Vertical Integration and Foreclosure: Evidence from Production Network Data*

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Abstract

This paper studies the prevalence of vertical market foreclosure using a novel dataset on U.S. and international buyer-seller relationships, and across a large range of industries. We find that relationships are more likely to break when suppliers vertically integrate with one of the buyers' competitors than when they vertically integrate with an unrelated firm. This relationship holds also, among other things, when conditioning on mergers that follow exogenous downward pressure on the supplier's stock prices, suggesting that reverse causality is unlikely to explain the result. In contrast, the relationship vanishes when using rumored or announced but not completed integration events. Firms experience a substantial drop in sales when one of their suppliers integrates with one of their competitors. This sales drop is mitigated if the firm has alternative suppliers in place.

Keywords: Mergers and acquisitions, Market foreclosure, vertical integration, production networks
JEL: L14, L42

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1 Introduction

Vertical integration of two firms has the potential to increase their economic efficiency by exploiting synergies in the design, production, and distribution of their goods and services, which may ultimately lead to lower prices for consumers. At the same time, it might give firms incentives to engage in anti-competitive behavior. One such case arises when one of the integrating firms controls access to a bottleneck input, such as access to vital infrastructure or technology. The integrated firm might use its access to the bottleneck to extend or preserve its market power in the upstream markets by refusing to provide rival firms in downstream markets with access to the bottleneck. These firms are said to be foreclosed. While a large theoretical literature investigates the motives for vertical foreclosure[1], the empirical evidence is restricted to a few very particular cases[2], not least because vertical relationships are rarely observed. This fact not only restricts our ability to test the theory, but also limits our understanding of the prevalence of foreclosure in reality.

The empirical prevalence of vertical foreclose is, of course, at least partly determined by competition law and its enforcement. Most of its forms are regarded as violating competition laws in a large range of jurisdictions. In the United States the Sherman and Clayton Antitrust Acts set out limitations to merger activity, and starting with *Terminal Railroad Association v. U.S.* (1912) U.S. courts have established a doctrine on foreclosure. Competition authorities typically issue guidelines on their assessment of vertical mergers to avoid unforeseen restrictions on mergers. At the same time – or perhaps as a consequence – enforcement of these vertical merger laws is relatively rare.[3] With recent work arguing that concentration and market power among US firms increased over the course of the last decades[4], and the finger being pointed at regulatory authorities[5], one is led to ask: is enforcement lax, or is actual foreclosure just very rare? What are the factors determining the prevalence of vertical foreclosure, and how severe are the consequences?

This paper examines the presence of vertical foreclosure across a large range of industries. We exploit a novel panel dataset on vertical relationships between large firms, both in the U.S. and abroad. These data allow us to study whether buyer-seller relationships break following vertical mergers and acquisitions. We show that the breaking of a buyer-seller relationship in response to the supplier vertically integrating with a third party is particularly likely when the third party is a competitor of the buyer — but not when the third party is not a competitor of the buyer. Consistent with theories of vertical foreclosure, relations are more likely to break following vertical integration of the supplier with a competitor of the buyer when there is little

[1] See Rey and Tirole (2007) for an overview. The classic references are Hart and Tirole (1990) and Ordover et al. (1990).

[2] Recent examples include Asker (2016) for the Chicago beer market and Crawford et al. (2018) for the US cable TV industry.

[3] Salop and Culley (2015) find only 46 vertical enforcement actions in the US over the period 1994–2013.

[4] De Loecker et al. (2018) estimate a rise in average US markups using Compustat and US Census data; Gutiérrez and Philippon (2017) document rising Herfindahl concentration indices in US industries, and Barkai (2016) documents a rise in the profit share of US non-financial corporations.

[5] See Gutiérrez and Philippon (2018) and The Economist (2018)

competition in the upstream industry. The increased hazard rate of links breaking cannot be explained by common industry-level (or industry-pair-level) shocks to merger activity or hazard rates.

The correlation we find does not immediately imply that vertical market foreclosure is taking place in the population of firms and relationships that we study. Vertical integration could be the *response* to relationships breaking. Alternatively, both integration and links breaking could be caused by unobserved shocks. Finally, the links breaking might not be the the consequence of foreclosure, but might be the consequence of the integrating parties being able to produce the final good at such a low cost that the buyer decides to exit the market (and hence stops purchasing the input).

A series of additional regressions indicates that these explanations are unlikely to explain the findings. We follow Edmans et al. (2012) to construct an instrumental variable for vertical mergers and acquisitions. The variable captures events where investor capital outflows of mutual funds put large downward pressure on firms' stock prices, thereby making the firm more likely to be acquired. The correlation between vertical integration and links breaking prevails for vertical acquisitions that follow situations where such events put downward pressure on the bottleneck supplier's stock price. If the investor capital outflows are unrelated to the performance of the supplier, these cases are integration events that are unlikely to happens for supply assurance reasons (as, for example, in Bolton and Whinston (1993)). We find similar results when conditioning on situations where the suppliers are "healthy" in the sense that they have seen sales increases prior to integrating.

Moreover, we study events where firms are rumored to vertically integrate or announce an integration, but end up not integrating. To the extent that these rumored integration events might be similarly selected to actual integration events, they make for a good comparison group. For relationships where suppliers are rumored to vertically integrate, we do not find a higher hazard rates of links breaking than in the average relationship. We also do not find the large difference in hazard rates between rumored integration with a competitor of the buyer versus firms unrelated to the buyer.

We then use our production network data to ask whether firms that have a foreclosure motive are more likely than others to integrate with a given supplier. We say that a firm b has a foreclosure motive when one of its suppliers also sells to one of b's competitors. In the sample of active relationships where the supplier is vertically integrating, such firms b are more likely to end up being the ones that integrate with the supplier. Again, these results are consistent with foreclosure motives for integration.

Finally, we study the performance of firms in the wake of their supplier's integration. Firms that have a supplier vertically integrate with one of its competitors experience a temporary decrease in sales. The sales drop is larger for firms that do not have another supplier from the same industry as the one that is integrating. We do not find a statistically significant response of employment to supplier's integration with a competitor. We also study the sales response of firms whose *competitor* is vertically integrating, and we find no statistically significant drop

in sales, suggesting that the breaking of vertical relationships in our main result is unlikely to be the consequence of firms being driven out of the market due to strong synergies among the integrating firms. This is consistent with the results of Blonigen and Pierce (2016), who find no significant increases in physical productivity among US plants that undergo a merger or acquisition, but an increase in market power as measured by markups.

We interpret our results as supporting the view that vertical market foreclosure along the extensive margin (in the sense that relationships fully break) is occurring in the population of firms and relationships that we study. These relationships are not representative of the overall population of buyer-seller relationships in the United States, or among industrialized countries: the set of firms reporting relationships in our data consists of mostly firms that are either listed on exchanges or issue traded securities. Those firms are also more likely to report relationships with important suppliers and customers. Given that the relationships in our sample will be more likely to be in the spotlight of antitrust authorities, we think that vertical foreclosure may also be prevalent outside the selected sample that we study.

Our paper relates to three different literatures. The first is the empirical literature on detecting vertical market foreclosure. Waterman and Weiss (1996), Chipty (2001), and Crawford et al. (2018) (in the cable TV industry) and Hastings and Gilbert (2005) (in the gasoline retailing industry) find evidence for vertical foreclosure; Hortaçsu and Syverson (2007) (in cement and ready-mixed concrete markets) and Asker (2016) (in the beer industry) find no vertical foreclosure in their respective industries. In contrast to this literature, we study a range of industries, which not only broadens the scope of statements that we can make, but also allows for comparisons across industries by their degree of competitiveness. We draw from data on vertical and competitor relationships, which ties our hands on the definition of markets and vertical integration. The drawback is that our data prevents us from studying prices or markups, and therefore consumer welfare. Instead, we look at the supplier network of potentially foreclosed firms, and how the relationship between integration and links breaking varies with market structure in the upstream market.

Our paper also links to the literature that studies the determinants and effects of mergers and acquisitions (Malmendier et al. (2018), Maksimovic et al. (2013), Rhodes-Kropf and Viswanathan (2004), Gugler et al. (2003), Blonigen and Pierce (2016)). In contrast to most of this literature[6], we study the impact not on integrating firms themselves, but on the vertically related ones. We also show that foreclosure considerations as determined by the structure of the production network predict vertical mergers.

Finally, our paper also relates to the growing literature on the importance of firm's position in the production network for its performance (Barrot and Sauvagnat, 2016, Giroud and Mueller, 2017, Bernard et al., 2017, Carvalho et al., 2016, Boehm et al., 2015). Related to our work, Bernard and Dhingra (2015) find increased integration and foreclosure following the 2012 Free Trade Agreement between Colombia and the United States. Our paper shows how the network matters through the strategic incentives of horizontally related firms, and for how the

[6]Recent exceptions are Gugler and Szücs (2016) and Stiebale and Szücs (2017), who study the impact of mergers on horizontally related firms.

production network itself is shaped by those incentives. We also introduce a new dataset on buyer-seller connections in the U.S. and abroad and document its properties.

The next section describes the data; Sections 3 and 4 present the econometric evidence.

2 Data

We combine three different datasets for our empirical analysis: a dataset describing supply chain and competitor networks, a dataset of mergers and acquisitions, and data on firm sales and employment. The first dataset is FactSet Revere, a panel of almost 900,000 vertical and horizontal relationships of large US and foreign firms. It describes the supplier, customer, and competitor relationships as well as partnerships of a set of large (mostly publicly listed or security-issuing) firms from the US and abroad (we call these companies the "covered" companies). Each relationship is coded with a relationship type, the identity of the firms, and a start and end date. The data vendor collects this information annually through the covered companies' public filings, investor presentations, websites and corporate actions, and through press releases and news reports. Since the relationship data is the main content of the dataset, its coverage is much broader than supplier data in Compustat or Bloomberg. While the data coverage is specifically geared towards large firms, many small and non-listed firms nevertheless show up in relationships with large firms, hence our overall network is much larger than the set of listed firms. Coverage varies by country; data for covered North American companies is available from 2003 to present; Revere starts to cover publicly listed and security-issuing companies from industrialized and major emerging economies (including Europe and China) from around 2007.[7] To the extent of our knowledge, our paper is the first one in the economics literature to use this dataset, so we show summary statistics in more detail than we otherwise would.

FactSet Revere contains thirteen different types of relationships (see Appendix A.1 for more details). We aggregate these relationship types into two networks: a directed network of buyer-supplier relationships (from supplier and customer relationships, as well as distribution, production, marketing, and licensing relationships) and an undirected network of competitors. Moreover, we annualize the relationship data: A relation of any kind is counted as active in a given calendar year if there is at least one day between start date and end date of the relation that falls into that calendar year. The result is a panel of relations that is identified by source company, target company and year.

Table I summarizes the resulting links in the network of firms, which is much more dense than suggested by data exclusively relying on SEC filings (as reported, for instance, by Barrot and Sauvagnat (2016)). Among the more than 180,000 firms in our dataset, 80,000 have at least one supplier link recorded. On average, our buyers have 3.85 suppliers, but many firms have substantially more. The average numbers of customers and competitors is just slightly lower, allowing to construct a dense network. The average length of buyer-supplier relationships in

[7] See Appendix A for details on coverage by country and year.

Table I—: Descriptive statistics for the firm network

	Full Sample			Sample of buyers		
	Mean	SD	Max	Mean	SD	Max
# Customers	2.13	8.28	533	3.37	10.72	533
# Suppliers	2.13	10.20	980	3.85	13.48	980
# Competitors	2.16	7.73	381	3.48	10.13	381
Obs. per firm (years)	3.97	4.30	14	6.24	4.28	14
Log Sales	12.00	2.81	20	12.70	2.62	20
Log Employment	6.27	2.56	15	6.90	2.46	15
Firms	180,192			80,287		

Note: Summary statistics for the number of links in the firm network (2003-2016). The left columns summarize the full set of firms in the database, the right columns only those firms that have at least one supplier in the database. "Observations per firms" summarizes the coverage length of firms. Sales and employment data come from Compustat, Orbis and FactSet Fundamentals. Note that coverage for sales (employment) is lower: 74,511 (73,613) firms in the full sample and 40,576 (40,389) among buyers.

our data is 4.45 years; the baseline hazard rate of buyer-supplier links breaking is 0.23. Only 6.3% of links that break over the observation period are reformed at a later point in time, and almost never more than once.

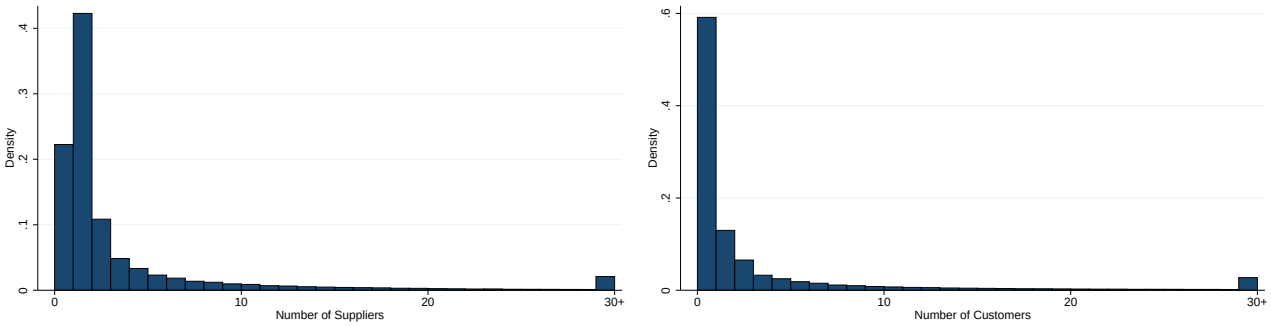


Figure 1: Distribution of the number of suppliers and customers

Note: The sample consists of firms that have at least one supplier.

Figure 1 shows the distribution of the number of suppliers and customers among firms. The distributions are very skewed, with most firms having few suppliers and customers, and some having many. Whenever we use the number of links in our regressions below, we will hence use the log of one plus the number of links instead of the raw count in order to avoid our results being driven by outliers. The fact that the number of relationships is heavily skewed is well-known from the literatures on firm heterogeneity and superstar firms.[8] Table II confirms that the firms with most connections account for a disproportionately large fraction of sales.

Finally, one word of caution about these data. While the coverage of relationships is better than in other large panels that span many industries and countries, it is probably still incom-

[8]The literature is vast; see, in particular, the recent empirical work by Bernard et al. (2017). Most similar to us, Carballo et al. (2018) document the skewness of the customer distribution and sales for international buyers of Latin American firms. In theoretical work, Oberfield (2018) explains how superstar firms emerge in a setting where firms search for suppliers.

Table II—: Total sales by percentile of the # suppliers distribution

	Fraction of Sales, %
All	100.0
Top 25%	78.1
Top 10%	58.6
Top 5%	46.8
Top 1%	25.8

Note: Table shows the average fraction of sales (over years) accounted for by firms in the top percentiles of the distribution of the number of suppliers (firms with at least one supplier only).

plete: relationships with small firms, and relationships that account for a small fraction of sales or costs are presumably less likely to be recorded. Our data show about 500 listed suppliers for Walmart in 2016, and Walmart is — together with Apple, Samsung, and the large auto manufacturers — one of the firms with the highest number of recorded suppliers. In reality though, Walmart probably has tens of thousands of suppliers, suggesting that many relationships are missing. The relationships recorded in our data are probably the larger or more important ones.

The second dataset we use is the set of mergers and acquisitions in Bureau Van Dijk's Zephyr database. Zephyr records deals and rumors about deals for mergers and acquisitions in which at least a 2% stake in the target company changes owners and the value of the deal exceeds GBP 1M (Bollaert and Delanghe (2015)). For each merger or acquisition, Zephyr reports the nature of the transaction, the identity of the target company, the acquiring company and the seller, as well as the date of announcement, the date when the transaction was finished, and the stake of the acquirer in the target before and after the acquisition. Zephyr also contains a large number of rumored deals that never materialized, which we will use as a placebo treatment in our regressions.

Analogously to the relationship data, we annualize the Zephyr data and construct a panel of mergers and acquisitions between acquiring and acquired company. We focus on transactions where one company fully acquires another or the entities merged. We infer the vertical or horizontal nature of an integration by combining M&A data with the input-output network constructed from our relationship data: a vertical integration is a merger or acquisition between two firms that have an ongoing buyer-seller relationship in the year of integration.

The vast majority of mergers and acquisitions in our sample is between firms that do not maintain a buyer-supplier relationship. Table III reports the number of mergers and acquisitions between firms for which supply chain information is available. Only 6.7% of full acquisitions in our sample result in vertical integration. The share is almost the same for partial acquisitions, which we do not use in our analysis but report here for completeness. The non-vertical mergers and acquisitions can be either purely horizontal or between unrelated firms that neither compete directly nor supply each other with inputs. For the sake of brevity, we will refer to both mergers and acquisitions as "mergers" for the remainder of the paper.

There is a small but non-negligible number of cases with risk of vertical foreclosure. Table

Table III—: Types of mergers and acquisitions

	Non-vertical		Vertical		Total	
	Count	%	Count	%	Count	%
Partial acquisitions	745	93.2	54	6.8	799	100.0
Full acquisitions & mergers	2,799	93.3	201	6.7	3,000	100.0
Total	3,544	93.3	255	6.7	3,799	100.0

Note: Number of partial and full mergers and acquisitions by presence vertical relation between the merging parties (2003-2016). Partial acquisitions exclude minority stakes. For a breakdown including horizontal mergers see Appendix A.

IV summarizes key statistics about the buyer-supplier relations in our sample. While the unconditional probability that a relation ends in a given year is only 22.5%, this probability is almost 50% in cases where the supplier integrates vertically with a competitor of the buyer. In our data, this happens in 208 out of the 7482 cases in which a supplier vertically integrates with another buyer.

Table IV—: Buyer-supplier links: hazard rates of links breaking and risk of foreclosure

	Value
P(link breaks)	0.225
Avg. relatation duration	4.45
Number of cases where supplier vertically integrates	7482
Number of cases where supplier integrates w. competitor	208
... and buyer-supplier link breaks	103

Note: The first row reports the unconditional probability that a buyer-supplier relationship ends in a given year. The second row reports the average length of these relations. The third row counts the number of cases in which a supplier vertically integrates. The fourth row restricts this number to cases where the vertical integration involves a competitor of the buyer. The fifth row counts the instances in which the buyer-supplier link breaks following vertical integration of the supplier with a competitor of the buyer.

Figure 2 shows the industry-wise and year-wise distribution of cases where the relationship breaks following vertical integration of the supplier with a competitor of the buyer. These situations are not confined to a narrow set of industries, but occur broadly across the economy. A particularly large number of such cases falls into computer and electronics manufacturing, in which there are many large firms that are frequently undertaking mergers and acquisitions.

In the short panel that is available to us, there is no clear trend over time in the number of potential foreclosure cases. Whereas recent research has documented a rise market power since the early eighties (De Loecker et al., 2018), this does not translate into an increase in the number of potential foreclosure cases over time in our sample.

We complement the relationship and M&A data by sales and employment figures and industry codes from Compustat, Bureau Van Dijk's Orbis database and FactSet Fundamentals (2003–2014). Since these data have been widely used in the literature, we will not describe them here.[9] The last rows of Table I show summary statistics for sales and employment.

[9]See Kalemli-Ozcan et al. (2015) for detailed information on Orbis. We use a current and past vintage of

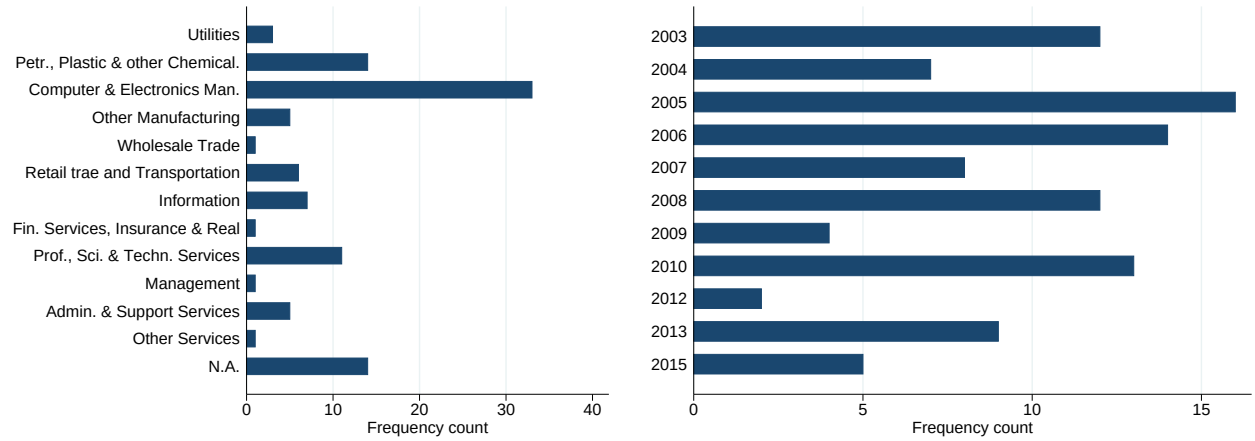


Figure 2: Potential foreclosure cases by sector and year

Note: A potential foreclosure case is a situation where a buyer-seller relationship breaks following integration of the supplier with a competitor of the buyer. About three quarters of potentially foreclosed firms are US firms.

3 Extensive-margin foreclosure

3.1 Empirical Strategy

Our empirical strategy is to study whether vertical relationships are more likely to break after the supplier integrated with a competitor of a buyer, than when it integrated with an unrelated firm. More precisely, we estimate the following linear probability model on the set of all triples (b, s, t) where s is listed as one of b's suppliers for at least one day in year t:

$$\begin{aligned}\mathbb{1}\{\text{LinkBreaks}\}_{bst} = \; & \alpha \mathbb{1}\{s \text{ vertically integrates}\}_{st} \\ & + \beta \mathbb{1}\{s \text{ integrates vertically w. competitor of } b\}_{bst} \\ & + \eta_{bs} + \eta_{bt} + \eta_{i(b)i(s)t} + \varepsilon_{bst} \end{aligned} \tag{1}$$

where $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$ is a dummy variable that is one if and only if the vertical relationship between b and s is active during year t, but not during year $t+1$; The right-hand side variables are a dummy for whether s vertically integrates during year t, and a dummy for whether s vertically integrates with a competitor of b during year t. We include (i) fixed effects for buyer $\times$ year, η_{bt}, to control for time-varying characteristics of the buyer that could make all its supplier relationships more likely to break during a given year (such as exit), (ii) buyer $\times$ supplier fixed effects, η_{bs}, thereby identifying the coefficients of interest, α and β, from within-relationship variation in the hazard rate of the relationships breaking, and in the firms' characteristics, and (iii) industry-pair $\times$ year fixed effects, $\eta_{i(b)i(s)t}$, which takes out industry-specific (or industry-pair-specific) shocks that may lead to a higher break probability (where industries are defined at the 3-digit NAICS level). We exclude relations from the regression where the buyer and suppliers themselves are vertically integrating.

Orbis to have a better coverage.

Table V—: Correlation of buyer-supplier link breaking with vertical integration of supplier

	Dependent variable: $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$			
	(1)	(2)	(3)	(4)
Supplier v. integrates	0.021	0.013	0.005	0.020
	(0.019)	(0.019)	(0.020)	(0.018)
Supplier v. integrates w. competitor		0.181**	0.178**	0.148**
		(0.059)	(0.062)	(0.051)
Controls				Yes
Relation FE	Yes	Yes	Yes	Yes
Buyer × Year FE	Yes	Yes	Yes	Yes
Industry Pair × Year FE			Yes	Yes
R^2	0.578	0.578	0.619	0.671
Observations	640725	640708	472763	472763

Note: Controls: number of upstream customers and competitors, age of the link, dummy indicating other links of the supplier breaking. Robust standard errors clustered at the supplier-year level. The number of reported observations is the number of non-singleton observations. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

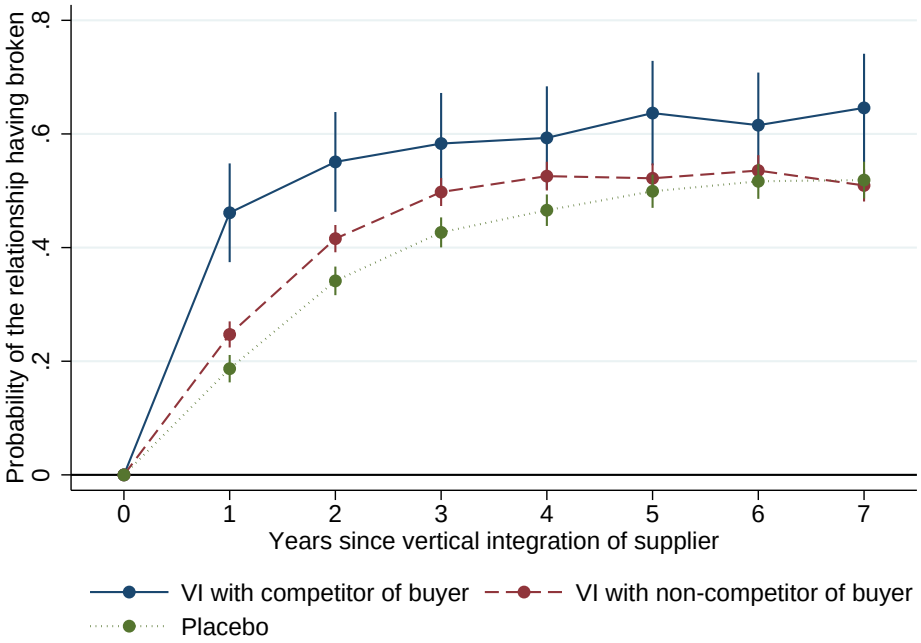
Table V shows the result from estimating equation 1 using ordinary least squares. The first column shows that when suppliers are vertically integrating, the probability of a given vertical relationship breaking is higher by about 2.1 percentage points (though this is not statistically significant). Given that the unconditional probability of a relationship breaking in our data is about 23%, this would constitute an increase of about 9%. Column (2) shows that the likelihood of the vertical relationship breaking is indeed much higher (18 percentage points difference, or a 80% higher probability) when the buyer is a competitor to the firm that the suppliers is integrating with. This difference remains large and statistically significant when including industry pair × year fixed effects to control for sector- or sector-pair-specific shocks (column 3), and when controlling for a range of supplier and relationship characteristics (column 4).

It is worth pointing out that the results above are unlikely to be driven by the possibility that a relationship may not be observed by FactSet following a merger, because the firm entity has ceased to exist, or because it may not be tracked anymore: if that was the case, we should be seeing a substantially increased hazard also following vertical mergers with firms that are not competing with the buyer.

Figure 3 shows graphically how break probabilities differ across these two types of vertical integration events. The horizontal axis shows the time after a vertical integration event of the supplier; the vertical axis shows the probability of the relationship having broken (i.e. one minus the probability of the relationship being active). By definition of the sample, in the year of integration of the supplier the buyer-seller relationship must be active. We see that relationships where the supplier integrates with a competitor of the buyer (solid blue line) are much less likely to survive the post-integration years, in particular the year following integration, than relationships where the supplier integrates with a non-competitor of the buyer

(dashed red line). The dotted green line shows relationship survival rates for simulated placebo events that are generated to occur with 0.5% probability in any given year where a relationship is active. The regression that generates these marginal effects include relationship, buyer-year, and industry-pair year fixed effects; the corresponding plot of a regression without fixed effects looks very similar.

Figure 3: Probability of relationships having broken after supplier's vertical integration



Note: The figure shows coefficients on dummies capturing the years since a supplier's vertical integration, in a regression of the probability of a buyer-seller relationship being inactive on time-since-integration dummies, as well as relationship, buyer × year, and industry-pair × year fixed effects. The solid blue line denotes relationships where the supplier integrates with a competitor of the buyer; the dashed red line denotes relationships where the supplier integrates with a non-competitor of the buyer; the dotted green line represents relationships where a placebo integration event has been drawn to occur. That placebo event is randomly drawn to occur with 0.5% probability in any given year where a relationship is active (and independently across relationship-years).

Next, we study variation across industries in the relationship between vertical integration and links breaking. Most theories of vertical foreclosure, in particular the raising rivals' cost theories and extending monopoly power theories of vertical foreclosure predict that market power in the bottleneck market increases the incentives to foreclose. We want to empirically assess this prediction. In order to do so, we study whether the correlation between integration with a competitor and relationships breaking is lower when the supplier has less market power. We measure the supplier's market power by the number of his competitors. More specifically, we run the regression

$$
\begin{aligned}
\mathbb{1}\{\text{LinkBreaks}\}_{bst} = \; & \alpha \mathbb{1}\{s \text{ vertically integrates}\}_{st} \\
& + \beta \mathbb{1}\{s \text{ integrates vertically w. competitor of } b\}_{bst} \\
& + \gamma \mathbb{1}\{s \text{ integrates vertically w. competitor of } b\}_{bst} \times C_{st} \\
& + \delta C_{st} \\
& + \eta_{bs} + \mu_{bt} + \varepsilon_{bst} \qquad (2)
\end{aligned}
$$

where C_{st} is a variable capturing the number of competitors of the supplier s at time t. Just like the number of buyers and suppliers is heavily skewed, so is the number of competitors, therefore we use the log of one plus the number of competitors for C_{st}.

Table VI shows the results. We find that the correlation between buyer-supplier-links breaking and vertical integration of a supplier with a competitor is lower when the supplier has more competitors (columns (1) and (2)). This result is in line with theories of foreclosure: the existence of more alternative suppliers to the buyer reduces the incentives of the acquirer to foreclose competitors. In columns (3) and (4) we also include interactions with the number of competitors of the buyer. Perhaps surprisingly, the point estimates of the coefficients on these interaction terms are slightly positive (though not statistically significant). While not being entirely conclusive, it does not seem to be the case that more competition in the downstream market reduces the probability of links breaking after integration with a competitor. This stands in contrast to theories where foreclosure arises to preserve market power on the downstream market.

Tables V and VI show a correlation that by itself is not evidence for vertical foreclosure. We see that relationships are relatively much more likely to break when the supplier is undergoing a vertical merger with a competitor of the buyer, than when it is merging with a firm that is not competitor of the buyer. The fact that this correlation is stronger when the supplier has few competitors lends support to the view that vertical foreclosure along the extensive margin could be occurring in the population of firms that we study. Yet, the regressions are not necessarily evidence for a causal link between mergers and the breaking of relationships, simply because mergers do not happen randomly. In particular, there are two main confounding explanations:

Firstly, it could be that the integration between the supplier and the competitor is a consequence of the relationship between buyer and supplier breaking; for instance because the supplier's acquirer might be concerned that the supplier would otherwise exit.[10] In that case our regression would suffer from reverse causality: integration with a competitor of the buyer would be relatively more likely because the competitor could be purchasing exactly those goods that the supplier is discontinuing.

Secondly, it could be that both the breaking of the relationship and the vertical integration are the result of an unobserved shock hitting one of the firms. Such a shock would need make

[10] Bolton and Whinston (1993) study firms' incentives to vertically integrate for supply assurance reasons. In this situation, "exit" does not have to be a complete exit of the supplier, but could be just an exit from a particular market.

Table VI—: Interaction with the number of upstream competitors

	Dependent variable: $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$			
	(1)	(2)	(3)	(4)
Supplier v. integrates w. competitor	0.562**	0.461**	0.325	0.246
	(0.171)	(0.160)	(0.342)	(0.312)
Supp. v. int. w. comp. × # upstream comp.	-0.127*	-0.111*	-0.126	-0.110
	(0.057)	(0.054)	(0.093)	(0.086)
Supplier v. integrates	0.008	0.025**	0.008	0.025
	(0.008)	(0.007)	(0.020)	(0.022)
# upstream competitors	-0.016**	-0.023**	-0.016**	-0.023**
	(0.002)	(0.002)	(0.003)	(0.003)
Supp. v. int. w. competitor × # downstream competitors			0.064	0.058
			(0.047)	(0.040)
Controls		Yes		Yes
Relation FE	Yes	Yes	Yes	Yes
Buyer × Year FE	Yes	Yes	Yes	Yes
Industry Pair × Year FE	Yes	Yes	Yes	Yes
R^2	0.619	0.667	0.619	0.667
Observations	472763	472763	472763	472763

Note: Controls: number of upstream customers, age of the link, dummy indicating other links of the supplier breaking. "Upstream competitors" is the number of competitors of the supplier; "downstream competitors" is the number of competitors of the buyer. Table reports robust standard errors, clustered at the supplier-year level. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

the supplier more likely to integrate with competitors of its buyers than with a non-competitor in order to explain the different magnitude of the coefficient estimates in Table V. We discuss these alternative explanations in turn.

3.2 Reverse causality: vertical integration for supply assurance?

Our relationship between links breaking and vertical integration may be driven by suppliers' motivation to exit certain product markets and cut ties with some of their customers, which in turn may cause them to be acquired by one of their customers. We therefore study two subsamples of firms and mergers in our population: one where we restrict attention to firms that are "healthy" and are therefore unlikely to cut substantial parts of their product mix; and one where we study vertical integration subsequent to events on financial markets that are unrelated to the firm's performance but make it more prone to acquisition.

Table VII shows results of estimating equation (1) on the subsample of firms that have positive sales growth between years $t-2$ and $t-1$ (columns (1) to (3)), or sales growth above the median of three percent (columns (4) to (6)). The point estimates of the coefficient on the integration with a competitor variable are larger than in our baseline specifications (even though the smaller sample makes the estimate less precise). Firms that are growing are much less likely to exit product markets (Goldberg et al., 2010). For the firms in this subsample,

the causality is hence much less likely to run from the breaking of the relationship to vertical integration.

Table VII—: Regressions on relationships with "healthy" suppliers

	Dependent variable: $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$					
	Sample: $\Delta \log \text{Sales}^s_{t-1} > 0$			Sample: $\Delta \log \text{Sales}^s_{t-1} > \text{median}$		
	(1)	(2)	(3)	(4)	(5)	(6)
Supplier v. integrates	0.033	0.021	0.033	0.048	0.022	0.036
	(0.026)	(0.028)	(0.025)	(0.032)	(0.035)	(0.030)
Supplier v. integrates w. competitor	0.387**	0.313*	0.213+	0.373**	0.361*	0.238
	(0.118)	(0.129)	(0.122)	(0.144)	(0.155)	(0.146)
Controls			Yes			Yes
Relation FE	Yes	Yes	Yes	Yes	Yes	Yes
Buyer × Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry Pair × Year FE		Yes	Yes		Yes	Yes
R^2	0.606	0.674	0.709	0.616	0.685	0.719
Observations	251966	191654	191654	197738	148121	148121

Note: Columns (1) to (3) restrict the sample to buyer-supplier pairs where $\Delta \log \text{Sales}^s_{t-1}$ is above zero, columns (4) to (6) where it is above the median. Controls: number of upstream customers and competitors, age of the link, dummy indicating other links of the supplier breaking. Number of observations exclude singleton observations. Robust standard errors, clustered at the supplier-year level, in parentheses. $^+ p < 0.10$, $^* p < 0.05$, $^{**} p < 0.01$.

Next, we restrict our sample to vertical mergers that are subsequent to shocks that are outside of the control of the firms. Edmans et al. (2012) show that when large mututal funds experience an outflow of capital, they are forced to sell off assets, which puts downward pressure on the share prices of firms in their portfolio. In turn, these firms become more likely to be acquired.

We follow Edmans et al. (2012) and Dessaint et al. (2016) to construct a variable capturing the *hypothetical* (not actual) share sales of large U.S. mutual funds in response to an outflow of investor capital. We first calculate the net inflow of capital to the fund based on its total net asset holdings and returns reported in the CRSP mututal funds database. For funds j that see a net outflow of more than five percent of its total net assets in a given quarter q, we calculate the hypothetical sales of a stock i if holdings of all assets were reduced proportionally to the outflow.[11] The total hypothetical sales of a stock i from mutual fund outflows are then

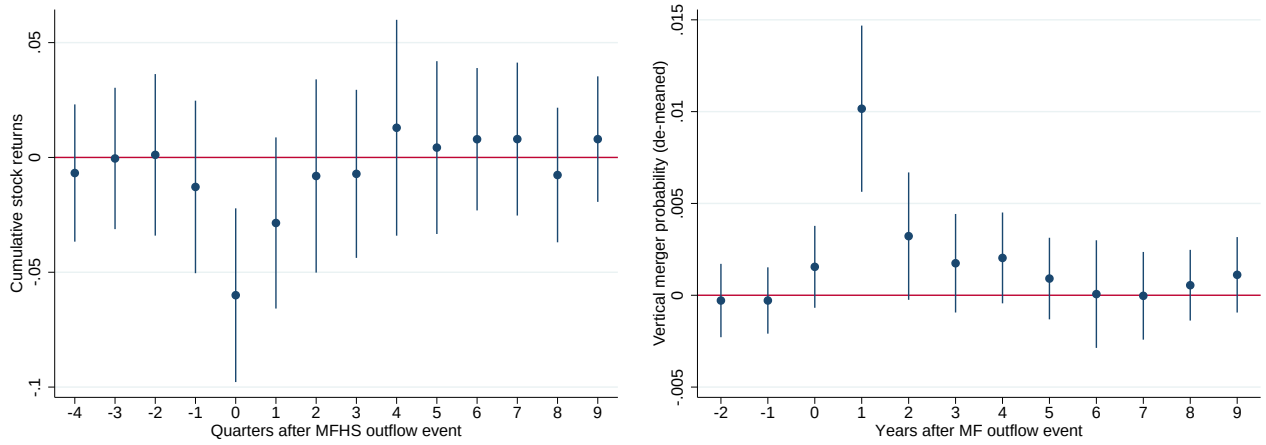
$$MFHS_{i,q} = \sum_{j:\ \text{Flow}_{j,q} < -0.05} (\text{Flow}_{j,q} \cdot \text{Shares}_{ji,q-1} \cdot \text{Price}_{i,q-1})$$

We sum this variable over the four quarters in the year and normalize the sum by the total trading volume in that year.

The normalized MFHS variable is meant to capture the downward pressure on prices that

[11] Data of mutual fund stock holdings come from the Thomson Spectrum CDA database, and stock prices from Thomson Worldscope. See Appendix A for data sources and definitions.

is exerted by the fund's capital outflow. Figure 4a shows the average response of cumulative stock returns following a large mututal fund outflow event (defined as normalized MFHS below the tenth percentile). Stock prices drop significantly and then recover to the pre-shock level. Figure 4b shows the response of the probability to be involved in the completion of a vertical merger or acquisition before and after such an event. In the year after the outflow event, the probability of integration is significantly higher. The one year lag between outflow event and completion of the acquisition may reflect the time to negotiate the acquisition and the antitrust authority's clearance.



(a) Cumulative stock returns

(b) Vertical merger probability

Figure 4: Response to a mutual fund outflow event

Note: The figures show the average response of cumulative stock returns (vertical axis, left panel), and the average response of the probability to engage in a vertical merger or acquisition (vertical axis, right panel) following a mutual fund capital outflow (defined as normalized MFHS being below the tenth percentile) at quarter 0. Both regressions contain firm and industry-time fixed effects; standard errors are clustered at the firm level.

Table VIII shows the results of estimating equation (1) with the interaction terms instrumented by an interaction of the competitor status with a dummy that is one if the vertical integration happens up to two years after a mutual fund outflow event (which, as the construction suggests, happens disproportionately often: in about a third of our cases of integration with a competitor). This instrument effectively limits the set of vertical mergers that are being considered to post-outflow vertical mergers, which are much less likely to be driven by the performance of suppliers or buyers. The estimates of the coefficient on the variable representing vertical integration with a competitor of the buyer remains statistically significant and is again larger than in the benchmark, suggesting that our baseline results are not driven by the possibility that integration is the response to links breaking.

3.3 Unobserved shocks: omitted variables

3.3.1 Comparison with rumors of mergers and acquisitions

Our next exercise speaks to the possibility that both vertical integration and the discontinuation of buyer-supplier relationships are the response to unobserved shocks. As discussed above, such

Table VIII—: Relationships breaking following Vertical Integration: IV results

	Dependent variable: $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$		
	(1)	(2)	(3)
Supplier v. integrates	-0.002	-0.008	0.006
	(0.021)	(0.021)	(0.021)
Supplier v. integrates w. competitor		0.262***	0.202*
		(0.074)	(0.081)
Controls			Yes
Method	IV	IV	IV
Relation FE	Yes	Yes	Yes
Buyer × Year FE	Yes	Yes	Yes
Industry Pair × Year FE			Yes
R^2	0.578	0.578	0.671
Observations	640725	640708	472763

Note: This table shows regressions where the interactions are instrumented by an interaction of the competitor dummy with a dummy that is one if the vertical merger happens up to and including two periods after a mututal funds outflow event. This effectively reduces the explanatory variable to include only post-outflow vertical mergers (instead of all vertical mergers). Robust standard errors, clustered at the supplier-year level, are in parentheses. $^{+}$ $p < 0.10$, * $p < 0.05$, ** $p < 0.01$.

shocks must be directed to make integration with a competitor of the buyer more likely in order to explain the correlation in the baseline tables. One could think of one buyer making an innovation which increases the need for customization of the supplied input, while also driving the competitor out of business. The innovator and supplier choose to vertically integrate to reduce the inefficiency associated with the hold-up problem (Klein et al., 1978).

We try to find a group of firms that is most comparable in terms of the shocks that they may have been facing, but for an *exogenous* reason do not manage to vertically integrate. The closest we can get to such a comparison group is by considering rumors of mergers and mergers that have been announced, but for some reason have not been completed. Zephyr collects the former from "unconfirmed reports", which "may be in the press, in a company press release, or elsewhere" (Bureau Van Dijk, 2017). Our approach is hence similar to the comparison of a placebo with the actual treatment in the sense that our rumor or attempted merger does not actually result in vertical integration (but potentially with the difference that even an attempted merger may lead to buyers switching suppliers). Rumors are dated at the time when they are first mentioned. While buyers in placebo and actual treatments are quite comparable, the suppliers that are rumored to integrate are somewhat larger than the suppliers that actually integrate (see Table XVI in the appendix). Note that we can control for these differences in our regressions and also do not find differential effects for larger or smaller suppliers.

We first study the benchmark specification, equation (1), with actual vertical integration events replaced by the rumors and announced but not completed mergers.[12] This specification compares the average probability of links breaking outside of such events with the average break

[12]We do not count a merger as a rumor if it has been later announced and completed.

probability under a rumored vertical integration, and one with a competitor of the buyer. Table IX reports the results of these regressions. Links break slightly less often during rumored vertical integration with non-competitors of the buyer, and slightly more often (though not statistically significantly so) during rumored vertical integration with competitors. The point estimate of the coefficient on the "rumored vertical integration with competitor" dummy is certainly much lower that the corresponding point estimate in the benchmark regression with actual mergers (though note that the comparison is not straightforward: the dummy here is one at the rumor or announcement date, whereas it is one in Table V on the *completion* date).

Table IX—: Links are not more likely to break following rumors of M&A

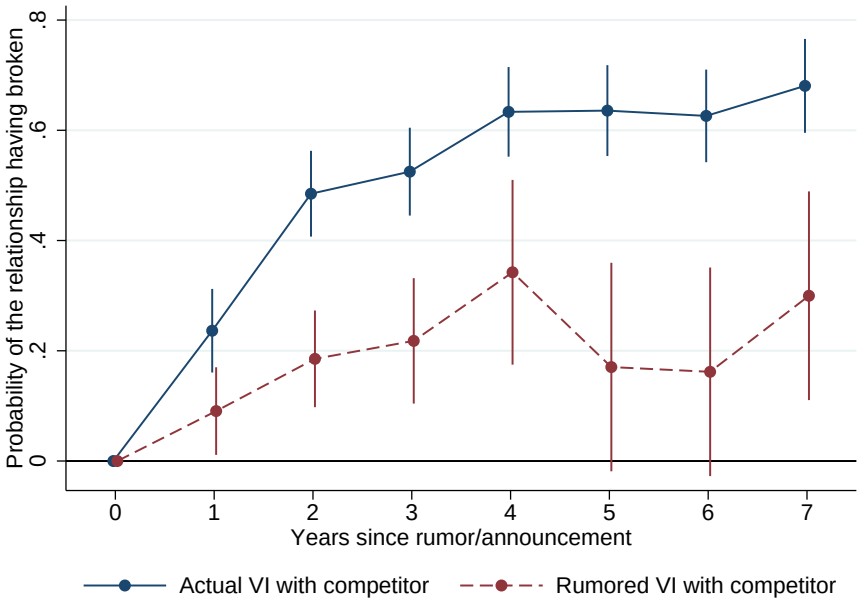
	Dependent variable: $\mathbb{1}\{\text{LinkBreaks}\}_{bst}$	
	(1)	(2)
Supplier v. integrates (rumor)	-0.030^{+}	-0.029^{+}
	(0.018)	(0.016)
Supplier v. integrates w. competitor (rumor)	0.031	0.020
	(0.039)	(0.035)
Controls		Yes
Relation FE	Yes	Yes
Buyer × Year FE	Yes	Yes
Industry Pair × Year FE	Yes	Yes
R^2	0.586	0.639
Observations	596656	596657

Note: Controls: number of upstream customers and competitors, age of the link, dummy indicating other links of the supplier breaking. Number of observations exclude singleton observations. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

To investigate more closely the timing aspect and to have the tightest possible comparison between actual and rumored/attempted mergers, we compare the break probability before and after actual mergers with buyers' competitors to the break probability before and after rumored/attempted mergers with buyers' competitors. In both cases we use the date of the announcement. More precisely, we run a regression of a binary variable that is one if the relationship is not active anymore on a set of dummies for the number of years since announcement, separately for actual and rumored mergers (and separately by whether the merger is with a competitor of the buyer), and including relationship, buyer × year, and sector-pair × year fixed effects.

Figure 5 shows the results. Following the announcement, break probabilities are substantially higher for actual than for rumored vertical mergers with competitors. Not only are relationships where there is a rumor about the supplier integrating with a competitor not more likely to break in the first period, but these relationships seem to be fairly long-lasting. To the extent that rumors and situations in which announced mergers are unsuccessful are a good comparison group to actual merger events, vertical integration and links breaking are unlikely to be driven by the same underlying unobserved shocks.

Figure 5: Probability of relationships breaking: actual vs rumored integration with competitor



Note: The figure shows coefficients on dummies capturing the years since a supplier's rumored (dashed red line) or actual (solid blue line) vertical integration, in a regression of the probability of a buyer-seller relationship being inactive on time-since-integration dummies (separately for rumored mergers with competitors, with non-competitors, and actual mergers with competitors, and with non-competitors) as well as relationship, buyer × year, and industry-pair × year fixed effects. Here, time zero is the time of the rumor or the announcement of the merger. We exclude rumors that are realized within three years.

3.4 Is foreclosure a merger motive?

The correlations presented above are consistent with theories of vertical market foreclosure. That said, even if the timing of a vertical integration of the supplier is exogenous, the party with whom the supplier integrates may not be unrelated to firm or market structure: an acquirer that senses a foreclosure opportunity may be willing to pay a premium, and is therefore more likely than alternative bidders to be the winning bidder.

To study whether vertical foreclosure is a merger motive, we run the regression

$$\begin{aligned}\mathbb{1}\{b \text{ integrates with } s\}_{bst} = \ & \alpha \mathbb{1}\{b \text{ has a competitor that is supplied by } s\}_{st} \\ & + \eta_{st} + \varepsilon_{bst} \end{aligned} \tag{3}$$

on the sample of active buyer-supplier relationships (b, s) at time t when the supplier s is undergoing a vertical integration with one of its customers. The coefficient α tells us whether buyers that have a competitor that is also a customer of the supplier are more likely to be the one that is integrating with the supplier — conditional on the supplier vertically integrating. These buyers potentially have a motive to foreclose their competitors.

Table X shows the results. The point estimate of α is positive and statistically significant. Given that the unconditional probability of being the integrating party in this sample is about three percent, having a foreclosure motive is associated with a roughly 55% higher probability of being the firm that integrates with the supplier. In column (2) we control for the buyer's

(log of one plus the) number of suppliers and competitors, which proxies for size and alleviates the concern that buyers with a competitor among the seller's customers are just those that are larger. In column (3) we include dummies for the buyer's industry times year, to control for industry-time-specific shocks. Neither of these controls affect the estimate of α much. Hence, firms that have a foreclosure motive (in the sense that s is also supplying their competitor) are more likely to be the integrating party at a time when s vertically integrates.

Table X—: Buyers with competitors that are also supplied by S are more likely to integrate with S

	Dependent variable: $\mathbb{1}\{\text{B and S integrate}\}_{bst}$		
	(1)	(2)	(3)
B has competitor supplied by S	0.017***	0.017**	0.017**
	(0.004)	(0.005)	(0.006)
Controls		Yes	Yes
Supplier × Year FE	Yes	Yes	Yes
Buyer Industry × Year FE			Yes
R^2	0.101	0.105	0.167
Observations	6812	6812	5960

Note: Sample consists of all active buyer-seller relationships at a time where the supplier vertically integrates with a buyer. Controls: number of buyer's competitors and suppliers. Reported number of observations is net of singleton observations. * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4 Impact on Foreclosed Firms

4.1 Impact on Sales

The results from the previous section show that buyer-seller relationships are more likely to break when the seller is vertically integrating with a competitor of the buyer. The obvious next question is: does it matter? If the input market is frictionless and perfectly competitive, the cost to losing a supplier is zero (of course, in such a situation there is no foreclosure motive at all). If, on the other hand, the use of outside suppliers is associated with a higher variable cost, then the loss of the supplier will push the buyer along the demand curve to a point where the firm operates at a lower scale.

We now study the response of firm sales to events where (1) a supplier of the firm vertically integrates; (2) a supplier of the firm vertically integrates with a competitor of the firm. Specifically, we estimate the equation

$$\begin{aligned} \log Sales_{bt} = \; & \alpha \mathbb{1}\{\text{A supplier vertically integrates}\}_{bt} \\ & + \beta \mathbb{1}\{\text{A supplier integrates vertically w. competitor of } b\}_{bt} \\ & + \eta_b + \mu_{it} + \varepsilon_{bt} \end{aligned} \tag{4}$$

where η_b is a buyer fixed effect, and μ_{it} is an industry × year fixed effect.

The first two columns of Table XI show the results. In a year where a supplier of the firm is integrating with a non-competitor, the firm's sales are slightly higher; if the integration happens with a competitor, the sales are slightly lower than average. But this small coefficient is masking a lot of heterogeneity. Columns (3) and (4) interact the dummy for vertical integration with a competitor with a variable capturing the number of other suppliers from the same 3-digit sector as the supplier that the firm is being cut off from (at the time of the integration). This means that the coefficient on the "integration with competitor" variable now captures the average sales response for a firm that does not already have any "alternative" suppliers in the sector where it loses the supplier.

Columns (3) and (4) of Table XI show that the point estimates of this coefficient are large and negative: firms that are cut off from a supplier that they do not have an alternative to are suffering a large drop in sales. On the other hand, the presence of alternative suppliers mitigates the sales impact. Note that the sales loss may capture both a movement along the demand curve due to higher variable costs, as well as a potential loss of market share due to the competitor experiencing cost reductions after the vertical integration. At the same time, we see the sales drop only when a supplier vertically integrates with a competitor – so unless the cost reductions are particularly taking place in vertical integration episodes with the buyer's competitors, it is unlikely that this channel plays a major role in driving the buyer's sales response.

Figure 6 shows an event study graph around the time of vertical integration of a supplier with a non-competitor (dashed red line) and with a competitor, for firms that have no alternative suppliers (solid blue line). We see that in cases where the supplier is vertically integrating with a competitor, firms' sales are substantially lower if they do not have alternative suppliers.

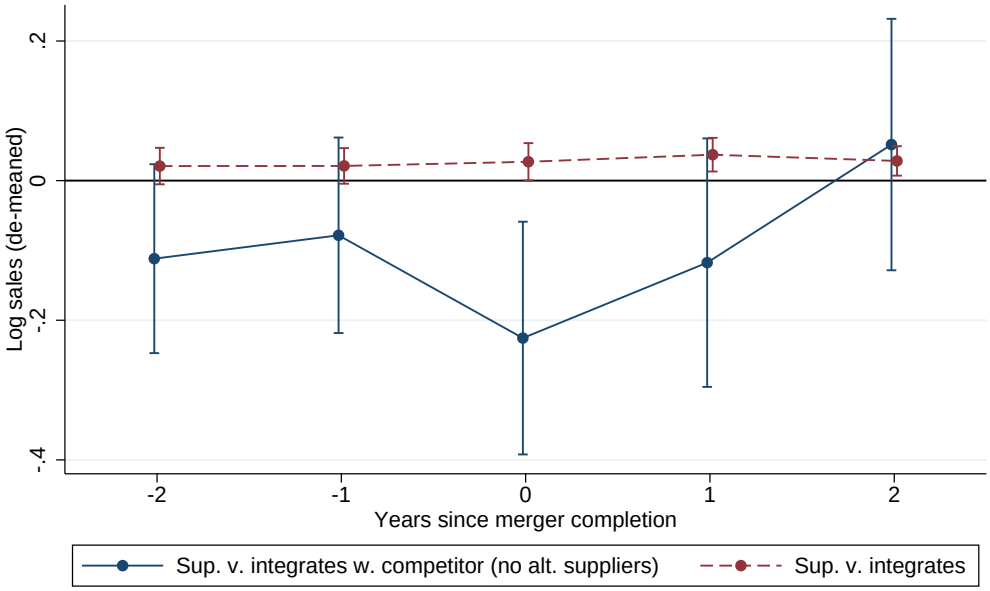
Table XI—: Impact on buyer's sales

	Dependent variable: Log sales			
	(1)	(2)	(3)	(4)
Supplier v.integrates	0.042**	0.018^{+}	0.042**	0.018^{+}
	(0.010)	(0.010)	(0.010)	(0.010)
Supplier v. integrates w. competitor	-0.038	-0.052^{+}	-0.137*	-0.143*
	(0.031)	(0.030)	(0.060)	(0.058)
$\times$ $log(1 + \#$ alt. suppliers)			0.043*	0.040*
			(0.017)	(0.017)
Buyer FE	Yes	Yes	Yes	Yes
Industry $\times$ Year FE	Yes	Yes	Yes	Yes
Controls		Yes		Yes
Observations	77,202	77,202	77,202	77,202
R^2	0.98	0.98	0.98	0.98

Note: Controls: number of customers, competitors and suppliers. Robust standard errors, clustered at the firm level, are in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

Table XII shows the impact on firm size, as measured by employment. The results are similar to sales, though somewhat smaller (about half of the percentage-wise effect on sales)

Figure 6: Timing of the correlation of buyers' log sales with vertical integration of a supplier



Note: The figure presents the results of estimating equation 4 with two leads and lags for both $\mathbb{1}\{\text{A supplier integrates vertically w. competitor of } b\}_{bt}$ and $\mathbb{1}\{\text{A supplier integrates vertically}\}_{bt}$. Confidence intervals are calculated using robust standard errors clustered at the firm level.

and not statistically significant.

Table XII—: Impact on buyer's employment

	Dependent variable: Log employment			
	(1)	(2)	(3)	(4)
Supplier v.integrates	0.028**	0.009	0.029**	0.009
	(0.010)	(0.010)	(0.010)	(0.010)
Supplier v. integrates w. competitor	-0.014	-0.028	-0.077	-0.086
	(0.053)	(0.052)	(0.100)	(0.098)
$\times\ log(1 + \#$ alt. suppliers)			0.027	0.025
			(0.024)	(0.024)
Buyer FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Controls		Yes		Yes
Observations	70,983	70,983	70,983	70,983
R^2	0.98	0.98	0.98	0.98

Note: Controls: number of customers, competitors and suppliers. Robust standard errors, clustered at the firm level, are in parentheses. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

4.2 Can synergies account for breaking supplier links?

One potential alternative explanation of our finding that vertical relations are more likely to end when the supplier vertically integrates with the buyer's competitor is that there are very strong synergies from the merger. If synergies give the integrated downstream firm a large cost

advantage, the unintegrated downstream competitor may be forced to exit the product market, which may lead it to cut its ties to the upstream firm.

If this explanation was driving our results, however, we would expect that vertical integration would adversely affect the market shares of all downstream firms in the industry, including competitors that did not have a supplier relationship with the integrating upstream unit. Table XIII shows results from a regression of log firm sales on a dummy that is one if the firm has a competitor in that year that vertically integrates (and firm and industry × year fixed effects, as well as the set of controls from above). We find no statistically significant correlation between a competitor vertically integrating and a change in firm sales. This stands in contrast to the situation that we looked at above, where a competitor is vertically integrating with the buyer's supplier, and where we observed a drop in firm sales.

Table XIII—: Impact of vertical integration on competitors' sales

	Dependent variable: Log sales			
	(1)	(2)	(3)	(4)
A competitor v.integrates	0.017	-0.020		
	(0.024)	(0.023)		
$max(t, t-1)$			0.005	
			(0.023)	
$max(t, t-1, t-2)$				0.023
				(0.023)
Buyer FE	Yes	Yes	Yes	Yes
Industry × Year FE	Yes	Yes	Yes	Yes
Controls		Yes	Yes	Yes
Observations	118,700	118,700	118,700	118,700
R^2	0.94	0.94	0.94	0.94

Note: The variable in the second (third) row is a dummy that is one if a competitor has undergone a vertical integration in the current or last year (current or last two years). Controls: number of customers, competitors and suppliers. Robust standard errors, clustered at the firm level, are in parentheses. The number of observations is larger here than in Table XI because we have more firms with sales data that have competitor relationships than firms with supplier relationships. $^{+}$ $p < 0.1$, * $p < 0.05$, ** $p < 0.01$.

These results are in line with the findings of Blonigen and Pierce (2016), who study the effect of mergers and acquisitions on physical productivity and markups of U.S. manufacturing establishment. They use a similar dataset of public and private mergers and acquisitions, and find no effect of physical productivity of integrating plants, but a significant increase in markups. While their data allows for a much more direct investigation of the productivity effects of mergers and acquisition than our indirect results on competitor's sales, the results support the view that much of the impact of M&A is to reduce competition, and little to increase economic efficiency.

4.3 Discussion

Even if the vertical foreclosure is taking place in some of the cases we studied, the overall welfare consequences are not necessarily negative, in particular because consumer prices might fall due to increases in productivity or changes in competition. Frictions in firm-to-firm markets are likely to impose additional transaction costs, which will be reflected in the prices paid by final consumers. A full structural analysis of the welfare cost of vertical foreclosure across a broad range of industries is beyond the scope of this paper, but we view our reduced-form evidence as a first step in this direction.

Having read newspaper coverage and SEC filings related to some of the potentially foreclosing mergers and acquisitions, we find it plausible that in many of these cases the integrating firms are not directly cutting off the competing downstream firm. The documents filed by the integrating firms typically emphasize that existing contracts with customers of the upstream firm will be honored. In some cases, however, firms also state that clauses in these contracts allow the customers to withdraw from the agreement. Upon integration, customers of the integrating supplier may find themselves wanting to break the relationships because continuing the relationship would be associated with a strategic disadvantage on the output market.[13] But even if these customers initiated the break, foreclosure is taking place when they have been hurt by the integration.

As an example, consider the acquisition of hard drive disk platter producer Komag by its customer Western Digital (WD) in 2007. Komag had also been supplying WD's rivals Seagate, Maxtor, and Hitachi, and these relationships ceased after integration. In a conference call with market analysts, a senior executive from WD said about Komag's future relationships with their existing customers: "[...] we are prepared to provide all customers with the committed volumes outlined in their existing volume purchase arrangement. However, customers will determine their [input] requirement. Therefore, there could be a significant reduction in volume from those customers [...]." (Securities and Exchange Commission, 2007).

5 Conclusion

This paper presents results that suggest that vertical foreclosure along the extensive margin is occurring among large firms – and across a range of sectors in the economy. Vertical relationships are much more likely to break when the supplier is integrating with a competitor of the buyer, than when the supplier is integrating with an unrelated party. Depending on market structure, the firm that integrated with the supplier may have an incentive to prevent its competitor from continuing to purchase from the supplier. We find that this higher hazard rate for links breaking remains statistically significant when only considering integration events that occur after exogenous downward pressure on the suppliers' stock price. Rumored integration that never takes place is not associated with higher hazard rate. We find that on average firms

[13] Such as strategic disadvantage may arise through the revelation of information to the competitor. See, e.g. Hughes and Kao (2001).

whose supplier vertically integrated with one of their competitors experience a temporary drop in sales. This sales drop is lower for firms that have relationships with other suppliers from the same industry in place.

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A Data Sources and Definitions

We combine three components to construct the database used in this paper:

- A production and competitor network between large firms from FactSet Revere
- A comprehensive M&A database, Bureau van Dijk's Zephyr, with information on deals and rumors about deals
- Company financials and industry classifications from Bureau van Dijk's Orbis, Compustat and FactSet Fundamentals

This appendix describes each of the data sources as well as the key variables we derive from them.

A.1 FactSet Revere supply chain data

Content and data sources

FactSet is a commercial data provider that mainly targets companies in the financial services sector. Its supply chain data provides information on the nature and duration of relations between firms. To the best of our knowledge, this is the first paper in the economics literature using these data.

FactSet collects information on relations from primary public sources such as SEC filings, investor presentations, corporate actions, company websites and press releases. For each firm, FactSet conducts an annual review to update the database. In addition, press releases and corporate actions are monitored daily for US firms.

Table XIV—: Number of relationships in raw FactSet data

	Frequency	Percentage
Supplier	114,136	12.71
Competitor	197,423	21.98
Customer	290,893	32.38
Partner: Distribution	24,725	2.75
Partner: Equity investment	53,602	5.97
Partner: Production	12,737	1.42
Partner: Investor	48,244	5.37
Partner: Joint-Venture	29,845	3.32
Partner: Licensing	37,083	4.13
Partner: Marketing	16,296	1.81
Partner: Other	876	0.10
Partner: Research Collaboration	46,273	5.15
Partner: Technology	26,189	2.92
Total	898,322	

Note: Frequency table of the raw number of relations in the relationship dataset from which we construct the firm network. In the final dataset, companies providing paid distribution, production, marketing and licenses are counted as suppliers.

Each relation between two companies is dated with a start date at which the relation was first recorded by FactSet and with an end date at which it was noticed that the relation no longer existed. In addition, each relation is categorized into buyer links, supplier links, competitor links or partnerships. These broad categories are detailed into 13 subcategories (see Table XIV). We use these categories to define two types of networks:

- Buyer-supplier network: a directed graph on which an edge is created when the target company is a supplier of the source company, i.e. at least one of the following is true:
  - the source company discloses the target company as a supplier of products or services
  - the target company discloses the source company as a customer of products or services
  - the target company provides paid manufacturing, distribution or marketing services to the source company
  - the target company licenses products, patents, technology or IP to the source company
- Competitor network: an undirected graph on which an edge is created if at least one of the two company discloses the other one as a competitor

We do not include the partnership links provided by fact set for our analyses (Joint ventures, Equity stakes, research collaborations and integrated product offerings).

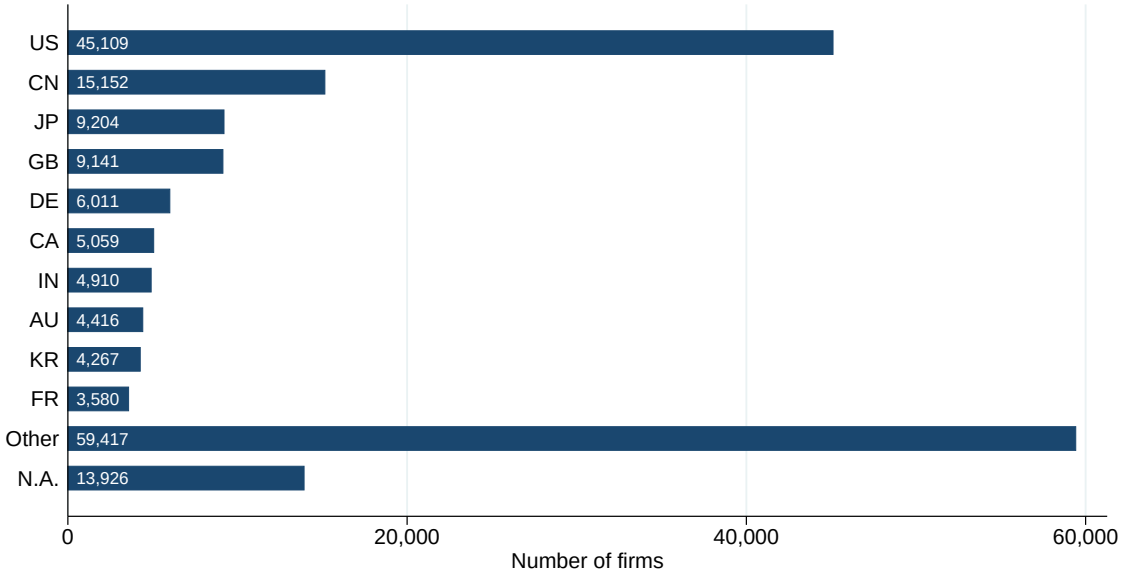
Finally, many relations are also provided with a few keywords explaining the links, though not in a fully systematic fashion. Companies can have multiple links, for instance in order to document that a supplier is also in competition with a given customer.

Coverage

The data contain 180,192 mostly large, publicly traded firms. FactSet determines coverage mainly based on membership of firms in large stock indexes. The provider aims to cover all companies listed in a set of global indexes, such as the FTSE Global All Cap, Russel Global, Stoxx Global and a range of global MSCI indexes. In addition, all US-based publicly traded firms are targeted as well as companies that are part of multiple local and regional stock market indexes, i.e. large non-US multinationals. FactSet achieves high but not complete coverge of the indexes. For example, 90.3% of the firms in MSCI ACWI All Cap have relationship information, 95.4% of the S&P 500 and 94.5% of the Russell 3000. While these coverage rules favor large listed firms, there are many smaller and non-listed firms in our sample because they deal with large firms.

Coverages varies by country. Figure 7 breaks down the number of firms in the database by the country of their headquarters. Consistent with the fact that FactSet originally only covered US firms, about a quarter of the firms is based in the US. Due to efforts to expand the database internationally starting in 2007, and because of foreign firms trading with US firms, international coverage goes well beyond large multinationals.

Figure 7: Number of firms by country



Note: The figure reports the number of firms in the FactSet database by country of headquarter.

While the database is not representative even of the universe of US firms, it does contain a wide range of industries. Figure 8 reports the number of firms in the sample by a high-level aggregation of NAICS industry codes. Various forms of manufacturing, especially machinery manufacturing, make up the largest sector in the dataset. It is followed by financial services and insurances, then by professional services.

FactSet documents the reasons for a company no longer being covered in its data base rather well. In particular, the data allow to identify the successor company in the case of a complete merger or acquisition so that links are not mechanically breaking at acquisition.

The coverage period of FactSet Revere starts in 2003 and has been gradually expanded over time (Figure 9). International firms were included in the coverage starting in 2007.

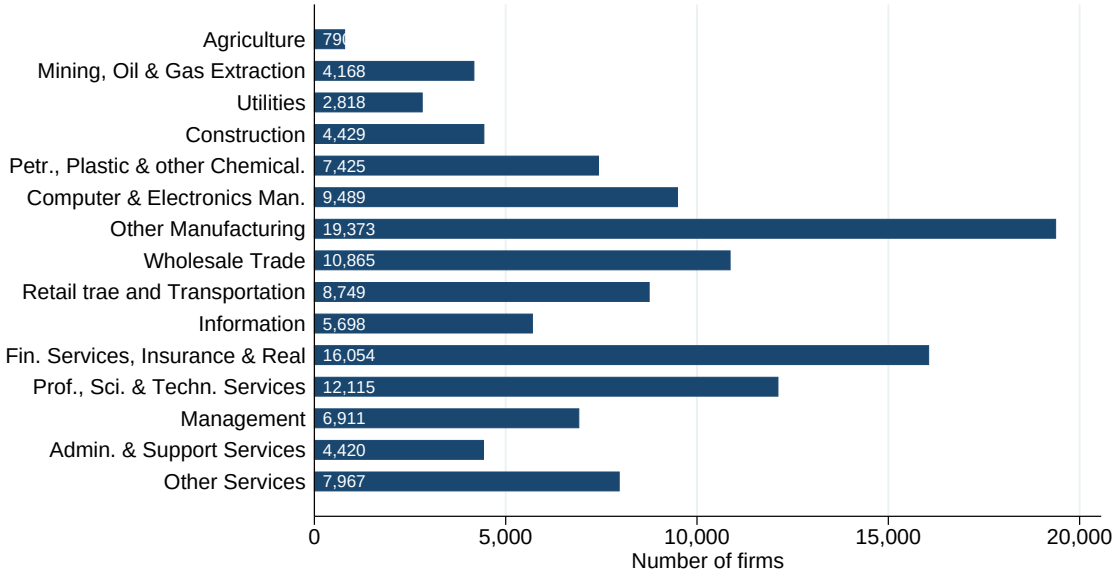
Key variables

We annualize the relationship data in order to facilitate the matching with the company financials. A relation of any kind is counted as active in a given year if there is at least one day between start date and end date of the relation that falls into that year. The result is a panel of relations that is identified by source company, target company and year.

Buyer-supplier link breaks: A key variable defined at the relationship level is a dummy variable indicating whether a buyer-supplier relation ended in a given year, the main outcome variables of our extensive margin analysis. It is set to one if and only if (i) the relation was active in the previous year but is no longer active and (ii), in case buyer and/or supplier were involved in a merger or acquisition, there is no active link between the successor company or acquiror and the buyer or supplier. The second condition rules out purely mechanically breaks in the supply chain that could result from mergers and acquisitions.

We set this variable to missing in a few cases to avoid other possible mechanical breaks.

Figure 8: Number of firms by industry



Note: The figure reports the number of firms in the FactSet database by primary industry classification.

If a buyer has dropped out of coverage and, in case of a merger or acquisition, the successor company or acquiror is not covered by FactSet in the current year, then its relations are not counted as breaking. This is to rule out that we erroneously count a link as broken purely because a firm is no longer covered. We also count the variable as missing when the buyer and the supplier in the given relation are integrating.

A.2 Zephyr M&A data

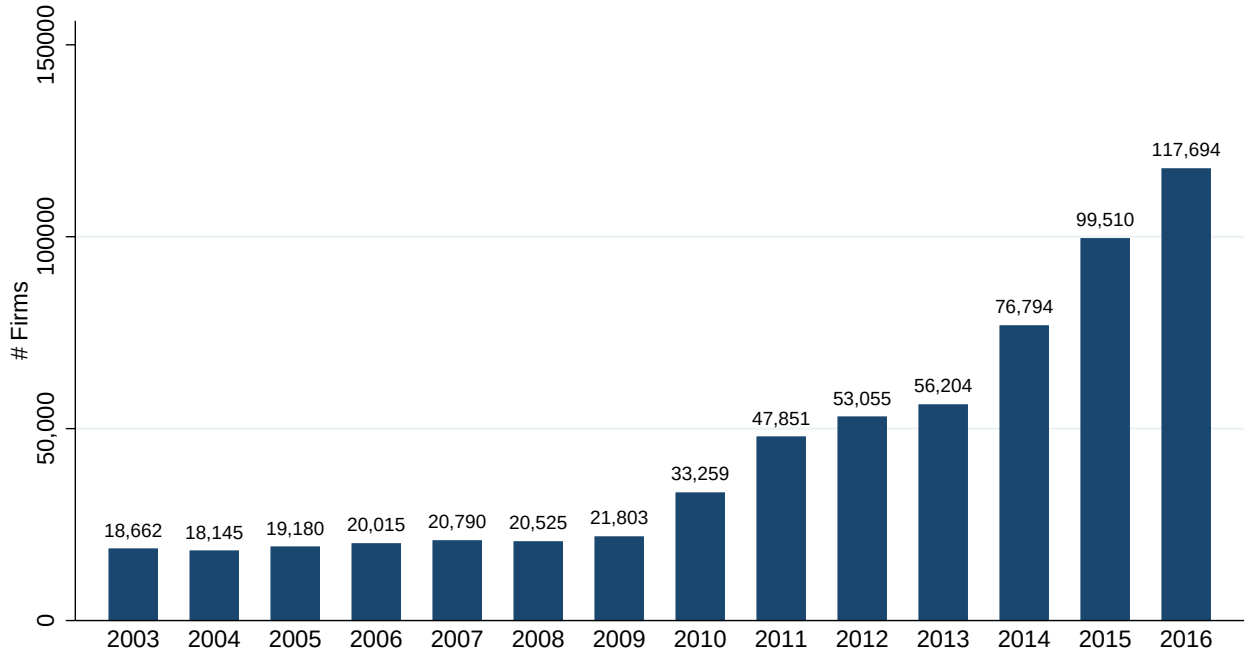
We use Bureau van Dijk's Zephyr database for information on mergers and acquisitions. Zephyr records deals and rumors about deals for mergers and acquisitions in which at least a 2% stake in the target company changes owners and the value of the deal exceeds GBP 1M. For an overview of Zehphyr's content, coverage and how it compares to other M&A databases, see Bollaert and Delanghe (2015). For the sake of brevity, we refer to any merger or acquisition simply as merger in the following.

Matching and merging with other data sources

Zephyr reports the exact dates of rumors, announcements and (expected) completions or withdrawals of mergers. Analogously to the FactSet data, we convert these data to a panel of merger events, where each observation is identified by the target firm, the acquiring firm and the calendar year of the completion date for completed mergers or the year of the rumor for mergers that were rumored but never completed.

We match firms in the FactSet and Zephyr databases using security identifiers such as CUSIP or ISIN as well as Ticker names wherever possible. For the remaining firms we use a string matching tool provided by Bureau van Dijk that takes into account company names and,

Figure 9: Number of firms over time



Note: The figure presents the number of firms in the FactSet database by year.

where available, addresses.

Table XV—: Types of mergers and acquisitions

	Vertical		Horizontal		Both		Unrelated		Total	
	Count	%	Count	%	Count	%	Count	%	Count	%
Partial acquisitions	46	5.8	51	6.4	8	1.0	694	86.9	799	100.0
Full acquisitions & mergers	132	4.4	568	18.9	69	2.3	2,231	74.4	3,000	100.0
Total	178	4.7	619	16.3	77	2.0	2,925	77.0	3,799	100.0

Note: Number of partial and full mergers and acquisitions by presence vertical and horizontal relation between the merging parties (2003-2016). Partial acquisitions exclude minority stakes.

Table XV breaks down the mergers and acquisitions between firms in the matched sample by the type of their relation in the network. In addition to vertical mergers, the data allow us to identify horizontal mergers and mergers that are both horizontal and vertical in nature. In our analyses, however, we focus on integrations that have a vertical dimension to them.

Table XVI reports summary statistics about buyer-supplier relations where the supplier was vertically integrating or rumored to be vertically integrating with a competitor of the buyer. While the buyers in both groups are quite comparable, it seems that rumors involve suppliers that are on average somewhat larger than those suppliers which actually undergo integration. Note that we control for these differences in our regressions and also do not find a differential effect for larger or smaller suppliers.

Table XVI—: Treated buyer-supplier relations and placebo counterparts

	Vertical M&A with Comp.		
	Actual M&A	Rumored M&A	Difference
New relationships	0.10	0.14	0.04
Ending relationships	0.51	0.16	-0.35***
Buyer's suppliers	71.00	78.09	7.10
Supplier's buyers	27.55	48.19	20.64***
Buyer's competitors	68.24	68.28	0.04
Supplier's competitors	19.58	36.14	16.56***
Age of relationship	3.51	3.98	0.47
Sales (log m$): Buyer	8.26	8.96	0.70**
Sales (log m$): Supplier	6.92	8.77	1.86**
Sales (log m$): Competitor	9.33	9.78	0.45**
Log Employment: Buyer	9.23	9.84	0.61*
Log Employment: Supplier	6.79	9.46	2.68**
Log Employment: Competitor	10.32	9.86	-0.46*
N	207	221	428

Note: Summary statistics for the buyer-supplier-years for which suppliers are involved in a vertical M&A-transaction with a competitor of the buyer.

Key variables

With the firm network and the merger information in place, we construct our main explanatory variables. For ease of exposition, for a given buyer-supplier-year observation, we refer to the buyer as firm A, to the supplier as firm B and to a firm that merges with the supplier as firm C.

Supplier vertically integrates: We construct a dummy variable that is equal to one at the buyer-supplier-year level if firm B is involved in a merger with firm C which is also a customer of B. We restrict attention here to full mergers and acquisitions in the sense that the stake of the acquirer after the acquisition is 100% but was either zero or unknown before. Firm B can be either the acquirer or the target in the M&A with firm C. Note that we only count mergers as vertical if there was an active buyer-supplier relationship between B and C in the year of integration.

Supplier vertically integrates with buyer's competitor: This dummy variable is equal to one at the buyer-supplier-year level if firm B and C are merging, B is an active supplier of C in that year and A and C have an active competitor relationship in that year.

For the placebo analyses we construct the same variables again using rumored mergers instead of actual mergers. These rumors come from "unconfirmed reports", which "may be in the press, in a company press release, or elsewhere" (Bureau Van Dijk, 2017). They may indeed come from announcements by one of the involved firm as long as the other firms have not yet confirmed the announcements. In the Zephyr database, this corresponds to deals for which the variable *deal status* is "Rumour". The timing of these events differs slightly: instead of the completion date (which is unavailable), we use the rumor date. In general however, there is little time elapsing between a rumor and the completion of a deal: 145 days on average and

about 92% of rumors which turn out to be true are realized within a year. For our placebo analyses, we exclude all rumors that materialize within three years.

A.3 Company financials and industry classifications

To achieve best possible coverage of company financials and industry classifications for the firms in our supply chain network, we use combine data from Orbis, Compustat (Wrds) and FactSet Fundamentals. The combination of the various data sources is necessary in particular because of varying coverage over time. While we have supply chain and merger information available from 2003 to present, Orbis data is only available to us from 2007 onwards. In contrast, Compustat and FactSet Fundamentals are available for earlier years as well.

Matching and merging with other data sources

As with the Zephyr database, we first match all firms for which securities identifiers are available. As Zephyr and Orbis share the same identifier, matching these data sources is straightforward. For the remaining firms and data sources we use the company names for string matching.

For firms where financials are available from multiple data sources, we only retain the information from the data source that provides the longest coverage of the sales variable of that firm. Hence, all of a given firm's financial information always come from the same data source in order to ensure consistency over time and across items. Wherever ties occur, preference is given first to FactSet Fundamentals, then to Orbis. Note that the variables from several datasets are almost perfectly correlated for the observations where we do have overlaps in coverage.

Key variables

Sales: The sales data are contained in the variables "ff_sales" in FactSet Fundamentals, "sales" in Orbis and "sale" in Compustat. Orbis reports all financials directly in USD, the sales data from the other data sources we convert to USD where necessary using exchange rate information included in those datasets. A few firms in the data exhibit unusual sales trajectories that seem to suggest reporting or data entry issues. In order to rule out that our results are driven by such observations, we exclude firms whose sales growth falls into the first or 99th percentile in one or more years.

employment: The number of employees is contained in the variables "ff_emp" in FactSet Fundamentals, and "emp" in Orbis and Compustat. We use these variables without further processing.

NAICS codes: From Orbis and Compustat we can also retrieve NAICS industry codes ("naics_primary" and "naics_secondary" in Orbis, "naics" in Compustat). When several NAICS codes are available, we restrict attention to the primary one for clustering or aggregation.

A.3.1 Mutual fund capital outflow instrument

To construct the MFHS instrument, we follow Appendix C of Dessaint et al. (2016). We construct quarterly capital net outflows of US mutual funds using the CRSP mutual funds data, and the hypothethical stock sales following large outflows using the funds' portfolio data in CDA Spectrum/Thomson. We match funds using the crosswalk provided by WRDS.