# Production and Ownership Networks*

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**Abstract**

Using data on both buyer-supplier and owner-subsidiary links between Japanese firms, we characterize the interconnection between production and ownership networks. In the cross-section, we find that the majority of the owner-subsidiary links are also buyer-supplier links, highlighting the role of goods or services transactions in vertical relationships. In addition, we find that firms are more likely to use buyers/suppliers that are already adopted by related parties, suggesting an indirect benefit of integration.

*Keywords.* production network, ownership network, the transfer of intangibles

*JEL Classification.*

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# 1 Introduction

How firm boundary affects economic outcomes and why firms get integrated are fundamental research questions in economics, dating back at least to Coase (1937). Various theories have been proposed to substantiate the benefits and costs of integration,[1] which can be divided into two broad categories. The first category argues that firm boundary facilitates and incentivizes the flow of tangible goods and services (e.g., the property rights theory as in (Grossman and Hart, 1986; Hart and Moore, 1990)), while the second one puts forward the argument that integration is associated with the transfer of (or redesigning) intangible assets such as the incentive scheme, the ability to coordinate (i.e., managerial oversight and planning), decision rights and valuable information (e.g., the multitasking theory as in Holmstrom and Milgrom (1991, 1994), the price theory of integration as in Legros and Newman (2013), the rent-seeking and adaptation theories as in (Williamson, 1971, 1973, 1979) and Williamson (1985)). Of course, each particular theory only captures reality from one angle, and progress has been made to provide evidence for some of those theories.[2] In this paper, we use a large-scale firm-level dataset that contains information on production and ownership networks to provide evidence for the flow of tangibles and intangibles within the firm boundary.

In this paper, we study the interconnection between production and ownership networks using firm-level data from Japan. The dataset used in this paper is the TSR dataset, which is built up from a survey that asks firms to report the set of buyers and sellers. The TSR survey is implemented by Tokyo Shoko Research Ltd. every year and covers firms in all industries. Although the TSR survey is not mandatory, the distribution of firms in terms of employment and industry classification is very similar to the statistics obtained from the Census data of Japan. Each firm is asked to report its buyers and sellers (up to 24 firms) in a given year, and we are able to uncover a more complete set of firm's buyers and sellers (more than what the firm reports) by utilizing information on reported buyers/suppliers from other firms. In 2006, the survey covers around 710,000 suppliers and 800,000 buyers. This part of the TSR dataset has been widely used in previous research (Bernard, Moxnes and Saito, 2018; Carvalho, Nirei, Saito and Tahbaz-Salehi, 2021a).

[1] See Gibbons (2005) for the four "elemental" theories.

[2] See Monteverde and Teece (1982), Masten (1984) and Joskow (1985) for early empirical work on vertical integration. All these papers focus on situations with physical input transfers. Tomiura (2007), Kohler and Smolka (2009) and Corcos, Irac, Mion and Verdier (2013) provide supporting evidence for the property-rights theory presented in Antràs and Helpman (2004) in the international context. Alfaro, Conconi, Fadinger and Newman (2016) presents supporting evidence for the price theory of integration. Atalay, Hortaçsu and Syverson (2014) and Ramondo, Rappoport and Ruhl (2016) substantiate the fact that only a subset of vertically integrated firms transfer intangible goods, while the former hints that vertical integration seems to facilitate the flow of intangibles.

An under-studied part of the TSR dataset is its information on firms' ownership structure. The TSR dataset has two modules that provide information about subsidiary-owner linkages: the company information module and the ownership link module. In the company information module, each firm reports its shareholders, including both companies and individuals. In contrast, the ownership link module only includes company shareholders and provides a unique identifier (company ID) for each shareholder. Based on information obtained from the two modules, we are able to construct an ownership network that features three types of ownership linkages: a parent (or a grandparent), a subsidiary (or a grandchild) and siblings (i.e., firms that are owned by the same parent firm).

We divide the buyer-seller relationship into three categories by using the information from the ownership network: (1) directly related buyer-seller, (2) indirectly related buyer-seller, (3) all others. Buyer/seller relationships that have one of the three ownership linkages as defined above belong to the first group. Indirectly related buyer-sellers are those relationships where either the buyer or the seller is a buyer or a seller of the other firm's parent (or grandparent), subsidiary (or grandchild) or sibling. In the data, roughly 7% (4%) firms have at least one owner (subsidiary). Most such firms have only one owner (or subsidiary).

The first set of facts we uncover is the coexistence of the production and ownership linkages in the Japanese data. Specifically, among firm-partner pairs where the partner is the focal firm's parent/grandparent/sibling firm, 41% or 37% of them have a buyer or seller relationship (i.e., backward/forward integration).[3] Those statistics either increase or slightly decrease, when we aggregate the firm-partner pair level statistics to the firm level or constrain our firm-partner pairs to be in upstream and downstream industry pairs (using the input-output table from Japan). Although our dataset does not reveal the value of each transaction, the above statistics are comparable to the ones reported in Atalay et al. (2014) and substantiate the fact that firms linked via ownership (to the focal firm) are an important set of buyers/suppliers of the focal firm. In short, this new finding using the Japanese data substantiates the importance of firm-boundary in determining goods transaction.[4]

Our empirical analysis yields several key findings that provide new insights into the interconnection between production and ownership networks. First, we document substantial overlap between ownership and production linkages. Among firm-owner pairs, 41% involve backward integration (owner as buyer) and 37% involve forward integration (owner as supplier), with 63% of all firm-owner pairs featuring either backward or forward integration.[5]

[3]In 15% of the pairs, the partner is both a buyer and a seller, which implies that 63% firm-partner pairs have transaction linkages. When we focus on partners that are siblings of the focal firm, 10.6% of them also have a buyer-supplier relationship.

[4]See Atalay, Hortaçsu, Li and Syverson (2019) for related evidence.

[5]15% of the pairs feature both backward and forward integration.

When aggregated at the firm level, we find that 51% of firms with owners sell to at least one owner or sibling, comparable to a similar probability reported in Atalay et al. (2014) for U.S. establishments. However, we also find that 52% of the firms buy from at least one owner/sibling, and 74% transact with owners/siblings in either direction. Therefore, focusing only on selling to owners/siblings, as in Atalay et al. (2014), understates the overall prevalence of buyer-supplier relationships among ownership-linked firms. In addition, we find that ignoring the links between pairs whose industries are not vertically linked (e.g., the upstream industry supplying no more than 1% of its output to the downstream industry) also understates the prevalence of buyer-supplier relationships among ownership-linked firms, likely because many firms expand multiple industries and the input-output table cannot fully capture the products they produce and the inputs they use. This bias has also been documented in the context of India (Garg, Ghosh and Tan, 2023) and Korea (Hong, 2023).

Second, we provide novel evidence for how firms find suppliers through indirect connections through the ownership and production networks. Specifically, we document that, among firms that have at least one owner, 13.6% of their suppliers are "indirectly related" to the focal firm, meaning they are shared with the firm's owners, siblings, or subsidiaries. To provide a benchmark, we simulate a scenario where firms randomly select suppliers from the pool of all potential suppliers in the same industry and location. Under this random matching benchmark, only 4.0% of suppliers would be indirectly related. Therefore, the observed 13.6% is more than three times as high as the random matching benchmark, indicating that ownership networks significantly facilitate access to suppliers. Similarly, among firms with at least one subsidiary, 8.6% of their buyers are indirectly related, compared to only 2.6% under random matching. The findings on indirectly related buyers are consistent with Atalay et al. (2014), who show that after an establishment is acquired, it is more likely to sell to zip codes where other establishments of the same parent firm are located.

In addition to the cross-sectional evidence, we provide evidence on the impact of indirect relationships on finding suppliers using panel data regressions. To make our sample manageable, we focus on firms in the motor vehicle industry and all their potential suppliers in the top upstream industries from 2006 to 2017. Using variation within a pair of firms over time and controlling for firm-potential-supplier pair fixed effects, we find that indirect relationships (potential supplier being the focal firm's owners' supplier) increase the probablity of link formation from 0.18% to 0.91%, a four-time increase of the baseline probability. These results are largely robust with stronger fixed effects and changing the dependent variable from whether the buyer-supplier link is active in the current year to whether it is active in the next period. Using event study methodology, we show that once an indirect ownership relationship is established, firms become progressively more likely to adopt their owner's

suppliers in subsequent years, with effects persisting for multiple periods. This temporal pattern suggests that knowledge transfer about supplier quality occurs gradually through the ownership network, reducing search costs and facilitating better supplier-buyer matching.

A large empirical literature studies the extent to which direct ownership links shape real buyer-supplier transactions. Recent work using U.S. establishment-level and Bureau of Economic Analysis (BEA) multinational firm data – most notably Atalay et al. (2014) and Ramondo et al. (2016) – documented that many vertically integrated units ship surprisingly little to one another. Both papers interpreted these patterns as evidence that vertical integration may primarily facilitate knowledge transfer, coordination, and the exchange of intangibles, rather than the flow of physical goods. More recent work using data on buyer-supplier networks or transactions, however, paints a different picture. Alfaro, Conconi, Kamal and Kroff (2025), combining linked U.S. Census-customs-BEA records, show that once survey measurement error is corrected, input-output linkages strongly predict both the probability and intensity of parent-affiliate trade. Using establishment-level shipment data, Garg et al. (2023) show that in one single Indian state, vertically integrated upstream manufacturing plants supply a large fraction of downstream plants' inputs. Focusing on large Korean firms and their self-reported transactions with unrelated and related suppliers, Hong (2023) documents that related-party trades are pervasive among Korean manufacturing firms, and that standard IO-based proxies capture only a small portion of these transactions.

Relative to this growing body of work, our paper makes two contributions. First, we provide the economy-wide evidence on how direct ownership linkages between map into buyer-supplier transactions in both directions. Our data covers large and small firms in a large, developed economy (Japan) and includes both manufacturing and services firms. We complement earlier work by documenting that a large fraction of firms transact within the firm. We show that, if we ignore forward integration (buying from related parties) or focus only on links between firms in vertically related industries defined by the aggregate input-output table, we will understate the prevalence of trade within ownership networks.

Second, and more importantly, we show that ownership networks shape production networks not only through direct transactions but also through sharing of supplier/buyer networks. Atalay et al. (2014) and Ramondo et al. (2016) emphasize the role of ownership structure in facilitating the transfer of intangible assets such as information, reputation, and coordination capabilities. Using both cross-sectional descriptive statistics (benchmarked against random matching) and panel data regressions with firm-pair fixed effects, we document that firms are significantly more likely to adopt suppliers and buyers that are already used by other firms within the business group. Taken together, our results show that ownership networks generate value not only by structuring direct input flows but also by facilitating

the diffusion of supplier and customer knowledge across related firms.

# 2 Data

Our empirical analysis relies on firm-level data from Tokyo Shoko Research (TSR) Ltd., covering the period 2006-2014. TSR is a private credit reporting company. Firms provide their information to TSR for obtaining credit reports on potential suppliers and customers or when attempting to qualify as a supplier. The information consists of basic firm-level characteristics (such as credit score, sales, and employment), the identities of the firm's buyers and suppliers, as well as the firm's major shareholders. The data has been used elsewhere for studying production networks and firm performance (see Bernard et al. (2018), Carvalho, Nirei, Saito and Tahbaz-Salehi (2021b)).

Each firm reports its sales, the number of employees, four-digit JSIC industry classification, and location. The unique feature of the TSR data comes from the information on transaction partners and shareholders. Firms report their top suppliers and top buyers, both up to 24 firms. To avoid this cutoff from limiting the coverage of the production network, we use both self-reported and other-reported information for each firm in the data to maximize the number of buyer-supplier links. Since a relationship with a buyer or supplier can be reported by either end of a relationship, the number of buyers (suppliers) of a supplier (buyer) can be much greater than 24.

The TSR dataset has two modules that provide information about subsidiary-owner linkages: the company information module and the ownership link module. In the company information module, each firm reports its shareholders, including both companies' and individuals' names in Japanese characteristics. In contrast, the ownership link module only includes company shareholders with a unique identifier (company ID) for each shareholder. In addition, the set of shareholders in the ownership link module is not a strict subset of those reported in the company information module. According to TSR, the names of major shareholders are listed in descending order of holdings, and up to 56 characters are provided. For some firms, due to a large number of shareholders, some shareholders are omitted from the major shareholder names in the company information module due to the character limit. But these shareholders are included in the ownership link module. Therefore, we can use the joint set of shareholders that appear in both data modules to identify important shareholders.

We use the following procedures to identify major company shareholders. First, we merge the list of shareholders in the company information and ownership link modules and keep the shareholders in both modules. Second, we drop financial shareholders. Financial

shareholders are most likely to invest in companies to obtain financial returns (instead of gaining control rights). We identify financial shareholders using two sources of information. We drop shareholders whose first industry code belongs to "Finance and Insurance" (division K, sectors 61-69 in JSIC Revision 11 or division J, sectors 62-70 in JSIC Revision 12 and 13). We then drop shareholders whose names contain an identifier indicating that they are not industrial companies, such as hospitals, investment companies, etc.[6] We provide more details about these selection procedures, including the number of ownership links dropped, in Online Appendix Table A.1.

## 2.1 TSR Coverage

The TSR data contains information on approximately one million firms each year in all sectors of the economy and all 47 prefectures across Japan. Though the TSR data is not a census or a representative survey collected by the government, its coverage is comprehensive. We compare the 2014 TSR data with the 2014 Economic Census for Business Frame, which contains information on 1,750,071 firms. The census is conducted by the Statistics Bureau in the Ministry of Internal Affairs and Communications.[7]

Table 1 reports the distribution of firm size (the number of employees) in the two datasets. As the table indicates, the firm size distribution in the TSR data closely matches that of the census data for firms with five or more employees though it underreports the fraction of very small firms with four or fewer employees. Figure 1 illustrates the industrial composition of firms and employment in the two datasets. Similarly, the distributions of the TSR sample well match those of firms in the Economic Census for Business Frame. The only major differences are in the fraction of firms that are active in the construction sector (top panel) and the number of employees in the construction, wholesale/retail trade, accommodation/restaurant, and medical/health care/welfare sectors (bottom panel).

Table 1: Share of firms by employment size categories: TSR v.s. Census, 2014

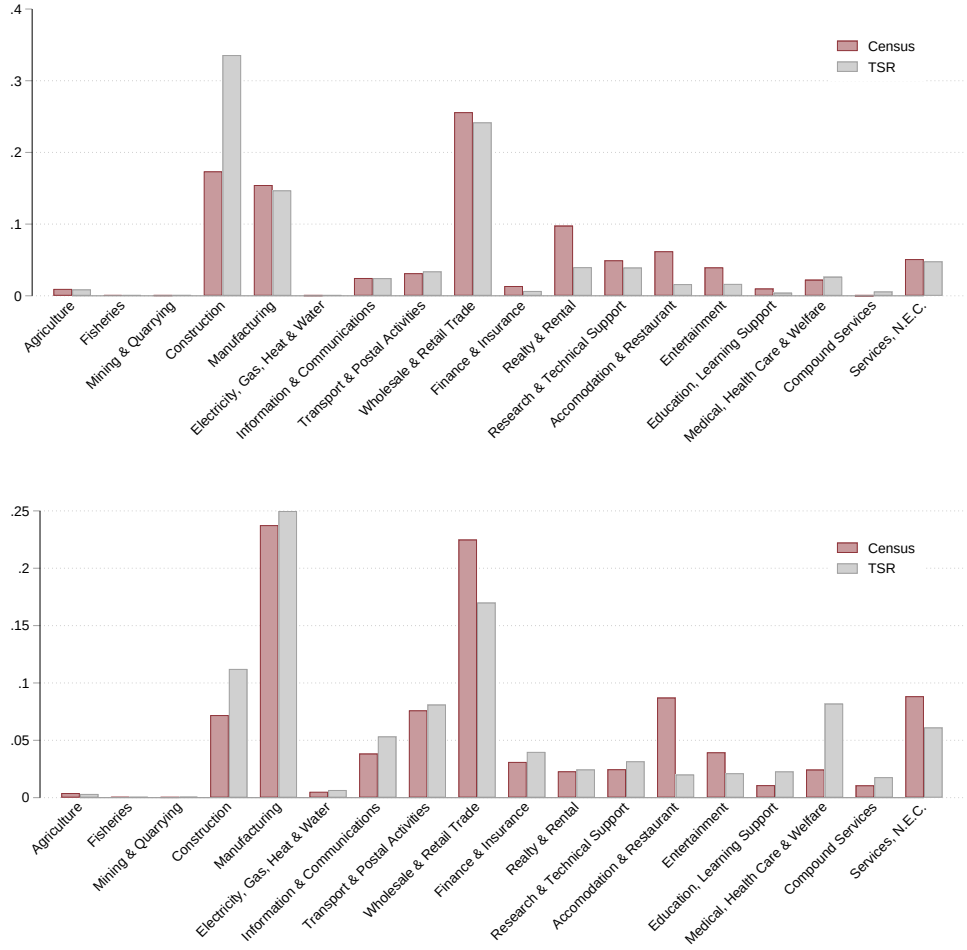
| # Employees | 0-4 | 5-9 | 10-19 | 20-29 | 30-49 | 50-99 | 100-299 | 300-999 | 1000-1999 | 2000+ |
|---|---|---|---|---|---|---|---|---|---|---|
| TSR | 43.4 | 23.7 | 14.7 | 5.6 | 4.9 | 3.8 | 2.7 | 0.9 | 0.1 | 0.1 |
| Census | 56.7 | 17.3 | 12.0 | 4.6 | 3.9 | 2.9 | 1.8 | 0.6 | 0.1 | 0.1 |

Notes. The table reports the share of firms with the number of employees in each of the respective bins. "TSR" refers to the 2014 TSR dataset, and "Census" refers to the 2014 Economic Census for Business Frame.

[6] We drop shareholders whose names contain the following type identifiers:

[7] The data comes from the survey entitled "The Economic Census for Business Frame," which identifies the basic structure of establishments and enterprises. It is available at: https://www.stat.go.jp/english/data/e-census/index.html.

Figure 1: Share of firms and employment by sector, Census v.s. TSR, 2014




Notes. The top panel plots the fraction of firms in each broad industry, and the bottom panel plots the share of employment. "TSR" refers to the 2014 TSR dataset, and "Census" refers to the 2014 Economic Census for Business Frame.

## 2.2 Descriptive Statistics of the Production Network, 2006 TSR

We explore the domestic production network in Japan in Table 2. There are 804,363 buyers and 708,933 suppliers in the TSR production network. The mean number of suppliers is 5.2 and the median is 3. The mean number of buyers is 5.9 and the median is 3. The top buyers (suppliers) have approximately 10,000 suppliers (buyers) in 2006. These results suggest that the distribution of the buyer-supplier links is very skewed, with most of the firms having substantially fewer buyers and suppliers.

Similarly, Figure 2 shows the number of firms by the number of suppliers in panel (a) and by the number of buyers in panel (b). As the figure indicates, the number of suppliers (buyers) is well approximated by a Pareto (power law) distribution, which is also highlighted by Bernard et al. (2018). Many firms only have one supplier or one buyer, and the number

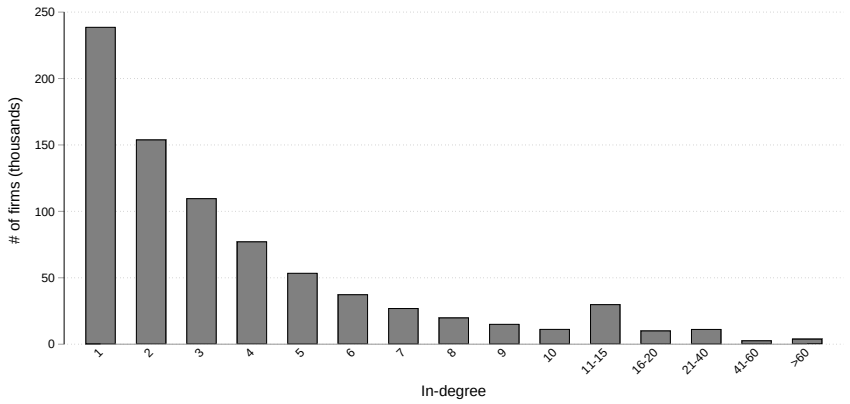
of firms decreases with the number of suppliers and buyers. Importantly, a small number of large buyers have substantially more suppliers than other buyers and vice versa.

Table 2: Summary statistics of number of links of each firm

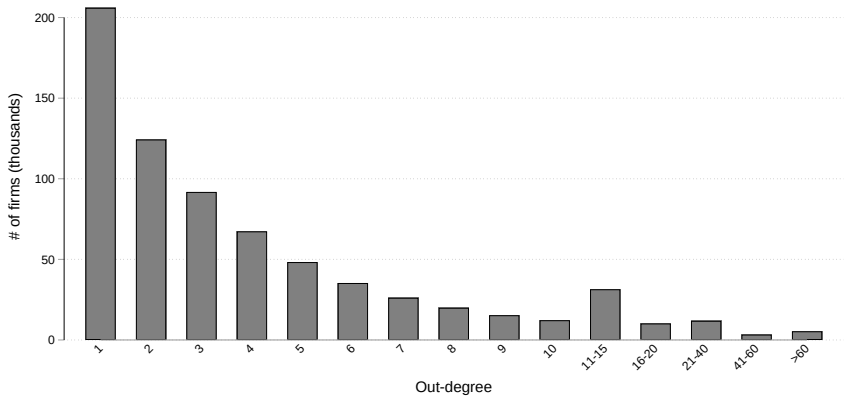
| | N | mean | p10 | p25 | p50 | p75 | p90 | p95 | p99 | max |
|---|---|---|---|---|---|---|---|---|---|---|
| In-degree | 804363 | 5.165 | 1 | 1 | 3 | 5 | 9 | 13 | 36 | 6599 |
| | N | mean | p10 | p25 | p50 | p75 | p90 | p95 | p99 | max |
| Out-degree | 708933 | 5.9 | 1 | 1 | 3 | 5 | 10 | 14 | 48 | 11143 |

Notes. The table reports summary statistics of TSR buyers' numbers of suppliers and TSR suppliers' numbers of buyers. We report mean, max and the 10th, 25th, 50th, 75th, 90th, 95th, and 99th percentiles.

Figure 2: Number of firms with different numbers of suppliers/buyers




(a) By # of suppliers




(b) By # of buyers

Notes. The two panels plot the distribution of the number of suppliers across TSR buyers and the number of buyers across TSR suppliers, respectively.

## 2.3 Descriptive Statistics of the Ownership Network, 2006 TSR

We take a first look at the domestic ownership network in Japan. Table 3 reports the number of firms by the number of owners (major shareholders) in panel A and the number of firms by the number of subsidiaries in panel B. We define a direct owner as a level-one owner (parent) and define an owner of a direct owner as a level-two owner (grandparent). Similarly, we define a direct subsidiary as a level-one subsidiary and define a subsidiary of a direct subsidiary as a level-two subsidiary (grandchild). Overall, being in an ownership network is exceptional. Panel A shows that the majority of subsidiaries only have one direct owner. The share of firms with at least one direct owner is 7.1%. This is also true for firms with both level-one and level-two owners. Similarly, Panel B shows that the majority of owners only have one direct subsidiary. The share of firms with at least one direct subsidiary is 3.9%. This is also true for firms with both level-one and level-two subsidiaries.

Table 3: Number of firms by number of owners or subsidiaries

| **Panel A: by number of owners** | | | | | | | |
|---|---|---|---|---|---|---|---|
| # Owners (lvl 1) | 0 | $\geq 1$ | 1 | 2 | 3 | 4 | $\geq 5$ |
| | 908,000 | 69,600 | 55,600 | 9,000 | 3,000 | 1,200 | 600 |
| # Owners (lvl 1 & 2) | 0 | $\geq 1$ | 1 | 2 | 3 | 4 | $\geq 5$ |
| | 908,000 | 69,600 | 38,200 | 16,700 | 7,400 | 3,400 | 3,800 |
| **Panel B: by number of subsidiaries** | | | | | | | |
| # Subsidiaries (lvl 1) | 0 | $\geq 1$ | 1 | 2 | 3 | 4 | $\geq 5$ |
| | 939,000 | 38,600 | 25,900 | 5,800 | 2,300 | 1,200 | 3,200 |
| # Subsidiaries (lvl 1 & 2) | 0 | $\geq 1$ | 1 | 2 | 3 | 4 | $\geq 5$ |
| | 939,000 | 38,600 | 23,600 | 6,200 | 2,700 | 1,500 | 4,500 |

Notes: panel A reports the number of firms with different numbers of owners, and panel B reports the number of firms with different numbers of subsidiaries. A level-one owner is a direct owner, and a level-two owner is an owner of a direct owner. Similarly, a level-two subsidiary is a subsidiary of a direct subsidiary.

# 3 Prevalence of related buyers/suppliers

We first examine the prevalence of buyer-supplier relationships among firms that are related via ownership. We first focus on "directly related" partners, i.e., partners that belong to the same business group as the focal firm via ownership linkages. Then, we study "indirectly related" partners, i.e., shared buyers/suppliers within the business group.

## 3.1 Directly related partners (vertical integration)

Table 4 reports the probability that a firm-partner pair is also a buyer-supplier pair. In particular, a partner can be a firm that shares a common owner with the focal firm (the focal firm's sibling), a direct owner of the focal firm, and an owner of a direct owner. These three cases correspond to partner owner levels being 0, 1 and 2 in the three columns. Focusing on the middle column, among the 95,523 firm-owner pairs, the partner is a buyer of the firm in 41% of the cases (backward integration) and is a seller to the firm in 37% of the cases (forward integration). In 15% of the cases, the partner is both a buyer and a seller. In total, the majority of the firm-owner pairs, 63%, feature either backward or forward integration.

We also report the prevalence of buyer-supplier relationships among firm-sibling pairs (column 1) and firm-indirect-owner pairs (column 3). There are more than two million possible firm-sibling pairs, and the fraction of pairs with buyer-supplier relationships is low (1.4%). Among firm-partner pairs in which the partners are the indirect owners, 10.6% of them also have a buyer-supplier relationship.

Table 4: Related partners being buyers/suppliers at firm-partner-pair level

| Partner is | Partner Owner Level | | |
|---|---|---|---|
| | 0 (siblings) | 1 (direct owner) | 2 (level 2 owner) |
| Buyer | 0.7 | 40.9 | 6.2 |
| Supplier | 0.8 | 36.8 | 5.6 |
| Buyer/Supplier | 1.4 | 62.5 | 10.6 |
| # Links | 2290896 | 95523 | 41104 |

Notes. Owner level = 1 denotes a firm-partner pair in which the partner is the direct owner of the firm. Owner level = 0 denotes partners that share a common level 1 owner with the focal firm, i.e., the focal firm's siblings. Owner level = 2 indicates that the partner is the firm's owner's owner. For a firm, the sets of siblings, direct owners and indirect owners are mutually exclusive.

Table 5: Probability that any level 0-2 owner is buyer/supplier at the firm level

| | Count links: | | |
|---|---|---|---|
| | IO share $\geq 5\%$ | IO share $\geq 1\%$ | All |
| **Panel A.** Sample: all firms with some level 0-2 owners | | | |
| any partner is buyer | | | 50.6 |
| | | | [99257] |
| any partner is supplier | | | 51.5 |
| | | | [99257] |
| any partner is buyer/supplier | | | 73.9 |
| | | | [99257] |
| any partner is buyer & supplier | | | 28.1 |
| | | | [99257] |
| **Panel B.** Sample: some partner's IO share $\geq 1\%$ | | | |
| any partner is buyer | | 45.3 | 53.8 |
| | | [79973] | [79973] |
| any partner is supplier | | 46.8 | 55.2 |
| | | [81685] | [81685] |
| any partner is buyer/supplier | | 70.0 | 75.2 |
| | | [91363] | [91363] |
| **Panel C.**Sample: some partner's IO share $\geq 5\%$ | | | |
| any partner is buyer | 43.1 | 53.1 | 62.2 |
| | [43860] | [43860] | [43860] |
| any partner is supplier | 35.3 | 51.6 | 60.3 |
| | [54575] | [54575] | [54575] |
| any partner is buyer/supplier | 54.9 | 73.4 | 78.6 |
| | [64199] | [64199] | [64199] |

Notes. This table reports the probability that a firm sells to or buys from the entire set of siblings, direct owners and indirect owners. Owner level 1 denotes a direct owner of the firm. Owner level 0 denotes a sibling of the firm. Owner level 2 denotes the owner of a direct owner.

Next, we aggregate the firm-partner pair level statistics to the firm level. In particular, we calculate the probabilities of firms that sells to or buys from at least one sibling or direct/indirect owners and present them in Table 5. To be consistent with Table 4, we first restrict our sample to firms with at least one owner, since only these firms have a chance to transact with siblings/owners. The firm-level probabilities are in general slightly higher than the pair-level probabilities. For example, the probability of a firm selling to siblings/owners is 50.6%, compared to 47.8% at the firm-partner level (summation of the three probabilities in the first row of Table 4). A similar fraction (51.5%) of firms buy from siblings or owners. 73.9% of firms with an owner transact with at least one of their siblings or owners. Therefore, the majority of firms with owners transact with at least one of their siblings or owners.

We now compare our results to those reported in Atalay et al. (2014). Atalay et al. (2014) use the U.S. Commodity Flow Survey (CFS) and calculate the probability that an establishment ships any products to a zip code where a related downstream establishment exists. They find that only 50.3% of the establishments have a potential internal shipment, and the median establishment ships less than 0.1% of their output to related downstream establishments.[8] Our firm-level probability that any sibling/owner is a buyer is the most

[8]Since in CFS, one does not know whether a shipment to a particular zip code where a related estab-

comparable measure to the probability of internal shipment they calculate (50.3%). However, they restrict their sample to establishments that have at least a related *downstream* establishment, where a downstream establishment is defined to be one in a four-digit SIC industry that accounts for at least 1% of the upstream industry's sales in the 1992 Bureau of Economic Analysis Input-Output Tables. When they drop this restriction, the probability of internal shipment increases to 77.2%. When they increase this threshold to 5%, the probability decreases to 46.1%.

To make our results more comparable to theirs, we restrict our sample to firms that have at least one sibling/owner in a downstream industry.[9] The middle column of Panel B in Table 5 reports that 45.3% of the firms in this restricted sample sell to an internal downstream firm, which is lower than the 50.3% probability reported in Atalay et al. (2014). However, focusing on this statistic may understate the prevalence of vertical integration. In the same column, we show that 46.8% of the firms buy from an internal upstream firm. In total, 70.0% of the firms with some upstream/downstream sibling/owner transact internally. This probability is much higher than the probability when we only focus on selling to downstream siblings/owners.

Other than omitting the other direction of vertical integration (buying from upstream siblings/owners), another reason for a low probability of transacting internally is that we only count links that have an input-output share above a certain threshold in the middle column of Panel B. When we remove this restriction, we see the probability of selling to siblings/owners increases from 45.3% to 53.8%, an 8-percentage-point increase. Input-output tables capture the average relationships between industries, and we may still find firms in industry pairs that have a small input-output share but still have transactions. In addition, firms may expand multiple industries. Using only the top industries reported by the firms cannot fully capture the products they produce and the inputs they purchase. Indeed, when we further restrict IO shares to be larger than 5%, the probability of selling to siblings/owners further decreases to 43.1% (the left column of Panel C), but removing the restriction but focusing on the same sample increases the probability to 62.2%. These patterns are consistent with the results in Atalay et al. (2014): the probability of internal shipment decreases when we increase the input-output share threshold.

lishment is located is indeed sold to the related establishment, we call these "potential internal shipments". They provide an upper bound for the share of actual internal shipments.

[9]We identify a downstream industry if the industry accounts for 5% of the total sales of an upstream industry in the Input-Output Tables in the Japan Industrial Productivity Database 2011 (JIP 2011, see `rieti.go.jp/en/database/JIP2011`). We map the four-digit JSIC industries to the JIP industries using a concordance provided by the JIP database. JIP 2011 contains fewer industries (108) than the US input-output table, so the upstream-downstream relationships may not be as precise.

Table 6: Supplier categories: actual v.s. simulated

| Year | # Supplier links | | | % Suppliers directly related | | | | % Suppliers indirectly related | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | All | Firms with owner | Firms with subsidiary | Also owner | Also subsidiary | Also sibling | Total directly related | Shared with owner | Shared with siblings | Shared with subsidiary | Total indirectly related |
| **Panel A: Actual data** | | | | | | | | | | | |
| 2006 | 4,154,000 | 794,000 | 698,000 | 2.5 | 2.7 | 1.0 | 6.2 | 5.9 | 3.4 | 4.3 | 13.6 |
| 2010 | 4,925,000 | 1,023,000 | 725,000 | 2.3 | 2.5 | 1.1 | 5.9 | 6.1 | 4.2 | 4.2 | 14.6 |
| 2014 | 5,209,000 | 1,098,000 | 909,000 | 2.0 | 2.2 | 1.0 | 5.2 | 5.6 | 4.0 | 3.9 | 13.5 |
| **Panel B: Randomly select suppliers in industry-location cells** | | | | | | | | | | | |
| 2006 | 4,039,000 | 782,000 | 691,000 | 0.2 | 0.3 | 0.2 | 0.7 | 1.2 | 1.8 | 1.0 | 4.0 |
| 2010 | 4,769,000 | 1,005,000 | 715,000 | 0.2 | 0.3 | 0.2 | 0.6 | 1.2 | 1.9 | 0.9 | 4.1 |
| 2014 | 5,047,000 | 1,081,000 | 899,000 | 0.2 | 0.2 | 0.1 | 0.5 | 1.1 | 1.7 | 0.8 | 3.6 |
| **Panel C: Randomly select suppliers in industry-location-labor cells** | | | | | | | | | | | |
| 2006 | 4,039,000 | 782,000 | 691,000 | 0.8 | 0.7 | 0.4 | 1.8 | 2.2 | 2.6 | 1.6 | 6.5 |
| 2010 | 4,769,000 | 1,005,000 | 715,000 | 0.7 | 0.6 | 0.4 | 1.7 | 2.3 | 2.8 | 1.6 | 6.7 |
| 2014 | 5,047,000 | 1,081,000 | 899,000 | 0.6 | 0.5 | 0.3 | 1.5 | 2.0 | 2.5 | 1.4 | 5.9 |

Notes: industry is defined as the suppliers' first four-digit JSIC industries. Location refers to a prefecture. Firm size is measured by employment and is divided into five bins: 1-4, 5-19, 20-49, 50-249, and $\geq$ 250.

Finally, we investigate the importance of ownership in the production network in the cross section. As shown in Panel A of Table 6, TSR reveals more than four million buyer-supplier links in 2006. We restrict our analysis to firm-supplier pairs in which the firm has owners or subsidiaries. Firms with owners have around 794,000 suppliers in total, while including firms with subsidiaries (but without owners) adds another 698,000 supplier links. Among the approximately 1.5 million firm-supplier links, 6.2% of the suppliers are either owners/subsidiaries/siblings of the focal firm, which we label as "directly related".

## 3.2 Indirectly related partners and supplier/buyer sharing

We next present evidence that many of the suppliers are "indirectly related" to the focal firm through the ownership and production networks. In particular, we examine whether the supplier is also a supplier of an owner/sibling/subsidiary of the focal firm. As shown in Table 6, in 2006, 5.9% of the suppliers are also firms' owners' suppliers, while the fraction of suppliers shared with siblings and subsidiaries is 3.4% and 4.3%, respectively. In total, 13.6% of the suppliers are indirectly related.

We compare the actual rate of directly and indirectly related suppliers to a counterfactual production network with random matching. Our concern is that, suppose a firm needs a particular input, and only its subsidiary produces this input, then the probability of using a related supplier is one. Therefore, it would not be surprising that we see a significant fraction of related suppliers. To address this concern, we simulate a production network by randomly allocating suppliers to firms. In particular, we first divide all suppliers in

the TSR data into supplier cells based on their main four-digit JSIC industry and location (prefecture), and randomly select a number of suppliers in the cell to be matched with the firm, keeping the number of suppliers from the cell the same as that observed in the data. For example, if Toyota has three tire suppliers in the Tokyo prefecture, we randomly select three tire producers in Tokyo to match with Toyota in the simulated network. We can then compute the share of related suppliers in the counterfactual network. Panel B of Table 6 shows that the shares of directly and indirectly suppliers are much lower, 0.7% and 4.0%, under the random matching benchmark. If we randomly select suppliers industry-location-employment cells by further restricting firms to select suppliers in the same employment size bins (1-4, 5-19, 20-49, 50-249, $\geq$ 250 employees), the related supplier shares become slightly larger but still much smaller than the observed shares (see Panel C).

Table 7: Buyer categories: actual v.s. simulated

| | # Buyer links | | | % Buyers directly related | | | | % Buyers indirectly related | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | All | Firms with owner | Firms with sub-sidiary | Also owner | Also sub-sidiary | Also sib-ling | Total directly related | Shared with owner | Shared with siblings | Shared with sub-sidiary | Total in-directly related |
| **Panel A: Actual data** | | | | | | | | | | | |
| 2006 | 4,154,000 | 901,000 | 666,000 | 2.7 | 2.3 | 1.0 | 5.9 | 3.3 | 2.8 | 2.5 | 8.6 |
| 2010 | 4,925,000 | 1,100,000 | 690,000 | 2.5 | 2.2 | 1.1 | 5.8 | 3.3 | 3.1 | 2.4 | 8.8 |
| 2014 | 5,209,000 | 1,147,000 | 709,000 | 2.5 | 2.1 | 1.0 | 5.6 | 3.2 | 3.1 | 2.4 | 8.8 |
| **Panel B: Randomly select suppliers in industry-location cells** | | | | | | | | | | | |
| 2006 | 4,039,000 | 528,000 | 230,000 | 0.6 | 0.4 | 0.3 | 1.3 | 0.6 | 1.6 | 0.4 | 2.6 |
| 2010 | 4,769,000 | 611,000 | 267,000 | 0.6 | 0.3 | 0.3 | 1.2 | 0.6 | 1.4 | 0.4 | 2.4 |
| 2014 | 5,047,000 | 630,000 | 283,000 | 0.5 | 0.3 | 0.3 | 1.2 | 0.6 | 1.3 | 0.4 | 2.3 |
| **Panel C: Randomly select suppliers in industry-location-labor cells** | | | | | | | | | | | |
| 2006 | 4,039,000 | 903,000 | 538,000 | 0.7 | 0.7 | 0.4 | 1.8 | 1.2 | 2.3 | 0.9 | 4.4 |
| 2010 | 4,769,000 | 1,070,000 | 588,000 | 0.7 | 0.7 | 0.4 | 1.7 | 1.2 | 2.5 | 0.9 | 4.6 |
| 2014 | 5,047,000 | 1,112,000 | 609,000 | 0.6 | 0.7 | 0.4 | 1.7 | 1.2 | 2.4 | 0.9 | 4.5 |

Notes: industry is defined as the buyers' first four-digit JSIC industries. Location refers to a prefecture. Firm size is measured by employment and is divided into five bins: 1-4, 5-19, 20-49, 50-249, and $\geq$ 250.

Table 7 presents the probability of related buyers among all firm-buyer pairs. Among approximately 1.6 million firm-buyer pairs in 2006 where the firm has at least one owner or subsidiary, 5.9% are directly related, and 8.6% are indirectly related. The observed shares of related buyers are much higher than the simulated shares under the random matching benchmarks in Panels B and C, where the simulated networks are the same as those in Table 6. Atalay et al. (2014) find that establishments acquired by a parent firm start shipping their outputs to zipcodes that the parent firm had been shipping to. With more accurate measures of buyer-supplier relationships, our result that firms tend to sell to buyers who are also their siblings' and owners' buyers confirms and extends the earlier finding in Atalay et al. (2014). Our evidence suggests that, beyond using directly related parties as buyers/suppliers, integration may provide firms with access to related parties' buyer and supplier networks as

an extra benefit.

# 4 Finding Suppliers via Indirect Ownership

In this section, we examine whether firms utilize indirect ownership links to find suppliers. In particular, we examine whether a firm is more likely to use a supplier that is also a supplier of its owner compared to a supplier that is not related through ownership.

We construct a comprehensive firm-supplier-year-level panel that includes all potential firm-supplier pairs from 2006 to 2017. Since TSR data encompasses hundreds of thousands of downstream and upstream firms, constructing a panel data set using all firms and years would far exceed computational limitations. Therefore, we select the motor vehicle production industry as a typical manufacturing industry in the downstream sector.[10] We calculate the number of actual linkages between motor vehicle manufacturing and its upstream industries and select the top supplying industries.[11] Using all firm in the motor vehicle production industry and all suppliers in key upstream industries, we construct an unbalanced panel inclduing all potential buyer-supplier links: we use all years from the first appearance of each firm pair in the dataset to the last appearance in the dataset.

We estimate the following linear probability model:

$$\text{Linked}_{ijt} \times 100 = \beta \text{DirectRelation}_{ijt} + \gamma \text{IndirectRelation}_{ijt} + \delta_{ij} + \delta_t + \epsilon_{ijt}, \tag{1}$$

where $i$ denotes a downstream firm in the motor vehicle production industry, $j$ denotes a potential supplier in the key upstream industries, and $t$ denotes the year. The dependent variable $\text{Linked}_{ijt}$ is an indicator variable that equals one if firm $j$ is an active supplier of firm $i$ in year $t$. We multiply it by 100 to make the coefficients easier to read. The independent variables of interest are $\text{DirectRelation}_{ijt}$ and $\text{IndirectRelation}_{ijt}$. The former is an indicator variable that equals one if firm $j$ is a direct owner (level-one owner) of firm $i$ in year $t$, while the latter equals one if firm $j$ is a supplier of a direct owner of firm $i$ in year $t$. We include firm-supplier pair fixed effects $\delta_{ij}$ to control for time-invariant pair-specific unobserved heterogeneity and year fixed effects $\delta_t$ to control for aggregate time trends. We also present specifications with weaker and stronger fixed effects. Standard errors are

[10] The motor vehicle production industry corresponds to the JSIC code 3011 (in revision 11) or 3111 (in revision 12).

[11] We categorize the number of linkages into 10 quantiles. In our baseline analysis, we select the manufacturing sector of the tenth quantile as the most important upstream industry, excluding 3011/3111 themselves. Using 2007 as the base year, the most important upstream industries include: 2551 and 2552 (tamped and pressed metal products), 2819 (miscellaneous communication equipment and related products), 3012 (motor vehicles bodies and trailers), and 3013 (motor vehicle parts and accessories).

clustered at the firm-supplier pair level.

Table 8: Comparing Directly and Indirectly Related Links, Only for Owners

| **Panel A** | Dep. Var.: Link active in $t$ | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner | 47.209$^a$ | 46.368$^a$ | -3.743 | -3.729 | -3.723 |
| | (7.961) | (7.946) | (3.376) | (3.378) | (3.400) |
| owner's supplier | 7.297$^a$ | 5.408$^a$ | 0.734$^a$ | 0.684$^a$ | 0.159 |
| | (0.350) | (0.339) | (0.215) | (0.216) | (0.214) |
| Cons. | 0.154$^a$ | 0.160$^a$ | 0.181$^a$ | 0.181$^a$ | 0.183$^a$ |
| | (0.003) | (0.003) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 14680953 | 14680953 | 14162763 | 14162763 | 14162763 |
| # of Pairs | 2902819 | 2902819 | 2384629 | 2384629 | 2384629 |
| Within R-squared | 0.012 | 0.008 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.012 | 0.043 | 0.901 | 0.901 | 0.902 |
| **Panel B** | Dep. Var.: Link active in $t+1$ | | | | |
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner | 47.856$^a$ | 47.030$^a$ | -3.582 | -3.575 | -3.691 |
| | (8.277) | (8.267) | (3.177) | (3.179) | (3.193) |
| owner's supplier | 7.745$^a$ | 5.671$^a$ | 0.777$^a$ | 0.751$^a$ | 0.400$^b$ |
| | (0.379) | (0.367) | (0.203) | (0.203) | (0.202) |
| Cons. | 0.172$^a$ | 0.179$^a$ | 0.202$^a$ | 0.202$^a$ | 0.204$^a$ |
| | (0.004) | (0.004) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 11778134 | 11778134 | 11397399 | 11397399 | 11397399 |
| # of Pairs | 2384629 | 2384629 | 2003894 | 2003894 | 2003894 |
| Within R-squared | 0.013 | 0.008 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.013 | 0.045 | 0.918 | 0.918 | 0.919 |

Notes: Standard errors are clustered at the potential firm-supplier pair level. Downstream firms are those in the motor vehicle production industry, while upstream firms are those in the most important upstream industries for motor vehicle production. Industry is defined as four-digit JSIC codes. All the potential links are included. Significance levels: a: 0.01, b: 0.05, c: 0.10.

Panel A of Table 8 reports the results of the above estimation equation. We identify direct relations if the potential supplier is a level-one or level-two owner of the downstream firm $i$. Indirect relations are identified if the potential supplier is also a supplier of a level-one or level-two owner of $i$. In column (1), we control for time fixed effects but not pair fixed effects, therefore the identification mainly relies on the variation *across* different firm pairs. Without direct or indirect relations, the average probability of an active buyer-supplier link is 0.15% (the constant term). Having a direct and indirect relation increases the probability of an active link by 47 and 7 percentage points, respectively. Column (2) further controls for focal firm $i$ and potential supplier $j$ fixed effects, but still relies on cross-pair variation

for identification. The results are similar to those in column (1).

In columns (3)-(5), we include firm-supplier pair fixed effects, and the identification relies on the variation *within* the same firm-potential-supplier pair over time. In column (3), we find that having a direct ownership relation no longer significantly increases the probability of an active buyer-supplier link. This suggests that the high probability of a direct owner being chosen as a supplier is mainly due to the two firms having a high degree of synergy, which fosters a better relationship and increases the likelihood of becoming business partners, either in production or in profit sharing. In contrast, having an indirect ownership relation still significantly increases the probability of an active buyer-supplier link by around 0.73 percentage points, about four times of the baseline probablity of link formation. This suggests that within the same firm pair, if an indirect ownership relation exists, the owner can provide downstream firms with knowledge and information about high-quality suppliers, thereby reducing searching costs and facilitating their ability to find suitable suppliers. The results remain similar when we further control for firm-year fixed effects in column (4). The estimate becomes smaller and statistically insignificant from zero when we include pair, firm-year and potential-supplier-year fixed effects at the same time in column (5).

Indirect relations may have a lagged impact on buyer-supplier link formation. For example, the firm may adopt indirectly related suppliers after their owners have used them for some time. Therefore, in Panel B of Table 8, we use the same regression specification but change the dependent variable to indicate whether the link is active in year $t + 1$. The results are similar to those in Panel A. One notable difference is that the coefficient of indirect relations remains statistically significant even when we include firm-year and potential-supplier-year fixed effects in column (5). This suggests that the effect of indirect ownership relations on supplier choice may take some time to materialize.

Table 9: Comparing Directly and Indirectly Related Links, for Owners/Subsidiaries/Siblings

| **Panel A** | Dep. Var.: Link active in $t$ | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner/subsidiary/sibling | 31.314$^a$ | 30.454$^a$ | 0.012 | 0.043 | 0.140 |
| | (1.572) | (1.540) | (0.725) | (0.725) | (0.715) |
| owner's supplier | 5.011$^a$ | 3.258$^a$ | 0.731$^a$ | 0.680$^a$ | 0.153 |
| | (0.349) | (0.339) | (0.216) | (0.217) | (0.214) |
| Cons. | 0.144$^a$ | 0.150$^a$ | 0.181$^a$ | 0.181$^a$ | 0.183$^a$ |
| | (0.003) | (0.003) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 14680953 | 14680953 | 14162763 | 14162763 | 14162763 |
| # of Pairs | 2902819 | 2902819 | 2384629 | 2384629 | 2384629 |
| Within R-squared | 0.041 | 0.035 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.041 | 0.069 | 0.901 | 0.901 | 0.902 |
| **Panel B** | Dep. Var.: Link active in $t+1$ | | | | |
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner/subsidiary/sibling | 32.122$^a$ | 31.222$^a$ | 0.574 | 0.590 | 0.625 |
| | (1.633) | (1.597) | (0.593) | (0.593) | (0.582) |
| owner's supplier | 5.362$^a$ | 3.438$^a$ | 0.759$^a$ | 0.733$^a$ | 0.381$^c$ |
| | (0.377) | (0.367) | (0.204) | (0.203) | (0.202) |
| Cons. | 0.161$^a$ | 0.168$^a$ | 0.202$^a$ | 0.202$^a$ | 0.203$^a$ |
| | (0.003) | (0.003) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 11778134 | 11778134 | 11397399 | 11397399 | 11397399 |
| # of Pairs | 2384629 | 2384629 | 2003894 | 2003894 | 2003894 |
| Within R-squared | 0.043 | 0.036 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.043 | 0.072 | 0.918 | 0.918 | 0.919 |

Notes: Standard errors are clustered at the potential firm-supplier pair level. Downstream firms are those in the motor vehicle production industry, while upstream firms are those in the most important upstream industries for motor vehicle production. Industry is defined as four-digit JSIC codes. All the potential links are included. Significance levels: a: 0.01, b: 0.05, c: 0.10.

Table 8 only treats owners as directly related firms. As a robustnbess check, in Table 9, we expand the definition of direct ownership to include subsidiaries and siblings as directly related firms. Comparing these directly related firms with indirectly related firms yields results similar to those of the baseline. In the cross-section, both direct and indirect relationships facilitate buyers' choices of a particular firm as their supplier, with the effect of direct relationships being more pronounced. However, within the same firm pair, direct relationships no longer significantly affect the likelihood of one firm becoming another's supplier. In contrast, firms with indirect relationships still have a significantly higher probability of being selected as suppliers by downstream firms. In Table B.2, we add the three direct relationships to the regression separately. The coefficients of indirect relationships are

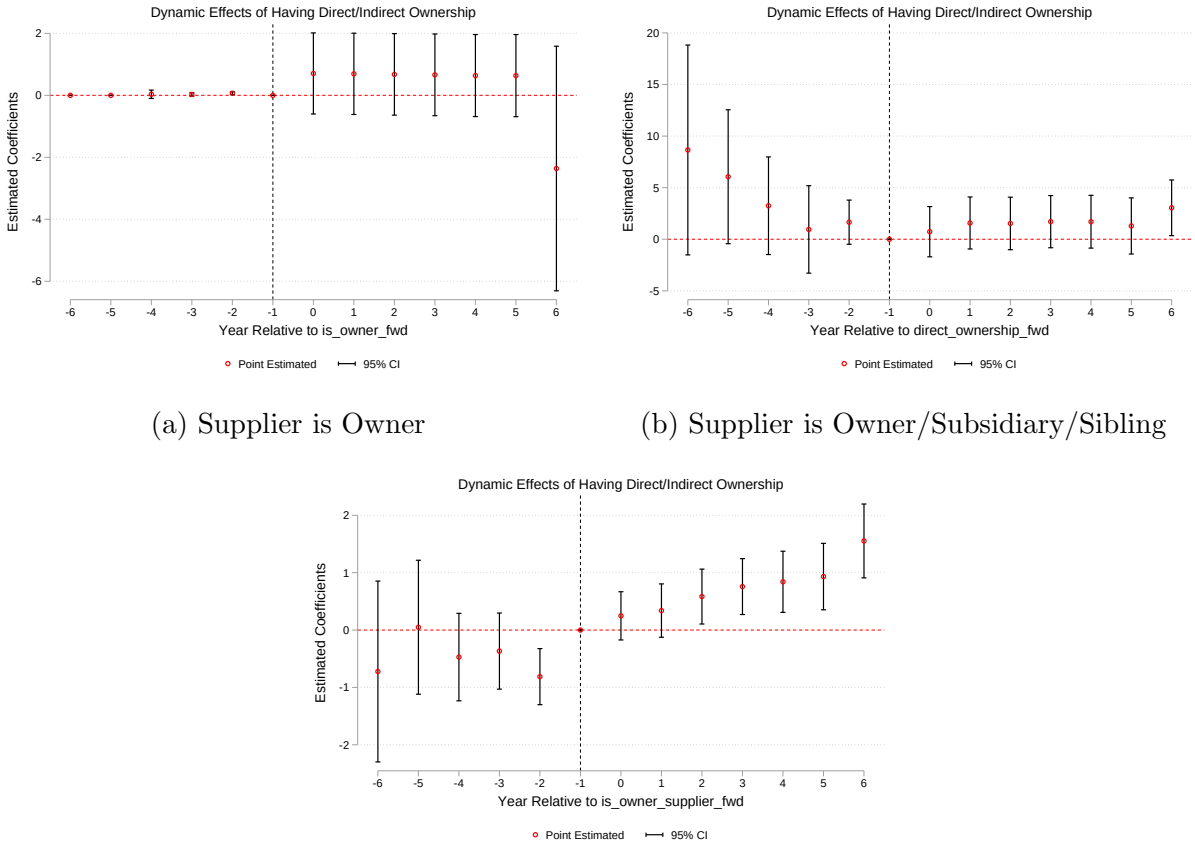
similar.

In equation (1), the direct and indirect relationship indicators can be "on-and-off", i.e., they can change from zero to one and back to zero over time. However, we may expect that once a direct or indirect ownership relationship is established between two firms, it is likely to have a persistant effect on the formation of buyer-supplier links. Therefore, we next examine the dynamic impact of the first establishment of direct and indirect ownership relationships on buyer-supplier link formation. We estimate the following staggered difference-in-differences specification:

$$\text{Linked}_{ijt} \times 100 = \sum_{k=-K, k\neq -1}^{K} \beta_k \mathbb{1}\left(t = E_{ij} + k\right) + \delta_{ij} + \delta_t + \epsilon_{ijt}, \tag{2}$$

where $E_{ij}$ denotes the year when either a direct or indirect ownership relationship is first established between firm $i$ and potential supplier $j$. The indicator variable $\mathbb{1}\left(t = E_{ij} + k\right)$ equals one if year $t$ is $k$ years away from the event year $E_{ij}$. We include firm-supplier pair fixed effects $\delta_{ij}$ and year fixed effects $\delta_t$. Standard errors are clustered at the firm-supplier pair level. We set $K = 6$ in our analysis, and use $k = -1$ as the omitted category.

Figure 3: Effects relative to time




(a) Supplier is Owner

(b) Supplier is Owner/Subsidiary/Sibling

(c) Supplier is Owner's Supplier

Notes: To ensure perfect collinearity across time periods, in the dynamic effects analysis, we allow that once a direct or indirect ownership relationship exists between two firms, that relationship is maintained in every subsequent period. However, the activity of buyer-supplier linkage remains consistent with the original data. The fixed effects included in the dynamic analysis are consistent with the fourth column of the regression table: pair fixed effects and firm-year fixed effects.

Figure 3 presents the estimation results from specification (2). Panels (a) and (b) show that being directly related firms does not significantly increase the likelihood of establishing a buyer-seller linkage. However, panel (c) shows that once an indirect connection exists between firms, buyers are more likely to choose the owner's supplier in subsequent business. This effect persists for years and gradually strengthens, demonstrating that knowledge derived from indirect ownership relationships is persistent.

# 5 Conclusion

In this paper, we use data on both buyer-supplier and owner-subsidiary links between Japanese firms to characterize the interconnection between production and ownership net-

works. In the cross-section, we find that the majority of the owner-subsidiary links are also buyer-supplier links, highlighting the role of goods or services transactions in vertical integration. In addition, we find that firms are more likely to use buyers/suppliers that are already used by related parties, suggesting that firms under the same ownership umbrella share information and reputation concerning suppliers/buyers. This provides an additional channel through which ownership networks affect production networks. Overall, our findings highlight the importance of ownership networks in shaping production networks.

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# Online Appendix - Not for Publication

## A Additional Data Description

Table A.1: Owner statistics in selected years, based on matched Link-level and Company Info Data

| Year | # Firms | # Links | # Links not company | # Link + not FIRE | # Links only in link data | # Links matched | # Links with share | Type: Perc | Type: # Shares | No Info | > 10% | > 25% | > 50% |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 2006 | 94636 | 281284 | 5487 | 40373 | 49274 | 115587 | 98593 | 0.564 | 0.346 | 0.091 | 0.813 | 0.564 | 0.333 |
| 2010 | 109479 | 324071 | 5744 | 42360 | 64374 | 124054 | 105624 | 0.578 | 0.315 | 0.107 | 0.815 | 0.571 | 0.345 |
| 2014 | 112941 | 320228 | 5541 | 41960 | 60172 | 131454 | 110562 | 0.592 | 0.299 | 0.109 | 0.817 | 0.583 | 0.360 |

Notes. We identify shareholders that are not industrial companies if their names contain the following type identifier in Japanese: We identify FIRE shareholders if their first industry code belongs to "Finance and Insurance" (division K, sectors 61-69 in JSIC Revision 11 or division J, sectors 62-70 in JSIC Revision 12 and 13).

We merge the link-level and company-info data at the firm-shareholder level, using firm ID and shareholder names. We drop firms that appear exclusively in the company-info data. In Table A.1, we see that around 95,000 firms appear in the link-level data in 2007. They have 281,000 links in total, according to both datasets. Around 49,000 appear only in the former, 116,000 in both and 116,000 only in the latter. Among the matched links, around 10% do not have information on owners' shares. Among those with share information, the majority of the links feature a share above 25%. However, it is difficult for us to assess the importance of the 49,000 links that appear only in the link data.

## B Additional Empirical Results

Table B.2: Comparing Non-exclusive Related Types

| **Panel A** | Dep. Var.: Link active in $t$ | | | | |
|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner | 45.949$^a$ | 45.256$^a$ | -3.656 | -3.647 | -3.659 |
| | (8.131) | (8.128) | (3.387) | (3.389) | (3.409) |
| supplier is subsidiary | 45.214$^a$ | 43.783$^a$ | 0.956 | 0.970 | 0.973 |
| | (2.229) | (2.192) | (1.116) | (1.115) | (1.098) |
| supplier is sibling | 10.430$^a$ | 10.211$^a$ | -1.057 | -1.003 | -0.759 |
| | (1.826) | (1.778) | (0.900) | (0.900) | (0.890) |
| owner's supplier | 6.362$^a$ | 4.578$^a$ | 0.760$^a$ | 0.709$^a$ | 0.178 |
| | (0.335) | (0.325) | (0.216) | (0.217) | (0.215) |
| Cons. | 0.140$^a$ | 0.146$^a$ | 0.181$^a$ | 0.181$^a$ | 0.183$^a$ |
| | (0.003) | (0.003) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 14680953 | 14680953 | 14162763 | 14162763 | 14162763 |
| # of Pairs | 2902819 | 2902819 | 2384629 | 2384629 | 2384629 |
| Within R-squared | 0.050 | 0.043 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.050 | 0.077 | 0.901 | 0.901 | 0.902 |
| **Panel B** | Dep. Var.: Link active in $t+1$ | | | | |
| | (1) | (2) | (3) | (4) | (5) |
| supplier is owner | 46.399$^a$ | 45.745$^a$ | -3.608 | -3.604 | -3.734 |
| | (8.474) | (8.479) | (3.177) | (3.179) | (3.191) |
| supplier is subsidiary | 45.614$^a$ | 44.127$^a$ | 0.916 | 0.922 | 0.907 |
| | (2.278) | (2.238) | (0.824) | (0.824) | (0.808) |
| supplier is sibling | 11.045$^a$ | 10.817$^a$ | 0.251 | 0.282 | 0.405 |
| | (1.954) | (1.901) | (0.821) | (0.821) | (0.809) |
| owner's supplier | 6.736$^a$ | 4.777$^a$ | 0.770$^a$ | 0.743$^a$ | 0.389$^c$ |
| | (0.363) | (0.353) | (0.204) | (0.204) | (0.203) |
| Cons. | 0.156$^a$ | 0.164$^a$ | 0.202$^a$ | 0.202$^a$ | 0.203$^a$ |
| | (0.003) | (0.003) | (0.001) | (0.001) | (0.001) |
| Year FE | Y | Y | Y | | |
| Firm FE | | Y | | | |
| supplier FE | | Y | | | |
| Pair FE | | | Y | Y | Y |
| Firm-year FE | | | | Y | Y |
| supplier-year FE | | | | | Y |
| $N$ | 11778134 | 11778134 | 11397399 | 11397399 | 11397399 |
| # of Pairs | 2384629 | 2384629 | 2003894 | 2003894 | 2003894 |
| Within R-squared | 0.051 | 0.044 | 0.000 | 0.000 | 0.000 |
| R-squared | 0.051 | 0.080 | 0.918 | 0.918 | 0.919 |

Notes: Standard errors are clustered at the potential firm-supplier pair level. Downstream firms are those in the motor vehicle production industry, while upstream firms are those in the most important upstream industries for motor vehicle production. Industry is defined as four-digit JSIC codes. All the potential links are included. Significance levels: a: 0.01, b: 0.05, c: 0.10.