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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, thus highlighting the role of goods or services transactions in vertical integration. In addition, we find that firms are more likely to engage with buyers/suppliers that have already been used by related parties, thereby suggesting an indirect benefit of integration. Finally, we show evidence that more capable firms are more likely to integrate buyers/suppliers conditional on the number of buyers/suppliers. As firms grow, however, they rely less on related buyers/suppliers and more on unrelated ones.

Keywords: production network, ownership network, firm dynamics
JEL classification: D22, D85, F14, L14, L22, L23

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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) and Hart and Moore (1990)), while the second one presents the argument that integration is associated with the transfer (or redesigning) of 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), and 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 in the provision of evidence to support some of such theories.[2] Herein 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 Tokyo Shoko Research (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 number of suppliers/buyers is approximately 0.71/0.8 million. This part of the TSR dataset has been widely used by various researchers by now.

An under-studied part of the TSR dataset is its information on firms' ownership struc-

[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.

ture. 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, and (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, approximately 7% (4%) of the firms have at least one owner (subsidiary). Most of such firms have only one owner (or subsidiary).

The first set of facts we uncover is the coexistence of the production and ownership linkages. 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] Such 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 summary, this new finding using the Japanese data substantiates the importance of firm-boundary in determining goods transaction.[4]

We next investigate whether the probability of a partner (via either direct or indirect ownership linkage) firm's being a supplier/buyer of the focal firm is far from being random.[5]. We first restrict our analysis to firm-supplier pairs in which the firm has owners or subsidiaries and find that 6% and 14% of them are either directly or indirectly related via

[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]Indirect ownership linkage means that the supplier/buyer is also a supplier/buyer of an owner/sibling/subsidiary of the focal firm

the ownership linkage. Next, we calculate the probability of selecting the partner as the supplier in a counterfactual production network with random matching. We find that the (hypothetical) probabilities (around 1.5% and 6%) of selecting the partner as the supplier in this counterfactual world are much smaller than the actual probability found from the data. This suggests that (1) firms linked via ownership have a higher probability of making transactions, (2) and firms under the same ownership umbrella are more likely to choose the same supplier(s).[6] The second implication here echos the argument made in Atalay et al. (2014) that the ownership linkage facilitates the transfer of intangibles (e.g., information of buyers/sellers or reputation of doing business with suppliers/buyers) within the firm.

We examine whether the related (via ownership linkage) suppliers/buyers differ from the unrelated ones. We explore the variation across suppliers within a particular firm by controlling the firm fixed effects. We find that the related suppliers are on average larger and more credit-worthy (i.e., more capable), and especially so for suppliers that are also an owner/sibling of the focal firm.[7] The only exception we find is that suppliers that are also subsidiaries of the focal firms tend to have fewer buyers than an unrelated supplier, probably because integrated suppliers specialize in producing customized products for their parent firms. Interestingly, we find that related suppliers, especially those directly related ones, are closer to the focal firms than the unrelated ones, which is consistent with the view that proximity facilitates investment within the firm boundary (Giroud, 2013; Campante and Yanagizawa-Drott, 2018).

Finally, we examine firm heterogeneity in using related buyers and suppliers. A key measure we use is the share of (directly) related buyers/suppliers in the full set of buyers/suppliers of the focal firm.[8] We document that firms with at least one owner or subsidiary are larger than those without. We also find that firms using related buyers/sellers tend to be larger, older and have more suppliers (and buyers) than firms that do not. However, we observe a strong negative relationship between the share of related buyers/suppliers and the above four outcome variables, when we zoom into the sample of firms with at least one directly-related supplier/seller. This is because bigger firms have a larger set of suppliers/buyers, while the number of related suppliers/buyers does not increase with firm size as fast as the number of unrelated suppliers/suppliers.

In order to shed light on how supplier/buyer networks coupled with the ownership network evolve over the firm's life cycle, we estimate the elasticity of the number of related (and all)

[6]The same pattern holds for the firm-buyer pairs in which the firm has owners or subsidiaries.

[7]Although we cannot divide the transaction links into goods and services. Morikawa (2019) finds that the productivity of firms that export services beyond the boundary of their firm groups is higher than that of those that export services only to their affiliate firms.

[8]Note that for firms without any owners/subsidiaries, this share is zero by construction.

suppliers/buyers with respect to firm size using the Poisson pseudo maximum likelihood (PPML) method with firm fixed effects. We find that the elasticity of the number of all suppliers/buyers with respect to firm sales is much larger than that of the number of directly-related suppliers/buyers, and especially so when we focus on the sample of firms with at least one directly-related supplier/buyer. This finding substantiates the point that when firms are young, they rely more on directly related suppliers/buyers. However, they start to search and get access to unrelated suppliers/buyers when they grow.

Our paper contributes to the literature on firm boundary (i.e., integration v.s. outsourcing) in two ways. First, we study the dynamic pattern of integration v.s. outsourcing over the firm's *life cycle* and find that the role played by integrated suppliers/buyers diminishes when the firm ages. Next, we complement the work on firm boundary and the flow of intangibles (e.g., Atalay et al. (2014)) by substantiating a specific channel through which firms under the same ownership umbrella share information and reputation concerning suppliers/buyers. Finally, existing research such as Atalay et al. (2014) and Ramondo et al. (2016) focuses on goods transfers and the manufacturing sector, while our empirical work covers both manufacturing and service sectors.

This paper is also related to the literature on production networks (e.g., Bernard, Moxnes and Saito (2018), Carvalho, Nirei, Saito and Tahbaz-Salehi (2021), Dhyne, Kikkawa, Mogstad and Tintelnot (2021) and Matsuura, Ito and Tomiura (2023)). While most papers in this literature focus on how trade costs (e.g., distance and tariffs etc.) and supply/demand shocks affect the formation of the production network, we show that the ownership network also plays a role in determining the supplier-buyer relationship.

Finally, this article sheds light on how firms grow their pool of suppliers and customers. Recent work by Sterk, Sedláček and Pugsley (2021) shows that ex-ante heterogeneity among startups is an important factor that determines how firms grow. Our finding that young firms rely disproportionately more on suppliers/buyers under the same ownership umbrella helps explain why some young firms grow faster than others consistently. Specifically, spin-offs and new affiliates of large corporations might have growth advantage ex ante, as they are inherited with a large set of related suppliers/buyers (via ownership) which they can choose from.[9]

[9]Bernard, Dhyne, Magerman, Manova and Moxnes (2022) shows that the key determinant of firm heterogeneity is the quality and size of the firm's customer base.

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 have been used elsewhere for studying production networks and firm performance (see Bernard et al. (2018), Carvalho et al. (2021)).

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. As 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, who 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.[10] 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, which contains information on 1,750,071 firms. The census is conducted by the Statistics Bureau in the Ministry of Internal Affairs and Communications.[11]

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 2014 census. 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

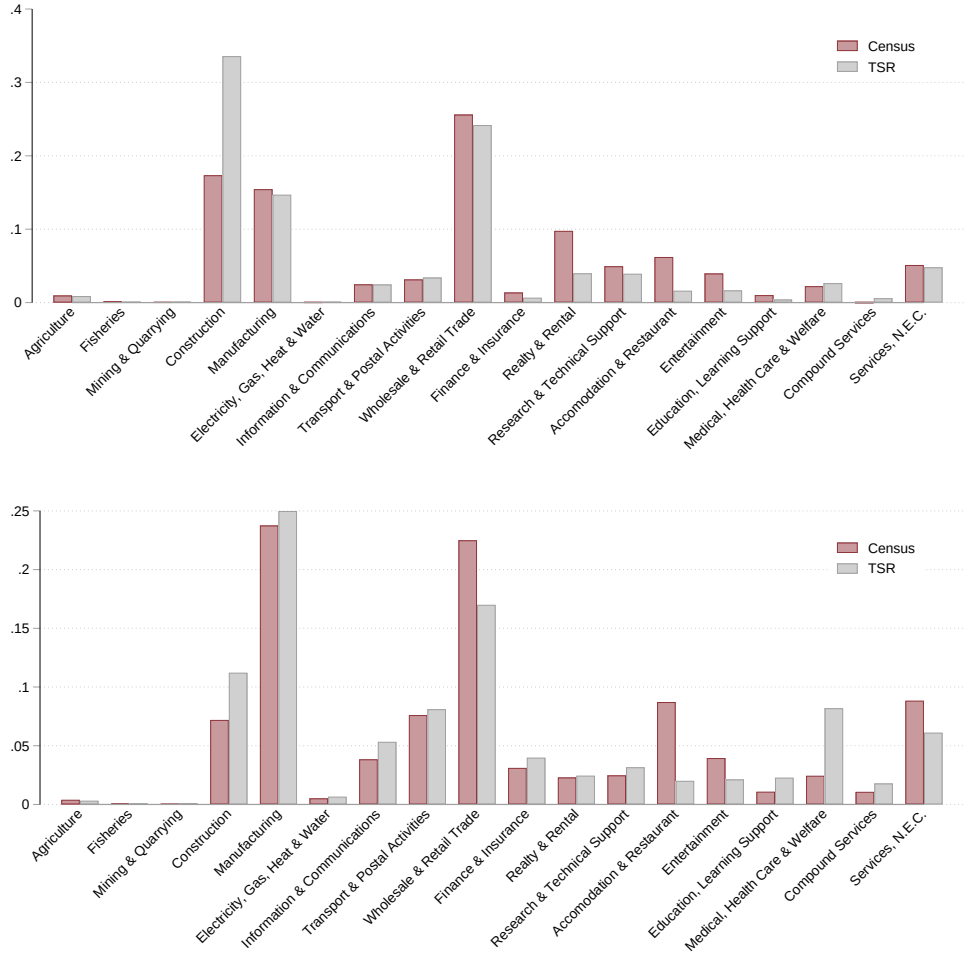
# Employees	0-4	5-9	10-19	20-29	30-49	50-99	100-299	300-999	1000-1999	2000+
TSR	43.4	23.7	14.7	5.6	4.9	3.8	2.7	0.9	0.1	0.1
Census	56.7	17.3	12.0	4.6	3.9	2.9	1.8	0.6	0.1	0.1

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.

[10] We drop shareholders whose names contain the following type identifiers: 医(Healthcare), 特定(NPO), 社福(Social Welfare), 協(Association), 資(Limited Partnership), 財(Foundation), 学(School), 社(Social Welfare), 名(Unlimited Partnership), 農法(Agricultural Corporation), 生協(Co-op), 宗(Religious Corporation), 協業組(Cooperative Partnership), 企組(Co-op), 協組連(Co-op), 監法(Audit Company), 相(Mutual Company), 銀行(Bank), 任意団体(Voluntary Organization), 和, 正, 鳶(Unidentified Social Group), 証券会社(Securities Company) .

[11] 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

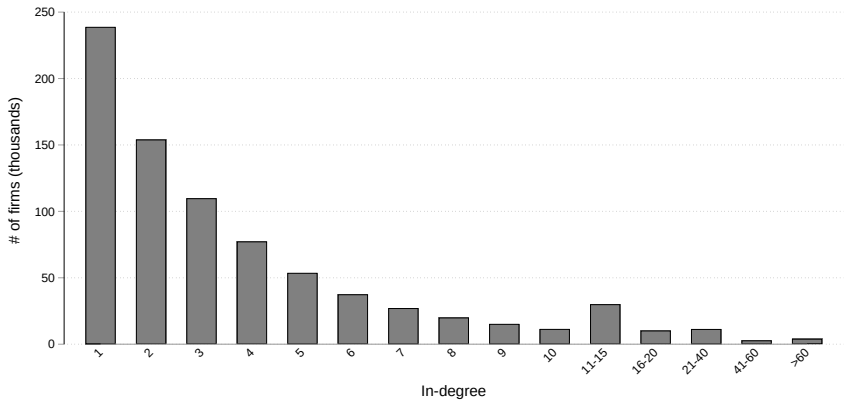
of firms decreases with the number of suppliers and buyers. Importantly, a small number of large buyers have substantially more suppliers than other buyers and vice versa.

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

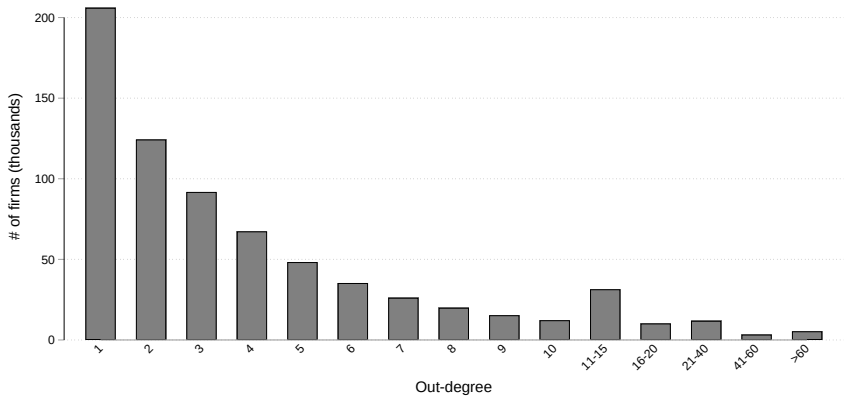
	N	mean	p10	p25	p50	p75	p90	p95	p99	max
In-degree	804363	5.165	1	1	3	5	9	13	36	6599
	N	mean	p10	p25	p50	p75	p90	p95	p99	max
Out-degree	708933	5.9	1	1	3	5	10	14	48	11143

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	≥ 1	1	2	3	4	≥ 5
	908,000	69,600	55,600	9,000	3,000	1,200	600
# Owners (lvl 1 & 2)	0	≥ 1	1	2	3	4	≥ 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	≥ 1	1	2	3	4	≥ 5
	939,000	38,600	25,900	5,800	2,300	1,200	3,200
# Subsidiaries (lvl 1 & 2)	0	≥ 1	1	2	3	4	≥ 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. 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 95,608 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

	Partner Owner Level		
	0	1	2
Partner is buyer	0.007	0.409	0.062
	[2292937]	[95608]	[41160]
Partner is supplier	0.008	0.368	0.056
	[2292937]	[95608]	[41160]
Partner is buyer or supplier	0.014	0.625	0.106
	[2292937]	[95608]	[41160]
Partner is buyer (IO share below 1 pct)	0.005	0.273	0.037
	[2290896]	[95523]	[41104]
Partner is supplier (IO share below 1 pct)	0.005	0.256	0.037
	[2290896]	[95523]	[41104]
Partner is buyer or supplier (IO share below 1 pct)	0.009	0.393	0.062
	[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. The number of firm-partner pairs is reported in the brackets. 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

	All partners	Partners in different JSIC
any partner is buyer, min share 0 pct	0.519	0.413
	[72610]	[65567]
any partner is buyer, min share 1 pct	0.431	0.327
	[61995]	[53951]
any partner is buyer, min share 5 pct	0.409	0.283
	[35612]	[30528]
any partner is supplier, min share 0 pct	0.512	0.407
	[72610]	[65567]
any partner is supplier, min share 1 pct	0.444	0.320
	[62234]	[54383]
any partner is supplier, min share 5 pct	0.291	0.199
	[44557]	[38236]
any partner is buyer or supplier, min share 0 pct	0.754	0.622
	[72610]	[65567]
any partner is buyer or supplier, min share 1 pct	0.696	0.561
	[68555]	[61883]
any partner is buyer or supplier, min share 5 pct	0.504	0.384
	[51627]	[46222]

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 sell to or buy from siblings/owners. The firm-level probabilities are generally higher than the pair-level probabilities. For example, the probability of a firm selling to siblings/owners is 51.9%, compared to 47.8% at the firm-partner level (summation of the three probabilities in the first row of Table 4). Some of the transactions are between firms and partners in the same industry. After we exclude firm-partner pairs that have any overlap in four-digit JSIC industries, the probability of a firm selling to siblings/owners declines to 41.3%.[12]

We now pause and compare our results to those reported in Atalay et al. (2014), who use the U.S. Commodity Flow Survey (CFS) and calculates the probability that an establishment ships any products to a zip code where a related downstream establishment exists. They find that 50.3% of the establishments have a potential internal shipment, but the share of potential internal shipments accounts for 0.1% of the total shipments.[13] Our firm-level probability that any sibling/owner is a buyer is the most comparable measure to their extensive margin probability (50.3%). However, they restrict their sample to establishments that have

[12]In the TSR data, firms report up to three four-digit JSIC industry codes. In Table 5, we treat a firm and its partner (a sibling, a direct owner or an indirect owner) to be in the same industry as long as they share one common industry code.

[13]Since in CFS, one does not know whether a shipment to a particular zip code where a related establishment 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.

at least a related *downstream* establishment, where a downstream establishment is defined to be one in a four-digit JSIC industry that accounts for at least 1% of the upstream industry's sales in the 1992 Bureau of Economic Analysis Input-Output Tables. We also report firm-level probabilities of selling to a related party conditional on the firm having at least one sibling/owner in a downstream industry.[14] Table 5 reports that 43.1% of the firms with at least one downstream sibling/owner sell internally. This fraction is slightly smaller than the reported probability in Atalay et al. (2014). Notably, restricting the sample to firms with downstream siblings/owners decreases the probability of selling to siblings/owners. This is likely due to the imprecision of the input-output table and using industry codes to determine what goods/services a firm produces.

Though the TSR dataset has the advantage of knowing exact buyer-supplier relationships, it does not provide the value or weight of the transactions between firms as in CFS. To gain more insight into the "intensive margins", we rely on the probabilities of related party transactions at the firm-partner pair level. As reported in Table 4, 41% of the firm-owner pairs feature the firm selling to the owner, thereby suggesting that a large fraction of these linkages involves some backward integration.[15] Taking into account forward integration cases in which the firm buys from the owner, the majority (63%) of the firm-owner pairs feature transactions in goods or services.

[14]We identify a downstream industry if it accounts for 1% 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.

[15]However, the transactions with owners may still be small relative to the firms' total sales. Our evidence is not necessarily contradictory to the intensive margin results reported in Atalay et al. (2014).

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	6.4
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	6.0

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 ≥ 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".

Next, we present evidence that many of the suppliers are "indirectly related" to the focal firm. In particular, we examine whether the supplier is also a supplier of an owner/sibling/subsidiary of the focal firm. In 2006, 5.9% of the suppliers are also firms' owners' suppliers, while the fractions of suppliers shared with siblings and subsidiaries are 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 code and location (prefecture), and randomly select a number of suppliers in the cell to be matched with the firm, while 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 related suppliers are much lower, 0.7% and 4.0% respectively, 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, and $\geq$ 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 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	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	530,000	230,000	0.6	0.4	0.3	1.3	0.6	1.6	0.4	2.6
2010	4,769,000	610,000	267,000	0.6	0.4	0.3	1.2	0.6	1.5	0.4	2.5
2014	5,047,000	630,000	284,000	0.5	0.3	0.3	1.2	0.5	1.4	0.4	2.3
Panel C: Randomly select suppliers in industry-location-labor cells											
2006	4,039,000	904,000	539,000	0.7	0.7	0.4	1.8	1.2	2.3	0.9	4.4
2010	4,769,000	1,071,000	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	608,000	0.6	0.7	0.4	1.7	1.2	2.3	0.9	4.4

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 Premium of related buyers/suppliers

In this section, we examine whether related suppliers/buyers are different from unrelated ones.

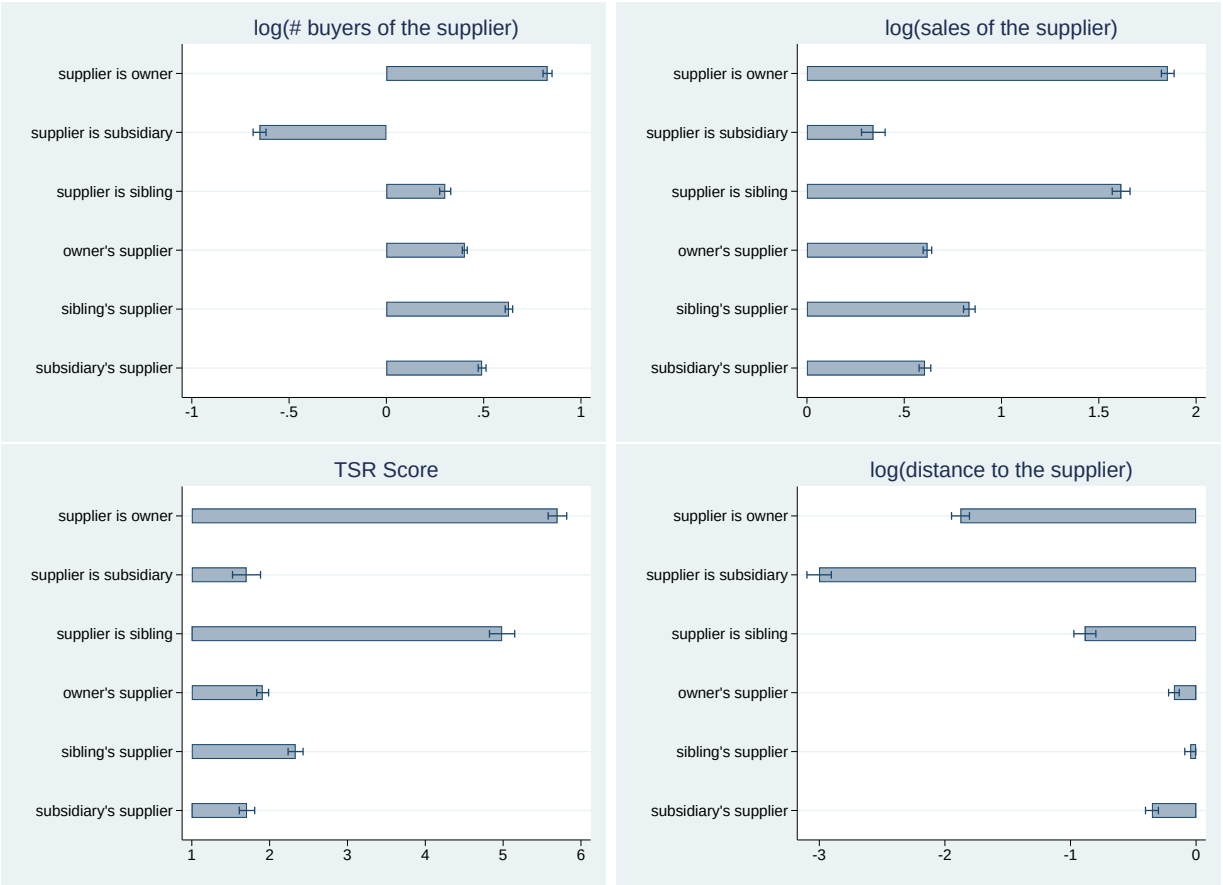
We first examine the variation across suppliers within a particular firm by controlling firm fixed effects in firm-supplier pair level regressions. We classify suppliers into seven mutually exclusive and exhaustive groups: (1) supplier that is also a direct or indirect owner of the firm; (2) supplier that is also a direct or indirect subsidiary of the firm; (3) supplier that is also a sibling of the firm; (4) supplier that is shared with the firm's owners; (5) supplier that is shared with the firm's siblings; (6) supplier that is shared with the firm's subsidiaries; and (7) others. We give priority to earlier groups so that the groups become mutually exclusive.[16] We then regress the outcome variables on indicators of whether a supplier belongs to each of the categories, leaving out "others" as the base group, while controlling for firm, partner industry and partner prefecture fixed effects. The estimated coefficients can be seen as the supplier's "premium" of being directly or indirectly related to the focal firm.

We present the premium estimates for four outcome variables in Figure 3. Directly and indirectly related suppliers are on average more capable, as measured by their total sales or TSR credit score. The largest premium occurs for suppliers that are also an owner/sibling of the focal firm. This is merely a correlation rather than a causal effect – for example, larger firms are more likely to become owners of other firms. We find that directly and indirectly related suppliers also tend to have more buyers, with the exception of suppliers that are also subsidiaries of the focal firm. This may happen if integrated suppliers specialize in producing customized products for their parent firms. Finally, we find that related suppliers, especially directly related ones, are closer to the focal firms than unrelated ones. This is consistent with the view that proximity facilitates investment within the firm boundary (Giroud, 2013; Campante and Yanagizawa-Drott, 2018).

We report the premium of being directly or indirectly related buyers in Figure 4. The results are qualitatively the same as the results for suppliers: related buyers are more capable in terms of sales and TSR credit scores; they have more suppliers except for buyers that are also subsidiaries which seem to be more dedicated and have fewer suppliers compared to unrelated ones; related, especially directly related buyers, are closer to the focal firms than unrelated ones.

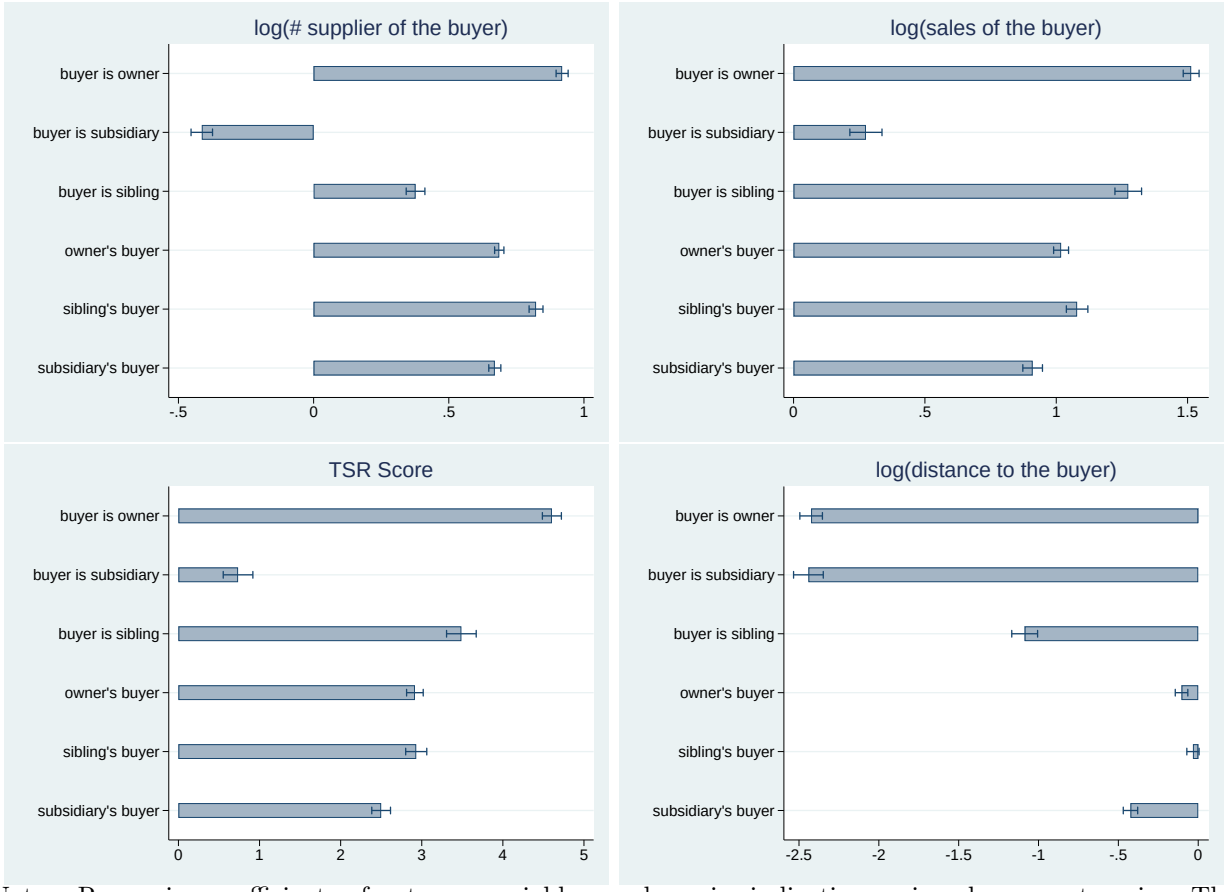
[16] For example, a supplier that is shared with both an owner and a sibling is classified as an "owner's supplier" (category #4 instead of category #5).

Figure 3: Premium of being directly or indirectly related among suppliers



Notes: Regression coefficients of outcome variables on dummies indicating various supplier categories. The sample is firm-supplier pairs, and we restrict firms to have at least one owner or subsidiary. All regressions control for partner prefecture, partner industry and firm fixed effects. Standard errors are clustered at the firm level. The categories are mutually exclusive. Top categories are given priority in the definition. For example, a supplier that is shared with both an owner and a sibling is classified as an "owner's supplier". The base category includes suppliers that do not belong to any of the six categories listed in the figures.

Figure 4: Premium of being directly or indirectly related among buyers



Notes: Regression coefficients of outcome variables on dummies indicating various buyers categories. The sample is firm-buyers pairs, and we restrict firms to have at least one owner or subsidiary. All regressions control for partner prefecture, partner industry and firm fixed effects. Standard errors are clustered at the firm level. The categories are mutually exclusive. Top categories are given priority in the definition. For example, a buyer that is shared with both an owner and a sibling is classified as "owner's buyer". The base category includes buyers that do not belong to any of the six categories listed in the figures.

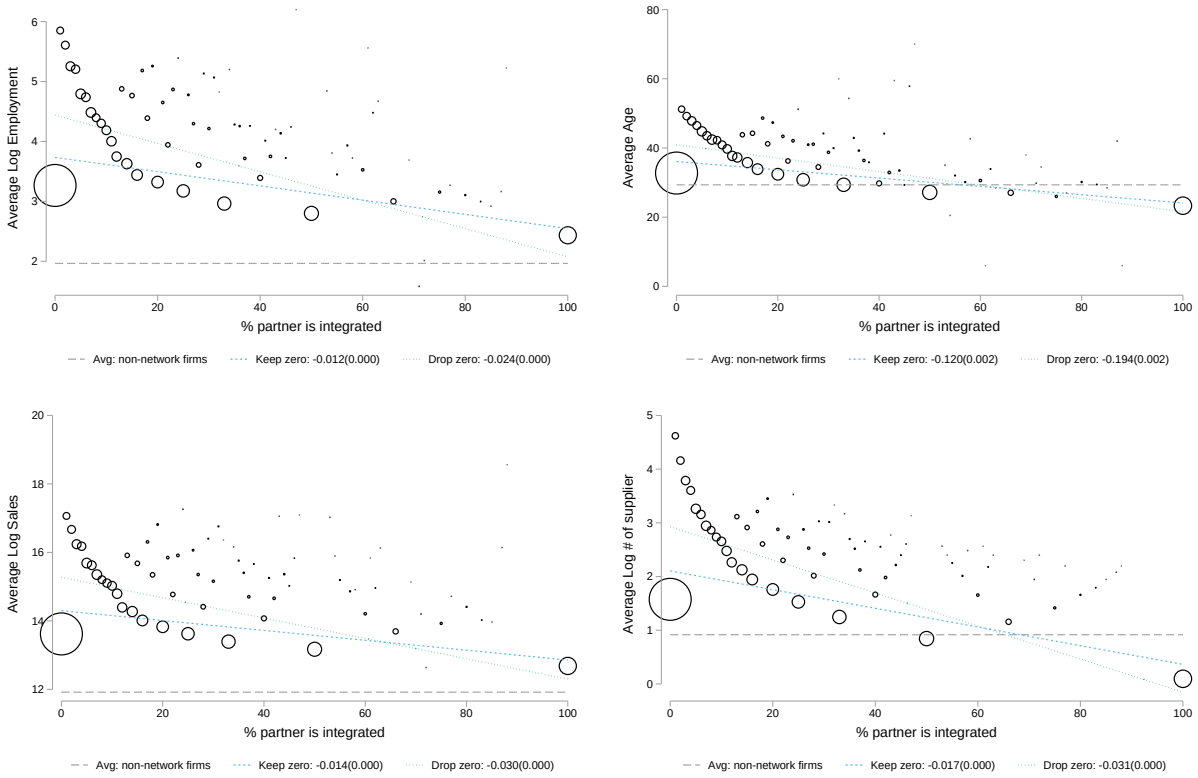
5 Firm heterogeneity in using related buyers/suppliers

In this section, we examine firm heterogeneity in using related buyers and suppliers. In particular, we are interested in whether more capable firms are more likely to use related parties in their production networks. Our results also shed light on firm dynamics.

We measure firms' intensity of using related parties by calculating the shares of buyers/suppliers that are directly/indirectly related. We then relate these shares to various measures of firm capabilities, such as the firm's employment, age, sales and the total number of buyers/suppliers. Note that for firms without any owners/subsidiaries, the shares are by construction zero. We separate them from firms with owners/subsidiaries but still have zero shares of related buyers/suppliers. In Figure 5, we plot the average firm outcome against

the percentage of directly related suppliers. The shares of related suppliers vary from zero to one and often take particular values such as 0%, 50% and 100%, given the discrete nature of the numerator and the denominator. We illustrate the average firm capability of firms without any owner/subsidiaries using a horizontal, dashed line. We find that firms with owners/subsidiaries tend to be larger in employment and sales, older and have more suppliers than firms without owners/subsidiaries, suggesting that more capable firms are selected to become owners/subsidiaries, consistent with the evidence in Section 4.

Figure 5: Firm capability and the share of directly-related suppliers



Notes. We plot the average firm outcome against the percentage share of suppliers that are directly related. The size of the circles is proportional to the number of firms with each particular share of directly-related suppliers. The horizontal dashed line represents the average outcome of firms without any owners/subsidiaries. The regression coefficients are obtained from regressing firm outcomes on the share of directly-related suppliers, controlling for firm industry and prefecture fixed effects. We report regression coefficients (and standard errors) either keeping or dropping firms without directly-related suppliers.

For firms with at least one directly-related supplier, however, there is a very strong negative correlation between all four measures and the share of related suppliers. This negative relationship is so strong that it leads to a negative correlation between the two variables even when we include firms in an ownership network but without any related suppliers. This is largely because larger firms have a larger supplier base and thus have

smaller shares of related suppliers. We find similar evidence for the share of indirectly-related suppliers (see Figure B.1).

Table 8: Having directly-related suppliers on firm characteristics, TSR 2006

Sample	All Firms	In Ownership Network		
	Dependent Var: Log sales			
Has owner/subsidiary	1.810^a			
	(0.006)			
Has related supplier		0.646^a		
		(0.012)		
Share of related supplier			-1.424^a	0.632^a
			(0.021)	(0.020)
Log # of supplier				1.152^a
				(0.004)
Industry FE	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	651741	78461	78461	78461
R^2	0.344	0.254	0.267	0.649
Within R^2	0.150	0.036	0.054	0.547
	Dependent Var: Log employment			
Has owner/subsidiary	1.307^a			
	(0.005)			
Has related supplier		0.478^a		
		(0.010)		
Share of related supplier			-1.174^a	0.445^a
			(0.017)	(0.017)
Log # of supplier				0.907^a
				(0.004)
Industry FE	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	650163	78254	78254	78254
R^2	0.347	0.243	0.262	0.603
Within R^2	0.130	0.029	0.053	0.490

Notes. Each observation is a firm in the 2006 TSR data. Robust standard errors in parentheses. Significant levels: a 0.01, b 0.05, c 0.1.

We examine the relationship between the share of directly-related suppliers and firm sales and employment using regressions in Table 8, controlling for firms' industry and prefecture fixed effects. Among all the firms in the 2006 TSR data, firms with an owner or a subsidiary are 181 log points larger in sales and 131 log points larger in employment. Among firms in an ownership network, having a directly-related supplier is positively associated with firm size, but the share of related suppliers among all the suppliers of the firm is negatively associated with firm size, consistent with patterns in Figure 5. However, when controlling for the total number of suppliers, the share of related suppliers positively predicts firm size. Therefore, the negative correlation between the share and firm capability, especially when conditional on having at least one related supplier, is because larger firms have more suppliers overall, while the number of related suppliers does not grow at the same speed as unrelated suppliers.

To substantiate this point, we estimate the elasticity of the number of different types of suppliers with respect to firm size. In particular, we estimate Poisson regressions of the

Table 9: The impact of firm sales on # of different types of suppliers, PPML, 2006 cross section

Sample	In Ownership Network			Directly-Related Supplier > 0		Indirectly-Related Supplier > 0	
Supplier Type	All	Dir-Rel.	Indir-Rel.	All	Dir-Rel.	All	Indir-Rel.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: firm-level regressions							
Log sales	0.732[a]	0.438[a]	0.744[a]	0.755[a]	0.338[a]	0.751[a]	0.614[a]
	(0.006)	(0.006)	(0.010)	(0.007)	(0.007)	(0.007)	(0.012)
Industry FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	Y	Y
Observations	78461	78382	78253	44822	44822	37090	37090
Pseudo R^2	0.813	0.301	0.616	0.847	0.279	0.845	0.613
Panel B: firm-partner-industry-level regressions							
Log sales	0.251[a]	-0.046[a]	0.277[a]	0.435[a]	0.050[a]	0.392[a]	0.138[a]
	(0.008)	(0.005)	(0.011)	(0.009)	(0.002)	(0.010)	(0.008)
Industry FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	Y	Y
Partner Ind FE	Y	Y	Y	Y	Y	Y	Y
Observations	706655	703532	703708	75307	75307	128068	128068
Pseudo R^2	0.193	0.077	0.136	0.516	0.015	0.431	0.104

Notes. PPML estimation. Each observation is a firm in Panel A, and a firm-supplier-industry combination in Panel B. The dependent variables are the numbers of different types of suppliers. Standard errors are clustered at the firm level. Significant levels: a 0.01, b 0.05, c 0.1.

number of all suppliers, directly-related suppliers and indirectly-related suppliers on firm log sales using pseudo maximum likelihood (PPML). Table 9 reports estimates based on the 2006 TSR data. Panel A uses firm-level data, while Panel B constructs the data at the firm-supplier-industry level so that we can control supplier-industry fixed effects beyond the focal firm's industry and prefecture fixed effects. When focusing on the sample of firms with at least one owner/subsidiary (Columns 1-3 in Panel A), we find that the elasticity of the number of all suppliers with respect to firm sales is much larger than the elasticity of the number of directly-related suppliers. The difference is even larger when we focus on the sample of firms with at least one directly-related supplier (Columns 4-5). Though the elasticity of indirectly-related suppliers is similar to that of all suppliers, as shown in Columns 1 and 3, it becomes smaller when we focus on the sample of firms with at least one indirectly-related supplier (Columns 6 and 7). The elasticities are, in general, much smaller when we estimate them based on firm-supplier-industry-level data, but the differences between unrelated and related suppliers persist (Panel B). Therefore, as firms grow larger, they add more unrelated suppliers than related suppliers, and the difference is more salient when we compare unrelated suppliers with directly-related ones.

In Table 10, we check the robustness of the results reported in Table 9 by using TSR data from all years and constructing a panel data of firms. Each observation is a firm-year combination. In each year, we constrain our sample to firms within an ownership network.

In Columns 1-3, we only control for industry, prefecture and year fixed effects, and we are estimating the elasticity using both within-firm and between-firm variations. We find similar estimates as in Columns 1-3 in Panel A of Table 9, suggesting that firms expand by adding more unrelated suppliers than directly-related suppliers. The elasticities become smaller when we control for firm fixed effects and focus on within-firm, over-time variation. However, there is still a significant difference between the elasticity of the number of all suppliers and the number of directly-related suppliers with respect to firm sales.

Table 10: The impact of firm sales on # of different types of suppliers, PPML Panel Regression

Supplier Type	All	Dir-Rel.	Indir-Rel.	All	Dir-Rel.	Indir-Rel.
	(1)	(2)	(3)	(4)	(5)	(6)
Log sales	0.710^a	0.422^a	0.754^a	0.235^a	0.152^a	0.209^a
	(0.006)	(0.005)	(0.007)	(0.007)	(0.008)	(0.012)
Industry FE	Y	Y	Y			
Prefecture FE	Y	Y	Y			
Firm FE				Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	930278	929977	929836	909880	607576	564851
Pseudo R^2	0.807	0.286	0.639	0.929	0.448	0.827

Notes. PPML estimation. Each observation is a firm-year combination. The dependent variables are the numbers of different types of suppliers. Standard errors are clustered at the firm level. Significant levels: a 0.01, b 0.05, c 0.1.

Note that our results are related but not directly comparable to those in Boehm and Oberfield (2022). Using input data on single-product Indian plants, Boehm and Oberfield (2022) show that plant-level sales are negatively correlated with their vertical spans, a measure of the distance between their inputs and output according to input-output tables. This suggests that more productive plants outsource upstream inputs instead of making them by themselves. We do not attempt to measure the distance between each firm's inputs and outputs, but focus on the fraction of suppliers that are integrated. The share of integrated suppliers may also be different from the share of integrated inputs, as the intensive margins (transaction values) are not captured by our data. On the other hand, we focus on firm-to-firm ownership linkages, but relational transactions between plants are largely ignored in the analysis of Boehm and Oberfield (2022).[17]

We find similar patterns in firms' heterogeneity in using related buyers. We present them in Online Appendix B.

[17]In Table XV of Boehm and Oberfield (2022), they show that the share of inputs sourced from related parties in total material costs is negatively associated with a plant's vertical span. They view the share as a measure of firm capability. This is consistent with our finding that firms in ownership networks are larger.

6 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 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 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. Finally, we show evidence that more capable firms are more likely to integrate buyers/suppliers conditional on the number of buyers/suppliers. As firms grow, however, they rely less on related buyers/suppliers and more on unrelated ones.

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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

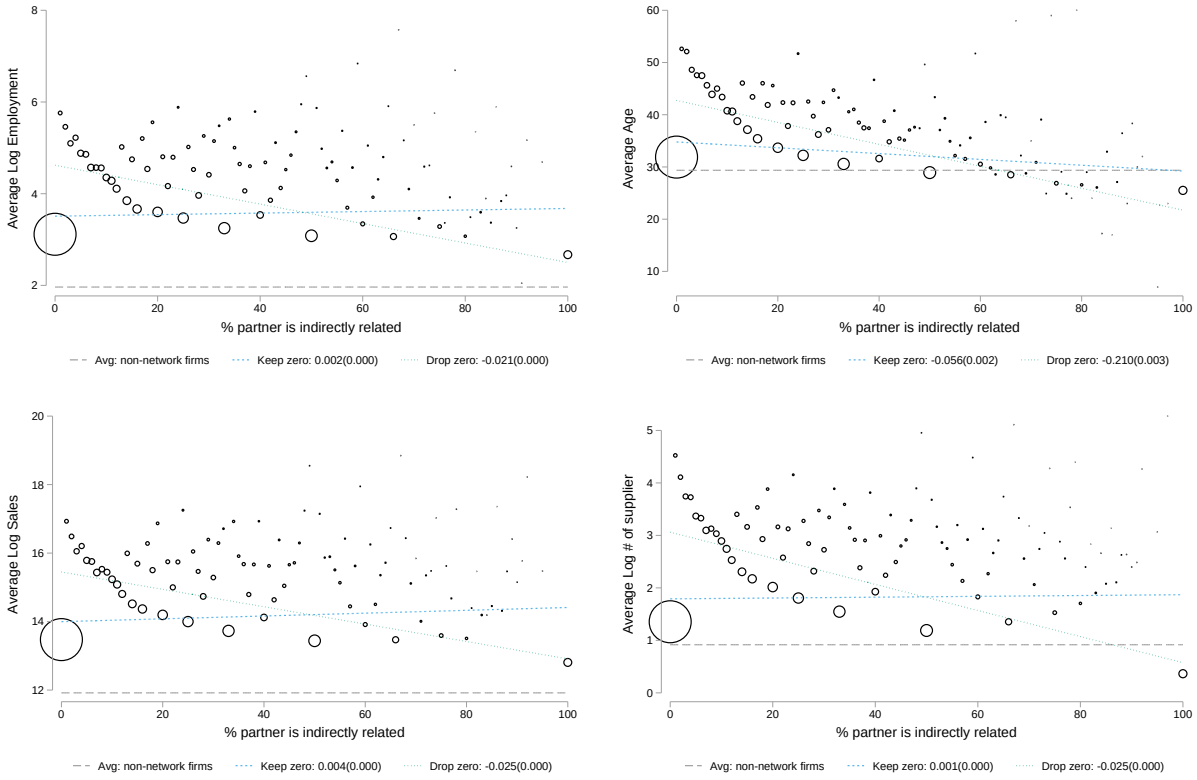
Year	# Firms	# Links	# Links not company	# Link + not FIRE	# Links only in link data	# Links matched	# Links with share	Type: Perc	Type: # Shares	No Info	> 10%	> 25%	> 50%
2006	94636	281284	5487	40373	49274	115587	98593	0.564	0.346	0.091	0.813	0.564	0.333
2010	109479	324071	5744	42360	64374	124054	105624	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: 医(Healthcare), 特定(NPO), 社福(Social Welfare), 協(Association), 資(Limited Partnership), 財(Foundation), 学(School), 社(Social Welfare), 名(Unlimited Partnership), 農法(Agricultural Corporation), 生協(Co-op), 宗(Religious Corporation), 協業組(Cooperative Partnership), 企組(Co-op), 協組連(Co-op), 監法(Audit Company), 相(Mutual Company), 銀行(Bank), 任意団体(Voluntary Organization), 和, 正, 鳶(Unidentified Social Group), 証券会社(Securities Company) . 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.

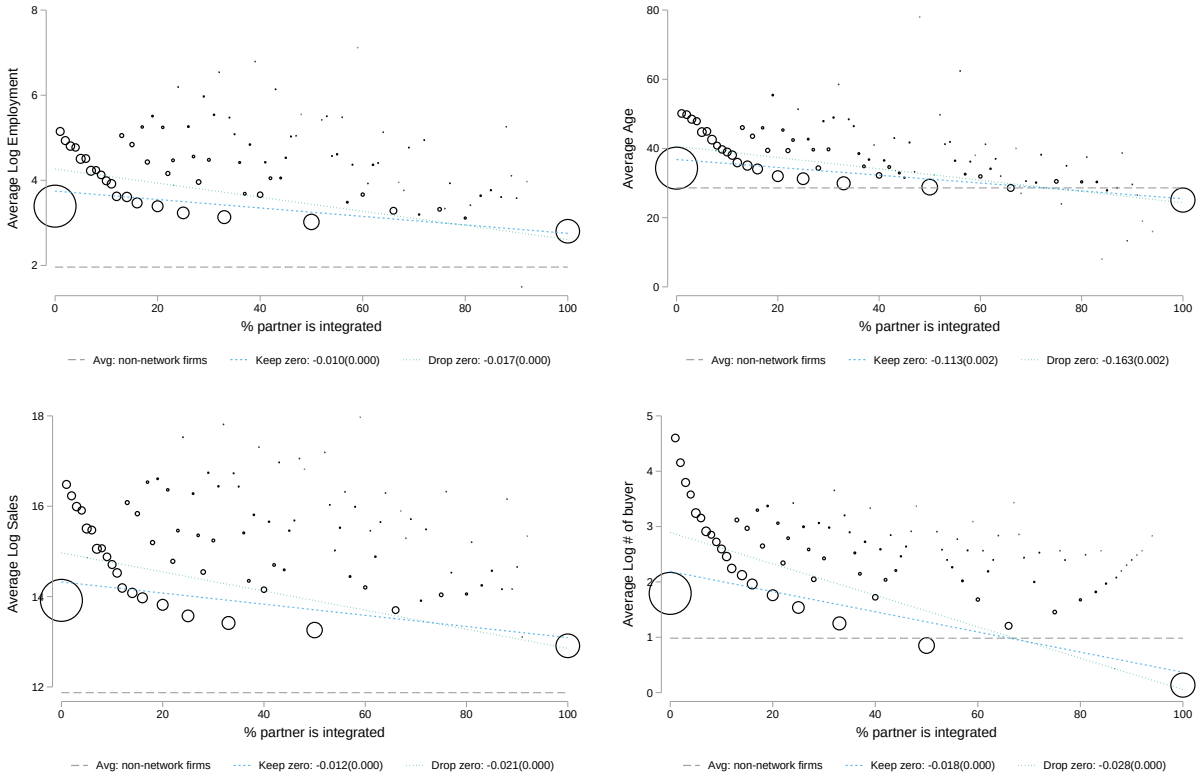
B Additional Empirical Results

Figure B.1: Firm capability and the share of indirectly-related suppliers



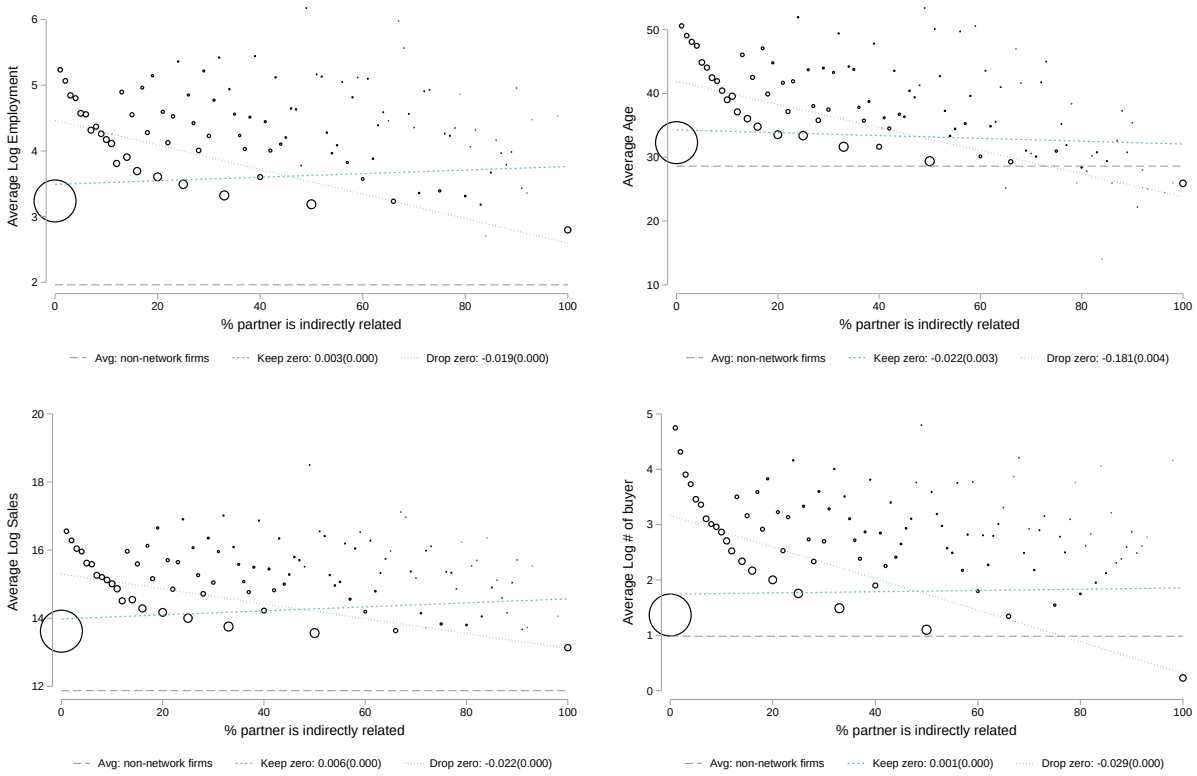
Notes. We plot the average firm outcome against the percentage share of suppliers that are indirectly related. The size of the circles is proportional to the number of firms with each particular share of indirectly-related suppliers. The horizontal dashed line represents the average outcome of firms without any owners/subsidiaries. The regression coefficients are obtained from regressing firm outcomes on the share of indirectly-related suppliers, controlling for firm industry and prefecture fixed effects. We report regression coefficients (and standard errors) either keeping or dropping firms without indirectly-related suppliers.

Figure B.2: Firm capability and the share of directly-related buyers



Notes. We plot the average firm outcome against the percentage share of buyers that are directly related. The size of the circles is proportional to the number of firms with each particular share of directly-related buyers. The horizontal dashed line represents the average outcome of firms without any owners/subsidiaries. The regression coefficients are obtained from regressing firm outcomes on the share of directly-related buyers, controlling for firm industry and prefecture fixed effects. We report regression coefficients (and standard errors) either keeping or dropping firms without directly-related buyers.

Figure B.3: Firm capability and the share of indirectly-related buyers



Notes. We plot the average firm outcome against the percentage share of buyers that are indirectly related. The size of the circles is proportional to the number of firms with each particular share of indirectly-related buyers. The horizontal dashed line represents the average outcome of firms without any owners/subsidiaries. The regression coefficients are obtained from regressing firm outcomes on the share of indirectly-related buyers, controlling for firm industry and prefecture fixed effects. We report regression coefficients (and standard errors) either keeping or dropping firms without indirectly-related buyers.

Table B.2: Having directly-related buyers on firm characteristics, TSR 2006

Sample	All Firms	In Ownership Network		
	Dependent Var: Log sales			
Has owner/subsidiary	1.795^a			
	(0.007)			
Has related buyer		0.279^a		
		(0.013)		
Share of related buyer			-1.223^a	0.483^a
			(0.018)	(0.020)
Log # of buyer				0.917^a
				(0.005)
Industry FE	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	577755	74557	74557	74557
R^2	0.353	0.235	0.274	0.514
Within R^2	0.156	0.006	0.057	0.369
	Dependent Var: Log employment			
Has owner/subsidiary	1.290^a			
	(0.006)			
Has related buyer		0.180^a		
		(0.011)		
Share of related buyer			-0.987^a	0.361^a
			(0.015)	(0.017)
Log # of buyer				0.724^a
				(0.004)
Industry FE	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y
N	576196	74337	74337	74337
R^2	0.324	0.231	0.269	0.486
Within R^2	0.133	0.004	0.053	0.335

Notes. Each observation is a firm in the 2006 TSR data. Robust standard errors in parentheses. Significant levels: a 0.01, b 0.05, c 0.1.

Table B.3: The impact of firm sales on # of different types of buyers, PPML, 2006 cross section

Sample	In Ownership Network			Directly-Related Buyer > 0		Indirectly-Related Buyer > 0	
Buyer Type	All	Dir-Rel.	Indir-Rel.	All	Dir-Rel.	All	Indir-Rel.
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: firm-level regressions							
Log sales	0.668^a	0.364^a	0.675^a	0.683^a	0.300^a	0.663^a	0.510^a
	(0.007)	(0.007)	(0.011)	(0.009)	(0.007)	(0.009)	(0.012)
Industry FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	Y	Y
Observations	74557	74489	74250	44046	44046	28274	28274
Pseudo R^2	0.702	0.253	0.523	0.742	0.254	0.731	0.510
Panel B: firm-partner-industry-level regressions							
Log sales	0.265^a	-0.005	0.299^a	0.435^a	0.070^a	0.394^a	0.162^a
	(0.005)	(0.006)	(0.010)	(0.011)	(0.003)	(0.013)	(0.007)
Industry FE	Y	Y	Y	Y	Y	Y	Y
Prefecture FE	Y	Y	Y	Y	Y	Y	Y
Partner Ind FE	Y	Y	Y	Y	Y	Y	Y
Observations	526051	521395	520865	69659	69659	68458	68458
Pseudo R^2	0.246	0.088	0.189	0.561	0.036	0.491	0.175

Notes. PPML estimation. Each observation is a firm in Panel A, and a firm-buyer-industry combination in Panel B. The dependent variables are the numbers of different types of buyers. Standard errors are clustered at the firm level. Significant levels: a 0.01, b 0.05, c 0.1.

Table B.4: The impact of firm sales on # of different types of buyers, PPML Panel Regression

Supplier Type	All	Dir-Rel.	Indir-Rel.	All	Dir-Rel.	Indir-Rel.
	(1)	(2)	(3)	(4)	(5)	(6)
Log sales	0.637^a	0.326^a	0.657^a	0.247^a	0.066^a	0.211^a
	(0.007)	(0.006)	(0.008)	(0.016)	(0.007)	(0.014)
Industry FE	Y	Y	Y			
Prefecture FE	Y	Y	Y			
Firm FE				Y	Y	Y
Year FE	Y	Y	Y	Y	Y	Y
Observations	894829	894604	893818	875718	592949	472584
Pseudo R^2	0.683	0.221	0.516	0.936	0.439	0.771

Notes. PPML estimation. Each observation is a firm-year combination. The dependent variables are the numbers of different types of buyers. Standard errors are clustered at the firm level. Significant levels: a 0.01, b 0.05, c 0.1.