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Reliance on major customers and product market competition

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A B S T R A C T

Although reliance on major customers has been growing over time, the literature has been largely silent on the determinants of customer base structure. This paper shows that low levels of product market competition in the customer industry is one important factor that can encourage supplier firms to establish relationship with major customers, and enhance existing ones. In support of the argument, we find that the fraction of suppliers' total sales to major customers is positively associated with customer industry product market concentration. We argue that the recent increase in concentration of customer industries could have increased reliance on major customers.

1. Introduction

Existing literature demonstrates that customer-supplier links are important determinants of the operating environment for many firms, enhancing profitability and efficiency (Patatoukas, 2012; Irvine et al., 2016), but also creating pressure to reduce prices and engage in customer-specific investment (e.g., Fee and Thomas, 2004; Dhaliwal et al. 2016). Although the benefits and costs of reliance on major customers are still subject to a debate, a robust stylized fact is that customer concentration has grown over the past several decades (Patatoukas, 2012; Irvine et al., 2016). Yet, the literature has been largely silent on what motivates supplier firms to form a concentrated customer base.

This paper hypothesizes that low levels of product market competition in the customer industry is one important factor that can encourage supplier firms to establish new relationship with major customers and enhance existing ones. There are several reasons for why this may be the case. First, firms in non-competitive markets are more profitable, financially stable, and less volatile (Grullon et al., 2019; Hou and Robinson, 2006; Irvine and Pontiff, 2009). As a result, suppliers' risk of relying on major customers as opposed to maintaining a diverse customer base is smaller when customer's market is less competitive. Second, barriers to entry can prevent supplier firms from entering the customer industry directly – practice denoted as "encroachment" (Tannenbaum, 1995; Tedeschi, 2005). If customer firms are better able to fend off new entrants, including competition from the supplier industry, suppliers may be more likely to establish relationship with corporate customers rather than engage in direct retail. This, in turn, may lead to higher reliance on major customers. Third, when customers industry is concentrated, the number of industry players is small, so the supplier's ability to diversify across many customers is limited (Campello and Gao, 2017). Finally, firms in less competitive markets have more heterogeneous output (Hotelling, 1929; Chamberlin, 1933; Hoberg and Phillips, 2016). Since customer–supplier ties often require customer-specific investment, such investment should be higher when customers operate in concentrated product markets, further limiting the ability of suppliers to work with multiple customers.

To provide empirical support of this argument, we demonstrate that decrease in competition in customer industries is associated with stronger reliance of supplier firms on major customers. To this end, we perform a panel regression analysis and estimate reliance on major customers as a function of customer industry Herfindahl-Hirschman Index (HHI) of sales (an inverse measure of product market competition), a vector of control variables, and fixed effects. We find that supplier firms with higher customer industry HHI increase their reliance on major customers in the following period.

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Our results are robust to alternative explanations. First, we apply firm-fixed-effects regressions in all our analyses, and use lagged independent variables, thereby alleviating potential simultaneity and omitted variables concerns. Second, we ensure that the findings are not driven by the presence of customers and suppliers operating in the same industry, as well as by propagation of merger waves along the supply chain. Third, we perform subsample analysis to further address reverse causality explanations. We show that our conclusion is unlikely to be confounded by these concerns.

Finally, we argue that the recent increase in concentration and market power across industries, and customer industries in particular, could have contributed to the evolution of suppliers' reliance on major customers. Existing papers have shown that the trend of product market consolidation has a number of implications, including a decline in business dynamism and entrepreneurship (Decker et al., 2014; 2016); increase in profitability (Grullon et al., 2019) and decline in investment (Barkai, 2016). This paper adds to this literature by showing that the effect of the increase in U.S. market concentration can also have an impact on the structure of the supply chain.

2. Sample, data, and main variables description

Our main sample is based on publicly-traded firms in Compustat and covers 1976–2016 period. We require that firms do not belong to the financial (SIC codes 6000–6999) or utilities (SIC codes 4900–4999) sectors and have total sales and total assets that are each greater than or equal to $1 million. Using this overall Compustat universe sample, we calculate Herfindahl–Hirshman index of concentration as the sum of squared market shares of individual firms in the industry (defined at a NAICS 3-digit level).[1]

To measure the reliance on major customers, we next limit the sample to firms that appear in Compustat Customer Segment Files. Starting from 1976, Financial Accounting Standards Board (FASB) has required that public firms disclose sales derived from all major customers, who account for at least 10% of the firms' total revenue.[2] The files provide the fraction of sales of supplier i to customer j in year t out of total sales of supplier i that year ($\%Sale_{i,j,t}$). In order to obtain customer's characteristics, we further restrict customer-supplier links to customers that are publicly-traded Compustat firms. We manually match each customer's name to a firm's name in Compustat Fundamentals Annual Files to obtain the customer's gvkey code.

Using the customer-supplier universe, for every supplier i we then sum up *%Sale* across all of its customers ($n_{i,t}$ is the number of major customers that supplier i has in year t) and use it as a measure of reliance on major customers (*%TotalSale*).

$$\%TotalSale_{i,t} = \sum_{j=1}^{n_{i,t}} \%Sale_{i,j,t}$$

An advantage of this metric is that it is not affected by mergers between two existing customers of a given supplier. Although merger is one channel through which customer industries become more concentrated, one may argue that increase in customer concentration due to customers' merger is mechanical and does not reflect other economic forces that drive customer industry consolidation, such as internal growth of market leaders through the erection of barriers to entry. By choosing *%TotalSales* we ensure that our results are not limited to the customer merger mechanism. For example, if customers A and B operate in the same industry and account for 15% and 10% of supplier *i*'s total sales, respectively, their merger will not have an impact on the supplier's *%TotalSales,* unless the supplier decides to allocate more than 25% of its sales to the newly combined entity.[3]

We then construct our main independent variable – customer industry's HHI (*wCustomerHHI*). Since some suppliers work with several customers, the measure is weighted by the fraction of sales to each customer (see, for example, Campello and Gao, 2017). The measure is constructed as follows:

$$wCustomerHHI_{i,t} = \sum_{j=1}^{n_{i,t}} w_{i,j,t} \times HHI_{j,t}$$

where[4]

$$w_{i,j,t} = \frac{\%Sale_{i,j,t}}{\%TotalSale_{i,t}}$$

Table 1 presents the summary statistics for our main sample. All the definitions of the variables are summarized in the Appendix. Suppliers, on average, allocate about 27% of its sales to major customers, have customer industry's HHI of 889, and employ 4900 workers. Panel B, which excludes same-industry links between customer and supplier, exhibits similar results.

[1] See Appendix for the details of HHI construction.

[2] Firms sometimes voluntarily report customers that account for less than 10% of their total sales, which could introduce self-selection bias. As a result, we include only supplier firms with at least 10% sales to a customer.

[3] Other commonly used measures of reliance on major customer, such as the fraction of sales to the largest customer, or the index of customer concentration, which sums the squared shares of sales of a supplier to each of its customers, can be affected by existing customers' mergers.

[4] Note that the denominator is the fraction of sales to each customer out of total sales to all major customers(%TotalSale), rather than out of total sales (Sale). The purpose of this adjustment is to ensure that the weights w sum upto one, so that the average HHI is not mechanically affected by the extent of reliance on major customers through theweight construction.

Table 1
Changes in the Levels of Product Market Concentration in the Customer Industry and Reliance on Major Customers - Baseline

This table summarizes the characteristics of main variables of interest used in the analysis, for the period 1976–2016. See Section 2 for the description of sample construction. Definitions for each variable are contained in the Appendix. Panel A relies on the overall sample, whereas in Panel B we exclude all the supply chain links where the supplier and the customer belong to the same industry. Industry is defined using a firm's three-digit NAICS code.

Panel A: All links

Variable	N	Mean	Median	25th Pctl	75th Pctl	Std Dev
%TotalSale	27,956	0.27	0.21	0.11	0.39	0.24
Number of customers	27,956	1.37	1.00	1.00	2.00	0.65
Employees ('000)	26,317	4.90	0.59	0.17	2.80	15.77
M/B	25,000	2.02	1.45	1.06	2.26	1.74
ROA	27,916	0.06	0.11	0.02	0.18	0.22
wCustomerHHI	27,956	889.3	576.6	328.8	876.5	970.5
HHI	27,656	678.0	457.0	290.1	763.7	735.9
M&A/Assets	27,040	0.02	0.00	0.00	0.00	0.07

Panel B: Excluding same-industry links

Variable	N	Mean	Median	25th Pctl	75th Pctl	Std Dev
%TotalSale	20,219	0.25	0.19	0.11	0.35	0.22
Number of customers	20,219	1.32	1.00	1.00	2.00	0.60
Employees ('000)	19,068	4.20	0.61	0.17	2.65	14.17
M/B	18,353	1.96	1.41	1.04	2.16	1.70
ROA	20,199	0.07	0.11	0.03	0.17	0.21
wCustomerHHI	20,219	1056.9	709.0	410.6	1188.2	1077.8
HHI	19,986	755.3	481.9	319.7	899.7	810.8
M&A/Assets	19,565	0.02	0.00	0.00	0.00	0.07

3. Results

Next, we turn to our main analysis, and estimate the parameters of the following regression model:

$$\%TotalSale_{i,t} = \alpha_i + \alpha_t + \beta_1 log(wCustomerHHI_{i,t-1}) + \beta_2 log(Emp_{i,t-1}) + \beta_3 M/B_{i,t-1} + \beta_4 ROA_{i,t-1} + \varepsilon_{i,t} \quad (1)$$

where α_i is a firm-fixed effect, α_t is a year-fixed effect, and the rest of the variables are as described in the Appendix. Standard errors are clustered at the firm level.

The results, presented in column (1) of Table 2, demonstrate that the relation between sales-weighted customer industry HHI and the fraction of sales to major customers is positive and statistically significant. In terms of economic significance, the coefficient of *wCustomerHHI* indicates that a one-standard deviation change in weighted average customer concentration encourages supplier to allocate additional 3% of its total sales to major customers, or 14% relative to *%TotalSales* median.

After establishing the main results, we confirm their robustness to alternative explanations. In column (2) we add lagged *%TotalSale* variable to consider a dynamic panel structure and alleviate potential endogeneity concerns. We find that the impact of *wCustomerHHI* coefficient remains pronounced and statistically significant. In specification (3) we address an explanation that mergers and industry consolidation may travel along the supply chain (Ahern and Harford, 2014), so that *wCustomerHHI* essentially proxies for competitive environment in the supplier, rather than customer, industry. We find that the impact of *wCustomerHHI* remains significant after we include supplier industry HHI, as well as acquisition of activity of the supplier firm. In columns (4)–(6) of Table 2 we re-estimate all the regressions after excluding customers and suppliers that operate in the same industry and find similar results.

Finally, in Tables 3 and 4 we consider reverse causality argument. While our specifications with firm-fixed and time-fixed effects, as well as the presence of lagged dependent variable, mitigate omitted variable concerns, one may argue that the relation between reliance on major customers and customer industry concentration works in the opposite direction. If increased reliance on major customers is a strategic move by suppliers (for example, it could be aimed to improve their bargaining position vis-à-vis customer firms), customers may consolidate in response. To address this argument, we perform another set of subsample analyses. If the reverse causality explanation is the channel at work, we should find that the relation between customer concentration and reliance on major customers is the most pronounced when suppliers are large, and also when customers are small. In these cases, the higher dominance of suppliers relative to customers will amplify the strategic response. At the same time, if customer industry consolidation generates barrier to entry and improves stability of its market players, we should find the exact opposite: The results will be more pronounced within the subsample of small suppliers, as well as large customer firms. Consistent with our argument, and in contrast with reverse causality explanation, we find that our findings hold, and are actually stronger, within the subsample of small suppliers (Table 3), as well as large customers (Table 4).

Table 2
Changes in the Levels of Product Market Concentration in the Customer Industry and Reliance on Major Customers - Baseline

This table reports coefficients from regressing the sum of sales to all major customer, scaled by the total sales of a supplier firm as a function of average customer industry concentration levels and other control variables. All the variables are defined in the Appendix. Specifications (1)–(3) rely on the overall sample, as described in Section 2. Specifications (4)–(6) exclude all the supply chain links where the supplier and the customer belong to the same industry. Industry is defined using a firm's three-digit NAICS code. All the independent variables are lagged by one year. Standard errors are clustered at the firm level. Symbols ***, **, and * indicate significance at 1%, 5%, and 10%, respectively, and standard errors are reported in the parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)
Log(wCustomerHHI)	0.010*	0.011***	0.011***	0.009	0.011***	0.011***
	(0.005)	(0.003)	(0.003)	(0.006)	(0.004)	(0.004)
%TotalSale		0.534***	0.534***		0.521***	0.521***
		(0.014)	(0.014)		(0.017)	(0.017)
Log(Employees)	−0.018***	−0.001	−0.000	−0.019***	−0.002	−0.001
	(0.004)	(0.003)	(0.003)	(0.005)	(0.003)	(0.003)
M/B	0.003*	0.001	0.001	0.004**	0.002	0.002
	(0.002)	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)
ROA	0.086***	0.039***	0.039***	0.073***	0.037***	0.037***
	(0.014)	(0.011)	(0.012)	(0.016)	(0.013)	(0.013)
Log(HHI)			0.001			0.002
			(0.005)			(0.005)
M&A/Assets			-0.090***			-0.089***
			(0.018)			(0.019)
N	24,125	24,125	23,090	17,697	17,697	16,938
adj.R2	0.527	0.614	0.614	0.522	0.608	0.609
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

4. Discussion

In this section we analyze market-wide implications of our results by evaluating the findings from the perspective of U.S. industry consolidation and decline in competition, a recent trend that has been demonstrated through a variety of research contexts. Since the beginning of the 21st century product market concentration has increased, and large firms have grown disproportionally bigger (Gutiérrez and Philippon, 2017; Grullon et al., 2019). Based on this dynamic, our cross-sectional results have macro-level inferences, and suggest that the recent trend of product market consolidation could be reflected in higher volume of sales to major customers.

Although a formal examination of factors behind cross-industry variation in consolidation is beyond the scope of this study, we would like to outline several reasons as to why customer firms could consolidate more rapidly. One possible motive is the introduction of new computer- and Internet-related technologies, operating based on network effects, which have led to the rise of "superstar" firms, including Facebook, Amazon, and Uber (Autor et al., 2017). If customer-dominant industries have better experience interacting with retail consumers, they could be also better positioned to exploit these technological advancements and generate network effects. As a result, they will grow and consolidate at a faster pace. Another potential reason could be related to size and economies of scale. If economies of scale are less applicable to intermediate, or commodity-type, outputs compared to the final products, supplier firms could benefit less from consolidation.

We show that the increase in reliance on major customer goes hand-in-hand with the increase in product market consolidation, which has also grown dramatically over the same period, and provide several stylized arguments in support of this idea. We start by analyzing the evolution of customer concentration over the past four decades. To this end, we use the overall Compustat universe of firms, as described in the first paragraph of Section 2, which we match with the data from Compustat Customer Segment Files. The purpose of this analysis is to capture reliance on major customers in the broadest possible way, so to measure sales to all major customer, we now include both identified and unidentified customers to calculate *%TotalSale*. Firms that do not rely on major customers receive a value of zero. We then calculate average total reliance on major customers in the Compustat universe and report our results in Fig. 1.

Consistent with prior studies, we find that customer concentration has been rising steadily in the 1980s and early 1990s. However, there is also an inflection point, and since the turn of the century customer concentration has been growing at a significantly faster pace. For example, during the 1997–2016 period the average concentration has increased by over 130%. The trend is consistent with the notion that customer firms have been growing and consolidating at a faster pace.

To further confirm the idea that the consolidation trend has been more pronounced in customer- compared to supplier-dominant industries, we perform a cross-sectional analysis of product market consolidation. We classify industries based on the fraction of firms that sell to major customers over 1993–1997 period and denote them as customer- (below or equal sample median) and supplier-driven (above the sample median) industries. We then average the HHI values within each category. Fig. 2 shows that although the level of product market concentration have been similar across the two groups prior to mid-1990s, it has diverged over the past two

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Table 3
Changes in the Levels of Product Market Concentration in the Customer Industry and Reliance on Major Customers – by Supplier Size

This table reports coefficients from regressing the sum of sales to all major customer, scaled by the total sales of a supplier firm as a function of average customer industry concentration levels and other control variables, by subsamples formed based on supplier size. Every year we split all the firms in a given supplier's industry into two groups based on the distribution of total sales. Panel A includes only small (below or equal to the median) firms; whereas Panel B includes only large (above median) firms. All the variables are defined in the Appendix. Specifications (1)–(3) rely on the overall sample, as described in Section 2. Specifications (4)–(6) exclude all the supply-chain links where the supplier and the customer belong to the same industry. Industry is defined using a firm's three-digit NAICS code. All the independent variables are lagged by one year. Standard errors are clustered at the firm level. Symbols ***, **, and * indicate significance at 1%, 5%, and 10%, respectively, and standard errors are reported in the parentheses.

Panel A: Small Suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Log(wCustomerHHI)	0.013*	0.014***	0.015***	0.016**	0.016***	0.018***
	(0.007)	(0.005)	(0.006)	(0.008)	(0.006)	(0.006)
%TotalSale		0.473***	0.474***		0.459***	0.464***
		(0.019)	(0.020)		(0.024)	(0.024)
Log(Employees)	−0.022***	−0.005	−0.004	−0.012	0.003	0.005
	(0.007)	(0.005)	(0.005)	(0.009)	(0.006)	(0.006)
M/B	0.003	0.001	0.000	0.006**	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
ROA	0.098***	0.049***	0.046***	0.074***	0.040**	0.035**
	(0.018)	(0.015)	(0.015)	(0.020)	(0.017)	(0.017)
Log(HHI)			0.009			0.003
			(0.009)			(0.010)
M&A/Assets			−0.109***			−0.109***
			(0.028)			(0.032)
N	11,986	11,986	11,622	8879	8879	8610
adj.R2	0.502	0.572	0.573	0.484	0.554	0.556
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Large Suppliers

	(1)	(2)	(3)	(4)	(5)	(6)
Log(wCustomerHHI)	0.012	0.009**	0.007	0.010	0.009*	0.007
	(0.007)	(0.004)	(0.004)	(0.008)	(0.005)	(0.005)
%TotalSale		0.576***	0.578***		0.573***	0.568***
		(0.020)	(0.020)		(0.025)	(0.026)
Log(Employees)	−0.017***	−0.003	−0.003	−0.025***	−0.010**	−0.010**
	(0.006)	(0.004)	(0.004)	(0.006)	(0.004)	(0.004)
MB	0.004	0.003	0.003	0.002	0.002	0.001
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
ROA	0.042*	0.013	0.016	0.066**	0.032	0.042*
	(0.024)	(0.020)	(0.021)	(0.026)	(0.021)	(0.023)
Log(HHI)			−0.001			0.002
			(0.006)			(0.006)
M&A/Assets			−0.076***			−0.084***
			(0.023)			(0.021)
N	12,139	12,139	11,468	8818	8818	8328
adj.R2	0.586	0.676	0.677	0.594	0.684	0.685
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

decades, and HHI index has been significantly higher in customer-driven industries compared to supplier-based ones. The results imply that higher barriers to entry in customer compared to supplier industries could have encouraged suppliers to increase their reliance on major customers.

5. Conclusion

This study explores the impact of customer industry market structure on supply-chain links. We predict that the reliance on major customers is more pronounced in firms that sell to customers operating in the environment of low product market competition. Using sales-weighted customer industry HHI index we show that when customer competition is low, suppliers condense their customer network by selling to a less disperse customer base. Other tests are also consistent with our main hypothesis.

Our results offer one channel through which reliance on major customers has surged dramatically since the late 1990s. Going

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Table 4
Changes in the Levels of Product Market Concentration in the Customer Industry and Reliance on Major Customers – by Customer Average Size

This table reports coefficients from regressing the sum of sales to all major customer, scaled by the total sales of a supplier firm, as a function of average customer industry concentration levels and other control variables, by subsamples formed based on customer size, measured as log of their sales. Every year we split all supplier firms into two groups based on the weighted average size of their customer firms. The weights for each customer are determined based on the ratio of supplier's sales to that customer to the supplier's total sales to all major customers (thus, the sum of all weights equals one). Panel A includes only suppliers that are linked to small-sized average customers (below or equal to the sample median in a given year); whereas Panel B includes only suppliers that sell to large customer industry firms (above median). All the variables are defined in the Appendix. Specifications (1)–(3) rely on the overall sample, as described in Section 2. Specifications (4)–(6) exclude all the supply-chain links where the supplier and the customer belong to the same industry. Industry is defined using a firm's three-digit NAICS code. All the independent variables are lagged by one year. Standard errors are clustered at the firm level. Symbols ***, **, and * indicate significance at 1%, 5%, and 10%, respectively, and standard errors are reported in the parentheses.

Panel A: Small Customers

	(1)	(2)	(3)	(4)	(5)	(6)
Log(wCustomerHHI)	0.003	0.010*	0.010**	−0.001	0.008	0.009
	(0.007)	(0.005)	(0.005)	(0.008)	(0.006)	(0.006)
%TotalSale		0.488***	0.491***		0.484***	0.486***
		(0.020)	(0.021)		(0.024)	(0.025)
Log(Employees)	−0.019***	−0.003	−0.001	−0.021***	−0.006	−0.003
	(0.006)	(0.005)	(0.005)	(0.008)	(0.005)	(0.006)
MB	0.005*	0.002	0.001	0.007***	0.003	0.002
	(0.002)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
ROA	0.066***	0.024	0.025	0.055**	0.016	0.021
	(0.020)	(0.016)	(0.016)	(0.022)	(0.020)	(0.020)
Log(HHI)			0.013			0.012
			(0.009)			(0.009)
M&A/Assets			−0.129***			−0.098***
			(0.031)			(0.034)
N	11,980	11,980	11,495	8684	8684	8328
adj.R2	0.501	0.572	0.574	0.504	0.576	0.579
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Panel B: Large Customers

	(1)	(2)	(3)	(4)	(5)	(6)
Log(wCustomerHHI)	0.024***	0.013**	0.013**	0.030***	0.015**	0.017**
	(0.009)	(0.006)	(0.006)	(0.011)	(0.007)	(0.007)
%TotalSale		0.559***	0.557***		0.547***	0.551***
		(0.021)	(0.021)		(0.027)	(0.027)
Log(Employees)	−0.021***	−0.002	−0.003	−0.017**	0.004	0.004
	(0.007)	(0.005)	(0.005)	(0.008)	(0.005)	(0.006)
MB	0.004	0.003	0.002	0.004	0.003	0.003
	(0.003)	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)
ROA	0.106***	0.060***	0.061***	0.100***	0.059***	0.055***
	(0.022)	(0.018)	(0.018)	(0.025)	(0.020)	(0.019)
Log(HHI)			−0.007			−0.006
			(0.008)			(0.009)
M&A/Assets			−0.061***			−0.084***
			(0.021)			(0.023)
N	12,145	12,145	11,595	9013	9013	8610
adj.R2	0.597	0.676	0.675	0.580	0.659	0.659
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

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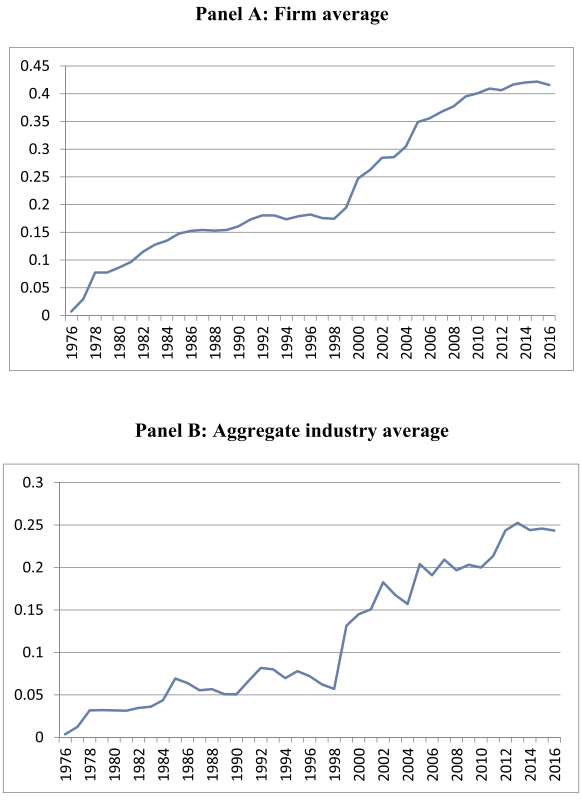

Fig. 1. Reliance on Major Customers over Time
This figure shows the time-series trend in the share of total sales to major customers over the 1976–2016 period. The sample is constructed as described in Section 1, with the exception that for the purpose of this time-series construction we consider all Compustat firms, regardless of whether they have sales to major customers. For firms that do not report sales to major customers total sales to major customers are assigned a value of zero. We further consider all sales to major customers (that is, do not limit customer-supplier links to identified publicly-traded customers). Panel A presents firm-level analysis. For every supplier we calculate the share of total sales to major customers, scaled by total sales, and average the resulting ratio across all sample firms in a given year. Panel B presents aggregate industry-level ratio of sales to major customers. For every industry-year we aggregate all sales to major customers (summed across all firms in a given industry-year), and scale them by the aggregate industry sales. We then calculate average ratio across industries, and present its time-series evolution in Panel B.

forward, they can help evaluate potential consequences of increased product market concentration for key market participants: customers, suppliers, and employees.

Author statement

The project “Reliance on Major Customers and Product Market Competition” is a solo-authored work.

CRediT authorship contribution statement

Yelena Larkin: Conceptualization, Methodology, Software, Writing - original draft, Writing - review & editing.

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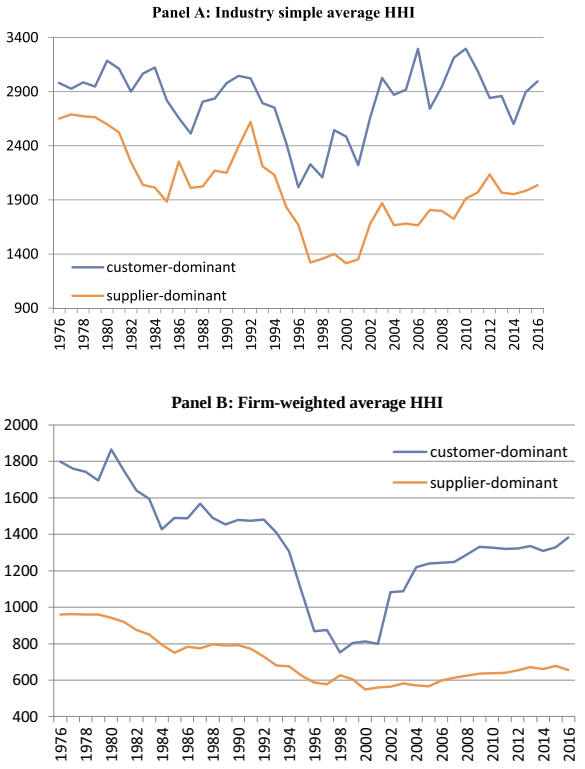

Fig 2. HHI Index across Customer- versus Supplier-based Industries
This figure shows the time-series trend in the HHI measure of industry sales concentration over the 1976–2016 period, across the two groups of customer- and supplier-based industries. The sample is constructed as described in Section 1, with the exception that for the purpose of this time-series construction we consider all Compustat firms, regardless of whether they have sales to major customers. For firms that do not report sales to major customers total sales to major customers are assigned a value of zero. We further consider all sales to major customers (that is, do not limit customer-supplier links to identified publicly-traded customers). We classify industries based on the fraction of firms that have major customers over 1993–1997 period and denote them as customer (below sample median) and supplier (above or equal the sample median) industries. HHI index (HHI_j) in industry j is defined based on NAICS 3-digit industry classification and is constructed as described in Appendix A. To aggregate the index across industries, we use a simple average approach (Panel A), or firm-weighted approach (Panel B).

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.frl.2020.101436.

Appendix A

This appendix defines each of the variables used throughout the paper. For clarification, we use the following subscripts: i for supplier firms, j for customer firms, t for year, $n_{i,t}$ for the number of major customers (customers that account for at least 10% of total sales) that supplier i has in year t; I_t [J_t] for the total number of firms operating in year t in the industry to which firm i [j] belongs.

Variable	Definition
$\%TotalSale_{i,t}$	For every supplier i in year t total sales to major customer are defined as the fraction of total sales that is coming from the set of customers the firm reports as "major customers" (that is, customers that account for at least 10% of total sales): $\%TotalSale_{(i,t)} = \sum_{j=1}^{n_{i,t}} \%Sale_{i,j,t}$ where $\%Sale_{i,j,t}$ is the fraction of sales of supplier i to customer j in year t out of total sales of supplier i in year t; and $n_{i,t}$ is the number of major customers that supplier i has in year t.
$Emp_{i,t}$	Total number of employees (EMP) of supplier i, in thousands. Values of zero are excluded.
$M/B_{i,t}$	Market-to-book assets ratio of supplier i in a given year t. It is calculated as the sum of book assets (AT) and market cap, minus book value of equity (CEQ) and deferred taxes (TXDB if available; zero otherwise), all scaled by book assets. The ratio is winsorized at 1% and 99% of the distribution.
$HHI_{i,t}$	The Herfindahl-Hirschman index (HHI) of concentration in supplier i's industry in year t, calculated by squaring the market share (expressed in percent) of each firm in an industry, and then summing the resulting numbers across all firms in the industry. Specifically: $HHI_{i,t} = \sum_{i=1}^{I_t} ((Sale_{i,t}/\sum_{i=1}^{I_t} Sale_{i,t})*100)^2$

	where $Sale_{i,t}$ is supplier i's total sales; and I_t is the total number of firms operating in the supplier's industry in year t. Industry is defined using a firm's three-digit NAICS code.
$HHI_{j,t}$	The Herfindahl-Hirschman index (HHI) of concentration in customer j's industry in a given year t, calculated by squaring the market share (expressed in percent) of each firm in an industry, and then summing the resulting numbers across all firms in the industry. Specifically: $HHI_{j,t} = \sum_{j=1}^{J_t} ((Sale_{j,t}/ \sum_{j=1}^{J_t} Sale_{j,t})*100)^2$ where $Sale_{j,t}$ is customer j's total sales; and J_t is the total number of firms operating in the customer j's industry in year t. Industry is defined using a firm's three-digit NAICS code.
$M\&A/Assets_{i,t}$	Total M&A activity (AQC) scaled by total assets (AT) of supplier i in a given year t. The ratio is winsorized at values of 0 and 1.
$ROA_{i,t}$	Operating income before depreciation (OIBDP), all divided by book value of assets (AT) of supplier i in a given year t. Winsorized at 1% and 99% of the distribution.
$Sale_{i,t}$ [$Sale_{j,t}$]	Total net sales (SALE) of supplier i [customer j] in a given year t, in million.
$wCustomerHHI_{i,t}$	For every supplier i in year t it is calculated as the average of Herfindahl-Hirschman indices of its customers' industries, weighted by the supplier firm's percentage sale to each customer out of total sales to major customers: $wCustomerHHI_{i,t} = \sum_{j=1}^{n_{i,t}} w_{i,j,t} \times HHI_{j,t}$ where $w_{i,j,t} = \frac{\%\,Sale_{i,j,t}}{\%\,TotalSale_{i,t}}$; $\%Sale_{i,j,t}$; is the fraction of sales of supplier i to customer j in year t out of total sales of supplier i in year t; $\%TotalSale_{i,t}$ is the fraction of total sales of supplier i to all of its major customers in year t (see definition of $\%TotalSale_{i,t}$ for more details); $HHI_{j,t}$ is the Herfindahl-Hirschman index of market concentration in customer j's industry in year t, and $n_{i,t}$ is the number of major customers that supplier i has in year t.

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