154**	0.077
Unaffiliated sales to the United States	-0.650***	0.133
Unaffiliated sales to host country	-0.143**	0.063
Former wholesale trade affiliate	0.063*	0.035
Affiliate R&D intensity	-0.628**	0.274
Same industry as the parent	0.061***	0.021
Divisibility of the production process	0.668**	0.263
Constant	-0.143	0.177
Observations	1,444	
Left-censored obs.	304	
Chi-Square value (66)	399.73	
Prob>chi-square	<0.00001	

* Significant at 10% level ** Significant at 5% level *** Significant at 1% level

Table 7: Elasticities

Variable	Elasticity
Parent R&D intensity	0.11
Multinationality	-0.45
Parent size	0.02
Parent capital intensity	0.13
Country size	0.02
Country income level	-0.39
Distance	-0.64
Commercial energy use	0.37
Gross domestic investment	1.39
Urbanization	0.80
Education	-0.005
Sales to parent	0.05
Affiliated sales to third countries	-0.15
Unaffiliated sales to third countries	-0.08
Unaffiliated sales to the United States	-0.06
Unaffiliated sales to host country	-0.37
Former wholesale trade affiliate	0.02
Affiliate R&D intensity	-0.04
Same industry as the parent	0.16
Divisibility of the production process	0.21