Horizontal vs. Vertical FDI: Revisiting Evidence from U.S. Multinationals

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ABSTRACT

Using confidential data from the Bureau of Economic Analysis, we document a new set of facts regarding the behavior of U.S. multinational firms. First, we find that intra-firm trade is concentrated among a small number of large affiliates. The median affiliate reports no shipments to the parent, and directs the bulk of its sales to unrelated parties in its country of operation. In this sense, "horizontal" rather than "vertical" FDI seems to better capture the role of most U.S. affiliates abroad. Second, multinational firms often own vertically linked affiliates, as defined by the input-output coefficients between their respective industries of operation. These vertical chains, however, are not associated with a corresponding intra-firm flow of physical goods between upstream and downstream units of production. Our findings suggest that a comparative advantage of multinational corporations is their ability to transfer intangible—rather than physical—inputs along vertically linked production units.

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1 Introduction

Multinational firms dominate foreign commerce through both foreign affiliate sales and international trade. In 1999, the foreign affiliates of U.S. multinational firms accounted for $566.4 billion of value added (approximately 6 percent of U.S. GDP) and $2,219 billion of sales, of which 63 percent were sales to unrelated parties in the country of operation. U.S. parents are also large exporters and importers, accounting in 1999 for 57 percent of total U.S. exports in goods, and 35 percent of total U.S. imports of goods. 40 percent of parent exports are shipped to affiliates and 44 percent of parent imports come from affiliates.[1]

Based on these figures, the literature aimed at understanding the patterns of foreign direct investment (FDI) has distinguished two main motives for locating production abroad. On the one hand, a firm may want to locate production in the destination market to save on transport costs; this mode is known as *horizontal* FDI. Exports and multinational production are, in this case, two alternative ways of supplying a foreign market.[2] On the other hand, the literature has pointed to comparative advantage across countries as a motive for the foreign location of some stages of production; this mode is known as *vertical* FDI. In this case, intra-firm trade between parents and affiliates producing vertically linked goods is a complement of FDI.[3]

In this paper we revisit the evidence on the motives for FDI by looking at the firm level data collected by the U.S. Bureau of Economic Analysis (BEA). Our findings suggest that, for the large part, affiliates do not exist to facilitate the physical shipment of goods within the firm, but rather, their main purpose seems to be to supply the destination market. In this sense, horizontal, rather than vertical, FDI appears to be the main motive for establishing affiliates abroad.

[1] These magnitudes refer to majority-owned, non-bank affiliates of American firms abroad, from the Bureau of Economic Analysis (BEA). Imports and exports in goods are from the Balance of Payments, also from the BEA.

[2] See Horstmann and Markusen (1992), Brainard (1997), Markusen and Venables (2000), and Helpman, Melitz and Yeaple (2004), among others.

[3] See Helpman (1984), Yeaple (2003), and Keller and Yeaple (2009). Ramondo and Rodríguez-Clare (2009) and Irrazabal, Moxnes and Opromolla (2010) combine the two motives for FDI into a unified framework.

We document that, although intra-firm trade represents an important share of overall U.S. imports and exports, it is concentrated among a small number of large firms. For most U.S. multinational firms, intra-firm trade represents a small fraction of the affiliate's operations, both relative to their input costs and total sales. In 1999, the median manufacturing affiliate received only 0.12 percent of its inputs from the parent firm, and sold 97 percent of its production to domestic unrelated parties; 60 percent of affiliates report no shipments to the parent.[4]

Despite the lack of intra-firm trade relative to the overall activities of the majority of affiliates, multinational corporations often own vertical production chains: most affiliates operate in industries upstream or downstream from those of the parent. Looking at the seven largest industries of operation of both parents and affiliates, disaggregated at the four digit level according to the BEA's NAICS-based International Surveys Industry (ISI) classification, we document that affiliates are mostly single-industry units, and 60 percent operate in the same primary industry as the parent. Of those that produce in a different industry, 91 percent are vertically linked with the parent, as defined by the input-output matrix. We find that parent-affiliate pairs are more likely to be vertically linked when the affiliate is located in a small country or if the affiliate belongs to a large firm. We also find that industry pairs with stronger vertical links are more likely to have foreign affiliates and that these affiliates are larger, as measured by employment.

Nonetheless, these vertical links are not matched with a corresponding intra-firm trade flow between upstream and downstream units of production. The presence of a vertical link between parent and affiliate, as defined by the input-output matrix, does not predict the existence and volume of intra-firm flows. In our empirical work, the coefficient that captures the effect of the vertical link between parent and affiliate on the trade flow between those two parties, is virtually zero, and usually, precisely estimated. For instance, an increase in our measure of vertical linkage is not found to affect the likelihood

[4]The skewness of intra-firm trade towards large multinational firms is consistent with the theoretical predictions in Grossman, Helpman and Szeidl (2006).

that an affiliate ships goods back to the parent. When restricting the sample to only those affiliates that register positive intra-firm flows, a 10 percent increase in our measure of the vertical link between an upstream affiliate and its parent, is associated with an increase in the intra-firm shipments of goods from the affiliate, as share of its total sales, of only 0.5 percent (s.d. 0.0233).

Our paper is closely related to Alfaro and Charlton (2009). Based on world wide information on ownership and industry of operation of parents and affiliates, they find that multinationals tend to own affiliates that operate the stages of production "vertically proximate" to their final production, according to the input-output matrix. Their result is similar to our finding that multinational corporations often own vertical production chains. Not having information on the intra-firm flows of physical goods, Alfaro and Charlton (2009) interpret this input-output "closeness" between parent and affiliates as evidence of vertical FDI. In our data we do observe the flows between parents and affiliates, so we are able to establish whether the presence of the vertical chain is a good predictor of intra-firm flows. We find that intra-firm flows are surprisingly low along the identified vertical chains, and we find that these flows are not associated with the presence of a vertical link between the parent and affiliate.

The empirical patterns we document do not seem to be exclusive to U.S. multinationals. Irrazabal et al. (2010), using a similar data set on the Norwegian manufacturing sector, for 2004, find that 62 percent of total affiliate sales are to the local market. Additionally, Norwegian parent imports from destinations where they have affiliates are, on average, 6 percent of affiliate sales. Our findings are also consistent with Hortacsu and Syverson (2009) who study the domestic operations of U.S. multi-plant firms. They find that shipments between establishments owned by the same firm are surprisingly low. Moreover, they report that sales by vertically linked establishments are, for the most part, destined to non-related parties located near the productive unit.

Our paper is also closely related to the large empirical literature on vertical FDI. We

find, consistent with the existing literature, that intra-firm shipments into the United States are positively related to the income per capita of the host country, but negatively related to host country size and distance to the United States.[5] Also consistent with the literature, we find that the income level of the host country and the distance to the United States are significantly and negatively related to the existence and the volume of exports from the U.S. parent to their affiliates.[6]

Given our findings, an important question arises: If shipment of goods along the vertical chain does not appear to be the motive for owning affiliates, why do firms own vertically integrated chains? Similarly to Hortacsu and Syverson (2009) for U.S. domestic firms, we conjecture that the role of vertical links is related to the transfer within the corporation of certain capabilities. Strong input-output requirements between two goods may signal the usage of a common set of specific intangible inputs. These intangibles can be understood as knowledge capital (Markusen (1984)), technology capital (McGrattan and Prescott (2010)), or managerial ability (Garicano and Rossi-Hansberg (2006)).

For example, consider the case of *Converted Paper Products (NAICS 3222)*—stationary and envelopes—which uses *Paper (NAICS 3221)* as its main input. The production of these goods likely involves similar knowledge about the quality of the materials, demand, suppliers, and competition that can be transmitted among the different units within the firm. Sharing these intangibles can be a source comparative advantage in the production of vertically linked goods, even in the absence of physical shipments between affiliates.[7] Overall, our findings contribute to understanding the determinants of vertical and horizontal FDI, and more broadly, the boundaries of the multinational firm.

The remainder of the paper is organized as follows. Section 2 describes the data. Section 3 reports the importance of intra-firm flows for U.S. foreign affiliates. Section

[5]See Yeaple (2006), Nunn (2007), Nunn and Trefler (2008), Chor, Foley and Manova (2008), Bernard, Jensen and Schott (2009), and Costinot, Oldensky and Rauch (2011), among others. Most of the tests in these papers has been motivated by the work by Albuquerque (2003) and Antras and Helpman (2004).

[6]See Borga and Zeila (2004), Hanson, Mataloni Jr. and Slaughter (2005), and Yeaple (2006).

[7]In a calibration exercise, Irrazabal et al. (2010) also interpret most of the intra-firm flows between affiliates and parent to be in the form of intangible inputs.

4 presents estimates of the relationship between vertical links, ownership, and intra-firm flows of foreign affiliates. Section 5 discusses the results. Section 6 performs some robustness analysis, and section 7 concludes.

2 The Data

Our firm level data are collected by the U.S. Bureau of Economic Analysis for the purpose of producing aggregate statistics on the operations of multinational companies. These data cover the universe of U.S. parents and their foreign affiliates in the year 1999. Parent and affiliate data are reported at different levels of aggregation. Parent data aggregate all U.S.-located company operations that are part of the fully consolidated firm. In the case of foreign affiliates, the data are, in general, more disaggregated at the affiliate level. Some affiliates of the same parent may report in a consolidated manner if they are located in the same country and are in the same four-digit industry. Affiliates may never consolidate across countries.

Detailed data on affiliate operations must be reported if affiliate sales, assets, or net income (loss) are greater than $7 million. Of the 40,155 existing affiliates, 23,980 are large enough to report.[8] The reporting cutoff level is low: Reporting affiliates account for 99.6 percent of total affiliate assets and 99 percent of total affiliate sales. Of these 23,980 affiliates, we keep the majority owned (more than 50 percent ownership by the parent), nonbank affiliates of nonbank parents. After dropping affiliates that do not report disaggregated sales, our sample consists of 19,224 affiliates that account for 81 percent of multinational sales.[9] Our analysis centers on manufacturing parents and affiliates; of those, our sample accounts for 85 percent of foreign multinational sales. Detail of the sample restrictions are presented in table 1.

[8] For affiliates that do not report, their total sales, employment, and assets are reported by the parent.

[9] We also drop 315 affiliates that do not report data on the costs of inputs, or the ratio of goods shipped from parent for resale or further processing (alternatively) to total costs of inputs is bigger than one. These observations only account for 0.2 percent of total sales of affiliates.

For each affiliate and parent in our data, we observe sales broken out in various ways. In one breakout, parents and affiliates report sales in each of their seven largest industries. These industries are classified according to the International Surveys Industry (ISI) classification, which is roughly equivalent to the 1996 NAICS. When we need a broad categorization of a firm—to claim, for example, that a firm is in the manufacturing sector—we use the industry code with the largest volume of sales. In our sample, affiliates span a total of 195 four-digit industries; 77 when the sample is restricted to manufacturing (see table 1). Affiliates are typically more focused on a core industry than the parent. On average, 84 percent of the parent's sales are in its main industry of operation, compared to 96 percent for affiliates; in manufacturing, 81 percent of a parent's sales are in the primary industry, and for affiliates, it is 95 percent.

The data for the parents reports an aggregate of all company operations of the fully consolidated firm located in the United States. This may make parents seem artificially more diverse than affiliates. For comparison, we also aggregate the operations of all the affiliates owned by the parent, by country; still, the share of sales in the primary industry is considerably higher than for the parent, 91 percent (89 percent for affiliates in manufacturing). The data are very skewed: the median affiliate operates in a single industry while larger affiliates (weighted by their level of employment) operate in a larger set of industries (see panel 2 in table 2).

Our main results are made possible by data on the destination of affiliate sales. Sales can be directed to the parent, unaffiliated U.S. parties, local affiliates, local unaffiliated parties, affiliated parties in neither the U.S. nor the host country (what we call "other countries"), and unaffiliated parties in other countries. Importantly, we observe the sales of the affiliate to the parent in total, as well as the sales from the parent firm to the affiliate in total, in goods "for further processing," and in goods "for resale." Being able to observe the flows between parents and affiliates is a unique feature of these data, and will allow us to say much more about how parents use (or do not use) affiliates to move goods

across countries. Table 2 presents a first description of these intra-firm flows. The median affiliate does not report any physical shipment of goods to or from the parent firm and sells exclusively to local unrelated parties. In the case of manufacturing, these figures are hardly changed: the median affiliate sells 97 percent of its production to the local market, and receives 0.1 percent of its inputs from the parent firm. Although the median firm does not engage in intra-firm trade, those that do tend to be larger: weighted by the affiliates' level of employment, average sales to local unrelated parties drops to 58 percent of the affiliates' total production, and the inputs shipped from the parent account for 8 percent of the affiliates' total input costs (see panels 3 and 4 in table 2).

In what follows, when we analyze shipment from the parent to the affiliate, we focus on the shipment of goods for further processing, and disregard trade of final goods for resale. Trade in goods for resale corresponds to affiliates operating in retail or wholesale industries; they do not participate in the production process. We think that these affiliate sales are better described theoretically by models of international trade, rather than models of FDI. For that reason, in most of the analysis below we focus on parent-affiliate pairs in which both parties operate in manufacturing industries. As reported in panel 4, table 2 (columns 4 to 6), shipments of final goods for distribution from the parent to the affiliate are virtually absent in our sample of manufacturing firms.

3 Patterns of Intra-firm Flows

Traditional models of vertical FDI assume that a parent creates an affiliate in order to carry out some stages of the production process, and that the home country remains the main destination market of the firm: Production involves flows of goods between the parent and the affiliate. In contrast, models of horizontal FDI are based on the assumption that a parent creates an affiliate to produce in, and to sell to, the host country. If a parent-affiliate relationship is horizontal, we would expect to see little trade between the parent

and affiliate, and most sales of the affiliate directed to the market of operation. There will be, of course, mixtures of vertical and horizontal FDI, but the relevance of intra-firm flows will provide information about the primary motive for establishing an affiliate.

To broadly frame our discussion, consider the following configuration possibilities for a parent-affiliate pair.

1. The parent may send partially finished goods to the affiliate to be completed, and then some, or all, of the goods may be shipped back to the parent;

2. The affiliate may produce the good without any shipments from the parent (though the affiliate may be receiving goods from other parties) and ship finished goods to the parent;

3. The affiliate may produce a partially completed good and ship it to the parent to finish production.

In these examples, we would expect to observe shipments from the affiliate to the parent, and in the first example, we would expect to observe shipments from the parent to the affiliate.

As mentioned in the introduction, U.S. multinational firms account for a large share of U.S. exports and imports. According to the aggregate figures from the BEA, in 1999, U.S. parents accounted for 57 percent of U.S. exports of goods and 35 percent of U.S. imports of goods. Approximately 40 percent of parent exports are to affiliates and 44 percent of parent imports are from affiliates. The remaining 60 percent of parent exports and 56 percent of parent imports are undertaken at arms-length. Restricting the sample to manufacturing firms, total affiliates shipments to the parent totaled $138,636 million, representing 13 percent of total manufacturing affiliate sales, and approximately 16 percent of U.S. manufacturing imports. Exports from U.S. parents in manufacturing to affiliates abroad were $108,350 million, 92 percent of which were in goods for further processing; about 6 percent of manufacturing parent shipments were goods for distribution. These intra-firm

shipments accounted for almost 20 percent of U.S. manufacturing exports.[10] Notice that these numbers imply a ratio of total affiliate sales to total U.S. exports in manufacturing goods of around two, as commonly reported, and a ratio of 1.2 for total affiliate sales to total U.S. imports in the same sector.

Behind these aggregate numbers, however, there is great heterogeneity at the firm, industry, and country level. Intra-firm trade is concentrated among a small number of large affiliates abroad. As described in panels 3 and 4 of table 2, the average affiliate ships only 4.3 percent of its production to the parent; the average rises to 6 percent if only manufacturing firms are considered. Meanwhile, shipments of goods for further processing from the parent represent, on average, a small fraction of the affiliate's total input costs, about 3 percent (8 percent when we restrict the sample to manufacturing firms). The average intra-firm flow is larger when weighted by the size (employment) of the affiliate, as reported in columns 3 and 6. The median manufacturing affiliate does not report shipments to or from the parent, and sells 97 percent of its output to local unaffiliated parties.

For a striking majority of affiliates, shipping goods to the parent does not seem to be the main purpose of their activity. We explore this further in figure 1. This histogram plots the distribution of affiliates by the share of total affiliate sales that go to the parent. We report this histogram for the entire sample, for parent-affiliate pairs in manufacturing, and for North American motor vehicles (ISI 3361-3363). The histograms make it clear that very little is shipped from the affiliate to the parent. In the entire sample, more than 90 percent of affiliates ship less than 5 percent of their output to the parent. The entire sample, however, includes service industries in which we would expect to see little trade regardless of the mode of FDI. When we restrict the sample to the manufacturing sector, 86 percent of affiliates ship less than 5 percent of their output to the parents, and an astonishing 60 percent of the affiliates in our sample report no shipments to the headquarters

[10] Data refer to majority-owned affiliates in the manufacturing sector, from the BEA. Data on U.S. imports and exports in manufacturing goods are from the U.S. Census. All data are for 1999.

(columns 1 and 5 in panel 1 of table 3). The third group of parent-affiliate pairs is restricted to affiliates in the motor vehicle industries in Canada and Mexico. Even in this sub-sample, more than 60 percent of affiliates ship less than 5 percent of their output to the parent, but almost 15 percent of affiliates ship more than 90 percent of output to their parent, as a model of vertical FDI would predict. This industry, however, is an exception: no other industry has more than 3-4 percent of its affiliates selling more than 90 percent of output to the parent.

The absence of trade from the affiliate to the parent is mirrored by the flows from the parent to the affiliate. Figure 2 presents an histogram of the value of the parent's shipments to the affiliate in goods for further processing as a share of the affiliate's total input cost. Again, very little trade in goods takes place within the firm. More than 80 percent of affiliates source less than 5 percent of their inputs from their parent firm. In fact, almost half of the affiliates report zero trade from their parent. Similarly to the affiliate to parent flow, when we restrict the sample to parents and affiliates in manufacturing, the results are hardly changed. Affiliates in Canada and Mexico, in the motor vehicles sector, are more likely to source inputs from their parent, but these inputs still represent a relatively small fraction of total input purchases done by the affiliate.

4 Vertical Links, Ownership, and Intra-firm Flows

In the previous section we documented that very few affiliates send goods to, or receive goods from, their parents, suggesting that most FDI is not undertaken to promote vertical specialization, but rather, to serve the market of operation. In this section, we analyze the ownership structure of multinational firms in terms of their vertical integration, and we find that most parent-affiliate pairs operate in vertically related industries. This finding, along with the one in the previous section, suggests that while multinational firms own affiliates in upstream and downstream industries, they do not do so with the purpose of

facilitating the transfer of goods along the production chain.

4.1 Do Vertical Links Predict Ownership?

We begin by determining which of our parent-affiliate pairs are vertically linked. We follow Alfaro and Charlton (2009) and Hortacsu and Syverson (2009) and base our classification on the industries in which each firm operates. We observe a parent in industry i and its affiliate in industry j. To what extent are industries i and j—and, by extension, parent and affiliate—dependent on each other for inputs into production?

To characterize the input relationships between industries, we use the direct requirements table for the United States in 1997. (In the robustness section, we also show results using the total requirements table.) In the direct requirements table, an observation is a commodity-industry pair and the direct requirements coefficient, denoted by d_{ij}, specifies the amount of inputs from industry i needed to produce one dollar of output in the industry j. The commodities and industries are defined using the Input-Output industry classification, which we map into the BEA NAICS-based ISI classification. There are 77 manufacturing industries in the classification. Of the 5929 possible commodity-industry pairs, 57.5 percent (3406) of them are non-zero.

The direct requirements matrix is an important input into our vertical link measures. In figure 3 we summarize the characteristics of the direct requirements matrix. The axes are the industry codes (manufacturing codes lie between 3111 and 3399); The x-axis is the using industry and the y-axis is the producing industry. In panel 3a we place a mark at each industry pair for which the direct requirement is greater than 0.001 and less than 0.05. In panel 3b we place a mark at each industry pair for which the direct requirement is greater than 0.05. It is immediately clear that most industries require inputs from similar industries: the entries in the direct requirements matrix tend to be largest on or near the diagonal.[11]

[11] As noticed by Alfaro and Charlton (2009), since requirements coefficients are large on or near the di-

Table 3 (panel 1) provides a simple measure of the extent of vertical relationships in our data. Parent-affiliate pairs are classified according to the vertical links between their main industries of operation (i.e., dr_{ap} and dr_{pa}). We consider an affiliate to be upstream vis-a-vis the parent, if the direct requirements coefficient of the primary industry, dr_{ap}, is positive. Analogously, the affiliate is downstream if the corresponding direct requirements coefficient of the primary industry, dr_{pa}, is positive. This simple measure suggests that almost all of the observed parent-affiliate pairs exist in vertical production relationships. In the sample of manufacturing parents and affiliates, 92 percent of parent-affiliate pairs have either a downstream parent, a downstream affiliate, or both.

More formally, we investigate the extent to which these vertical links predict multinational ownership. Following Alfaro and Charlton (2009), we estimate a Tobit specification that accounts for the effect of vertical links on both the likelihood of owning affiliates and the number (or size) of them

$$FDI_{apc} = \beta_v^u dr_{ap} + \beta_v^d dr_{pa} + \beta_c X_c + \beta_p X_p + \beta_{cp} X_c \times X_p + \epsilon_{apc}. \quad (1)$$

The unit of observation is a triplet, apc, that refers to the primary industry of the affiliate, the primary industry of parent, and the affiliate's country of location. We measure multinational activity, FDI_{apc}, by: (1) the number of affiliates in country c, industry of the parent p, and industry of the affiliate a; and (2) total employment of affiliates in country c, industry of the parent p, and industry of the affiliate a. Our manufacturing sample spans 64 host countries and 77×77 industry pairs, for a total of 379,456 possible combinations, many of which display no multinational activity. To estimate equation (1) we aggregate the firm-level data on the number of affiliates and the employment of affiliates to derive FDI_{apc}.

The variables dr_{ap} and dr_{pa} correspond to the direct requirements coefficients between

agonal for four-digit industries, an important share of the vertical chains is unreported when the data are aggregated to the two-digit level.

the (principal) industry of the parent and affiliate, with the affiliate in the upstream and downstream industry, respectively. The coefficients β_v^u and β_v^d indicate the importance of vertical chains as determinants of the number (and size of) foreign affiliates in a country and parent-affiliate industry pair.

The vector X_c contains country-level controls: the host country GDP and GDP per capita from the Penn World Table 6.3, as documented in Heston, Summers and Aten (2009); the distance to the United States from CEPII, as documented in Mayer and Zignago (2006); a measure of the rule of law from Beck, Clarke, Groff, Keefer and Walsh (2001); the average years of schooling attainment from Barro and Lee (2000); and the capital-output ratio from Klenow and Rodriguez-Clare (2005). The vector X_p contains parent-industry controls: the capital and skill intensity of the parent's primary industry, from the NBER-CES manufacturing industry database from Becker and Gray (2009). Additionally, as is customary in the literature, we include a term that interacts the industry factor intensity with the host country factor abundance.

Columns 2 and 5 in table 4 present the baseline results for the number and total employment of affiliates, respectively. Larger upstream and downstream direct requirements between the main industry of operation of the parent and the affiliate are found to be significant predictors of FDI flows. Moreover, comparing the pseudo R^2 in columns 1 and 2 (4 and 6 in the case of employment size), the explanatory power of the regression almost doubles when the vertical link measures are added.[12]

The coefficients of the Tobit regressions are not straightforward to interpret as they combine the effects on the probability of having affiliates as well as their number and size. We observe affiliates in only 3,277 of the 379,456 potential country-affiliate-parent-industry combinations. Therefore, the probability of observing an affiliate is very small ($0.0086 = 3,277/379,456$) and the overall Tobit coefficients are, correspondingly, large. In particular, an increase in the direct requirements coefficients from the 50th to the 75th

[12]Table 4 reports McFadden's (adjusted) pseudo R^2 which are increasing in the likelihood of the model.

percentile (i.e., from 0.00042 to 0.0021), corresponds to a 75 percent increase in the average number of affiliates in a given industry-pair-country combination: the average jumps from 0.02 to 0.032.[13] For employment, the unconditional effects are also large: an analogous change in the direct requirements coefficients implies that, on average, employment increases from 5.5 employees in a given industry-pair-country combination to almost 17 employees.[14]

These big effects come almost entirely from the extensive margin. We report in columns 3 and 6 the marginal effects for each regressor on the expected number of affiliates, and affiliate employment, provided that we observe at least one affiliate in the industry-pair-country cell. The intensive margin effects are tiny: an increase in the direct requirements coefficients from the 50th to the 75th percentile (i.e., from 0.00042 to 0.0021), corresponds to an increase in the expected number of affiliates in a given industry pair and country combination from 2.09 (the average across triplets with a positive number of U.S. affiliates) to 2.091. Column 6 reports the marginal effects on affiliate employment conditional on the existence of an affiliate. The same increase in the direct requirements coefficients is associated with an increase in employment in U.S. affiliates from 636 employees (the average across industry-pair and country triplets with a positive number of U.S. affiliates) to 637 employees.

4.2 Do Vertical Links Predict Intra-Firm Flows?

The previous set of results establishes that a vertical link between the industries of operation of the parent and the affiliate is a good predictor of multinational activity across countries and industries. This result coincides with Alfaro and Charlton (2009). Not having

[13] Computed as: $\overline{FDI}'_{apc} = \overline{FDI}_{apc} + (\beta_v^u + \beta_v^d)\Delta dr_{ap}$, where $\Delta dr_{ap} = 0.0021 - 0.00042$, and $\overline{FDI}_{apc} = \overline{FDI}^{+}_{apc} \times \Pr(FDI_{apc} > 0) = 2.09 \times 0.0086 = 0.02$ (the average number of affiliates across all possible parent-affiliate industry-country triplets).

[14] This effect is calculated in an analogously way as the one explained in the previous footnote, using β_v^u and β_v^d reported in column 5 of table 4, and $\overline{FDI}_{apc} = \overline{FDI}^{+}_{apc} \times \Pr(FDI_{apc} > 0) = 636 \times 0.0086 = 5.5$ (average employment across industry-pair-country triplets with a positive number of employees in U.S. affiliates, times the probability of observing an U.S. affiliate in such triplet).

data on trade flows between parents and affiliates, however, they interpret the presence of a vertical link between parent and affiliate as the presence of vertical FDI, conjecturing that these input-output links are accompanied by substantial flows of physical goods between parent and affiliate. We turn to this point next: Are input-output linkages able to predict trade flows between parents and affiliates? Does the presence of a vertical link materialize as vertical FDI? Using data on the observed flows of physical goods between parents and affiliates, our answer is negative: while a vertical link is a good predictor of the existence of a multinational firm, it is not associated with substantial intra-firm trade.

The descriptive statistics in table 3 (panel 2) present a first overview of the characteristics of intra-firm trade patterns between vertically linked establishments. Not only is the share of intra-firm trade very small for the average affiliate, it is also remarkably invariant with respect to the position of the affiliate in the vertical chain (downstream, upstream, or neither of both, from parent). On average, only 6 percent of an affiliate's sales are shipped to the parent, irrespective of whether the affiliate operates in an upstream industry. Parents provide less than 8 percent of an affiliate's inputs, irrespective of whether the affiliate operates in a downstream industry.

The same conclusion emerges from the histograms over the share of intra-firm flows for parent-affiliate pairs with industries related and non-related by I-O vertical links in figures 4 and 5. Affiliate shipments to the parent are, for most of the affiliates, a very small fraction of their sales. Moreover, it is not larger for affiliates operating in industries upwards of their parents. Correspondingly, the share of affiliate inputs that are shipped from the parent is, for most of the affiliates, very small, irrespective of whether affiliates operate in industries downward from that of the parent.

To check for the importance of vertical links while controlling for other factors, we turn to the firm-level data. Given that only 40 percent of affiliates report positive shipments to the parent, we estimate the following Tobit specification, which captures the determinants

of both the probability of reporting positive flows and their magnitude,

$$Y_{apc} = \beta_v VertLink_{ap} + \beta_c X_c + \beta_s X_p + \beta_{cs} X_c \times X_p + \beta_p P_p + \epsilon_{apc}. \tag{2}$$

The dependent variable Y_{apc} corresponds to shipments from affiliate a in host country c, to the parent p, as share of the affiliate's total sales.

The vectors X_c and X_p contain affiliate country controls, and parent industry characteristics, as used in (1). In addition, we include the number of affiliates owned by the parent and the total U.S.-located employment of the parent in P_p.

We measure the vertical link between an upstream affiliate and the downstream parent in two ways: (i) $VertLink_{ap} = dr_{ap}$ is the direct requirements coefficient of the main industry of affiliate a in the production of the main industry of the parent; and (ii) $VertLink_{ap} = v_{ap}$, defined as

$$v_{ap} \equiv \frac{\sum_{i \in A, j \in P} dr_{ij} \times sales_j^p}{total\ sales^a}, \tag{3}$$

where $total\ sales^a$ is affiliate total sales and $sales_j^p$ corresponds to parent sales in industry j, which is observed in the data for the main seven industries of operation. dr_{ij} is, as before, the direct requirements coefficient of affiliate industry i in the production of parent industry j, according to the I-O matrix. This second measure aggregates the requirements of all the affiliate's industries into the production of all the industries of the parent. Since sales by parents and affiliates are very skewed towards their primary industry, the two alternative measures of the vertical links are similar.

Columns 1-3 in table 5 report the results from estimating equation (2) with and without our variable of interest, $VertLink_{ap}$ (column 2 and 3 correspond to the different measures of vertical link: dr_{ap} and v_{ap}, respectively). We find that intra-firm shipments into the United States are, as expected, significantly lower for affiliates located in distant countries and greater for affiliates located in countries with high income per capita. Our measure of rule of law implies the opposite. Consistent with the descriptive statistics, larger

multinational parents in terms of employment are associated with more intra-firm flows (non-reported). The coefficient on our variables of interest, dr_{ap} and v_{ap}, are negative, very close to zero, and not significant.

Columns 4, 5, and 6 of table 5 report the corresponding results for the intra-firm flow of goods for further processing from the parent to the affiliates. The baseline regression is a Tobit specification,

$$Y_{pac} = \beta_v VertLink_{pa} + \beta_c X_c + \beta_s X_p + \beta_{cs} X_c \times X_p + \beta_p P_p + \epsilon_{pac}. \tag{4}$$

The dependent variable, Y_{pac}, refers to shipments in goods for further processing from the parent, p to the affiliate, a, in country c, as share of total affiliate input costs. The set of country, industry, and parent controls is the same as in equation (2). Column 5 reports the results using, as a measure of vertical link, the direct requirements coefficient of the main industry of the parent in the production of the affiliate's main industry (i.e. $VertLink_{pa} = dr_{pa}$). Column 6 uses an alternative measure $VertLink_{pa} = v_{pa}$, defined parallel to (3),

$$v_{pa} \equiv \frac{\sum_{i \in A, j \in P} dr_{ji} \times sales_i^a}{total\ input\ costs^a}, \tag{5}$$

where affiliate sales in industry i, $sales_i^a$, are available for the main seven industries of operation, and affiliate total input costs, $total\ input\ costs^a$, are observed in the data. This measure captures the potential importance of all inputs produced by the parent in the affiliate's multi-product production.

Distance between the location of the affiliate and the U.S. is, again, a significant predictor of intra-firm flows. Affiliates located in countries with poor rule of laws receive a significantly larger fraction of their inputs from the parent. Our measures of the vertical link between the upstream industry of the parent and the downstream industry of the affiliate are not a significant predictor of flows of unfinished goods from the parent to the affiliate. Moreover, the marginal Tobit coefficients on the probability of the existence of

a positive intra-firm flow from the parent even *decreases* with the strength of the vertical link between parent and affiliate (non reported).

In Section 6, we show that the results found in this section are robust to different definitions of the measure of a vertical link, and to the empirical specification.

5 Discussion

We established above that most multinational firms own foreign affiliates operating both upstream and downstream in vertically linked industries. But, for the most part, these affiliates ship a surprisingly small share of their production to the parent operating in a downstream industry, and they receive a very small share of their physical inputs from upstream parents. Moreover, most of the affiliates in these vertically linked chains appear to sell almost exclusively to local unrelated parties. These results raise the question about the motives for not only owning foreign affiliates, but also the firm's multi-product patterns. Why do multinational firms own internationally segmented production chains if not for the transfer of physical goods along it? Our proposed answer to this question is in line with the answer given by Hortacsu and Syverson (2009) for U.S. domestic firms: the vertical chain within the firm exists for the purpose of transferring intangible goods such as know-how, brands, and organizational capabilities along it. These intangibles can be transmitted internationally to the affiliates within the firm, and they can be a source of comparative advantage in the production of vertically linked goods, even in the absence of physical shipments between affiliates.

The results in this paper can be easily rationalized within the now benchmark framework of horizontal FDI in Helpman et al. (2004), by incorporating this additional source of comparative advantage in the production of vertically linked goods. Consider multi-product firms as in Bernard, Redding and Schott (2011): Each firm i with ideas for a *vector* of differentiated goods $\omega = [\omega_1 ... \omega_N]$ has a vector of productivity coefficient $\mathbf{z}_i =$

$[z_i(\omega_1), z_i(\omega_2), ..., z_i(\omega_N)]$ drawn from a joint distribution function $F_i(\mathbf{z})$. These parameters enter into the production of a good ω_n by an affiliate in country c within the corporation as

$$y_{ic}(\omega_n) = z_i(\omega_n) L_{ic}(\omega_n) \tag{6}$$

where $y_{ic}(\omega_n)$ is the total amount produced of good ω_n in country c, and L is the bundle of factors used in production (hired in the country of production).

The productivity vector $\mathbf{z_i}(\omega)$ of the firm and the distribution function $F(\mathbf{z})$ are reduced-form representations of the sources of comparative advantage for the firm: why are some firms more productive than others? how does a firm's comparative advantage in the production of one good translate to other potential products? According to the empirical findings in this paper, the properties of the joint distribution function are related to the I-O matrix: firms tend to have comparative advantage in producing goods related by vertical links. Formally,

$$\frac{\partial \Pr(z(\omega_n) > \overline{z}^m | z(\omega_k) > \overline{z}^m)}{\partial dr_{nk}} > 0 \qquad \frac{\partial \Pr(z(\omega_n) > \overline{z}^m | z(\omega_k) > \overline{z}^m)}{\partial dr_{kn}} > 0 \tag{7}$$

where $\Pr(z(\omega_n) > \overline{z}^m | z(\omega_k) > \overline{z}^m)$ is the probability that the productivity draw for good ω_n within a firm i is larger than the threshold $\overline{z}^m$, given that the productivity draw for good ω_k is large enough. dr_{nk} (dr_{kn}) corresponds to the direct requirements coefficients for input ω_n into the production of good ω_k (input ω_k into good ω_n, resp.).

The source of this correlation within the firm can be interpreted in different ways. As shown in figure 3, most industries require inputs from similar industries: the entries in the direct requirements matrix tend to be largest on or near the diagonal. Consider, for example, the case of *Converted Paper Products (NAICS 3222)*—i.e., stationary and envelopes—which uses *Paper (NAICS 3221)* as its main input. Presumably, the production of these goods involve similar knowledge about the quality of the materials, demand, suppliers, and competitors. This commonly required knowledge can be understood as the capacity

to solve related problems, as in Garicano and Rossi-Hansberg (2006), or as the stock of *technology capital*, as in McGrattan and Prescott (2010), specific to goods with similar characteristics, or the stock of knowledge capital that is public good within the corporation, as the seminal work of Markusen. If this is the case, the firm may have comparative advantage in producing vertically linked goods even in the absence of intra-firm physical flows.

6 Robustness

This section explores the robustness of our results to different empirical specifications and alternative measures of the vertical links between the affiliate and the parent.

6.1 Alternative Empirical Specifications

Any measure of intra-firm trade flows may be contaminated by the reporting of artificially low values of goods traded, a phenomenon known as *transfer pricing*. While transfer pricing may bias downward the value of trade reported, it is unlikely a firm with significant intra-firm trade could report zero trade. Given that one of the most striking features of our results is the low number of parent-affiliate pairs reporting any intra-firm flows, we estimate the following linear probability model,

$$d(Y_{apc}) = \beta_v VertLink_{ap} + \beta_c X_c + \beta_s X_p + \beta_{cs} X_c \times X_p + \beta_p P_p + \epsilon_{apc}. \tag{8}$$

The dependent variable is a binary variable $d(Y_{apc})$ ($d(Y_{pac})$ for flows from the parent to the affiliate) that takes value one if shipments from the affiliate to the parent are positive and zero otherwise. Arguably, transfer prices cannot contaminate this 1-0 variable for the existence of intra-firm flows. The results from estimating (8) are reported in columns 1 and 2 of table 6 for the flows from the affiliate to the parent, and columns 3 and 4

for exports from the parent to the affiliate. In all cases, the coefficients of interest are non significant or have a negative sign: a larger vertical link is associated with a lower probability of finding flows between the parent and the affiliate.

We also estimate an empirical specification for the importance of vertical chains in explaining the intensive margin of intra-firm flows; that is, the magnitude of the flow given that is positive. We restrict the sample of affiliate-parent pairs to only those that report positive shipments. In the case of flows from the affiliate to the parent, the sample is restricted to only 40 percent of the original observations. In the case of shipments from the parent to the affiliate, the sample is reduced by approximately 50 percent (see table 3). Columns 5 to 8 in table 6 report the elasticities of intra-firm trade to changes in our measure of vertical link, based on the OLS specification,

$$\log(Y_{apc}) = \beta_v \log(VertLink_{ap}) + \beta_c X_c + \beta_s X_p + \beta_{cs} X_c \times X_p + \beta_p P_p + \epsilon_{apc}. \tag{9}$$

The dependent variable is $\log(Y_{apc})$ for positive flows from the affiliate to the parent and $\log(Y_{pac})$ for flows from the parent to the affiliate.

Again in this specification, vertical links are not found to be a statistically significant predictor of intra-firm flows and their point estimates are very close to zero. Only in one specification, using v_{ap} defined in (3) as measure of vertical link, is the elasticity of sales from the affiliates to the parent found to be significantly different from zero (column 6). The economic significance of this elasticity is very small: a 10 percent increase in the measure of vertical link is associated with a 0.5 percent increase in the share of affiliate sales shipped to the parent: from 0.15 (the mean, conditional on positive flows) to 0.151.

6.2 Alternative Measures of Vertical Links

In this section we replicate the results in table 5 using different measures of vertical linkages.

Columns 1-2 and 5-6 in table 7 present the results for the Tobit regression in equations (2) and (4) using total requirements (instead of direct requirements) coefficients as a measure of vertical links. The estimates of the effect are either non significant or the point estimates have the opposite sign than what is expected.

The strong diagonal in the matrix of direct requirements, shown in figures 3a and 3b, introduces a source of ambiguity into the interpretations of our results. Affiliates operating in the same industry as the parent could be interpreted to follow a horizontal motive. However, given the often large direct requirements coefficient for the diagonal elements, they are also consistent with a vertical motive for FDI. To avoid any source of ambiguity in this matter, we estimate the Tobit regressions in (2) and (4) excluding all observations with affiliates and parents operating in the same industry. The results are presented in columns 3 and 4 for flows from the affiliate to the parent, and columns 7 and 8 for shipments from the parent to the affiliate. The restricted sample is 2777 parent-affiliate pairs, approximately 40 percent of the total sample (see table 3).

Results for shipments from the affiliate to the parent are reported in columns 3 and 4 of table 7, for the two alternative measures of vertical links. Again, vertical links are not found to be a significant predictor of intra-firm shipments back to the U.S. In the case of flows from the parent to the affiliate, the exclusion of all parent and affiliate pairs that operate in the same primary industry substantially affects the results. Columns 7 and 8 report that flows from the parent to the affiliate are significantly larger when the parent operates in an upstream industry relative to the affiliate; a parent's supply of physical inputs to its affiliate is correlated to the I-O links between the industries of operations of the two establishments. For instance, estimates in column 7 imply that an increase in the direct requirements coefficient from the 50th to the 75th percentile (excluding same-industry pairs) between the upstream industry of the parent and downstream industry of the affiliate is associated with an increase in the share of shipments from the parent in goods for further processing of 1 percent for the mean affiliate, which is 0.081 in our

sample (see table 2).

That we find a significant relationship between vertical linkages and trade flows for parents and affiliates in different industries may be reflecting the coarseness of the ISI classification. Alfaro and Charlton (2009), using data classified by 4 digit SIC, find that many parent-affiliate pairs operate in industries that are "close" to each other: they share the same 3 digit SIC industry, but have different 4 digit SIC industries. In our data's classification, there are 77 manufacturing industries compared to the 459 manufacturing industries in the 1987 SIC. The industry classification does not affect, however, our firm level results about the prevalence of intrafirm trade: parents and affiliates ship very little to each other.

Overall,the links found between the industries of operation of parents and affiliates are not found to be significant predictors of the existence, nor the magnitude, of intra-firm flows, which are in all cases a very small fraction of an affiliate's sales and inputs. This is particularly relevant in the case of intra-firm shipments to the United States: affiliates sell most of their production in the local market, and the share that is shipped to the United States is very small, irrespective of whether those goods may be inputs into the production of the parent.

7 Conclusion

Using confidential firm-level data from the Bureau of Economic Analysis, this paper uncovers new facts on the behavior of U.S. multinational firms. We find that intra-firm trade is concentrated among a small number of very large affiliates. For the large majority of affiliates, shipments to the parent account for a very small fraction of total sales, and shipments of goods for further processing from the parent accounts for a small share of total input cost. For most U.S. foreign affiliates, local unrelated parties are the main destination of sales. In this sense, "horizontal" FDI, as opposed to "vertical" FDI, seems to better

capture the role of the majority of U.S. affiliates abroad.

Despite the lack of intra-firm trade, relative to the overall activity of affiliates, we find that multinational corporations often own vertical production chains: most affiliates operate in industries upstream or downstream from those of the parent. Nonetheless, these vertical links are not matched with a corresponding intra-firm flow of physical goods between upstream and downstream units of production. More precisely, the presence of a vertical link between parent and affiliate, as defined by the input-output matrix, does not predict the existence of, or volume of, intra-firm flows. This fact suggests that the comparative advantage of multinational firms is not the ability to transfer physical goods within the corporation. Rather, we conjecture that corporations may have a comparative advantage in producing vertically related goods that share intangible inputs, such as managerial ability or organizational capital.

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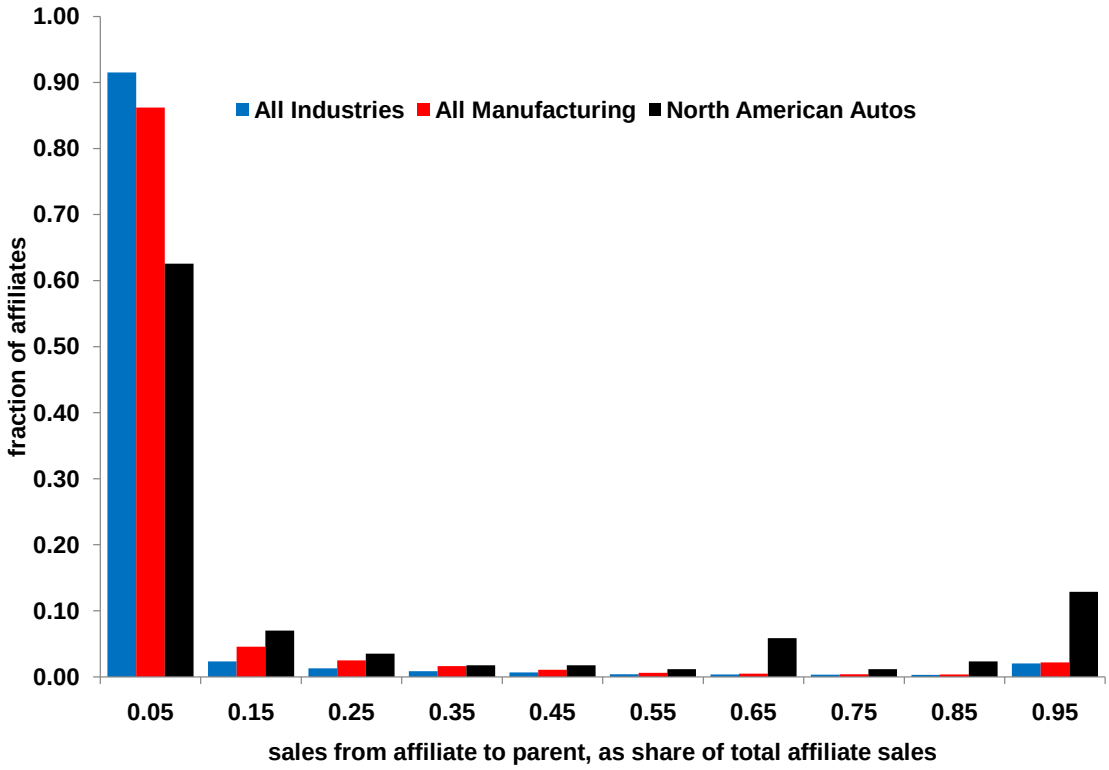
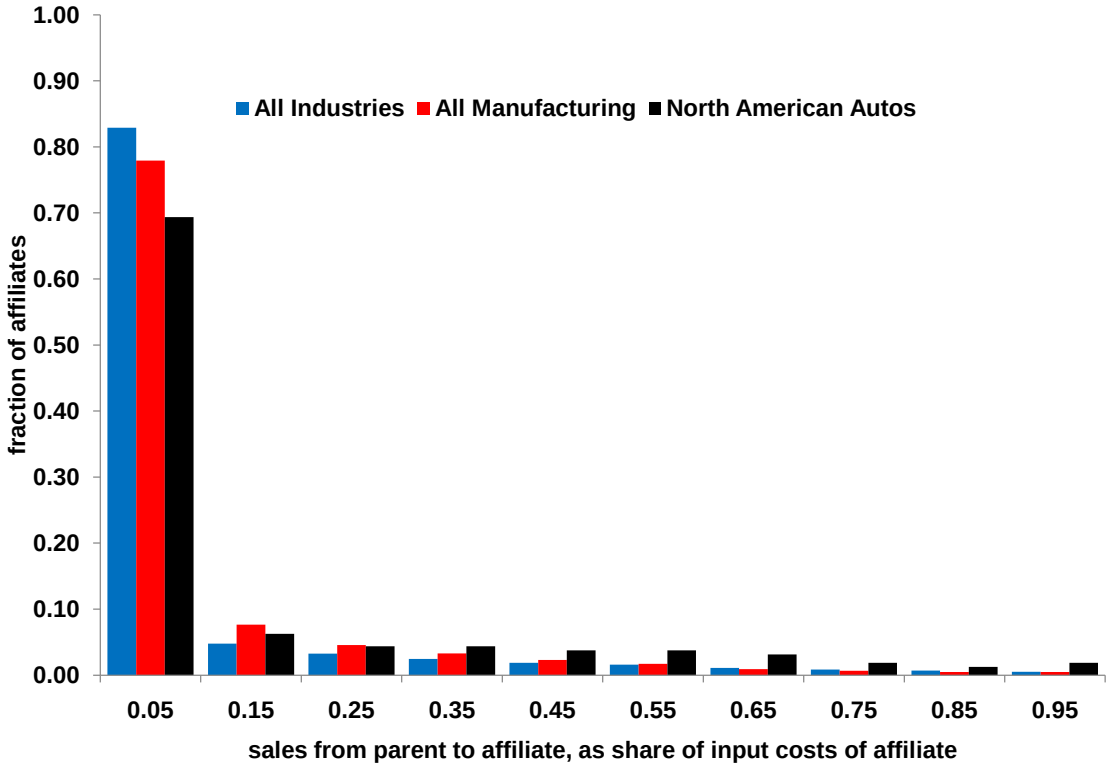
A Figures and Tables

Figure 1: Distribution of affiliates by share of sales to parent



Notes: Majority-owned foreign affiliates of U.S. parents that are required to report intra-firm flows in the BEA survey benchmark year 1999. "All industries" includes parent-affiliate pairs in all sectors of the economy. "All manufacturing" includes parent-affiliate pairs in which both the parent and the affiliate are in the manufacturing sector. "North American Autos" includes only parent-affiliate pairs both in the auto industry, operating in Canada and Mexico.

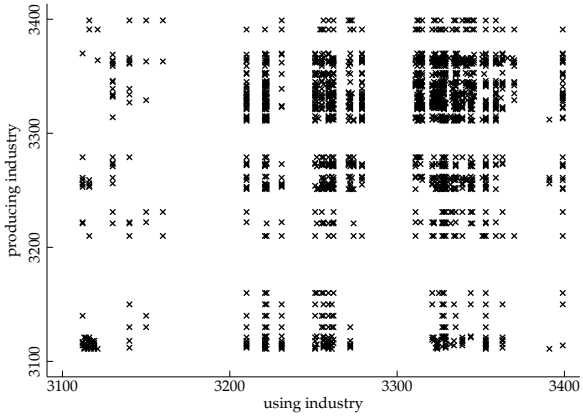
Figure 2: Distribution of affiliates by share of total input costs sourced from parent.



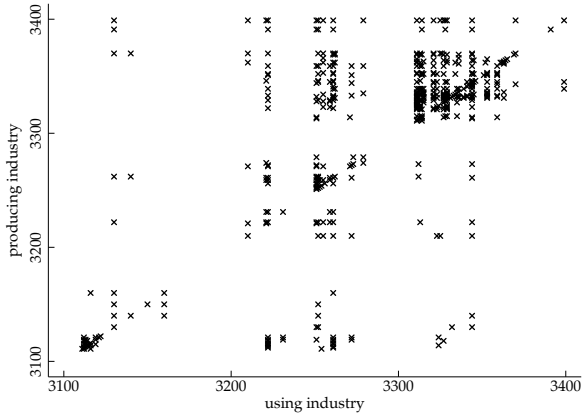
Notes: Majority-owned foreign affiliates of U.S. parents that are required to report intra-firm flows in the BEA survey benchmark year 1999. "All industries" includes parent-affiliate pairs in all sectors of the economy. "All manufacturing" includes parent-affiliate pairs in which both the parent and the affiliate are in the manufacturing sector. "North American Autos" includes only parent-affiliate pairs both in the auto industry, operating in Canada and Mexico. Sales from parent to affiliate refers to goods for further processing only.

Figure 3: The 1997 direct requirements matrix

(a) Industry pairs with low dependence

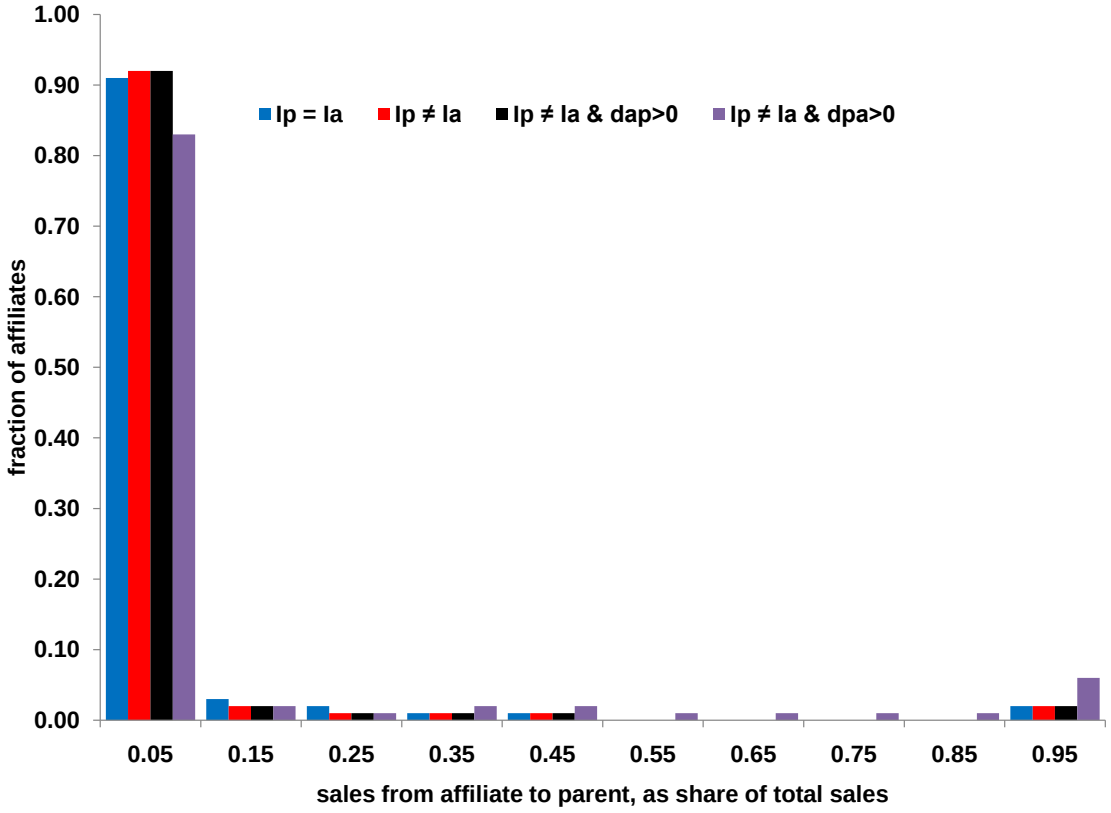


(b) Industry pairs with high dependence



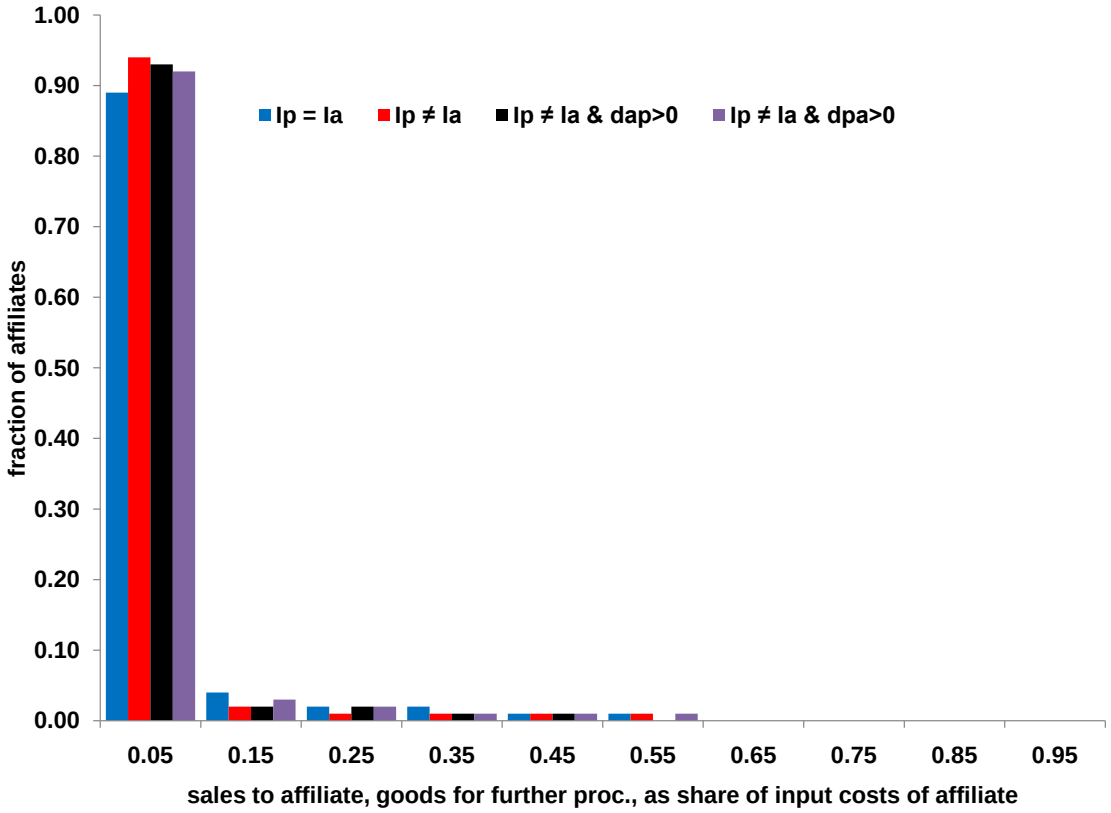
Notes: Manufacturing goods only (BEA ISI codes between 3111 and 3399); The x-axis is the using industry and the y-axis is the producing industry. In the left panel we have placed a mark at each industry pair where the direct requirements coefficient is between 0.001 and 0.05. In the right panel we have placed a mark at each industry pair where the direct requirements coefficient is larger than 0.05.

Figure 4: Distribution of affiliates by share of sales to parent and vertical links



Notes: $I_a = I_b$includes parent-affiliate pairs operating in the same primary industry. $I_p \neq I_a$ corresponds to parent-affiliate pairs operating in different industries; which are further decomposed into affiliate-industry pairs with affiliate operating in upward industry ($I_p \neq I_a, d_{ap} > 0$) and downward ($I_p \neq I_a, d_{pa} > 0$).

Figure 5: Distribution of affiliates by share of total input costs sourced from parent and vertical links



Notes: $I_a = I_b$ includes parent-affiliate pairs operating in the same primary industry. $I_p \neq I_a$ corresponds to parent-affiliate pairs operating in different industries; this group is further decomposed into parent-affiliate pairs with affiliate operating in upstream industry ($I_p \neq I_a, d_{ap} > 0$) and downstream industry ($I_p \neq I_a, d_{pa} > 0$).

Table 1: Sample Construction

	Universe		Parent-affiliate in mfg.	
	All	Sample	All	Sample
	(1)	(2)	(3)	(4)
# Parents	3,970	2,410	1,654	1,107
# Affiliates	40,155	19,540	12,028	6,926
Total P sales	6,274,285,285	5,631,107,004	2,574,363,335	2,455,057,523
Total A sales	2,705,066,210	2,195,819,121	1,162,955,126	985,918,430
# P-Industries	191	184	75	74
# A-Industries	195	191	77	77
# Countries	189	166	142	108

Notes: Columns 2-4 describe the sample of majority-owned affiliates that are required to report intra-firm flows in the BEA survey benchmark year 1999. Sales expressed in thousands of US dollars. The "manufacturing" sample includes only the parent-affiliate pairs in which the primary industry of both the parent and affiliate are in manufacturing.

Table 2: Summary Statistics

	All			Parent & Affiliate in mfg		
	Mean (1)	Median (2)	Weighted Ave (3)	Mean (4)	Median (5)	Weighted Ave (6)
Panel 1: Number of industries						
# A industries	1.30	1.00	1.57	1.41	1.00	1.68
# P industries	2.36	2.00	3.42	2.64	2.00	3.96
Panel 2: Share of sales in main industry						
Affiliate	0.957	1.00	0.923	0.95	1	0.92
Affiliate-country aggregate	0.911	1.00	0.835	0.89	1	0.81
Parent	0.838	0.99	0.750	0.81	0.93	0.72
Panel 3: Share of affiliate sales						
to local unaffiliated parties	0.821	1.00	0.716	0.76	0.97	0.58
to parent	0.043	0.00	0.082	0.06	0.00	0.12
Panel 4: Share of affiliate shipments from parent						
for distribution	0.038	0.00	0.01	0.001	0.00	0.004
for further processing	0.031	0.00	0.05	0.081	0.001	0.081

Notes: Columns 2 and 5 report the average of the 9 firms surrounding the median. In columns 3 and 6 the average is weighted by affiliate employment. ‡An observation is the aggregate over all affiliates of a parent, by country.

Table 3: Vertical Links

	$I_P = I_A$			$I_P \neq I_A$			
	all	$dr_{ap} = dr_{pa} > 0$	other	all	$dr_{ap} > 0$	$dr_{pa} > 0$	other
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel 1: Number of affiliates							
total	4076	4062	14	2777	2211	1869	244
share with shipments to parent > 0	0.40	0.40	0.36	0.39	0.39	0.38	0.38
share with shipments from parent > 0	0.53	0.53	0.50	0.50	0.51	0.49	0.48
Panel 2: Avg. affiliate shipment size							
to parent (share of total sales)	0.06	0.06	0.05	0.05	0.06	0.06	0.04
from parent† (share of total input costs)	0.08	0.08	0.00	0.07	0.07	0.08	0.06
to local unaffiliated (share of total sales)	0.75	0.75	0.85	0.77	0.77	0.78	0.73

Notes: Figures correspond to the sample of manufacturing parent and affiliates in column 4 of table 1. $dr_{ap} > 0$ corresponds to all affiliates for which the direct requirements of its main industry into the production of the main industry of the parent is positive. Correspondingly, $dr_{pa} > 0$ corresponds to all affiliates for which its main industry of operation uses as inputs the main industry of the parent. †goods for further processing

Table 4: Vertical Links and FDI flows

Dep. Variable:	# affiliates$_{apc}$			employment$_{apc}$		
	(1)	(2a)	(2b)	(3)	(4a)	(4b)
dr_{ap}		3.975^{***}	0.324		$3,288.0^{***}$	266.2
		(0.248)			(384.3)	
dr_{pa}		4.213^{***}	0.343		$3,510.0^{***}$	284.1
		(0.294)			(385.5)	
$\log(gdp_c)$	1.322^{***}	1.291^{***}	0.105	$1,099.0^{***}$	$1,110.0^{***}$	89.8
	(0.065)	(0.066)		(115.1)	(120.0)	
$\log(gdpl_c)$	1.240^{***}	1.220^{***}	0.099	946.3^{***}	957.1^{***}	77.5
	(0.157)	(0.157)		(151.6)	(157.6)	
$\log(distance_c)$	-0.800^{***}	-0.762^{***}	-0.062	-671.5^{***}	-662.3^{***}	-53.6
	(0.080)	(0.079)		(94.1)	(95.9)	
$\log(law_c)$	0.842^{***}	0.845^{***}	0.069	668.2^{***}	689.7^{***}	55.8
	(0.257)	(0.259)		(220.1)	(229.3)	
$\log(k/gdp_c)$	-0.931^{***}	-0.960^{***}	-0.078	-652.8^{***}	-690.2^{***}	-55.9
	(0.275)	(0.273)		(229.8)	(235.7)	
$\log(schooling_c)$	-0.069	-0.579	-0.047	-341.9	-764.1	-61.9
	(0.645)	(0.636)		(542.3)	(560.5)	
Ind controls	yes	yes		yes	yes	
P controls	yes	yes		yes	yes	
Observations	379456	379456		379456	379456	
Positive obs.	3277	3277		3277	3277	
Pseudo R^2 adj.	0.074	0.124		0.037	0.061	

Notes: Results from the Tobit regression in (1). In columns 1 and 2 the dependent variable is the number of affiliates in industry a in country c owned by parents in industry p. In columns 3 and 4, the dependent variable is aggregate employment in affiliates in industry a in country c owned by parents in industry p. Columns 2b and 4b report the marginal effects on the expected value of the dependent variable, conditional on being positive. Industry controls include physical and human capital intensities, as well as their interaction with the respective country factor abundance. Parent controls include total employment and total number of foreign affiliates. Robust S.E., clustered at the country-main industry of the parent level, are in parentheses. Levels of significance are denoted *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 5: Vertical Links and Intra-Firm Shipments

Dep. Variable:	Y_{apc}			Y_{pac}		
	(1)	(2)	(3)	(4)	(5)	(6)
dr		-0.030			-0.111	
		(0.098)			(0.083)	
v			$-3.85e{-}05^{**}$			-0.025
			$(1.51e{-}05)$			(0.025)
$\log(gdp_c)$	-0.009	-0.009	-0.009	0.001	0.001	0.001
	(0.007)	(0.007)	(0.007)	(0.005)	(0.005)	(0.005)
$\log(gdpl_c)$	0.044^{*}	0.044^{*}	0.042^{*}	-0.013	-0.013	-0.013
	(0.023)	(0.023)	(0.023)	(0.014)	(0.014)	(0.014)
$\log(distance_c)$	-0.064^{***}	-0.064^{***}	-0.064^{***}	-0.032^{***}	-0.032^{***}	-0.032^{***}
	(0.009)	(0.009)	(0.009)	(0.006)	(0.006)	(0.006)
$\log(law_c)$	-0.124^{**}	-0.125^{**}	$-0.120{**}$	-0.087^{***}	-0.088^{***}	-0.088^{***}
	(0.060)	(0.060)	(0.060)	(0.027)	(0.027)	(0.027)
$\log(k/gdp_c)$	0.039	0.039	0.038	0.0158	0.015	0.016
	(0.047)	(0.047)	(0.047)	(0.028)	(0.027)	(0.027)
$\log(schooling_c)$	0.106	0.106	0.109	0.034	0.033	0.033
	(0.110)	(0.110)	(0.111)	(0.061)	(0.061)	(0.061)
Ind controls	yes	yes	yes	yes	yes	yes
P controls	yes	yes	yes	yes	yes	yes
pseudo R^2 adj	0.060	0.060	0.068	0.055	0.055	0.055
Observations	6638	6638	6638	6638	6638	6638

Notes: In Columns 1-3, the dependent variable, Y_{apc}, is shipments from affiliate to parent as a share of the affiliate's total sales. $dr = dr_{ap}$ is the direct requirements coefficient of the main industry of the affiliate in the production of the parent's main industry, and $v = v_{ap}$ is the measure of vertical link defined in (3). In columns 4-6, the dependent variable, Y_{pac}, is exports from parent to affiliate as a share of the affiliate's total input cost, $dr = dr_{pa}$ is the direct requirements coefficient of main industry of the parent in the production of the affiliate's main industry, and $v = v_{pa}$ is the measure of vertical link defined in (5). Industry controls include physical and human capital intensities of the parent industry, as well as their interaction with the respective country factor abundance. Parent controls include total employment and total number of foreign affiliates. Robust S.E., clustered at the country-main industry of the parent level, are in parentheses. Levels of significance are denoted *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 6: Robustness. Alternative Empirical Specification

Dep. Variable:	d(Y_{apc})		d(Y_{pac})		log(Y_{apc})		log(Y_{pac})	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
dr	-0.033^{***}		-0.171					
	(0.008)		(0.141)					
v		$-1.05e{-}08^{***}$		-0.045^{*}				
		$(2.17e{-}09)$		(0.027)				
$\log(dr)$					0.018		0.006	
					(0.021)		(0.018)	
$\log(v)$						0.048^{**}		0.001
						(0.023)		(0.022)
$\log(gdp_c)$	-0.156	0.020^{***}	0.015^{**}	0.014^{**}	-0.262^{***}	-0.256^{***}	-0.110^{***}	-0.110^{***}
	(0.112)	(0.007)	(0.007)	(0.007)	(0.057)	(0.057)	(0.0419)	(0.042)
$\log(gdpl_c)$	0.020^{***}	0.115^{***}	0.016	0.016	-0.689^{***}	-0.665^{***}	-0.227^{*}	-0.229^{*}
	(0.007)	(0.024)	(0.027)	(0.027)	(0.243)	(0.243)	(0.135)	(0.135)
$\log(distance_c)$	0.115^{***}	-0.073^{***}	-0.024^{**}	-0.024^{**}	-0.431^{***}	-0.427^{***}	-0.231^{***}	-0.231^{***}
	(0.024)	(0.010)	(0.009)	(0.009)	(0.067)	(0.067)	(0.043)	(0.043)
$\log(law_c)$	-0.073^{***}	-0.066	-0.177^{***}	-0.176^{***}	-0.865^{*}	-0.832^{*}	-0.342	-0.342
	(0.010)	(0.052)	(0.047)	(0.047)	(0.499)	(0.498)	(0.229)	(0.229)
$\log(k/gdp_c)$	-0.066	-0.013	-0.032	-0.031	0.517	0.509	0.081	0.080
	(0.052)	(0.051)	(0.046)	(0.046)	(0.411)	(0.411)	(0.253)	(0.253)
$\log(schooling_c)$	-0.012	0.111	-0.004	-0.005	0.281	0.267	0.246	0.245
	(0.051)	(0.107)	(0.108)	(0.108)	(0.974)	(0.973)	(0.586)	(0.586)
Ind controls	yes	yes	yes	yes	yes	yes	yes	yes
P controls	yes	yes	yes	yes	yes	yes	yes	yes
R^2 (adj)	0.047	0.047	0.021	0.021	0.121	0.122	0.043	0.043
Observations	6638	6638	6638	6638	2355	2355	2984	2984

Notes: Columns 1-2 and 3-4 correspond to the linear probability model in equation (8), for flows from affiliate to parent (Y_{apc}) and parent to affiliate (Y_{pac}), respectively. Columns 5-6 and 7-8 report the results for the OLS estimation of equation (9), for intra-firm flows to and from the parent. In columns 1-2 and 5-6, the measures of vertical links are $dr = dr_{ap}$ and $v = v_{ap}$. In columns 3-4 and 7-8 the measures are $dr = dr_{pa}$ and $v = v_{pa}$. Industry controls include physical and human capital intensities of the parent's industry, as well as their interaction with the respective country factor abundance. Parent controls include total employment and total number of foreign affiliates. Robust S.E., clustered at the country-main industry of the parent level, are in parentheses. Levels of significance are denoted *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.

Table 7: Robustness. Alternative Measures of Vertical Links

Dep. Variable:	Y_{apc}				Y_{pac}			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
tr	793.4				-0.033^{***}			
	(20,724)				(0.012)			
v^{tr}		-20.23				-0.031^{***}		
		(15.44)				(0.009)		
dr^{ex}			49,774				0.350^{**}	
			(47,833)				(0.149)	
v^{ex}				-190.5				0.178^{**}
				(116.3)				(0.090)
$\log(gdp_c)$	8,494	8,357	1,872	8,847	0.001	0.001	-0.005	0.001
	(9,850)	(9,840)	(1,196)	(9,972)	(0.004)	(0.004)	(0.006)	(0.005)
$\log(gdpl_c)$	$115{,}949^{**}$	$113{,}085^{**}$	$13{,}005^{***}$	$113{,}703^{**}$	-0.013	-0.012	-0.056^{***}	-0.014
	(55,269)	(54,192)	(5,011)	(54,421)	(0.014)	(0.014)	(0.020)	(0.014)
$\log(distance_c)$	$-71{,}843^{*}$	$-71{,}300^{*}$	$-12{,}703^{***}$	$-71{,}000^{*}$	-0.032^{***}	-0.033^{***}	-0.038^{***}	-0.032^{***}
	(41,566)	(41,371)	(3,345)	(41,278)	(0.006)	(0.006)	(0.010)	(0.006)
$\log(law_c)$	$-76{,}620$	$-72{,}766$	$-9{,}558$	$-72{,}042$	-0.089^{***}	-0.089^{***}	-0.062^{*}	-0.085^{***}
	(62,141)	(62,183)	(8,195)	(61,564)	(0.027)	(0.027)	(0.037)	(0.027)
$\log(k/gdp_c)$	9,823	9,453	6,701	9,308	0.015	0.015	0.073^{**}	0.014
	(56,541)	(56,575)	(8,005)	(56,780)	(0.027)	(0.027)	(0.036)	(0.028)
$\log(schooling_c)$	$-170{,}381$	$-164{,}191$	$-9{,}869$	$-168{,}294$	0.034	0.032	0.157^{*}	0.038
	(229,866)	(227,756)	(27,292)	(229,659)	(0.061)	(0.061)	(0.095)	(0.061)
Ind controls	yes	yes	yes	yes	yes	yes	yes	yes
P controls	yes	yes	yes	yes	yes	yes	yes	yes
Pseudo R^2 (adj)	0.003	0.003	0.006	0.003	0.057	0.059	0.046	0.057
Observations	6638	6638	2700	6638	6638	6638	2700	6638

Notes: In columns 1-4, the dependent variable, Y_{apc}, is shipments from affiliate to parent as share of the affiliate's total sales; In columns 5-8, it is Y_{apc}, goods for further processing shipped from the parent as a share of the affiliate's total inputs. In columns 1-2 and 5-6, the two measures of vertical links are defined using total requirements coefficients: $tr = tr_{ap}$ and $tr = tr_{pa}$ in columns 1 and 5; and $v^{tr} = v^{tr}_{ap}$ and $v^{tr} = v^{tr}_{pa}$ in columns 2 and 6. In columns 3-4 and 7-8, the sample is restricted to parent and affiliates operating in different industries; The measures dr^{ex}_{ap} and dr^{ex}_{pa} in columns 2 and 7, and v^{ex}_{ap} and v^{ex}_{pa} in columns 4 and 8 exclude the coefficients in the diagonal of the direct requirements coefficient matrix. Industry controls include physical and human capital intensities of the parent's industry, as well as their interaction with the respective country factor abundance. Parent controls include total employment and total number of foreign affiliates. Robust S.E., clustered at the country-main industry of the parent level, are in parentheses. Levels of significance are denoted *** $p < 0.01$, ** $p < 0.05$, and * $p < 0.1$.