Vertical Integration and Input Flows

Enghin Atalay, Ali Hortaçsu, and Chad Syverson

Online Appendix

A. Construction of Production Variables

We describe here details on the construction of our production variables. Since the production variable definitions match those previously used in Hortaçsu and Syverson (2007), the descriptions given here will draw heavily on the Data Appendix of that paper.

Output. Establishment output is its inventory-adjusted total value of shipments, deflated to 1987 dollars using industry-specific price indexes from the NBER Productivity Database.

Labor Hours. Production worker hours are reported directly in the CM microdata. To get total establishment hours, we multiply this value by the establishment's ratio of total salaries and wages to production worker wages. This, in essence, imputes the hours of non-production workers by assuming that average non-production worker hours equal average production worker hours within establishments.

Labor Productivity. We measure labor productivity in terms of establishment output per worker-hour, where output and total hours are measured as described above.

Total Factor Productivity. We measure productivity using a standard total factor productivity index. Establishment TFP is its log output minus a weighted sum of its log labor, capital, materials, and energy inputs. That is,

$$\mathrm{TFP}_{it} = y_{it} - \alpha_{lt} l_{it} - \alpha_{kt} k_{it} - \alpha_{mt} m_{it} - \alpha_{et} e_{it} \,,$$

where the weights α_j are the input elasticities of input $j \in \{l, k, m, e\}$. Output is the establishment's inventory-adjusted total value of shipments deflated to 1987 dollars. While inputs are establishment-specific, we use industry-level input cost shares to measure the input elasticities. These cost shares are computed using reported industry-level labor, materials, and energy expenditures from the NBER Productivity Database (which is itself constructed from the CM). Capital expenditures are constructed as the reported industry equipment and building stocks multiplied by their respective BLS capital rental rates in the corresponding 2-digit industry.

Real Materials and Energy Use. Materials and energy inputs are establishments' reported expenditures on each divided by their respective industry-level deflators from the National Bureau of Economic Research Productivity Database.

Capital-Labor Ratio. Equipment and building capital stocks are establishments' reported book values of each capital type deflated by the book-to-real value ratio for the corresponding 3-digit industry. (These industry-level equipment and structures stocks are from published Bureau of Economic Analysis data.) Any reported machinery or building rentals by the establishment are inflated to stocks by dividing by a type-specific rental rate.[1] The total productive capital stock k_{it} is the sum of the equipment and structures stocks. This is divided by the establishments' number of labor hours to obtain the capital-intensity measure used in the empirical tests.

Nonproduction Worker Ratio. Establishments directly report both their number of production and nonproduction employees. Nonproduction workers are defined by the Census Bureau as those engaged in "supervision above line-supervisor level, sales (including a driver salesperson), sales delivery (truck drivers and helpers), advertising, credit, collection, installation, and servicing of own products, clerical and routine office functions, executive, purchasing, finance, legal, personnel (including cafeteria, etc.), professional and technical [employees]. Exclude proprietors and partners." The nonproduction worker ratio is simply such employees' share of total establishment employment.

B. Identifying Pairs of Vertically Linked Industries

The purpose of this section is to detail our methodology of identifying pairs of industries (at the 4-digit SIC level) that are vertically linked to one another. As mentioned in Section II.A of the paper, we classify industry *I* to be upstream of industry *J* if the fraction of shipments from *I* to *J* is greater than some threshold. In the baseline specification, this threshold is set at one percent of the total value sent by establishments in industry *I*. In this section, we describe how we impute the value of shipments sent from SIC industry *I* to SIC industry *J*.

There are two steps to this procedure. First, we must impute how much of each (STCC) commodity *C* was received by any (SIC) industry *J*. Our imputation method is different for *J*'s that are in the wholesale sector, in the retail sector, and in any other sector. The first step is described in Web Technical Appendices B.1, B.2, and B.3. Second, we aggregate over the commodities shipped by each upstream industry, *I*, to generate the estimate of the value of shipments from *I* to *J*. This step is described in Web Technical Appendix B.4.

B.1. Measuring the Flow of Goods through Sectors Other than Wholesale or Retail

For industries outside of the wholesale and retail sector, we start with the 1992 BEA Use Table. This dataset contains information on the amount purchased by different industries of different commodities. Within the BEA Use Table, both industries and commodities are defined according to the BEA's IOIND classification. The main task, for us, is to relate IOIND commodity codes to the Commodity Flow Survey's STCC commodity codes, and to relate IOIND industry codes to the (4-digit) SIC industry codes.

Use $\gamma \in \Gamma$ to refer to IOIND commodities, $\varphi \in \Phi$ to refer to IOIND industries, *C* to refer to STCC commodities, and *I* and *J* to refer to SIC industries. The task at hand is to impute the purchases, P_{CJ}, of commodity *C* by industry *J* using information on the purchases of commodity γ made by industry φ.

[1] Capital rental rates are from unpublished data constructed by the Bureau of Labor Statistics for use in computing their Multifactor Productivity series. Formulas, related methodology, and data sources are described in U.S. Bureau of Labor Statistics (1983) and Harper, Berndt, and Wood (1989).

Towards this goal, we use the concordance—between SIC industries and IOIND industries—provided by the BEA.[2] With one minor exception, each 4-digit SIC code can be uniquely matched to a single IOIND industry.[3] We assume that, for the SIC industries *J* that correspond to the same IOIND industry φ, purchases of γ are proportional to industry *J*'s employment. In other words:

$$P_{\gamma J} = P_{\gamma\phi} \times \frac{Emp_J}{\sum_{J' \in \Lambda(J)} Emp_{J'}}$$

In this equation, Emp_J refers to the total employment in SIC-industry *J*, and Λ(*J*) denotes the set of SIC industries, J', that correspond to the same IOIND industry as SIC industry, *J*. The presumption here is that commodity purchases of an industry are proportional to the industry's size and that SIC industries that share a common IOIND industry have roughly similar factor requirements.

We employ a similar procedure to impute P_{CJ} from $P_{\gamma J}$. First, we construct a correspondence between IOIND commodities, *γ*, and STCC commodities, *C*. The concordance of CFS STCC commodity codes and the BEA IOIND commodity codes is produced in a two-step process. To match STCC commodities to the corresponding SIC industries, we use a table provided to us by John Fowler at the U.S. Census Bureau. Then, to match SIC codes to IOIND commodities, we use the concordance provided by the BEA, described in the previous paragraph. The result of this two-step process is a many-to-many correspondence between IOIND commodities and STCC commodities.

Consider a single IOIND commodity, γ, which we have matched to multiple STCC commodities, *C*. We assign the purchases (by *J*) of these multiple *C*'s in proportion to their prevalence in the Commodity Flow Survey. Since a given commodity *C* can correspond to multiple *γ*'s, we need to sum over the *γ*'s to estimate the flows of STCC-commodity *C* to SIC-industry *J*. In other words, our assumptions lead to the following expression for P_{CJ}:

$$P_{CJ} = \sum_{\gamma \in \Theta(C)} P_{\gamma J} \times \frac{V_C}{\sum_{C' \in \Psi(\gamma)} V_{C'}}$$

In this equation, V_C refers to the total amount of commodity *C* that we observe being shipped in the 1993 Commodity Flow Survey, Ψ(*γ*) refers to the set of STCC commodities that correspond to the IOIND commodity *γ*, and Θ(*C*) refers to the set of IOIND commodities that correspond to the STCC commodity *C*.

[2] The concordance can be found at http://www.bea.gov/scb/pdf/national/inputout/meth/io1992.pdf; see pages M33-M36.

[3] The exception is in agriculture (SIC industries 0100-0299). For these industries, there are certain 4-digit SIC industries that can be matched to multiple BEA IOIND industries. For these industries, we tried several methodologies: dropping all agriculture establishments from our baseline sample, allowing for many-to-many merges, and using our best judgment over the IOIND industry which most closely matched any given 4-digit SIC. In the end we chose the latter methodology. Because establishments within agriculture are not part of the CFS sample, the choice of the methodology has essentially no effect on any of the paper's results. (The only way in which the results of the paper could at all be affected by this choice is if agriculture was an important downstream industry for many of the establishments in our sample. This turns out not to be the case.)

In the construction (SIC industries 1500-1799, 6552), there are also several 4-digit SIC industries that correspond to multiple BEA industries. This is not an issue, however, since the BEA Input-Output tables consider all of construction as a single industry (despite the fact that there are multiple IOIND industries within construction).

B.2. Measuring the Flow of Goods through the Wholesale Sector

The Input-Output Tables treat both the entire wholesale and retail sectors as single industries. Further, they do not keep track of shipments by manufacturers to or through wholesalers or retailers, instead measuring only those inputs directly used by wholesalers and retailers in the production of wholesale and retail services. To better measure the flow of goods through these sectors, we employ algorithms that rely less on the BEA's Use Table.

If industry J is in the wholesale sector, we impute the industry's purchases of each commodity C using CFS data on establishments' shipments of commodity C along with data from the Annual Wholesale Trade Survey (AWTS). Aggregating across establishments in the CFS gives a measure of aggregate sales, T_{CJ}, of each commodity by each wholesale industry. Second, the AWTS contains information on wholesale industries' aggregate commodity purchases and aggregate commodity sales. Using data from the AWTS, we compute the ratio R_J of commodity purchases to sales. Given these two pieces of information, we impute industry J's purchases of commodity C as

$$P_{CJ}=T_{CJ}\times R_J.$$

To give an example, establishments in the motor-vehicle-related wholesale industries (SICs 5010-5019) had sales of $159 billion and purchases of $131 billion in 1993. We therefore set $R_J = 0.82$ (131/159) for all vehicle-related wholesale industries. For each commodity and industry within SICs 5010-5019, we impute aggregate purchases as 82 percent of the shipments of the respective commodity that we observe CFS establishments making.

B.3. Measuring the Flow of Goods through the Retail Sector

When J is a retail industry, we utilize the CFS data along with the Annual Retail Trade Survey (ARTS). The U.S. Census Bureau uses the ARTS to collect information on purchases of groups of retail industries. For example, in 1993, establishments in the household appliance industries (SICs 5720–5734) purchased $35.8 billion in intermediate materials. Unfortunately, we do not know how much total merchandise was purchased by each SIC industry within these groupings, nor do we know the amount of any specific commodity purchased by these groups. To impute these values, we rely on data from the Commodity Flow Survey and then hand match commodity-specific shipments to the most appropriate retail industry within the ARTS groupings.

To demonstrate, we continue with our household appliance retailers example. Our hand match specifies IOIND commodities 510102 (calculating and accounting machines), 510103 (electronic computers), 510104 (computer peripheral equipment), and 510400 (other office machines) as those that are sold to SIC 5734 (computer and software stores). Repeating this process for all commodities and industries yields a table of commodity-retail-industry pairs such that the 4-digit retail industry could potentially purchase the given commodity. The amount of the commodity purchased by the industry is assumed proportional to a) the amount of the good shipped, according to the Commodity Flow Survey, b) the 4-digit retail industry's share of employment among its larger grouping of industries, and c) the total amount purchased by the industry group.

For example, suppose we want to impute the purchases of computers (STCC 37531) by computer and software stores. We know that total goods purchases by retailers in SICs 5720–5734 is $35.8 billion. Since employment in computer and software stores is 14.6 percent (30,000/205,000) of employment in this retailer group, we impute goods purchases of \$5.2 billion by computer and software stores.[4] (As in Web Technical Appendix B.1, we are presuming that a) purchases of a given 4-digit SIC are proportional to employment, and b) purchase intensities are constant, across SICs, within the larger group of industries.) To impute the amount of this total that is computers specifically, we multiply the \$5.2 billion figure by the value of shipments of computers as a fraction of all commodities that can be purchased by computer and software stores, where both of these commodity values are computed from the CFS (again, mirroring an assumption that we make in Web Technical Appendix B.1).

B.4. Aggregating across the Commodities Shipped by a Given Industry

In the previous three subsections, we have described how to compute the total value, P_{CJ}, of STCC-commodity *C* purchases made by each SIC industry, *J*.

In addition to this information, from the Commodity Flow Survey we are able to compute the amount of each STCC commodity that is shipped by each SIC–industry, *I*. From this, we can compute the fraction, F_{CI}, the fraction of all shipments of (STCC) commodity, *C*, that originate from (SIC) industry *I*.

Thus, to estimate the total values of shipments from *I* to industry *J*, we sum over all of the commodities that industry *I* ships:

$$S_{IJ} = \sum_{C} P_{CJ} \times F_{CI}$$

Note that, in terms of defining pairs of vertically linked industries, the defining traits of an industry are the commodities that it ships and receives. In this way, a wholesaler and manufacturer who ship the same commodity may each be defined to be upstream of a retail industry. To give an example, both Auto Assemblers (SIC 3711) and Auto Wholesalers (SIC 5010) ship large quantities of assembled automobiles (STCC 37111). Our methodology will thus define both of these industries to be upstream of the New and Used Car Dealers (SIC 5511) industry.

B.5. Some Aspects of the Resulting Definitions of Pairs of Vertically Linked Industries

We conclude this section by describing the resulting definition of vertically linked industries. The number of industries, *J*, that are classified as downstream of industry *I* depends on the cut-off that is used to determine whether industries are vertically linked to one another. For the average upstream industry, *I*, approximately 18 (out of the 900 possible downstream SIC industries) have sales for which S_{IJ} is greater than one percent. In other words, under our benchmark definition, there are 18 industries that are downstream of the average industry. Using a five percent cutoff—as we do in the robustness check given in row 8 of panel B of Table 1—the average industry has 3 industries, *J*, that are downstream of it.

Table A1 depicts these patterns for a single upstream industry, Cane Sugar, Except Refining (SIC 2061). This table presents the estimated flows from *I* to *J*. Under the benchmark definition, 15 industries are defined to be downstream of Cane Sugar. Prepared Flour Mixes and Doughs (SIC 2045) is defined to be downstream of the Cane

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[4]For these employment figures, see the "Establishment and Firm Size" document at http://www.census.gov/epcd/www/92result.html.

Sugar industry, but Prepared Feeds and Feed Ingredients (SIC 2048) is not. With the five percent cutoff, Grocery Stores (SIC 5411), Farm Product Raw Materials (SIC 5159), Cane Sugar, Except Refining, (SIC 2061), and Beet Sugar (SIC 2063) are the four industries defined to be downstream of the Cane Sugar industry.

C. Data Issues

C.1. Do the Census Firm Identifiers Accurately Reflect Ownership?[5]

The Census Bureau takes particular care to ensure that the firm identifiers used in the Economic Census reflect true ownership patterns that exist across establishments. The primary source of the firm identifiers is the Establishment Identification Number (EIN), originally retrieved by the IRS. Additional surveys and audits, performed by the Census, are aimed at determining whether establishments with different EIN numbers are actually part of a single firm.

The Report of Organization Survey (also known as the Company Organization Survey), conducted by the Census, is designed specifically to correctly measure firms' ownership of different establishments. Firms with more than 500 employees receive and are required to fill out this survey annually. The survey gives firms a list of all establishments currently considered by the Census to be under ownership control by the firm and asks the firms to make any corrections. The survey also asks firms to add any establishments they own that are not currently listed. Note that, among other things, every establishment has an EIN field, so it is easy to handle cases where establishments under the firm's control happen to have different EINs. Also note that the firm itself must report whether it is under more than 50 percent ownership control by some other entity, in which case the Census would consider this other entity to be the owner of all the establishments. The survey forms, as well as additional information about the Report of Organization Survey, can be found at http://bhs.econ.census.gov/bhs/cos/form.html.

In addition, "important" companies (based on their overall prominence or salience within a sector) have a Census Bureau analyst assigned to them. This analyst knows the firm very well, is supposed to check that all company reports conform with his/her knowledge, and is tasked with resolving any discrepancies. This is part of the survey auditing process.

In summation, it seems that, certainly for firms with more than 500 employees, the Economic Census firm identification numbers should very closely reflect the true ownership patterns that exist across establishments.

C.2. The Commodity Flow Survey's Sample Design

In this subsection, we summarize the sampling methodology used to construct the Commodity Flow Survey. See U.S. Census Bureau (1996, 1999) for additional details. The design, over which shipments to sample, comprises a multi-stage process: the first stage over which establishments to survey, the second stage over which weeks of the year to request data, and the third stage over the shipments for the given respondent-week. The primary objective of the sample design is to "estimate shipping volumes (value, tons, and ton-miles) by commodity

[5] This subsection has benefited greatly from conversations with Javier Miranda, a Senior Economist at the U.S. Census Bureau. We are grateful to him for helping us understand how the Census generates its firm identifiers.

and mode of transportation at varying levels of geographic detail." (U.S. Census 1999, p. Appendix C1)

In the first stage, establishments within each industry-region are categorized as either "certainty" or "non-certainty" establishments.[6] Within each industry-region, a cut-off value is selected. Establishments that are larger[7] than the cut-off value are sampled with certainty (these are the "certainty" establishments), while other establishments—the "non-certainty" establishments—are sampled with probability less than one.

In the second stage, for each quarter, sampled establishments are assigned to different reporting periods. For the 1993 Commodity Flow Survey, the reporting period is a two-week interval. For the 1997 CFS, the length of a reporting period is one week. "To avoid potential quarterly cycles, reporting periods in subsequent quarters were assigned so that an establishment did not report at the same time each quarter." (U.S. Census 1996, p. Appendix C1)

Third, for each reporting period, each sampled establishment reports a set number of shipments. The number of shipments that an establishment reports depends on the number of shipments that the establishment actually makes during the reporting period. For respondents that make fewer than 40 shipments in the reporting period, all shipments are reported. Establishments that send between 40(n-1)+1 and 40n shipments are asked to list every n^{th} shipment that they make. For example, an establishment that sends between 41 and 80 shipments is asked to report every other shipment that it made during the reporting period.

Sample weights are constructed from the inverse of the probability that the observed shipment would—ex ante—be included in the sample.[8]

D. Additional Robustness Checks

D.1. Establishment-Level Shares of Internal Shipments

This section contains six additional robustness checks, related to those presented in Section III.B.1. First, we compute the distribution of internal shares using successively more restrictive definitions of vertically linked industries. Then, we compare our measures of establishments' internal shares to the measures constructed directly from the Census of Manufacturers. Third, we discuss how our definitions of a) vertically linked industries and b) establishments' internal shipments differ from the definitions we gave in an earlier draft. Fourth, we examine how robust the measured internal shares are to a definition of vertical links in which retail/wholesale industries are always allowed to be at the downstream end of a vertical link. Fifth, we consider how the measured internal share distribution would look if each surveyed establishments reported a larger fraction of their shipments. Finally, related to the discussion of Appendix C.1, we discuss whether there is a jump in our measured internal shares for establishments in firms with fewer than—or greater than—500 employees, as might be the case if firm identifiers

[6] Here, industries are grouped by their 3-digit SIC code. Regions are defined according to the National Transportation Analysis Region (NTAR) classification. See http://www.census.gov/geo/www/mapGallery/images/ntar000.pdf for a map of the 89 NTARs.

[7] For the 1993 Commodity Flow Survey, an establishment's payroll defines its size. For the 1997 Commodity Flow Survey, a combination of employment, payroll, and sales is used to characterize size.

[8] When computing the sample weights, the Census conducts adjustments for sampling error and survey non-response. See page C2 from U.S. Census (1996) or pages C2–C3 from U.S. Census (1999), for details.

better represented ownership patters for firms with more than 500 employees.

In the benchmark calculations, we define industry *J* to be downstream of industry *I* provided at least one percent of industry *I*'s sales were purchased by establishments in industry *J*. In the body of the paper, we also compute the internal share distribution, using a five percent cutoff rule. In rows 1-3 of Table A2, we consider the effect of changing the one percent cutoff to 10 percent, 15 percent, or 20 percent. As the cutoff increases two things occur: First, our sample of upstream establishments shrinks. Second, for any particular establishment in our sample, fewer shipments are classified as being sent along an internal, vertical link. Increasing the cutoff from 1 to 20 percent reduces the size of our sample by three-fifths. At the same time, however, the distribution of establishments' internal shares is not substantially altered using the more restrictive definition of vertical integration. Under the 20-percent cutoff, the 75^{th}- and 90^{th}-percentile internal shares are 4.5 percent and 28.2 percent, respectively, only somewhat smaller than the values given in Table 1.

Next, we compare our measure of internal shares to a measure derived from the Census of Manufacturers. The purpose is to show that the two internal share measures match up once we have comparable samples and comparable definitions of internal shipments. As mentioned in Section III.B of the paper, the Census records manufacturers' interplant transfers. These are shipments made to other manufacturing establishments, within the same firm, for further assembly. Since the Census of Manufacturers also contains information on each establishment's total value of shipments, it is straightforward to compute an alternate measure of internal shares by taking the ratio of interplant transfers to total value of shipments. We begin our comparison, in rows 4 and 5 of Table A2. Row 4 characterizes the distribution of interplant transfers for the 766 thousand establishments surveyed in the 1992 and 1997 version of the Census of Manufacturers. In row 5, we restrict the sample to the 37,000 establishments which are also included in our benchmark sample of establishments at the upstream end of a vertical link. Within this subsample, 76.6 percent of the establishment report no interplant transfers; the 75^{th}-percentile internal share is 13.2 percent.

We next describe the internal share distribution, using our benchmark methodology, (i.e., using data from the Commodity Flow Survey and the algorithm specified in Section II of the paper). Row 6 restricts the benchmark sample to establishments in the manufacturing sector. For this subsample, the 75^{th}- (90^{th}-) percentile internal share is 6.2 percent (33.7 percent), slightly lower than the values given in Table 1 (7.0 percent and 37.6 percent, respectively).

The difference between rows 6 and 7 originates from differences in what is defined as an internal shipment. Interplant transfers, which are shipments to other establishments for further assembly, only comprise shipments sent to establishments in the manufacturing sector. Our definition, using data from the Commodity Flow Survey, includes shipments sent to same-firm establishments in any sector. In row 7, we only count a shipment as internal if there is a downstream establishment, from the same firm, that is also in the manufacturing sector.[9] The 75^{th}- and

[9] Consider the following example of an establishment, sending a shipment of auto parts to zip code, *z*. Suppose there is a same-firm auto parts wholesaler (SIC 5013), but no manufacturing establishments in an industry that consumes auto parts, in zip code *z*. This shipment would be classified as internal according to the calculations of row 6, but not in the calculations corresponding to row 7.

90th-percentile internal shares are 0.3 percent and 11.7 percent, respectively, reasonably close to the values given in row 5.

To summarize, the interplant transfers variable yields smaller values for internal shipments, compared to the variable constructed from the Commodity Flow Survey, because it omits shipments sent to non-manufacturing establishments. If it were not for this difference, the two variables would be similar to one another.

Our definitions over which industries are vertically linked and when shipments are counted as internal were slightly different in an earlier draft of the paper (Hortaçsu and Syverson 2009). It turns out that results are qualitatively similar whether one uses the old or new definitions of vertically linked industries or internal shipments. For completeness, we review these old definitions, as well as the internal shares that resulted from these definitions.

In the previous draft, we had a less stringent definition for internal shipments. We did not require that the shipment be destined to an establishment that is in an industry directly downstream to the shipping establishment, only that the destination be an establishment that is on the downstream end of *any* vertical link in a firm.[10] In row 8 of Table A2, we recomputed internal shares for the benchmark sample, with this less strict definition of internal shipments. The median establishment has an internal share of 3.0 percent, and only 29.1 percent of establishments have no internal shipments. Compared to the benchmark calculations, the mean internal share is almost 6 percent larger (16.1 percent, compared to 10.2 percent). Thus, under our old definitions, we were being very liberal when computing internal shipments.[11]

A second difference, compared to the previous draft, originates from the way in which vertically linked industries are defined. In the previous draft, we defined two industries to be vertically linked only using information from the BEA Input-Output Tables. Specifically, a substantial link exists between Industry *A* (using the BEA definition of input-output industries) and any industry from which *A* buys at least five percent of its intermediate materials, or any industry to which *A* sells at least five percent of its own output. As we discuss in Section II and Web Technical Appendix B, the old definition is potentially problematic if the downstream industry is retail or wholesale. For wholesalers and retailers, the BEA doesn't keep track of the gross shipments by sent to wholesalers/retailers. Instead, the BEA measures the industries which are used by wholesalers/retailers in the production of wholesale/retail services. Because of this issue, there are several pairs of industries that are, in reality, linked with one another, but are not classified as such under the old definition.

In row 9 of Table A2, we compute internal shares using the old definition of vertically linked industries (but retain the new definition of when shipments are internal to the firm). With the old definition of vertically linked industries, the sample of vertically integrated establishments is less than half as large, 29,900 compared to 67,500 establishment-years. The 75th-percentile (90th-percentile) internal share is 1.0 percent (17.4 percent). These are considerably less than corresponding values of the benchmark calculations for the 75th and 90th percentiles, 7.0

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[10] For instance, suppose a firm has two upstream establishments U_1 and U_2, and two downstream establishments D_1 and D_2, and U_1-$D_1$and U_2-D_2 are separate vertical links. According to the old definitions, a shipment from U_1 would be classified as internal if it is destined to *either* D_1 or D_2's zip codes, not just D_1's.

[11] Since a main objective of the paper is to point out that internal shipments are surprisingly small, being liberal in defining internal shipments is innocuous.

percent and 37.6 percent.

In row 10 of Table A2, we compute internal shares using both the old definition of when shipments are classified as internal, and the old definition of when industries are classified as vertically linked. Under these definitions, the median establishment has an internal share of 2.5 percent, the 90^{th}-percentile establishment has an internal share of 57.7 percent, and 2.1 percent of establishments have a 100 percent internal share.

In row 11 of Table A2, we explore the sensitivity of our internal share measures to different assumptions over the extent to which retailers and wholesalers are on the downstream end of vertical links. Given the benchmark sample of 67,500 establishment-year observations, we apply a more liberal definition of when shipments are classified to be flowing within the firm: A shipment is internal to the firm either if a) it was classified as internal, according to the baseline methodology, or b) there is a same-firm retail or wholesale establishment in the destination zip code. Under this extreme assumption, internal shares are only moderately higher. We take this finding to suggest that our original baseline methodology is not causing us to miss too many intra-firm upstream-downstream shipments.

In rows 12 through 15, we check the effect of changing the number of sampled shipments per survey participant on the estimated distribution of internal shares. As a reminder, surveyed establishments are asked to list only 20 to 40 shipments per quarter. As a result, we are almost certainly overstating the fraction of establishments that have 0 percent or 100 percent of their shipments staying within the firm. In this robustness check, we explore the magnitude of this bias induced by the limited sample size. We will try to estimate what would happen if, counterfactually, the CFS had requested many more shipments per respondent.

In this exercise, we assume that each sampled establishment has an establishment-specific probability, p, with which any of its shipments are sent internal to the firm. Again, because of sampling variability, p won't be equal to the fraction of shipments that are observed to be internal to the firm. We assume that the p's are independently drawn from a Beta(α, β) distribution. (Here, we use the Beta distribution mainly because it is flexible and has the unit interval as its support.) For an establishment with $p_i = p$, the likelihood of observing m_i out of N_i shipments being internal to the firm equals $\binom{N_i}{m_i} \cdot (p_i)^{m_i} \cdot (1 - p_i)^{N_i - m_i}$. Given our data on m_i and N_i we can estimate α and β via maximum likelihood. We do so: our estimates of α and β are 0.0280 and 0.955.

With the estimated distribution of p's in hand, we are able to assess how the observed distributions would change with greater or fewer reported shipments per establishment. We report the percentiles of distributions, where we assume that the number sampled shipments per establishment is 1 time, 2 times, 5 times, and 25 times what is actually observed. The results are presented in rows 12-15 of Table A2. Consistent with the robustness check presented in the first row of Table 1B, assuming that the sample sizes are larger decreases the fraction of establishment-year observations with 0 percent and 100 percent internal shares. However, a larger sample size probably would not affect the measured 50^{th}-percentile, 75^{th}-percentile, or 90^{th}-percentile internal shares. For example, if each establishment submitted data on 25 times as many shipments (compared to the number of shipments that they actually recorded), then the 50^{th}- and 75^{th}-percentile internal shares would be 0.6 percent and 8.9

percent, respectively.[12]

Finally, we examine whether the distribution of internal shares differs according to the size of the establishment's firm. As we explain in Appendix C.1, firms with over 500 employees receive the Report of Organization Survey. This survey is aimed at accurately depicting the patterns of establishment ownership, across firms. If there are organizations that own establishments with multiple firm identifiers, and if establishments within these organizations sent shipments to one another, then we would (incorrectly) classify these shipments as being inter-firm ("external") shipments. This would cause us to underreport the extent of internal shipments within vertically integrated firms. Thus, if there are problems, in our dataset, with firm identifiers, we should notice a jump—around the 500 employee cutoff—in our measured internal shares.

As we report in rows 16-19, the internal share measure is larger for establishments in firms with greater than 500 employees. However, the increase around the 500-employee cutoff is small (the value-weighted mean internal shares for the "0–500 employee" group and the "500–1000 employee" group are 6.9 percent and 7.0 percent, respectively). At the same time, internal shares are higher for the "1,000–10,000 employee" group, and even higher for the "greater than 10,000 employee" group. In combination, these results suggest that inaccurate firm identifiers are not causing us to underreport the share of internal shipments.

D.2. Is Geographic Proximity Important?

It's quite likely that some of the low internal shares we see above arise because a firm's establishments are too spatially separated to make internal shipments practical. Of course, if this is the case, this may be a *result* as much a *cause* of the lack of within-firm goods transfers along a production chain. If moving physical products down a production chain was the only reason for vertical ownership, after all, no firm would own vertically related establishments that were located too far from one another to make intra-firm shipments impractical. The fact that firms do own vertically linked producers that are far apart suggests other motives for ownership.[13]

Nevertheless, it is interesting to quantify how much distance matters. We take two approaches. The first is to compute the distribution of internal shipment shares for firms whose establishments are all located close to one another. The second is to compare establishments' shipment distances to the distances they are from other establishments in their firms.

To see shipment patterns of closely-spaced firms, we use the subset of upstream establishments from our CFS sample where *all* of the establishments that their firm owns are in the same county. (This is determined from

[12] Because of the parametric assumption that we make on the distribution of the p's, the internal share distribution resulting from our MLE estimates will not match the observed distribution, even when the number of shipments is set equal to what is actually observed. The Beta distribution has trouble fitting, for example, the small share of establishments with a 100 percent internal share.

[13] Hortaçsu and Syverson (2007) document examples of vertically integrated cement and concrete firms that own clusters of ready-mixed concrete establishments that are remotely located from their upstream cement establishments. These firms, in fact, do not internally supply these clusters with cement. The downstream concrete establishments instead report buying cement in the local market from the firm's upstream competitors. We find evidence that the firms' motives for owning these concrete establishment clusters is to harness logistical efficiencies in a business that shares a common final demand sector (construction) with cement.

the Economic Census, which includes state and county codes for virtually all establishments. This location information is not subject to the limitations of the EC zip code data, where codes for 10 percent of establishments are missing.) This subset is small—2,300 establishment-years and 200,000 shipments—and contains a large number of two-establishment firms with one upstream and downstream establishment each. Nevertheless, it offers a rough gauge the role of distance.

The results are consistent with the patterns described in Table 1. Just under half (46.7 percent) of the upstream establishments report no shipments to downstream units in their firm. The 90th-percentile establishment ships 49.0 percent of the value of its shipments internally. The fraction of establishments with all shipments staying in the firm is above that in the benchmark sample, however, at 2.4 percent. Thus it appears that vertically structured firms with closely located establishments are less likely to make internal shipments on average, but somewhat more likely to contain internally dedicated upstream establishments.

We next compare the shipment distances of our entire sample of upstream establishments in the CFS to their distances from other establishments in their firms (both measured in great circle terms). It's clear from pooling shipments across establishments that internal shipments go shorter distances. In fact, the average external shipment is sent roughly 55 percent further (349 miles versus 225 miles) than the average internal shipment. This may reflect upstream establishments "bypassing" their downstream units with some of their shipments, but it may also reflect composition effects if internally dedicated, high-volume upstream establishments are located close to downstream units in their firm.

We can decompose these contributions to the pooled numbers by looking within establishments. We find that for 8.2 percent of upstream shipment establishments, their farthest-traveling shipment does not go as far as the distance to the nearest downstream establishment in their firm. These establishments account for just over one-eighth of the one-half of our upstream establishments that report no internal shipments, showing the importance of distance. But this also means the other two-thirds of establishments reporting no internal shipments do send output at least as far as their nearest establishment. This pattern isn't unusual across the broader sample. Looking across establishments, the average of the within-establishment medians of reported shipment distances is 267 miles, while the average distance to the closest downstream establishment within the firm is 193 miles.

D.3. Is There Vertical Integration Within Establishments?

Our definition of vertically integrated ownership links requires multiple establishments by definition. A firm must own at least one establishment each in vertically related upstream and downstream industries. This definition could be problematic if firms commonly vertically integrate production within a single establishment. In such cases, the firm would be operating a vertically integrated production process and obviously supplying its own input needs. We would miss this type of integration, however, because we would not classify the establishment as integrated. There would be no shipments from the upstream to downstream parts of the production process in the CFS, since those goods transfers never leave the establishment.

To give a concrete example, consider the two following hypothetical firms. One has two establishments. The upstream establishment refines copper ore into billets which are then shipped to the downstream establishment to be extruded into pipe. The second firm operates a similar production process in a single establishment: one side refines ore into billets, and the other side turns billets into pipe. We would define the former establishments as vertically integrated, but not the latter, even though each firm operates the same production processes.

How can we tell if this sort of misclassification is a big problem? We compare the materials purchase patterns of establishments that we classify as being in vertical structures to those in the same industry not classified as such. In the context of the above example, we compare the two copper pipe establishments. (Since establishments are classified into industries in the Economic Census based upon their outputs, both the downstream establishment in the first firm and the second firm's establishment would be classified in the same industry, SIC 3351: Rolling, Drawing, and Extruding of Copper.) The pipe establishment in the first firm—the one that we would have classified as in a vertical ownership structure—will list copper billets as an intermediate materials purchase in the Census of Manufactures materials supplement. The second establishment, where billet production is inside the establishment, will list copper ore as a materials purchase. Hence if we see substantial differences in materials use patterns across establishments (in the same industry) that we classify respectively as vertically linked or not, we should be concerned that we are missing a lot of vertical production that occurs "under one roof." On the other hand, a lack of significant differences suggests this sort of misclassification is less of a concern.

We make three such comparisons between the materials use patterns of what we classify as vertically linked establishments and others in their industry. (Again, our analysis is restricted to establishments in the manufacturing sector because of the detailed intermediate materials data requirements.) We first compute the share of each establishment's intermediate materials purchases that is for "raw materials," which we define as the products of the agricultural, fisheries, forestry, or mining sectors—i.e., SIC product codes beginning with "14" or below. We then regress this share on a set of industry-year fixed effects and an indicator equal to one if we classify the establishment as in a vertical ownership link. In essence, we test whether there are significant differences in the intensity of raw materials use across establishments that we classify as vertical and non-vertical in the same industry. We would expect that if the "under one roof" misclassification problem were substantial, we would find that establishments we designate as *non*-vertical would have a larger raw materials share, since a greater portion of the production chain would be operated within the establishment. Again, to return to our example, the pipe establishment in the second firm reports copper ore (a raw material) as a materials purchase, while the establishment in the first firm purchases copper billets.

We run this regression on a sample of over 453,000 establishment-years from the Census of Manufactures. (We don't need the CFS for this.) The coefficient on the vertical ownership link indicator is 0.47 percent, with a standard error of 0.05 percent. Thus establishments we classify as vertical use raw materials more, not less, intensively compared to other establishments in their industry. (Recall that we would expect establishments we classify as vertically linked to use raw materials less intensively). Further, the point estimate of the share difference is small, less than one-fifteenth the average raw materials share of 8.2 percent. Even if we restrict our comparisons only to those roughly 85,000 establishments that report using positive raw materials shares, the vertically linked coefficient is -1.87 percent with a 0.19 percent standard error. The estimated difference is small, relative to the 44 percent average materials share, for establishments that report positive materials purchases.

Our second check aggregates this raw materials use data to the industry level. We add up raw and total materials use of establishments classified as vertical within an industry year, and compare the ratio of the two to the same share computed for non-vertical (again, under our classification) establishments in the same industry. We then conduct a t-test for equality of means across our sample of 1867 industry-years. The mean difference is 0.08 percent, with a standard error of 0.22 percent. Here, there are no significant within-industry differences in raw materials usage intensity across the two types of establishments.

Our final check is also done at the industry-year level. We separately aggregate materials purchases of our designated vertical and non-vertical establishments for each industry year. We then order materials by decreasing intensity of use for each type of establishment (as measured by their aggregate share of purchases). This yields 86,659 industry-year-materials ranks for both vertical and non-vertical establishments. We then compare these ranks within industry-year to see if there are systematic differences. The two ranks move together; the correlation coefficient is 0.74. Table A3 shows the frequency of relative rank orderings for the five most intensively used materials by industries' non-vertical establishments. (Material 1 is the most intensively used.) Only ranks 1 through 7 of vertical establishments are shown for parsimony. If materials usage patterns were exactly the same, we would only see entries on the diagonal of the table. The most intensively used material of an industry's vertical establishments would be the most intensively used among its non-vertical establishments; the second-most used would be so for both types of establishments, and so on. Clearly, this is not the case. However, the general pattern holds. The diagonal is the largest element of a row or column, and the frequency of other pairings falls as they move further away from the diagonal. Hence, these results suggest, as do the raw materials use tests above, that there are not systematic differences in the mix of materials used by establishments we classify as in vertical ownership links and those we do not classify as such.

D.4. Cross-Industry Differences in Internal Shares

Table A4 presents, for different 2 and 3-digit industries, establishments' average internal shares. The first five columns use data from the Commodity Flow Survey, while the final three columns use data from the Census of Manufacturers. [14]

The first column gives, for all establishments surveyed in the Commodity Flow Survey, the fraction of establishments which we classify as being at the upstream end of a vertical link (i.e., these are the establishments in our main benchmark sample). The second column gives, again for all establishments, the fraction that have a positive internal share. Columns 3 through 5 give, respectively, the mean internal shares for establishments that are in our benchmark sample, the mean share for establishments that have at least some internal shipments, and the mean share for all establishments. All industry averages are establishment-sales weighted.

There is substantial variation, across different goods-producing industries. Establishments in petroleum and transportation equipment manufacturing have the largest fraction of establishments within positive internal shares; furniture manufacturers and furniture and lumber wholesalers have the smallest fraction of establishments

[14] Results for select 4-digit SIC industries can be found at the AER webpage corresponding to this article.

with positive internal shares. There is also substantial variation, among industries, in average internal shares, with the highest average internal shares being the fabric and petroleum manufacturing industries, and the lowest average internal shares being the furniture manufacturing industry and the lumber, metals, drugs, chemicals, and beer and wine wholesaling industries.

Columns 6 through 8 display the corresponding calculations, using the interplant transfers variable from the Census of Manufacturers. While both the sample and the definition of internal shares differ between columns 1–5 and columns 6–8, the cross-industry patterns of internal shares are similar across the two sets of calculations. Paper, transportation equipment, and primary metals manufacturing are some of the more vertically integrated industries; furniture manufacturing and printing are two of the least vertically integrated.

The petroleum industry is a bit of an outlier, and deserves extra attention. Petroleum is an industry that has one of the highest internal shares in columns 1–5, but one of the lowest internal shares in columns 6–8. This difference results from the different definitions of internal shipments across the two datasets. The interplant transfers variable, collected in the Census of Manufacturers, asks establishments to give the value of shipments sent to other manufacturing establishments for further assembly. Since shipments by petroleum manufacturers are mainly sent to wholesalers, and not to other manufacturers, the internal shares computed from the Census of Manufacturers tend to be significantly smaller than the internal shares computed using data from the Commodity Flow Survey.

D.5. Firm Size Differences by Firm Structure

Figure A1 plots the densities of firm size (log total employment, since revenue is unavailable outside of manufacturing) for three mutually exclusive and exhaustive sets of multi-establishment firms. One set includes firms with vertical ownership structures.[15] The other two multi-unit organizational structures are single-industry and multi-industry-unintegrated firms.[16]

The figure reveals that each of the (log) employment size distributions is unimodal, though they clearly have different central tendencies.[17] Single-industry multi-unit firms are the smallest and have the most symmetric size distribution. Vertically integrated firms are clearly the largest on average, and their distribution is more skewed than the other firm types. (While not plotted, single-establishment firms are smaller than the multi-unit single-

[15] Recall that we define vertical ownership at the establishment, not firm, level. For our purposes here, however, we define a firm as vertically structured if it owns any vertically linked establishments. As a practical matter, most establishments in what we call vertically structured firms here are also in vertical chains according to our establishment-specific definition.

[16] The distribution of establishments across these firm sets is as follows. Over the entire manufacturing sample, multi-unit establishments of all types accounted for 19.7 percent of establishments, 71.8 percent of employment, and 86.5 percent of the capital stock. Vertically integrated establishments' shares were, respectively, 14.5, 60.4, and 79.2 percent. Multi-unit single-industry establishments accounted for 2.8 percent of establishments and 5.2 and 3.2 percent of employment and capital, while multi-industry unintegrated establishments comprised 3.7, 8.0, and 5.3 percent of establishments, employment, and capital, respectively.

[17] We only plot the 1997 distributions rather than those pooled across years in order to remove any secular shifts in firm sizes. Checks of other years show similarly shaped distributions.

industry firms, as one might expect.) Thus, not only are vertically integrated establishments larger, their firms are as well.

D.6. Establishment Attributes by Vertical Ownership Structure

When using a one percent cutoff rule, 74 percent (=14.5/19.7) of establishments in multi-unit firms are classified, by our methodology, to be part of a vertical production chain. Thus, the comparisons described in Tables 3-5 of the paper are, to a large extent, between establishments in multi-unit firms and establishments in single-unit firms.

For this reason, we re-examine Tables 3-4 using a five percent cutoff rule. With the more stringent definition, a smaller fraction of manufacturing establishments are classified to be part of a production chain. However, as Tables A5 and A6 demonstrate, the differences in establishment attributes by vertical structure are robust to the cutoff rule that we have chosen.

D.7. Flows of Intangible Inputs

In our product mix and shipment destination tests, we use the following algorithm to identify establishments that experienced ownership changes. From the Longitudinal Business Database, we begin with all establishments for which the firm identifier changes between *t* and *t*+1. Since firm identifiers may change across years for a number of reasons, we need to discard the observations which are unrelated to mergers or acquisitions.[18] For the establishments that change firm identifiers, we say that a change of ownership has occurred if they share the same firm identifier with some other set of establishments in period *t*+1, but not in period *t*. We define the other set of establishments to be an acquiring firm, if their firm identifier is the same in both years *t* and *t*+1.[19]

Here, we complement our analysis in the main text of summary data with more formal analyses. In Table A7, we estimate the probability that establishment *i* will produce a given 7-digit product in year *t* as a function of the year *t*-5 production patterns of the acquiring and acquired firms. We find that an establishment is more likely to produce a product in year *t* if either the acquiring or the acquired firm was producing the product. The probability that an acquired establishment produces a given 7-digit product in year *t* is 6 percent higher for products that were produced by the acquiring firm in year *t*-5. Compared to other products in their 4-digit industry, acquired establishments are also more likely to produce the products that its original firm was producing: The probability that

[18] For example, legal reorganizations may cause a change in firm identifiers without an actual change in ownership. For an additional example, multi-unit and single-unit firms are coded differently by the Census: A single-unit establishment that opens a new establishment elsewhere will have its firm identifier change, again without any change in ownership.

[19] An example will help explain how the algorithm works. Consider a two-establishment firm with establishment identifiers I_1 and I_2, firm identifier F in year t, and firm identifier G in year t+1. If there are no other establishments in year t+1 that have firm identifier G, then the algorithm would not identify a change of ownership. On the other hand, if there exists some establishment, I_3 that had firm identifier G in year t, our algorithm would identify I_3 as the sole establishment in the acquiring firm; I_1 and I_2 would then be classified as members of the acquired firm. Using a different method, Nguyen (1998) constructs a sample of acquired establishments, called the Ownership Change Database. As a robustness check, we re-create Tables A7 and A8 using the Ownership Change Database. The results are presented in the final columns of Tables A9 and A10.

establishment *i* produces a given 7-digit product is 7 percent higher for products that were produced in year *t*-5 by some other establishments of the acquired firm.

To further explore the evolution of acquired establishments' shipping patterns, we run a series of logit regressions to estimate the probability that an acquired establishment *i* will ship to any particular zip code *z* in 1997. In these regressions, the variables of interest measure the shipping patterns of the acquiring and acquired firms in 1993. In addition, we include the following control variables: establishment-by-destination-county fixed effects, control variables for total sales to zip code *z*, the great-circle distance between *i* and *z*, an indicator variable equal to one if there exists an establishment from the same firm in 1997, and an indicator variable equal to one if establishment *i* shipped to *z* in 1993.

Table A8 contains the results from these regressions. An establishment is significantly more likely to ship to a zip code if either the acquiring or acquired firm sold to that zip code in previous years. The probability that establishment *i* sells to zip code *z* in 1997 is 1.2 percent higher when an establishment from the acquiring firm sold to that zip code in 1993. The estimated marginal effect is significantly larger, 4.6 percent, if the establishment from the acquiring firm shares the same 4-digit industry as the acquired establishment. Finally, these marginal effects are economically meaningful. The average probability that an acquired establishment in our sample sells to a particular zip code is 4.0 percent. Furthermore, the acquired establishment *i* is more likely to ship to the zip codes that it used to sell to, and to the zip codes that other establishments in the acquired firm were selling to.

We also estimate these logit regressions with different subsets of the sample of acquired establishments. In Table A9, we re-estimate the probability than an establishment manufacturers a given 7-digit product. Again, we cut the data according to the year of the acquisition (column 1 versus column 2). We also run the logit regression separately for establishments that were in multi-unit firms and single-unit firms (column 3 versus column 4). Finally, we use a dataset—the Ownership Change Database constructed by Sang V. Nguyen of the Census Bureau—as an alternate source of acquired establishments. Coefficient estimates are similar across the different subsamples. In particular, in each specification, the probability that establishment i manufactures a particular 7-digit product is at least 5.5 percent larger when the acquiring firm had an establishment that, in year *t*-5, produced that same product.

Table A10 presents robustness checks related to the estimation of the probability that an acquired establishment ships to a particular zip code. In the first two columns, we show that the estimated effects are similar for establishments that merge earlier or later on. In the third and fourth columns, we show that the estimated effects are similar for establishments that were, in 1992, part of a multi-unit or a single-unit firm.[20] In the fifth column, we estimate the probability of shipping to a particular zip code for establishments in the wholesale, instead of the manufacturing, sector. Finally, in the sixth column, there is no substantial difference in the estimated effects from using the Ownership Change Database to define the set of acquired establishments.

E. Industries Mentioned in Lafontaine and Slade (2007)

[20] Since, in the fourth column, the sample includes only establishments that are in single-unit firms in 1992, the I(in 1993, another establishment, from the acquired firm, shipped to *z*) indicator is 0 for all establishments. Thus, this variable is excluded from the list of independent variables.

In this section, we describe the twelve 4-digit industries used in the robustness check of Table 1B, row 6. These industries are analyzed in the studies reviewed in Lafontaine and Slade (2007). The industries listed below are at the upstream end of their vertical links. (For example, *Auto Parts Manufacturers* refers to the link from automotive parts markers to automotive assemblers.)

Aerospace Parts Manufacturers. Masten (1984) studies the make-or-buy decision for airplane assemblers. We include the parts suppliers (SIC 3724, Aircraft Engines and Engine Parts).

Auto Parts Manufacturers. Several articles, including Masten, Meehan, and Snyder (1989), discuss the relationships between auto parts manufacturers (SIC 3714, Motor Vehicle Parts and Accessories) and auto assemblers (SIC 3711).

Cement. Vertical relationships between cement and ready-mix concrete manufacturers are the focus of Hortaçsu and Syverson (2007). Cement is produced primarily by establishments in 4-digit industry number 3241.

Coal. Establishments that engage coal mining reside in two SIC industries:1221: Bituminous Coal and Lignite, Surface Mining; and 1222: Bituminous Coal, Underground Mining. Joskow (1985) studies integration and contractual relationships between these coal-mining establishments and electricity-generating establishments. He notes that only a small fraction of coal shipments—approximately 15 percent, by value—are within-firm shipments. Indeed, among the Lafontaine and Slade (2007) subsample, the two coal-producing industries have two of the lowest fraction of within-firm shipments: 9 percent for Surface Mining and 12 percent for Underground Mining.

Industrial Gases. Both Lieberman (1991) and Mullainathan and Scharfstein (2001) study vertical relationships between organic chemical manufacturers and their customers. Mullanathian and Scharfstein (2001) focus on producers of vinyl chloride monomer (part of SIC 2869, Industrial Chemicals NEC), while the sample in Lieberman (1991) contains numerous products. The five largest products in their sample are propylene (part of SIC 2869), benzene (part of SIC 2865, Cyclic Organic Crudes and Intermediates), chlorine (part of SIC 2812, Alkalies and Chlorine), toluene (part of SIC 2865), and ethylene (part of SIC 2869). Due to data confidentiality regulations, we cannot include SIC 2812 in our calculations. However, we can include both SIC 2865 and SIC 2869.

Petroleum Refiners and Petroleum Wholesalers. Like the auto industry, petroleum refining and distribution has received substantial interest from industrial organization economists (e.g., Gilbert and Hastings (2005)). The three industries that we include are SIC 2911 (Petroleum Refining), 5171 (Petroleum Bulk stations and Terminals), and 5172 (Petroleum and Petroleum Products Wholesalers, Except Bulk Stations and Terminals).

Shoe Manufacturing. Woodruff (2002) studies the integration decisions of Mexican footwear manufacturers and retailers. We include men's footwear (SIC 3143) in our subsample of industries with a prior of high internal shipments. We cannot separately report women's footwear (SIC 3144) without violating Census data confidentiality regulations.

Soft Drink Bottlers. Muris, Scheffman, and Spiller (1992) chronicle the evolution of the soft drink industry, in particular the transition towards integration between soft drink bottlers and the two concentrate manufacturers (Coca-Cola and Pepsi). The soft drink bottling industry is SIC 2086.

Other Industries. The Lafontaine and Slade (2007) article reviews several additional industries, which we could not include in our calculations. The majority of these industries are those that are not included in the Commodity Flow Survey's sample frame. These include retail and service industries, but also some of the mining industries. For example, we could not include the iron ore mining industry, which is analyzed in Mullin and Mullin (1997), for this reason. There are also industries included in the CFS sample frame that we could not include. In these industries, there are too few establishments to pass the Census confidentiality requirement. Pulp mills (SIC 2611), analyzed in Ohanian (1994), is an example of one such industry. The other industries that we could not include, for this reason, are women's footwear (SIC 3144) and ship building (SIC 3731).

Appendix References

Harper, Michael, Ernst R. Berndt, and David O. Wood. 1989. "Rates of Return and Capital Aggregation Using Alternative Rental Prices." In *Technology and Capital Formation*, edited by Dale W. Jorgenson and Ralph Landau. Cambridge, MA: MIT Press.

Hastings, Justine S. and Richard J. Gilbert. 2005. "Market Power, Vertical Integration, and the Wholesale Price of Gasoline." *Journal of Industrial Economics*, 53(4): 469-92.

Hortaçsu, Ali and Chad Syverson. 2007. "Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices." *Journal of Political Economy*, 115(2): 250-301.

Hortaçsu, Ali and Chad Syverson. 2009. "Why Do Firms Own Production Chains?" U.S. Census Bureau Center for Economic Studies Paper No. CES 09-31.

Joskow, Paul L. 1985. "Vertical Integration and Long-Term Contracts: The Case of Coal-Burning Electric Generating Plants." *Journal of Law, Economics, and Organization*, 1(1): 33-80.

Lafontaine, Francine and Margaret Slade. 2007. "Vertical Integration and Firm Boundaries: The Evidence." *Journal of Economic Literature*, 45(3): 629-85.

Lieberman, Marvin B. 1991. "Determinants of Vertical Integration: An Empirical Test." *Journal of Industrial Economics*, 39(5): 451-66.

Masten, Scott E. 1984. "The Organization of Production: Evidence from the Aerospace Industry." *Journal of Law and Economics*, 27(2): 403-17.

Masten, Scott E., James W. Meehan Jr., and Edward A. Snyder. 1989. "Vertical Integration in the U.S. Auto Industry: A Note on the Influence of Transaction Specific Assets." *Journal of Economic Behavior and Organization*, 12(2): 265-73.

Masten, Scott E., James W. Meehan Jr., and Edward A. Snyder. 1991. "The Costs of Organization." *Journal of Law, Economics, and Organization*, 7(1): 1-25.

Mullainathan, Sendhil and David Scharfstein. 2001. "Do Firm Boundaries Matter?" *American Economic Review*, 91(2): 195-99.

Mullin, Joseph C., and Wallace P. Mullin. 1997. "United States Steel's Acquisition of the Great Northern Ore Properties: Vertical Foreclosure or Efficient Contractual Governance?" *Journal of Law, Economics, and Organization*, 13(1): 74-100.

Muris, Timothy J., David T. Scheffman, and Pablo T. Spiller. 1992. "Strategy and Transaction Costs: The Organization of Distribution in the Carbonated Soft Drink Industry." *Journal of Economics and Management Strategy*, 1(1): 83-128.

Nguyen, Sang V. 1998. "The Manufacturing Plant Ownership Change Database: Its Construction and Usefulness." *Journal of Economic and Social Measurement,* 24(3-4): 209-32.

Ohanian, Nancy K. 1994. "Vertical Integration in the U.S. Pulp and Paper Industry, 1900–1940." *Review of Economics and Statistics*, 76(1): 202-07.

U.S. Bureau of Labor Statistics. 1983. "Trends in Multifactor Productivity: 1948-81." Bulletin 2178. Washington D.C.: Government Printing Office.

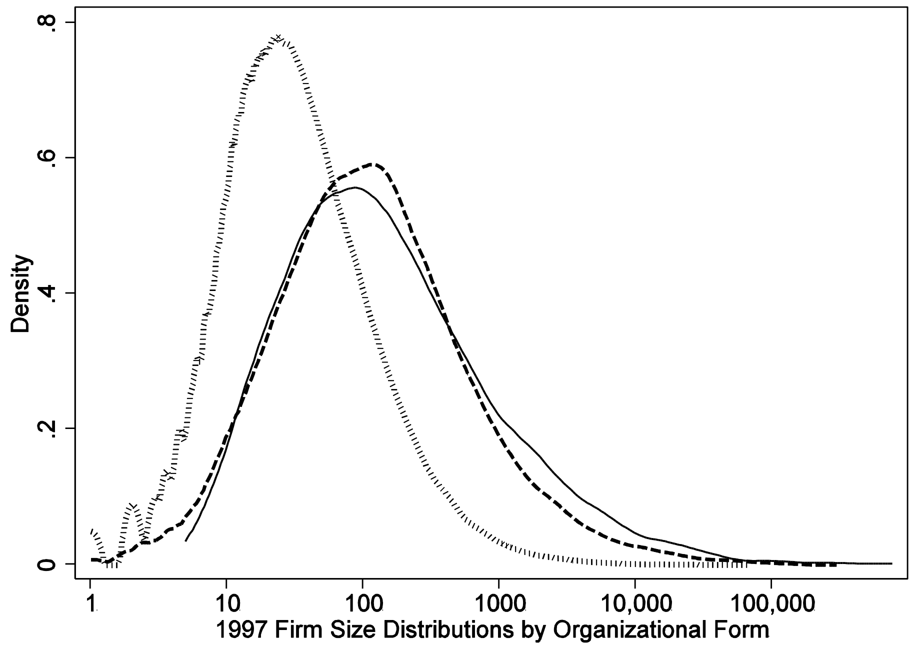
U.S. Census Bureau. 1996. "1992 Census of Transportation, Communications, and Utilities: 1993 Commodity Flow Survey, United States." Washington D.C.: Department of Commerce, Economic and Statistics

Administration.

U.S. Census Bureau. 1999. “1997 Census of Transportation: 1997 Commodity Flow Survey.” Washington D.C.: Department of Commerce, Economic and Statistics Administration.

Woodruff, Christopher. 2002. “Non-Contractible Investments and Vertical Integration in the Mexican Footwear Industry.” *International Journal of Industrial Organization*, 20(8): 1197–1224.

Figure A1. Firm Size Distributions by Organizational Structure



Notes: This figure shows density plots of the firm size distributions (measured by log total employees) for the three types of multi-establishment firms: single-industry, multi-establishment firms (thick, dashed line); multi-industry, non-VI firms (thin, dashed line); and VI firms (thin, solid line). See text for details.

Table A1: The Flows of Goods from the Cane Sugar, Except Refining, Industry to Other Industries

Downstream Industry SIC	Downstream Industry Name	S_{IJ}
5411	Grocery Stores	28.1%
5159	Farm Product Raw Materials	27.0%
2061	Cane Sugar, Except Refining	6.0%
2063	Beet Sugar	5.0%
5812	Eating Places	4.4%
2062	Cane Sugar Refining	4.1%
2051	Bread, Cake, and Related Products	3.5%
5410	Grocery and Convenience Stores	1.7%
2043	Cereal Breakfast Foods	1.7%
2052	Cookies and Crackers	1.6%
5149	Groceries, Not Elsewhere Classified	1.6%
2099	Food Prep., Not Elsewhere Classified	1.6%
2066	Chocolate and Cocoa Products	1.5%
5194	Tobacco and Tobacco Products	1.4%
2045	Prepared Flour Mixes and Doughs	1.0%
2048	Prepared Feeds and Feed Ingredients	0.9%
2033	Canned Fruits and Vegetables	0.7%
2087	Flavoring Extracts and Syrups	0.6%
2024	Ice Cream and Frozen Desserts	0.6%
5191	Farm Supplies	0.5%
2086	Bottled and Canned Soft Drinks	0.5%

Notes: This table shows the flows, according to the algorithm described in Web Technical Appendices B.1-B.4, originating from industry SIC 2061 (Cane Sugar, Except Refining). Under the benchmark definition, the first 15 industries are classified to be downstream of the Cane Sugar industry.

Table A2. Establishment-Level Shares of Internal Shipments: Additional Robustness Checks

Specification/Sample	Percentile 50th	75th	90th	95th	Frac. = 0	Frac.= 1	Weighted Mean	Approx. Establishment.-years
1. 10 percent cutoff definition for VI	0.0%	4.4%	28.7%	58.8%	55.1%	0.8%	12.1%	42,800
2. 15 percent cutoff definition for VI	0.0%	4.3%	27.3%	55.3%	55.0%	0.7%	9.8%	34,300
3. 20 percent cutoff definition for VI	0.0%	4.5%	28.2%	55.1%	55.1%	0.7%	9.3%	27,400
4. Interplant transfers	0.0%	0.0%	0.0%	0.0%	97.8%	0.1%	6.1%	766,000
5. Interplant transfers, establishments surveyed in benchmark sample	0.0%	0.0%	13.2%	51.1%	76.6%	1.1%	9.1%	37,000
6. Establishments that are in the CMF	0.0%	6.2%	33.7%	64.5%	50.9%	1.1%	12.2%	37,000
7. Establishments that are in the CMF, shipments to manufacturers	0.0%	0.3%	11.7%	33.5%	71.1%	1.1%	5.6%	37,000
8. Don't require the sending and receiving establishments to be part of a vertical link	3.0%	19.4%	59.2%	84.8%	29.1%	2.1%	20.8%	67,500
9. Original method for defining vertical links	0.0%	1.0%	17.4%	44.5%	67.5%	0.8%	6.4%	29,900
10. Original method for defining vertical links & don't require the sending and receiving establishments to be part of a vertical link.	2.5%	18.9%	57.7%	84.0%	33.7%	2.1%	19.3%	29,900
11. Retail and wholesale are always classified as downstream of other industries.	1.4%	14.6%	52.0%	80.2%	36.8%	1.7%	19.0%	67,500
12. MLE Estimate	0.0%	8.9%	40.4%	65.0%	51.4%	0.2%		67,500
13. MLE Estimate & the number of sampled shipments per surveyed estab. was 2 times as large.	0.5%	8.9%	40.2%	64.7%	45.3%	0.1%		67,500
14. MLE Estimate & the number of sampled shipments per surveyed estab. was 5 times as large.	0.5%	8.9%	40.1%	64.6%	37.3%	<0.1%		67,500
15. MLE Estimate & the number of sampled shipments per surveyed estab.	0.6%	8.9%	40.1%	64.5%	34.5%	<0.1%		67,500

was 25 times as large.								
16. Establishment in firm with 10,000+ employees	1.1%	15.2%	57.9%	82.7%	38.3%	1.4%	21.4%	19,000
17. Establishment in firm with 1000-10,000 employees	0.0%	5.3%	30.1%	61.8%	52.3%	1.0%	10.9%	21,600
18. Establishment in firm with 500-1000 employees.	0.0%	3.4%	25.0%	55.4%	57.6%	1.0%	7.0%	5,600
19. Establishment in firm with fewer than 500 employees.	0.0%	4.4%	27.6%	58.8%	55.0%	1.1%	6.9%	21,300

Notes: Each row shows, for a different subsample, the distributions of the shares (by dollar value) of upstream integrated establishments' shipments that are internal to the firm. The criteria for inclusion in and size of each subsample is discussed in the text. For data confidentiality reasons, the reported percentiles are averages of immediately surrounding percentiles, e.g., the median = 0.5*(49th percentile + 51st percentile).

Table A3. Relative Material Use Intensity Ranks between Establishments in Vertical Ownership Structures and Other Establishments

		Material's intensity rank in non-vertically linked establishments				
		1	2	3	4	5
Material's intensity rank in vertically linked establishments	1	50.5%	13.7%	8.0%	4.5%	3.3%
	2	14.7%	26.1%	15.4%	10.1%	6.0%
	3	8.1%	14.7%	19.1%	13.2%	9.8%
	4	5.6%	10.6%	12.1%	14.8%	11.8%
	5	3.1%	6.5%	9.6%	11.2%	11.3%
	6	3.2%	5.1%	6.5%	7.9%	10.4%
	7	2.2%	4.3%	5.9%	6.4%	7.3%

Notes: This table shows, for a sample of 9,545 industry-material-year cells, the ranks of materials intensity use (by share of materials purchases) for the five most intensively used materials in establishments we define as not in vertical ownership structures. The entries in the table correspond to the fraction of cells where vertical and non-vertical establishments in the same industry share a particular pair of materials intensity rankings. For example, across all industry-years in the sample, the most intensively used (rank 1) material by non-vertical establishments in an industry-year is the most intensively used material by the industry-year's vertical establishments 50.5 percent of the time. Non-vertical establishments' rank 1 material is vertical establishments' second most intensively used material 14.7 percent of the time, and so on. Industries are defined according to the BEA's IOIND classification.

Table A4. Establishment-Level Shares of Internal Shipments, by Industry

	Using Commodity Flow Survey Data					Using Census of Manufacturers Data		
Industry	Fraction of ests. that are in the VI sample	Fraction of ests. w/ share > 0	Mean share for ests. in the VI sample	Mean share, cond. on share > 0	Mean share	Fraction of ests. w/ share > 0	Mean share, cond. on share > 0	Mean share
12, Coal Mining	78.4%	26.0%	13.5%	40.8%	10.6%			
14, Stone	65.9%	27.7%	10.0%	23.7%	6.6%			
20, Food	82.0%	52.4%	13.4%	20.9%	11.0%	3.7%	13.9%	3.5%
22, Fabric	78.1%	50.5%	22.3%	34.4%	17.4%	8.3%	53.1%	20.5%
23, Apparel	55.6%	32.9%	11.9%	19.9%	6.6%	0.8%	46.4%	4.3%
24, Wood	53.7%	31.1%	11.4%	19.5%	6.1%	1.4%	27.3%	4.7%
25, Furniture	39.5%	16.1%	4.1%	10.2%	1.6%	0.9%	10.1%	0.9%
26, Paper	73.0%	40.4%	7.7%	13.9%	5.6%	11.1%	25.1%	10.0%
27, Printing	55.4%	21.6%	4.3%	11.2%	2.4%	0.3%	16.7%	0.6%
28, Chemicals	86.7%	49.2%	9.6%	16.9%	8.3%	6.4%	19.4%	7.5%
29, Petroleum	94.0%	76.8%	30.6%	37.5%	28.8%	8.8%	6.8%	3.0%
30, Plastics	58.7%	28.0%	7.5%	15.8%	4.4%	4.0%	18.0%	3.4%
31, Leather	64.0%	38.0%	17.5%	29.6%	11.2%	1.3%	31.3%	3.7%
32, Glass, Stone	69.1%	38.5%	8.8%	15.9%	6.1%	1.5%	25.0%	4.0%
33, Primary Metals	77.6%	48.9%	10.8%	17.2%	8.4%	7.6%	26.1%	11.0%
34, Fabr. Metals	50.6%	26.7%	10.7%	20.3%	5.4%	2.1%	34.2%	6.1%
35, Ind. Machinery	67.5%	40.8%	7.1%	11.9%	4.8%	1.3%	18.8%	4.4%
36, Elc. Equipment	73.9%	46.4%	9.6%	15.3%	7.1%	3.5%	26.3%	6.5%
37, Trans. Equip.	86.2%	65.6%	13.0%	17.2%	11.2%	4.5%	28.6%	9.4%
38, Instruments	74.8%	43.8%	9.0%	15.4%	6.7%	2.2%	11.4%	3.3%
39, Miscellaneous	35.4%	11.9%	6.2%	18.4%	2.2%	0.5%	13.3%	1.1%
501, Vehicles	75.9%	52.7%	8.8%	12.7%	6.7%			
502, Furniture	39.0%	17.5%	5.6%	12.5%	2.2%			
503, Lumber	53.7%	17.9%	2.8%	8.4%	1.5%			
504, Prof. Equip.	49.5%	31.4%	10.3%	16.1%	5.1%			
505, Metals	59.5%	24.3%	3.4%	8.4%	2.0%			

506, Electrical	57.4%	34.4%	6.1%	10.0%	3.5%
507, Hardware	56.5%	25.3%	5.0%	10.9%	2.8%
508, Machinery	48.2%	29.1%	6.0%	10.0%	2.9%
509, Miscellaneous	28.6%	8.7%	3.8%	13.1%	1.1%
511, Paper	61.8%	34.8%	4.0%	7.2%	2.5%
512, Drugs	77.1%	26.5%	1.7%	5.0%	1.3%
513, Apparel	43.5%	27.6%	8.0%	12.8%	3.5%
514, Groceries	62.8%	32.3%	10.8%	21.0%	6.8%
515, Farm Products	63.3%	33.1%	19.9%	38.0%	12.6%
516, Chemicals	44.8%	20.4%	4.0%	8.8%	1.8%
517, Petroleum	73.1%	52.9%	23.5%	32.5%	17.2%
518, Beer & Wine	47.2%	11.1%	2.5%	11.0%	1.2%
519, Miscellaneous	49.0%	22.0%	9.0%	20.1%	4.4%

Note: Each row shows, for a different SIC industry, the fraction of establishments that have positive internal shipments, as well as the average share of internal shipments. Industries in the mining and manufacturing sectors are averaged over 2-digit industries. Industries in the wholesale sector are averaged over 3-digit industries. Tobacco (SIC 21) is combined with Food (SIC 20). All calculations are sales-weighted (i.e, 10.6 percent of the shipment value in the coal-mining industry is within firm).

Table A5. Establishment Attributes by Vertical Ownership Structure: Five Percent Cutoff Rule

	Output per hour	TFP	Output	Capital-labor ratio
A. Within-industry differences				
Indicator for vertical estabs.	0.377*	0.009*	1.515*	0.460*
	(0.002)	(0.001)	(0.005)	(0.003)
Approximate N	970,000	879,000	991,000	937,000
Approximate N[vertical estabs.]	144,000	137,000	147,000	142,000
B. Differences among new establishments				
Indicator for vertical estabs.	0.320*	0.024*	1.288*	0.363*
	(0.006)	(0.004)	(0.012)	(0.008)
Approximate N	240,000	213,000	248,000	233,000
Approximate N[vertical estabs.]	23,000	21,000	24,000	23,000
C. Comparing unintegrated establishments: to-be-vertical vs. remaining non-vertical				
Indicator for to-be-vertical estabs.	0.243*	0.007*	1.265*	0.295*
	(0.006)	(0.004)	(0.012)	(0.008)
Approximate N	453,000	415,000	462,000	439,000
Approximate N[to be vertical]	13,000	12,000	13,000	13,000
D. Changes upon entering vertical ownership				
Newly vertical indicator	0.043*	-0.010*	0.005	0.033*
	(0.006)	(0.004)	(0.008)	(0.009)
Approximate N	397,000	345,000	407,000	375,000
Approximate N[newly vertical]	13,000	12,000	13,000	12,000

Notes: This table shows establishment "type" comparisons between establishments in (or to-be-in) vertical ownership structures and their non-vertical counterparts. Unlike Table 3, industry *I* is defined to be upstream of industry *J* if greater than five percent—not one percent—of industry *I*'s output is sent to industry *J*. Panel A compares across all establishments for which type measures are available. Panel B compares new establishments. Panel C compares *prior period* types among non-vertical establishments that will become part of vertical ownership structures by next period to those remaining non-vertical. Panel D compares changes in type for establishments that become part of vertical ownership structures to changes for unintegrated establishments that remain so. All regressions include industry-year fixed effects; industries are defined according to the BEA's IOIND classification. Samples are comprised of non-administrative-record manufacturing establishments. See text and Web Technical Appendix A on construction of type measures and additional details. An asterisk denotes significance at the five percent level.

Table A6. Establishment Type Differences Controlling for Firm Size: Five Percent Cutoff Rule

	Output per hour	TFP	Output	Capital-labor ratio
VI indicator	0.070* (0.004)	-0.002 (0.002)	0.300* (0.007)	0.069* (0.005)
Approximate N	231,000	220,000	235,000	227,000
Approximate N[VI Indicator]	131,000	125,000	134,000	129,000

Notes: This table shows the results from regressing establishment-level type measures on an indicator for vertically integrated establishments, a set of industry-year fixed effects, and control variables for firm size; industries are defined according to the BEA's IOIND classification. The sample consists of establishments in multi-industry firms. Unlike Table 4, industry *I* is defined to be upstream of industry *J* if greater than five percent—not one percent—of industry *I*'s output is sent to industry *J*. The firm size control variables include quintics of several measures of the establishment's owning-firm size: (log) employment, the (logarithm of the) number of establishments, and the (logarithm of the) number of industries. These firm size measures are computed by summing over the *other* plants in the firm of the establishment in question. An asterisk denotes significance at the five percent level.

Table A7. Logit Regression: Probability that Establishment *i* Produces a Given 7-digit Product in Year *t*

I(estab. produced 6-digit product in *t*-5)	1.215* (0.037) 0.086	0.921* (0.038) 0.052	1.058* (0.039) 0.063
I(estab. produced 7-digit product in *t*-5)	2.313* (0.036) 0.469	2.366* (0.036) 0.422	2.189* (0.037) 0.399
I(in t-5, another estab. from the acquired firm produced the 6-digit product)		0.774* (0.041) 0.055	0.321* (0.059) 0.018
I(in t-5, an estab. from the acquiring firm produced the 6-digit product)		0.619* (0.038) 0.041	0.113* (0.054) 0.006
I(in t-5, another estab. from the acquired firm produced the 7-digit product)			0.608* (0.054) 0.052
I(in t-5, an estab. from the acquiring firm produced the 7-digit product)			0.702* (0.051) 0.053
Approx. N	140,000	140,000	140,000
Approx. number of establishment-by-4-digit industry groups	7,600	7,600	7,600
Pseudo R^2	0.353	0.363	0.368
Average probability that *i* produces the 7-digit good in year *t*	13.1%	13.1%	13.1%

Notes: Each column gives the results from a separate logit regression. For each variable, coefficient estimates, standard errors, and marginal effects are reported. The dependent variable equals 1 provided establishment *i* produces 7-digit product, *p*, in year *t*. The sample includes all *i*-*p* pairs for which a) *i* was purchased between *t*-5 and *t*-1, and b) product *p* was produced at least such acquired establishment in year *t*. Control variables for total sales in year *t* of the 7-digit product (minus sales of the product by establishment *i*) are included, but not reported. $t \in \{1992, 1997\}$. All regressions include establishment-by-4-digit-industry fixed effects. An asterisk denotes significance at the five percent level.

Table A8. Logit Regression: Probability that Establishment *i* Ships to Zip Code *z* in 1997

I(estab. *i* sold to zip code *z* in 1993)	2.357* (0.017) 0.178	2.226* (0.018) 0.156	2.215* (0.018) 0.154	2.212* (0.018) 0.153	2.176* (0.039) 0.155	2.223* (0.020) 0.153
I(in 1997, an estab. from the merged firm has a physical location in *z*)	1.141* (0.030) 0.047	0.988* (0.031) 0.0377	0.986* (0.031) 0.037	0.982* (0.031) 0.037	1.292* (0.050) 0.059	0.794* (0.039) 0.027
ln(distance)	-0.127* (0.017) -0.003	-0.114* (0.017) -0.003	-0.112* (0.017) -0.003	-0.112* (0.017) -0.003	0.007 (0.037) 0.000	-0.152* (0.019) -0.003
I(in 1993, another estab. from the acquired firm shipped to *z*)		1.1299* (0.024) 0.046	0.802* (0.044) 0.027	0.801* (0.044) 0.027	0.587* (0.090) 0.019	0.872* (0.051) 0.03
I(in 1993, an estab. from the acquiring firm shipped to *z*)		0.638* (0.017) 0.02	0.435* (0.022) 0.012	0.432* (0.022) 0.012	0.480* (0.045) 0.014	0.417* (0.025) 0.011
I(in 1993, another estab. in the same 2-digit SIC, from the acquired firm shipped to *z*)			0.454* (0.051) 0.027	0.155* (0.068) 0.008	0.298* (0.126) 0.014	0.114 (0.082) 0.006
I(in 1993, an estab. in the same 2-digit SIC, from the acquiring firm shipped to *z*)			0.420* (0.029) 0.017	0.187* (0.034) 0.007	0.186* (0.064) 0.007	0.182* (0.041) 0.007
I(in 1993, another estab. in the same 4-digit SIC, from the acquired firm shipped to *z*)				0.406* (0.061) 0.027	0.422* (0.109 0.028	0.401* (0.074) 0.027
I(in 1993, an estab. in the same 4-digit SIC, from the acquiring firm shipped to *z*)				0.526* (0.040) 0.027	0.659* (0.071) 0.039	0.454* (0.049) 0.022
Include establishments with (or without) internal shipments?	Both	Both	Both	Both	Internal Share>0	Internal Share=0
Approx. N	1.45 million	1.45 million	1.45 million	1.45 million	0.31 million	1.14 million
Number of establishment-by-destination counties	46,500	46,500	46,500	46,500	10,500	36,000
Pseudo R^2	0.178	0.189	0.190	0.191	0.203	0.188
Average probability that *i* ships to *z* in 1997	4.0%	4.0%	4.0%	4.0%	4.0%	4.0%

Each column gives the results from a separate logit regression. For each variable, coefficient estimates, standard errors, and marginal effects are reported. The dependent variable equals 1 provided establishment *i* ships to zip code *z* in 1997. The sample includes all *i*-*z* pairs for which *i* was purchased between 1992 and 1996, and *z* was a destination zip code for at least one such acquired establishment in 1997. Control variables for total sales in zip code *z* (minus sales from establishment *i*) are included, but not reported. All regressions include establishment-destination county fixed effects. An asterisk denotes significance at the five percent level.

Table A9. Logit Regression: Probability that Establishment *i* Produces a Given 7-digit Product in Year *t*: Robustness Checks

I(estab. produced 6-digit product in *t*-5)	1.086* (0.051) 0.070	1.022* (0.061) 0.060	1.066* (0.042) 0.064	1.009* (0.103) 0.064	1.046* (0.034) 0.057
I(estab. produced 7-digit product in *t*-5)	2.093* (0.049) 0.391	2.326* (0.058) 0.427	2.181* (0.040) 0.399	2.241* (0.101) 0.418	2.379* (0.032) 0.427
I(in *t*-5, another estab. from the acquired firm produced the 6-digit product)	0.306* (0.074) 0.018	0.336* (0.097) 0.019	0.317* (0.059) 0.018		0.343* (0.051) 0.018
I(in *t*-5, an estab. from the acquiring firm produced the 6-digit product)	-0.054 (0.072) -0.003	0.343* (0.083) 0.020	0.090 (0.058) 0.005	0.224 (0.142) 0.013	0.065 (0.058) 0.003
I(in *t*-5, another estab. from the acquired firm produced the 7-digit product)	0.599* (0.069) 0.053	0.631* (0.087) 0.056	0.612* (0.055) 0.052		0.644* (0.047) 0.052
I(in *t*-5, an estab. from the acquiring firm produced the 7-digit product)	0.752* (0.068) 0.054	0.651* (0.077) 0.056	0.675* (0.055) 0.050	0.879* (0.139) 0.073	0.787* (0.055) 0.055
Year of merger	*t*-5 to *t*-3	*t*-2 to *t*-1	*t*-5 to *t*-1	*t*-5 to *t*-1	*t*-5 to *t*-1
Multi-unit/single unit in *t*-5?	Either	Either	Multi	Single	Either
Use Ownership Change Database to define mergers?	No	No	No	No	Yes
Approx. N	83,000	57,000	119,000	21,000	215,000
Approx. number of establishment-by-4-digit-industry groups	4,700	2,900	6,600	1,000	10,600
Pseudo R^2	0.353	0.391	0.375	0.322	0.385
Average probability that *i* produces the 7-digit good in *t*	13.2%	13.0%	13.3%	11.8%	11.8%

Notes: Each column gives the results from a separate logit regression. For each variable, coefficient estimates, standard errors, and marginal effects are reported. The dependent variable equals 1 provided establishment *i* produces 7-digit product, *p*, in year t. The sample includes all *i*-*p* pairs for which a) *i* was purchased between *t*-5 and t-1, and b) product *p* was produced at least such acquired establishment in year *t*. Control variables for total sales in year *t* of the 7-digit product (minus sales of the product by establishment *i*) are included, but not reported. See text for details. $t \in \{1992, 1997\}$. All regressions include establishment-by-4-digit-industry fixed effects. An asterisk denotes significance at the five percent level.

Table A10. Logit Regressions: Probability that Establishment *i* Ships to Zip Code *z* in 1997: Robustness Checks

I(Estab. *i* sold to zip code *z* in 1993)	2.184* (0.023) 0.155	2.249* (0.027) 0.152	2.201* (0.019) 0.151	2.304* (0.057) 0.146	1.489* (0.027) 0.132	2.263* (0.015) 0.174
I(in 1997, an estab. from the merged firm has a physical location in *z*)	0.931* (0.038) 0.035	1.066* (0.053) 0.040	1.003* (0.031) 0.038	0.600* (0.142) 0.016	1.192* (0.055) 0.095	0.991* (0.030) 0.041
ln(distance)	-0.100* (0.022) -0.002	-0.126* (0.026) -0.003	-0.100* (0.018) -0.002	-0.228* (0.052) -0.004	-0.104* (0.021) -0.005	-0.096* (0.015) -0.002
I(in 1993, another estab. from the acquired firm shipped to *z*)	0.842* (0.058) 0.030	0.746* (0.068) 0.024	0.805* (0.044) 0.027		0.777* (0.124) 0.051	0.558* (0.037) 0.018
I(in 1993, an estab. from the acquiring firm shipped to *z*)	0.458* (0.030) 0.013	0.406* (0.032) 0.011	0.434* (0.022) 0.012	0.408* (0.085) 0.010	0.595* (0.046) 0.036	0.462* (0.024) 0.014
I(in 1993, another estab. in the same 2-digit SIC, from the acquired firm shipped to *z*)	0.080 (0.090) 0.004	0.262* (0.105) 0.013	0.161* (0.068) 0.008		0.187 (0.206) 0.018	0.384* (0.052) 0.019
I(in 1993, an estab. in the same 2-digit SIC, from the acquiring firm shipped to *z*)	0.162* (0.046) 0.006	0.217* (0.051) 0.008	0.187* (0.036) 0.007	0.184 (0.129) 0.005	-0.025 (0.092) -0.002	0.158* (0.038) 0.007
I(in 1993, another estab. in the same 4-digit SIC, from the acquired firm shipped to *z*)	0.538* (0.080) 0.038	0.216* (0.094) 0.013	0.402* (0.061) 0.027		0.015 (0.173) 0.002	0.450* (0.047) 0.033
I(in 1993, an estab. in the same 4-digit SIC, from the acquiring firm shipped to *z*)	0.637* (0.053) 0.036	0.381* (0.062) 0.017	0.513* (0.042) 0.026	0.642* (0.133) 0.030	-0.013 (0.121) -0.001	0.552* (0.045) 0.032
Year of merger	92-94	95-96	92-96	92-96	92-96	92-96
Multi-unit/single unit in 1992?	Either	Either	Multi	Single	Either	Either
Manufacturing/wholesale?	Manuf.	Manuf.	Manuf.	Manuf.	Whole.	Manuf.
Use Ownership Change Database to define mergers?	No	No	No	No	No	Yes
Approx. N	869,000	589,000	1.31m	147,000	255,000	1.98m
Approx. number of establishment-by-destination counties	28,000	18,000	42,000	4,700	11,000	65,000
Pseudo R^2	0.192	0.190	0.193	0.179	0.138	0.183
Average probability that *i* ships to *z* in 1997	4.0%	4.0%	4.0%	4.0%	7.8%	4.1%

Notes: Each column gives the results from a separate logit regression. For each variable, coefficient estimates, standard errors, and marginal effects are reported. The dependent variable equals 1 provided establishment *i* ships to zip code *z* in 1997. The sample includes all *i*-*z* pairs for which *i* was purchased between 1992 and 1996, and *z* was a destination zip code for at least one such acquired establishment in 1997. Control variables for total sales in zip code *z* (minus sales from establishment *i*) are included but not reported. All regressions include establishment-by-destination-county fixed effects. An asterisk denotes significance at the five percent level.