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Abstract

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Supply Chain Risk: Changes in Supplier Composition and Vertical Integration

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Keywords: Supply chains; textual analysis; vertical integration; competition

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Production relies on global and complex supply chains, which have often been optimized to reduce costs. Major events, such as the Sino-American trade war, the Covid-19 pandemic, the Suez-canal accident, or the 2011 Japanese earthquake, tend to disrupt supply chains and production. Existing literature has widely documented that even small negative shocks are transmitted to firms upstream and downstream (Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi, 2012; Barrot and Sauvagnat, 2016; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2020).

However, even though both the academic literature and recent events highlight that supply chains shocks are an important source of disruption, we know little about whether firms systematically update their investors about this source of risk. We are also unable to quantify its effects on corporate policies. Concerns have been raised that due to the complexity of supply chains, firms are often unaware of the supply chain risks their suppliers are subject to (Choi, Rogers, and Vakil, 2020) and may consequently not be able to manage this source of risk.

Quantification of the supply chain risk faced by different firms and how this varies over time would be important, but it is extremely challenging because supply chain risk comes from many sources and multiple channels. For instance, firms may be indirectly exposed if their suppliers face bottlenecks. Similarly, firms may be exposed through their customers if downstream firms are unable to source complementary inputs and are forced to limit production. Furthermore, commercial data sources mainly focus on big customers and suppliers, providing limited coverage on the potential source of shocks over the supply network. While these data sources may be useful for quantifying the effects of shocks propagation, they do not allow us to gauge how firms perceive the supply chain risk and whether and how they adapt their strategies to mitigate supply assurance concerns.

Our objective in this paper is to develop a proxy for supply chain risk, that is, the second moment of any shocks related to supply chain, using textual analysis, while controlling for supply chain shocks. Our newly developed measure enables us to study which firms are mostly affected by supply chain risk and the extent to which supply chain risk affects firms' policies and industrial structure.

To shed light on these issues, we perform a textual analysis of earnings calls to construct measures of the first two moments of supply chain shocks faced by US listed companies, using a methodology introduced by Hassan, Hollander, Van Lent, and Tahoun (2019) to quantify firm-level political risk. We measure the first moment of supply chain shocks as the sentiment of supply chain discussions and the second moment, supply chain risk, using the discussion of supply chain issues related to words capturing risk and uncertainty.

We start by quantifying the extent to which supply chain is an important source of risk for firms and how this risk varies in response to various events. We then use our proxy for supply chain risk to evaluate how firms manage this source of risk.

Supply chain sentiment turns negative and supply chain risk increases on average in conjunction with events that are known to have disrupted supply chains, such as the 2011 Japanese earthquake and the Thai floods (Haraguchi and Lall, 2015; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2020). The increase in supply chain risk and drop in supply chain sentiment appear unprecedented during the Covid-19 pandemic.

However, even though macroeconomic shocks matter, the way firms discuss supply chain risk appears to be highly idiosyncratic. Most of the variation in supply chain risk is explained by firm-specific shocks rather than time- or industry-specific shocks. This may largely depend on the fact that firms with different characteristics appear to have different exposures to supply chain risk.

Supply chain risk appears to be higher for firms that have suppliers in different continents and are small relatively to their suppliers suggesting that they have limited bargaining power. Firms that have many suppliers in a given industry are less exposed to supply chain risk, suggesting that hold up problems magnify supply chain uncertainty. Large firms, possibly having more complex supply chains, are more exposed to supply chain risk.

Next, we investigate what actions firms take to manage supply chain risk. First, firms appear to actively manage supply chain risk by investing more and increasing the number of their suppliers. This finding is consistent with the theory of Elliott, Golub, and Leduc (2020), which predicts that firms will increase investment and multisource to reduce their dependence on specific suppliers and to minimize the risk of production disruption. We also look at the characteristics of new suppliers and show that firms that communicate more uncertainty about their supply chain establish relationships with suppliers that can be considered industry leaders and with nearby suppliers. Increasing investment and establishing relationships with geographically closer suppliers and firms that are industry leaders indicate that firms put effort in increasing the reliability of their supplier network.

In addition, we find that supply chain risk affects the boundaries of the firm and industrial structure. Firms that report high supply chain risk are involved in more vertical M&As indicating that they tend to acquire customers and suppliers. Financial constraints limit firms' ability to perform M&A, potentially hampering their long-term competitive advantage.

Interestingly, supply chain sentiment, which is presumably more closely related to the negative effects of any shocks affecting a firm's suppliers have different or no effects on corporate policies, supplier compositions, and vertical M&As. This is consistent with Ersahin, Giannetti, and

Huang (2021), who find that supply chains are overall stable following negative idiosyncratic shocks and suggest that financially flexible firms react when uncertainty increases.

Our results are robust to a battery of tests and alternative specifications. First, we show that the change in corporate policies is driven by supply chain risk and not by supply chain sentiment. Second, results are robust if we control for firm level measures of political risk and climate risk, which are constructed with similar techniques and have been shown in previous literature to affect firms' policies (Hassan, Hollander, Van Lent, and Tahoun, 2019, 2020a, b; Sautner, Ven Lent, Vilkov, and Zhang, 2021). These findings indicate that our measure of supply chain risk captures a different source of shocks. More importantly, while firms appear to decrease investment when they face political risk, they do not do so, but rather invest by acquiring customers and suppliers, when uncertainty arises from availability of inputs.

Finally, we address the concern that firms may discuss supply chain risk to justify vertical M&As and changes in their supplier composition. Thus, instead of using our textual measure of supply chain risk, we show that M&As with customers and suppliers as well as the number of suppliers that are geographically closer or industry leader increased following the Great East Japan earthquake and the Thailand flood, that is in periods in which exogenous shocks disrupted supply chains increasing firms' risk perceptions.

Our work is related to several strands of the literature. First, we contribute to the literature on the boundaries of the firm. Production is believed to be coordinated within a firm, rather than through the market, when transaction costs and hold up problems are severe (Coase, 1937; Klein, Crawford and Alchian, 1978; Grossman and Hart, 1986). A more recent strand of this literature focuses on global supply chains and explores the effects of demand and technological characteristics for the decision to integrate different stages of production (e.g., Antras and Chor,

2013; Alfaro, Antràs, Chor, and Conconi, 2019). While it is well recognized that mergers favor collaboration especially in innovative industries (Bena and Li, 2014; Hsu, Li, Liu, and Wu, 2021), there are few empirical studies exploring vertical mergers. Existing work focuses on the role of industry shocks (Ahern and Harford, 2014), cash-flow uncertainty (Garfinkel and Hankins, 2011), and R&D incentives (Fan and Goyal, 2006; Fresard, Hoberg, and Phillips, 2020).

The role of supply chain risk in vertical integration decisions, first highlighted by Williamson (1971), has been largely neglected, even though theoretically, supply assurance concerns are known to affect the decision to integrate vertically (Bolton and Winston, 1993). To the best of our knowledge, we are the first to show empirically that supply chain risk can be a driver of vertical integration.

Second, from a methodological point of view, we contribute to a nascent literature that uses textual analysis to measure risk and uncertainty. The most prominent contributions relate to measures of political risk (Baker, Bloom, and Davis, 2016; Hassan, Hollander, Van Lent, and Tahoun, 2019). Textual analysis has also been widely used in measuring climate risk and climate risk disclosure (Sautner, Ven Lent, Vilkov, and Zhang, 2021; Li, Shan, Tang, and Yao, 2021). To the best of our knowledge, we are the first to construct a textual analysis measure of supply chain risk.

Finally, the literature on networks highlights the importance of complementarities between different phases of the production process (Kremer, 1993). While empirical work typically studies the consequences of negative realizations of supply chain risk, recent theories acknowledge that companies' decisions to diversify the source of inputs reflect disruption risk in a way that is not necessarily socially optimal (Bimpikis, Fearing, and Tahbaz-Salehi, 2018). To the best of our knowledge, we are the first to develop a proxy for supply chain risk and explore how firms manage

their supply chains in response to this source of risk. This contrasts with previous literature that typically takes the supply chain as given and explores how shocks are transmitted given current customer supplier links focusing on natural disasters (e.g., Barrot and Sauvagnat, 2016; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2020), credit shocks (Alfaro, Garcıa-Santana, and Moral-Benito, 2021; Costello, 2020), data breaches (Crosignani, Macchiavelli, and Silva, 2021), or pandemic closures (Bonadio, Huo, Levchenko, and Pandalai-Nayar, 2021). Using our newly developed proxy for supply chain risk, we capture firm level perceived supply chain uncertainty potentially arising from any of the above shocks, while controlling for supply chain negative shock realizations using supply chain sentiment.

1. Data Sources

We combine a variety of data sources. First, we collect 194,561 transcripts of conference calls held in conjunction with an earnings release (hereafter, earnings calls) held by 5,723 public firms listed in the United States from 2002 to 2020 through Refinitiv Eikon database to construct our firm-level proxies for the first and second moments of supply chain shocks. Firms generally hold quarterly earnings conference calls to inform investors and analysts about the firm's performance. Presentation by the management is followed by a question-and-answer session. Conference calls have been widely used to construct proxies for corporate culture (Li, Mai, Shen, and Yan, 2021) as well as to quantify firms' exposure to political risk (Hassan, Hollander, Van Lent, and Tahoun, 2019), Covid-19 (Hassan, Hollander, Van Lent, and Tahoun, 2020a), Brexit (Hassan, Hollander, Van Lent, and Tahoun, 2020b), and climate risk (Sautner, Ven Lent, Vilkov, and Zhang, 2021; Li, Shan, Tang and Yao, 2021). We construct our proxies using the entire

conference call including both the presentation and the question-and-answer session, following the approach introduced by Hassan, Hollander, Van Lent, and Tahoun (2019).

Second, we obtain information on supply chains from Factset Revere, including specific supplier-customer pairs and their locations. Factset Revere collects relationship information from primary public sources such as SEC 10-K annual filings, investor presentations, and press releases, and classifies the relationship types. Factset Revere spans the period 2003 – 2020 and limits our sample period. On average, for the sample firms we observe 8 suppliers and 10 customers.

Third, we use the Securities Data Company (SDC) U.S. Mergers and Acquisitions database for mergers and acquisitions (M&A). To identify whether the target and the acquirer are in vertically related industries, we use the Bureau of Economic Analysis's (BEA) Input-Output tables which provide the dollar flow of goods and services between producing and purchasing industries. Our objective is to explore whether vertical integration is more likely to arise when supply chain risk increases and bottlenecks may arise due to the delayed delivery of any input, regardless of its cost relative to other inputs used in the production process. We thus use the links between industries, regardless of the size of the flows between industries.

Finally, we use Compustat for firm-level variables. We construct outcome variables, including inventory, sales growth, capital expenditure, and employment, to measure firm policy changes in response to supply chain risk. We also construct control variables including size, Tobin's Q, cash holdings, and cash flow and Whited-Wu (2006) and Hadlock and Pierce (2010) financial constraints measures.

Table 1 summarizes the main variables that we introduce as we progress with the analysis. All variables are defined in Appendix A.

2. Measuring Supply Chain Sentiment and Risk

Empirical analysis of supply chain related topics typically relies on specific customer-supplier linkages available from corporate filings and commercial datasets. These sources reveal the most important customers and suppliers of a company and have allowed in-depth analysis of how negative shocks such as natural disasters and liquidity shocks are transferred to customers and suppliers.

In contrast to previous literature that documents how negative or occasionally positive shock realizations spread, we aim to quantify uncertainty on the reliability of the supply chain. Quantifying the uncertainty associated with the reliability of supply chains using major customers and suppliers is, however, more challenging. First, large companies have thousands of suppliers. Since inputs are highly complementary in most production processes, supply chain uncertainty may be high even if the major suppliers, which we typically observe from commercial datasets, are fully reliable. Second, and perhaps more importantly, while it is straightforward to establish when a supplier is affected by a negative shock, it is fuzzier to understand when firms may have concerns about the ability of their suppliers to timely satisfy their needs in the future. As shown by recent events, this may depend not only on the operating difficulties faced by a firm's suppliers but also on the functioning of ports and transportation costs. Firms may also choose to prioritize different customers and different markets, which could lead to different exposure to supply chain risk even for firms that share the same suppliers.

For all these reasons, we use textual analysis to directly quantify the supply chain risk a firm is exposed to from managerial statements in conference calls.

2.1 Textual Analysis

We build on recent work that uses the proportion of the conversations during a conference call that is centered on a particular topic as a source for identifying various risks and opportunities (Hassan, Hollander, Van Lent, and Tahoun, 2019, 2020a, b). Specifically, we follow Hassan, Hollander, Van Lent, and Tahoun (2019), who study firm-level political risk and determine signal bigrams by comparing training libraries of a political textbook to bigrams appearing in nonpolitical texts, specifically an accounting textbook. We thus construct a training library of bigrams related to supply chains using the textbook, *Supply Chain Management: Strategy, Planning, and Operation* (6th edition; Chopra and Meindl, 2016). We also construct another training library of non-supply-chain topics using the financial accounting textbook, *Financial Accounting* (10th edition; Libby, Libby, and Hodge, 2020), which allows us to capture words used in the discussion of general financial and accounting issues.

We define the training library archetypical of the discussion of supply chain issues, *S*, and the other training library of general corporate financial issues, *N*. Each training library is the set of all adjacent two-word combinations (bigrams) contained in the respective supply chain and financial accounting texts (after removing all punctuation, numbers, pronouns, shortened pronouns, adverbs, and single words except for "a"). We then decompose all the conference calls of firm *i* in year *t* into a list of bigrams contained in the filings, $b = 1, ..., B_{it}$. We focus on yearly variation, even if the earnings calls occur quarterly, because firms are likely to face switching and search costs when changing suppliers or deciding whether to vertically integrate. Since any reactions are likely to take more than a quarter, measuring supply chain risk at higher frequency would be likely to just increase noise.

We consider as related to supply chain issues all bigrams that appear in the supply chain textbook but not in the financial accounting textbook; in addition, since there is some overlap

between supply chain and financial accounting topics, and the bigram "supply chain" naturally appears in the financial accounting textbook, we include in our supply chain training library any bigrams that are at least 30 times more frequent in the supply chain textbook than in the financial accounting textbook.

Using this methodology, we identify a total of 70,820 bigrams associated with supply chain discussions, of which only 59 also appear in the financial accounting textbook, but are enormously more frequent in the supply chain book.

Figure 1 shows the fraction of firms that discuss supply chain topics during a year. The fraction of firms has steadily increased since the beginning of the sample period and has increased dramatically in 2020 in conjunction with the Covid-19 pandemic and the widely discussed supply chain disruptions.

To define the second moment of supply chain shocks, we count the number of occurrences of bigrams indicating discussion of supply chains within the set of 10 words surrounding a synonym for "risk" or "uncertainty" on either side in the earnings calls performed during year t, and divide by the total number of bigrams in the transcript:

$$SCRisk_{i,t} = \frac{\sum_{b}^{B_{i,t}} I[b \in S \backslash N] \times I(|b - r| < 10) \times \frac{f_{b,S}}{B_S}}{B_{i,t}},$$

where I[•] is the indicator function, $B_{i,t}$ is the set of bigrams contained in *S*, but not *N*, r is the position of the nearest synonym of risk or uncertainty, $f_{b,S}$ is the frequency of the term b in the supply chain training library, and B_S is the total number of terms in the supply chain training library. The numerator thus simply counts the number of bigrams associated with discussion of supply chains, but not other corporate finance topics, that occur within 10 words to a synonym for

risk or uncertainty. Terms are given a larger weight if they recur in the training library more often. The denominator captures the total number of bigrams in the transcript of firm *i* in year *t*.

Table 2 lists the top 100 bigrams mentioned in connection with uncertainty and risk. "Safety Inventories," "Product Availability," and "Transportation Cost(s)" figure among the top 100 bigrams together with bigrams related to inventory management and uncertainty related to demand.

Following a procedure similar to that for the construction of *SCRisk*, we define the mean of supply chain shocks considering the sentiment used in the discussion of supply chain topics. Specifically, we condition on the proximity to positive and negative words, identified from Loughran and McDonald's (2011) dictionary of words related to sentiment in financial texts. The first moment of supply chain shocks is thus defined as:

$$SCSentiment_{i,t} = \frac{\sum_{b}^{B_{i,t}} I[b \in R] \times \frac{f_{b,S}}{B_S} \times \sum_{c=b-10}^{b+10} S(c)}{B_{i,t}},$$

where *S(c)* is a function that assigns a value of +1 if bigram c is within 10 words of a term associated with positive sentiment and a value of -1 if bigram b is within 10 words of a term associated with negative sentiment; *S(c)* takes value zero otherwise. Also in this case, we weigh words based on their frequency in the training library.

Finally, to confirm that we are not simply capturing idiosyncrasies of the language used in earnings calls, we verify the reliability of conference calls as a source of information about supply chain risk using 8-Ks and exhibits, which we download from January 2002 to December 2020 through the Security and Exchange Commission's (SEC) EDGAR website.

The SEC requires firms to disclose any material information such as earnings projections, bankruptcy, officer departures, material definitive agreements, or shareholder vote results within

four business days, making 8-K filings a critical source of information for investors and analysts. In line with this, 8-K filings are among the most viewed filings on EDGAR website and lead to significant market reactions (Gibbons, Iliev, and Kalodimos, 2021; Lerman and Livnat, 2010; He and Plumlee, 2020).

We run our code to extract any information about supply chains contained in 8K filings and construct our firm-level proxies for the first and second moments of supply chain shocks as we did for the earnings calls. As shown in Figure IA.1, the time-series of the supply chain risk measures constructed from earnings calls and 8K filings have a correlation in excess of 90 percent, confirming that firms provide similar discussions of supply chain issues in these two very different outlets.

2.2 Properties and Validation

SCSentiment and SCRisk are our proxies for the first and the second moment of a firm's supply chain shocks during a year, respectively. The mean SCRisk is 0.006; fewer than one percent of the sample firms never discuss supply chains in conjunction with risk and uncertainty, indicating that this is an important topic so far neglected in the literature. Naturally, the first and second moments of supply chain shocks appear to be negatively correlated. When a firm receives news that the provision of some inputs is disrupted, it simultaneously faces a lower mean and higher uncertainty on the future stability of its supply chain. However, the correlation between SCSentiment and SCRisk is low at around 5%, indicating that these two proxies have independent sources of variation.

To validate our newly developed proxies, we explore whether they exhibit cross-sectional and time-series variation which aligns with reasonable priors. Table 3 lists the industries in which

on average during our sample period, firms appear to have higher SCRisk. It is evident that manufacturing industries, which rely on global supply chains, score higher in terms of supply chain risk than nontradable industries and services that mostly rely on local inputs and demand.

To further validate our measure, we also compare the most affected industries as reported in Table 3 with third party reports on supply chains. We mainly focus on two sources: Boston Consulting Group's report (BCG report) on global supply chains and reports from Euromonitor International, a leading provider of business intelligence and market analysis.

Euromonitor reports a list of manufacturing industries that are most sensitive to supply chain risks in 2019, which includes textiles, machinery, hi-tech, and mineral products, and exhibit significant overlap with the top industries for SCRisk in Table 3. BCG also documents that the semiconductor industry is one of the industries most affected by the supply chain problems associated with the Covid-19 pandemic. The semiconductor industry is included in the two-digit SIC code 36, which is among the top industries for supply chain risk according to our metrics.

Figure 2 describes how the mean of SCRisk and SCSentiment vary over time. It is again comforting that supply chain risk appears to be heightened and, to a somewhat lower extent, supply chain sentiment becomes more negative in connection to events that are widely known to have disrupted global supply chains, such as the 2011 great East Japan earthquake and the Thailand floods, the Sino-American trade war, and more recently with the Covid-19 outbreak. More surprisingly, the 2003 SARS outbreak does not appear to be associated with an increase in supply chain risk or a decrease in sentiment.

From the plot of SCSentiment, it emerges that, differently from what existing literature emphasizing natural disasters seems to imply (see, e.g., Barrot and Sauvagnat, 2016; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2020), supply chain risk is not one-sided. Specifically, there are

firms and periods with positive supply chain sentiment. These instances presumably refer to firms that see opportunities for outsourcing to reduce costs. There are also periods of negative sentiment when concerns about bottlenecks and the reliability of supply chains emerge.

Figure 3 relates the mean of SCRisk with a measure of supply chain strains based on transportation costs, developed by Benigno, di Giovanni, Groen, and Noble (2022). The two measures evolve similarly, even though supply chain risk and average transportation costs also exhibit noticeable differences, indicating that supply chain risk does not simply arise from transportation costs. Both measures show that supply chain risk reached unprecedented levels in 2020. Importantly, though, SCRisk captures meaningful variation also before because our results are robust if we exclude 2020 or exploit cross-sectional differences between firms by including year fixed effects.

This is also evident from Table 4, which lists excerpts from the conference calls of firms that exhibit the highest SCRisk and considers also episodes predating the Covid-19 pandemics. The excerpts also illustrate why the sources of supply chain uncertainty may be hard to quantify in the absence of our proxy. For instance, Mercury Systems, Inc., a technology company providing services to the aerospace industry, lists among the concerns in the 2020 earnings calls the financial vulnerability of the suppliers as well as disruptions, shutdowns, and other operational difficulties due to the pandemic at the suppliers' facilities. Tariffs and the inability to predict customers' demand also figure prominently in the excerpts in Table 4.

Overall, the timing of the peaks in supply chain risk and negative shock realizations, the cross-sectional differences among industries, and the excerpts of texts associated with the highest levels of SCRisk provide strong support that our proxy captures actual supply chain risk.

However, only a limited proportion of supply chain risk is explained by time or industry specific shocks. To reach this conclusion, Table 5 presents the variance decomposition of SCRisk and SCSentiment. Economy-wide shocks, as captured by time-fixed effects, overall explain very little of the first and second moments of supply chain shocks, as the R-square is about 6 percent for supply chain uncertainty and 1 percent for the sentiment measure. Three-digit industry fixed effects and, more relevantly, interactions of industry and time fixed effects explain about 10 to 20 percent of the first and second moments of supply chain shocks, suggesting that firms within an industry may perform very differently in response to widespread supply chain disruption.[1] Interestingly, most of the variation in SCSentiment and especially SCRisk appears to be driven by idiosyncratic firm shocks. When we include firm fixed effects, together with the interactions of industry and year fixed effects, the R-squared increases to 37 percent for SCRisk and to 54 percent for SCSentiment, suggesting that some firms appear to be more exposed to supply chain shocks. This feature of SCRisk is common to similarly constructed proxies for political risk and climate risk.

Finally, we explore whether SCRisk is indeed related to the risk and uncertainty faced by a firm. We measure a firm's realized volatility as a firm's standard deviation of daily returns during a given year. Table 6 presents estimates of Fama-MacBeth regressions of a firm's realized volatility on SCRisk. In column 1, it is apparent that firms with higher SCRisk tend to have higher realized volatility. A one-standard-deviation increase in SCRisk is associated with an increase in realized volatility equivalent to 2.76% of the standard deviation. In column 2, we control for SCSentiment, which is negatively related to stock price volatility. Thus, negative supply chain shocks as other negative shocks also increase price volatility.

[1] We also use 2-digit and 4-digit SIC codes to define industry. The patterns of the R-squared are very similar.

Finally, in column 3, we evaluate whether our proxies for supply chain risk capture independent sources of risk, by running a horse race with the firm level proxy for political risk of Hassan, Hollander, Van Lent, and Tahoun (2019) and the proxy for climate risk of Sautner, Van Lent, Vilkov, and Zhang (2021). Our proxy remains statistically significant and its coefficient is barely affected, indicating that we are capturing a genuinely different source of risk. While political risk also contributes positively to stock price volatility, we do not find that this is the case for the climate risk proxy of Sautner et al. (2021).

3. Firms' Exposure to Supply Chain Risk

Table 7 relates the first and second moments of supply chain shocks to firm characteristics to understand which firms are relatively more exposed. Throughout the analysis, we control for interactions of industry and year fixed effects to recognize that inputs in some industries may be hard to source leading to more supply chain shocks. Also, the number and type of suppliers of a firm may depend on the characteristics of the industry affecting the demand for different inputs.

Unsurprisingly, supply chain risk is higher for firms that report suppliers in other continents and large firms that tend to have more complex supply chains. A one-standard-deviation increase in the fraction of suppliers located in other continents is associated with a 4.7% increase in our measure of supply chain risk relative to the sample median. Similarly, a one-standard-deviation increase in firm size is associated with a 4.4% increase in supply chain risk. These findings suggesting that distance and supply chain complexity increases supply chain risk further corroborate our proxy.

Supply chain risk also appears to be related to a company's bargaining power with its suppliers. For instance, companies that are large relative to their suppliers tend to exhibit less

supply chain risk suggesting that they may benefit from being the most valued customers of their suppliers. The importance of bargaining power is also supported by the negative effect of the number of suppliers in the same industry, which presumably provide the same input. Firms with multiple providers of the same inputs can more easily switch and substitute suppliers again leading to lower supply chain risk. The effect is not only statistically, but also economically significant: On average, one more supplier of the input across industries decreases a firm's supply chain risk by 9.5% relative to the sample median.

Financial constraints do not affect supply chain risk, while firms with higher growth opportunities, which possibly rely more on knowledge than physical inputs for their production, face less supply chain risk. Finally, it does not appear that institutional owners push firms to discuss supply chain issues and risk, in particular, as institutional ownership is negatively related to our proxy for supply chain risk.

Interestingly, supply chain sentiment, but not supply chain risk, is more negative for firms that face a more competitive environment as proxied by a low market share, suggesting that these firms may more easily lose customers. The estimated coefficient is not only statistically significant but also economically significant: a 10% decrease in market share is associated with a 3.6% decrease in supply chain sentiment.

4. How firms manage supply chain risk

4.1 Corporate Policies

After showing which firms are exposed to supply chain risk, we investigate how firms manage it. In line with this, Table 8 explores how supply chain risk is associated with firms' policies and performance.

To evaluate whether companies change their strategy to address supply chain risk, we first investigate whether there are any changes in investment policies when supply chain risk increases. Theories offer conflicting predictions. On the one hand, previous literature highlights that firms facing an uncertain environment tend to cut investment and employment, which is consistent with theories of precautionary behavior (Bernanke, 1983; Bloom, Bond, and Van Reenen, 2007; Bloom, 2009). On the other hand, firms may increase investment when supply chain risk increases in order to reduce its impact. For instance, Elliott, Golub, and Leduc (2020) predict that in the presence of idiosyncratic risk, besides multisourcing, firms may invest to make the relationships with their suppliers stronger. For instance, firms may acquire stakes in their suppliers or make other relationship-specific investments. These actions would increase a firm's capital expenditures.

Column 1 shows that supply chain risk does not lead to a drop in investment. The effect of supply chain risk on investment is not only statistically significant but also economically relevant. Going from the median to the 95^{th} percentile of SCRisk increases investment by 2.9% relative to the sample median.

Furthermore, in column 2, heightened supply chain risk is associated with higher inventories suggesting that firms react to high uncertainty on their supply chain's reliability by increasing inventories. The increase in inventories may also result from the drop in sales that appears to be associated with supply chain risk in column 3.

Thus, firms appear to invest more to address supply chain concerns, for instance, by attempting to control adjacent stages of the production process and ensuring the availability of the inputs, an issue that we explore in the next section. Importantly, any changes in the sourcing of inputs and other relationship-specific investments do not appear to be associated with supply chain

risk in column 4. Also, firms do not appear to vary employment in response to supply chain risk (column 5).

Any effects of supply chain shocks on firms' policies appear to arise from supply chain risk and uncertainty, while the first moment of supply chain shocks does not have a statistically significant relationship with firms' policies and performance. This is consistent with evidence that supply chains appear stable following negative shocks (Ersahin, Giannetti, and Huang, 2021).

4.2 Supplier Composition

Another way through which firms can minimize the probability of supply chain disruption is by changing their supplier pool. Bimpikis, Fearing, and Tahbaz-Salehi (2018) and Elliott, Golub, and Leduc (2020) predict that firms may react to heightened supply chain risk by increasing the number of suppliers and multisourcing key inputs to reduce their dependency on specific suppliers. Table 9 explores the effect of supply chain risk on the composition of the supply chain. In column 1, firms indeed appear to increase the number of suppliers in response to supply chain risk. The estimated coefficient of interest is economically significant: going from the median to the 95th percentile of SCRisk leads to a 5.3% increase in the number of suppliers.

Firms address supply chain risk not only through the number, but also through the quality of their suppliers. Elliott, Golub, and Leduc (2020) argue that firms can minimize the probability of production disruption through the reliability of the supplier network or by forming stronger relationships with their suppliers. One way to do this is through geographical proximity. First, uncertainty about transportation costs or travel damages increases as the physical distance between a firm and its supplier increases (Schmitt and Van Biesebroeck, 2013; Bray, Colak, and Serpa, 2019). Second, firms can better monitor physically closer plants, which can help them maintain a

consistent product quality (Giroud, 2013). Finally, being able to monitor more frequently coupled with more face-to-face communication can help firms build trust with their suppliers (Schmitt and Van Biesebroeck, 2013). Therefore, we would expect that firms establish relationships with geographically closer suppliers when supply chain risk increases.

We test this conjecture in columns 2 and 3. We look at the number of suppliers in the same continent and in the U.S., respectively. The estimated coefficients of interest are positive and statistically significant at the 1% confidence level and imply that following an increase in supply chain risk, U.S. public firms start working with an increasing number of suppliers located in the same continent, mainly in the U.S.

Another way to increase the reliability of the supplier network is to work with suppliers that are leaders in their industries. We define industry leaders as firms with a high market share in an industry. Industry leaders are expected to have a stronger reputation to be able to deliver on their commitments, which should be particularly important when firms have concerns about the ability to source their inputs.[2] We test this conjecture in column 4. We classify firms as industry leaders if their sales are above the 3-digit SIC industry median. The positive coefficient of interest shows that firms establish relationships with suppliers that are leaders in their industries when supply chain risk increases.

Taken together, Table 9 shows that firms make significant changes to their supplier pool, when they face heightened supply chain risk. Not only the number but also the composition of suppliers changes, as firms establish new relationships with geographically closer suppliers and suppliers that are industry leaders. This analysis also shows that firms strategically choose their suppliers to minimize the risk of costly production disruption (Elliott, Golub, and Leduc, 2020).

[2] At the earnings call for the third fiscal quarter of 2020, Mark Aslett, the President and CEO of Mercury Systems, Inc., describes this firm behavior as "flight to quality suppliers."

4.3 Vertical Integration

Supply chain risk can affect not only the composition of suppliers but also the firms' boundaries. Theories of the boundaries of the firm suggest that supply assurance concerns may lead firms to integrate vertically (Williamson, 1971; Bolton and Whinston, 1993). When supply chains uncertainty increases and bottlenecks become more likely, the intensity of hold up problems between a firm and its suppliers intensifies, making vertical integration more desirable (Grossman and Hart, 1986). For these reasons, we may observe more vertical M&As, when supply chain risk increases.

Table 10 explores whether firms engage in more vertical M&As when supply chain risk increases. Throughout the analysis, we include interactions of three-digit industry and year fixed effects to control for industry shocks, which are known to lead to merger waves (e.g., Ahern and Harford, 2014). Column 1 evaluates the probability that a firm is involved in an M&A with a firm in an upstream industry, while column 2 considers M&A with firms in downstream industries. In both cases, we find that an increase in SCRisk leads to a higher probability of M&As. In particular, going from the 25th percentile to the 75th percentile of SCRisk increases the probability of an M&A with a supplier or a customer by 26.8% and 25.3% relative to the baseline merger probability of 0.51% and 0.43%, respectively[3]. In column 3, we find no evidence that the firms engage in M&A in industries that are not vertically related when supply chain risk increases.

We also control for supply chain sentiment. Negative sentiment decreases the probability of vertical M&As in a significant way: going from the 25th percentile to the 75th percentile of supply chain sentiment decreases the probability of an M&A with a supplier and a customer by

[3] In Table IA.2, we show that our results are robust to the requirement of at least one percent flow for two industries to be considered vertically related.

19.8% and 20%, respectively. This finding highlights the importance of distinguishing supply chain risk from the first moment of supply chain shocks and negative shock realizations. Specifically, firms are likely to experience cash shortfalls and incur in financial constraints following negative supply chain shocks. Such an interpretation is consistent with the evidence in Table 11, showing that financially constrained firms are less likely to be involved in vertical M&As when supply chain risk increases.

Next, we analyze how financial constraints affect the use of vertical integration as a way to manage supply chain risk. Financially constrained firms do not have the liquidity or the ability to issue external finance and we would therefore expect that they are not able to use M&As to manage supply chain risk. By testing whether the propensity to engage in vertical M&As is reduced for financially constrained firms, we check whether the empirical evidence is consistent with the mechanism on which our interpretation of the empirical evidence relies.

In Table 11, we use two measures of financial constraints: The index based on size and age introduced by Hadlock and Pierce (2010) in Panel A and the Whited-Wu index proposed by Whited and Wu (2006) in Panel B. We classify firms as financially constrained (unconstrained) if their index value is above (below) the median. In columns 1 and 2 of panels A and B, the estimated coefficients on the interaction terms are negative and statistically significant, which shows that financially constrained firms are significantly less likely to be involved in vertical M&As when supply chain risk increases.

This finding implies that financially constrained firms may be less able to hedge their operations against supply chain risk and resonates with empirical evidence showing that airlines approaching financial distress engage less in fuel price hedging and thus remain more exposed to oil price movements (Rampini, Sufi, and Viswanathan, 2014).

4.4 Robustness and Identification

Table 12 explores to what extent supply chain risk is distinct from political risk and climate risk as these other sources of risk may also impact firms through the supply chain. Our results in Table 9 and Table 10 are robust to the inclusion of the political and climate risk proxies developed by Hassan, Hollander, Van Lent, and Tahoun (2019) and Sautner, Van Lent, Vilkov, and Zhang (2021), respectively. Furthermore, in Panel A and Panel B, we see that contrary to supply chain risk, political and climate risk have a negative or no effect on vertical integration and supplier composition, respectively. Not only does this confirms that our proxy for supply chain risk captures a different source of risk, but also that supply chain risk has considerably different effects on corporate policies and industrial structure in comparison to other more widely studied sources of risk.

Finally, Table 13 addresses the concerns that management may use supply chain risk to justify vertical M&As or changes in supplier composition. We consider that the Thai flood and the Great East Japan Earthquake led to an exogenous increase in supply chain risk for firms with suppliers in Thailand and Japan, respectively (Haraguchi and Lall, 2015; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2020). If supply assurance concerns really lead to more vertical integration or changes in supplier composition, we should observe that these firms are more likely to be involved in vertical M&As or to establish relationships with geographically closer and industry leader suppliers following these shocks. We also control for the negative supply chain sentiment reported by the firm to try to distinguish the effect of supply chain uncertainty from that of the negative shocks affecting the suppliers that propagate downstream. This task is made easier by our previous findings showing that supply chain sentiment is unrelated or has different effects on supply chain

composition from earlier findings. Hence, observing that the Thai floods and the Japanese earthquake have similar effects as SCRisk on relationships with suppliers and supply chain risk could be attributed to an exogenous increase in supply chain uncertainty.

The estimates in Table 13 show that firms with suppliers in Japan and Thailand become more likely to be involved in vertical M&As as well as work with suppliers that are geographically closer and that are industry leaders following the Thai flood and the Great East Japan Earthquake.

Table IA.1 confirms these results while controlling for a firm's sales to further capture any effects of shock propagation, which, as highlighted by Barrot and Sauvagnat (2016), reduces firms' sales. Firms appear to increase the number of suppliers and establish relationships with suppliers that can be considered more reliable because they are close or high quality when their sales are higher, not when they face negative shocks, further mitigating concerns that our coefficient of interest captures the effects of shock propagation.

Overall, the positive and significant coefficient on the interaction capturing firms exposed to the Thai floods and the Great Japanese earthquake suggests that an exogenous increase in supply chain uncertainty leads firms to diversify their suppliers as well as to establish relationships with closer and higher quality suppliers. Exogenous increases in supply chain uncertainty also appear to lead to a higher probability of vertical M&As. We can thus conclude that our findings are not due to reverse causality

5. Conclusions

Supply chains and input availability are crucial determinants of comparative advantage. We develop a novel proxy for supply chain uncertainty based on textual analysis and explore how supply chain uncertainty affects corporate policies.

We show that firms facing more supply chain uncertainty diversify their suppliers by establishing new relationships. Firms also establish relationships with suppliers in the same continent and suppliers that are industry leaders. More importantly, firms that face more supply chain risk are more likely to become vertically integrated by entering into M&As with their customers and suppliers.

These results suggest that higher supply chain uncertainty could be associated with changes in the geography and organization of economic activity with protracted long-term effects on the performance of different geographical areas. Exploring these issues is an exciting area for future research.

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Figure 1
This figure shows the fraction of firms that discuss the key word "supply chain" in their earnings calls between 2002 and 2020.

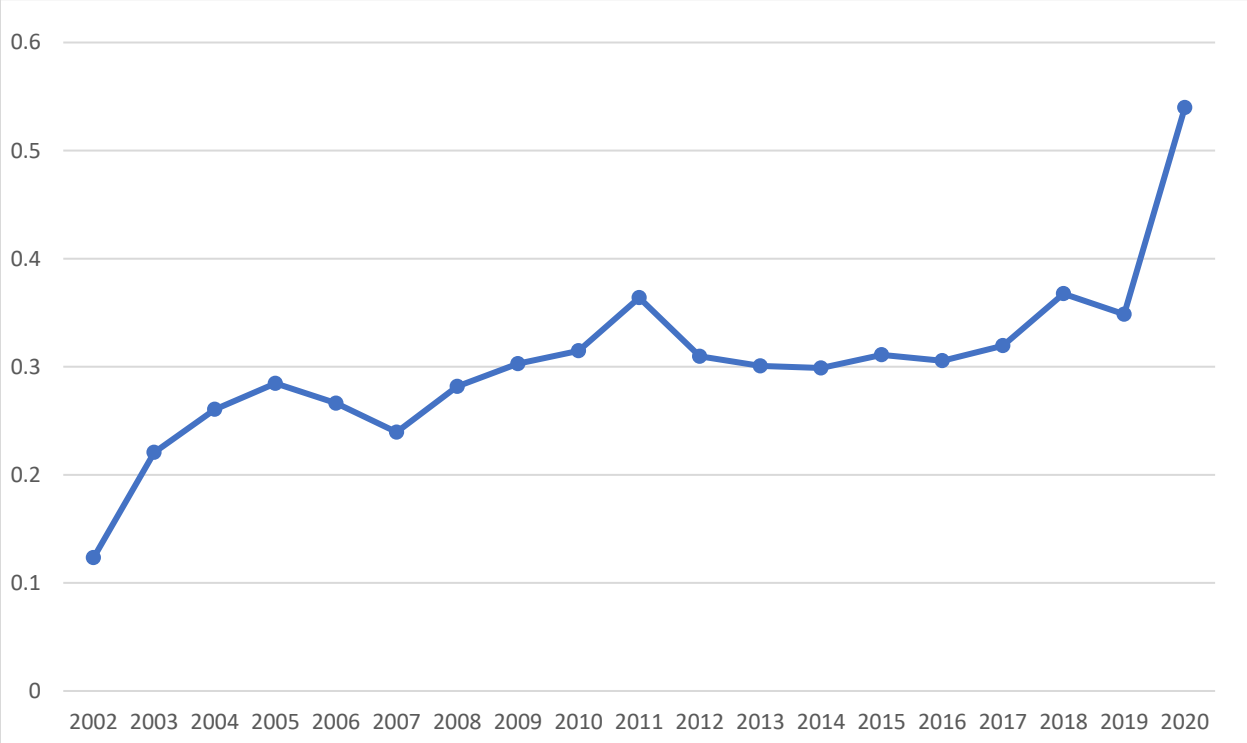
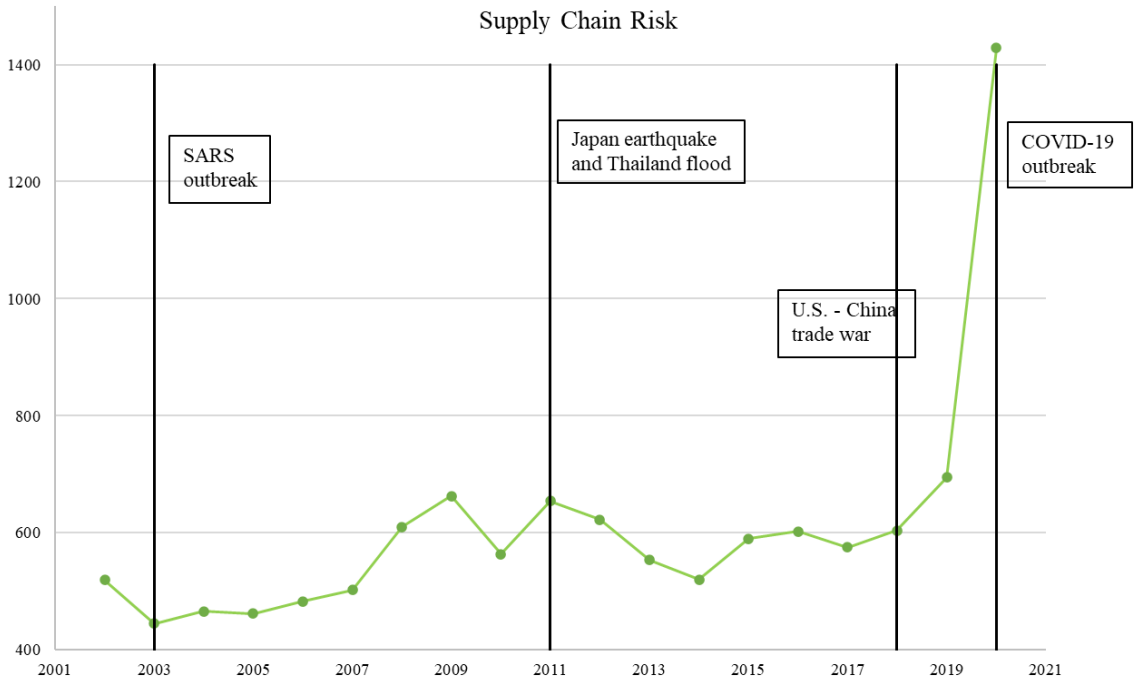


Figure 2
This figure shows the mean of SCRisk and SCSentiment along with indicators for key events related to supply chain shocks.

Panel A. SCRisk



Panel B. SCSentiment

Figure 3
This figure shows the mean of SCRisk and the global transportation costs index (transportation costs) developed by Benigno, di Giovanni, Groen, and Noble (2022).

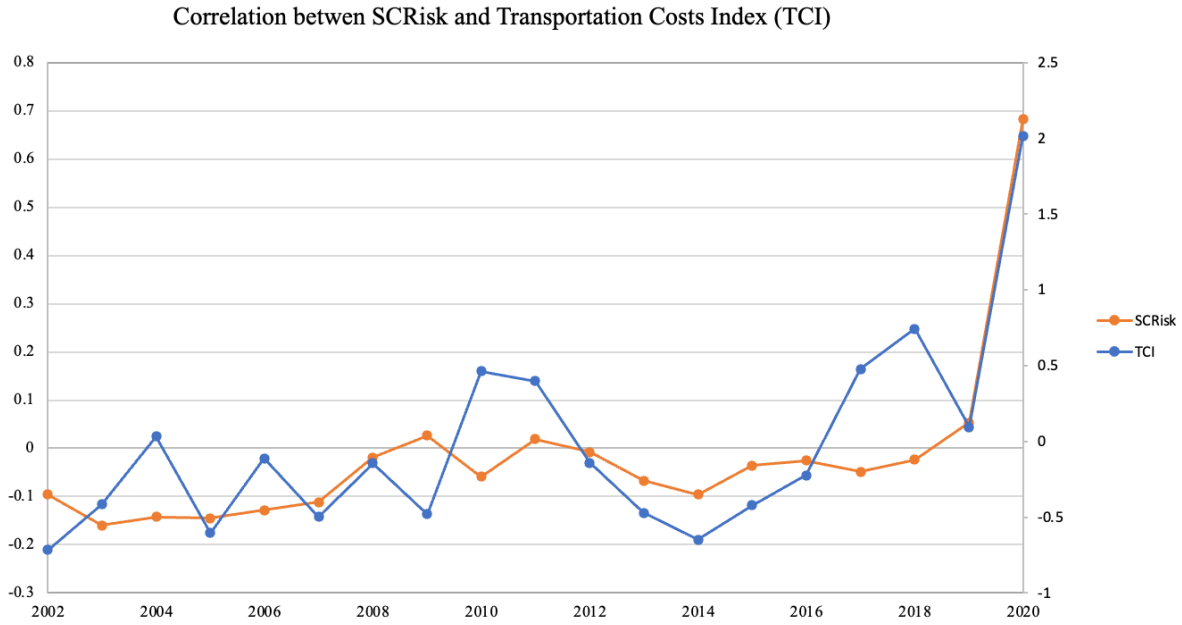


Table 1. Summary statistics

This table presents summary statistics for the main variables used in our analysis. All variables are defined in Appendix A.

Variables	(1) N	(2) Mean	(3) SD	(4) P25	(5) P50	(6) P75
SCRisk	33,920	0.0060	0.0083	0.0023	0.0037	0.0061
SCSentiment	33,920	0.0612	0.0967	0.0150	0.0377	0.0731
Different continents	33,920	0.1455	0.2454	0	0	0.2222
Relative size	33,920	0.7706	8.4310	0.0065	0.0337	0.2384
Average number of suppliers in an input industry	33,920	0.3884	0.4921	0	0.2007	0.5855
Market share	33,920	0.1055	0.2103	0.0012	0.0129	0.0902
Financial constraint	33,920	0.5322	0.4990	0	1	1
Institutional ownership	33,920	0.5778	0.3607	0.2595	0.6925	0.8777
Size	33,920	6.7511	1.8499	5.4331	6.6771	7.9526
Tobin's Q	33,920	2.1894	1.5288	1.2302	1.6799	2.5542
Cash holdings	33,920	0.2262	0.2353	0.0454	0.1364	0.3334
Cash flow	33,920	-0.0145	0.1965	-0.0223	0.0375	0.0782
Inventory	33,920	0.0956	0.1223	0	0.0516	0.1463
Sales growth	33,920	0.1246	0.3730	-0.0190	0.0690	0.1867
COGS	33,920	0.9152	1.9847	0.4253	0.6339	0.8157
CapEx/K	33,920	0.3189	0.3503	0.1240	0.2130	0.3775
Log(emp)	33,920	1.5474	1.3137	0.4337	1.2423	2.3418
Number of suppliers	33,920	8.2304	11.7143	1	3	10
Number of suppliers in the same continent	33,920	4.0289	6.3667	0	1	5
Number of U.S. suppliers	33,920	3.8864	6.0831	0	1	5
Number of industry leader suppliers	33,920	3.7407	5.3745	0	1	5
M&A with supplier	33,920	0.0051	0.0710	0	0	0
M&A with customer	33,920	0.0043	0.0655	0	0	0
Unrelated M&As	33,920	0.1611	0.3677	0	0	0
Political risk	33,920	0.0011	0.0012	0.0004	0.0007	0.0014
Climate risk	33,920	0.0021	0.0068	0	0	0

Table 2. Top 100 bigrams and their weights

This table reports the 100 bigrams with the highest frequency in the training library used for the construction of SCRisk. The weight column reports the number of occurrences of the bigram across all earning calls filings.

Bigram	Weight	Bigram	Weight	Bigram	Weight
supply_chain	761.63	third_party	52.66	of_scale	31.34
the_supply	281.15	demand_and	52.66	supply_and	30.03
a_supply	146.23	given_by	52.66	demand_during	30.03
safety_inventory	143.19	cycle_inventory	50.49	if_demand	30.03
the_retailer	133.18	mean_of	50.05	the_aggregate	29.59
of_demand	104.89	size_of	47.44	to_improve	29.59
the_manufacturer	104.89	the_season	45.26	fill_rate	29.16
the_optimal	100.97	the_quantity	44.83	the_lot	29.16
lead_time	98.79	chain_surplus	42.22	chain_is	28.72
standard_deviation	98.79	demand_in	40.91	chain_profits	28.72
demand_is	93.14	fraction_of	40.04	cycle_service	28.29
deviation_of	86.61	and_demand	39.6	forecast_error	27.85
product_availability	80.95	revenue_management	38.73	see_worksheet	27.85
of_product	79.21	of_transportation	38.73	weekly_demand	27.85
lot_size	77.03	chain_management	38.3	customer_order	27.42
the_demand	74.42	response_time	37.43	store_manager	27.42
in_table	74.42	is_thus	36.99	annual_cost	26.98
holding_cost	71.81	demand_uncertainty	36.99	spot_market	26.98
the_supplier	71.81	service_level	36.56	is_likely	26.98
transportation_cost	64.41	the_forecast	36.12	network_design	26.55
in_figure	60.06	aggregate_planning	36.12	time_is	26.55
normally_distributed	59.62	aggregate_plan	35.69	is_obtained	26.11
in_period	58.32	management_review	35.25	quantity_discounts	25.68
using_equation	57.01	order_size	33.95	chain_performance	24.81
of_supply	56.58	customer_demand	33.95	demand_from	24.81
transportation_costs	56.58	economies_of	33.51	low_demand	24.81
seven_eleven	56.14	order_is	33.08	replenishment_lead	24.37
an_order	55.71	eleven_japan	32.64	chain_in	23.94
distributed_with	55.27	strategic_fit	32.64	milk_runs	23.94
a_mean	54.84	of_safety	32.21	the_lead	23.94
expected_profit	53.53	chain_to	31.77	lead_times	23.94
supply_chains	52.66	the_goal	31.34	harvard_business	23.5
a_standard	52.66	to_order	31.34		

Table 3. Industry Level Supply Chain Exposure

This table reports the top and bottom 10 industries in terms of our measure of overall supply chain risk, SCRisk. Industry-year average of firms' SCRisk is used to rank the industries.

SIC2	Top 10 industries	SIC2	Bottom 10 industries
14	Nonmetallic Minerals, Except Fuels	21	Tobacco Products
22	Textile Mill Products	27	Printing & Publishing
25	Furniture & Fixtures	41	Local & Interurban Passenger Transit
33	Primary Metal Industries	48	Communications
35	Industrial Machinery & Equipment	53	General Merchandise Stores
36	Electronic & Other Electric Equipment	54	Food Stores
37	Transportation Equipment	58	Eating & Drinking Places
50	Wholesale Trade – Durable Goods	72	Personal Services
52	Building Materials & Gardening Supplies	79	Amusement & Recreation Services
75	Auto Repair, Services, & Parking	82	Educational Services

Table 4. Excerpts from Earnings Calls

This table reports excerpts from earnings calls with high SCRisk, together with firm name, earnings call date, and the text expressing the supply chain risk.

Firm Name	Date of Report	Text
Mercury Systems, Inc.	April 28, 2020	The key supply chain issues that we're facing are twofold. The first is that suppliers may be financially vulnerable. This applies more so to those suppliers that are heavily exposed to the commercial aerospace sector. As you know, commercial aerospace has been significantly more impacted by COVID than defense. The other **major supply chain risk** is the potential for COVID-related manufacturing **disruptions**, that is temporary site **shutdowns** that could affect the supply of U.S. sourced components to Mercury. We're also facing other **operational risks**, the first being the potential for COVID-related disruptions within Mercury's own manufacturing facilities…That said, the **risk** does remain elevated.
Select Interior Concepts, Inc.	November 05, 2020	As we look at international supply chain, it's fairly fragmented. And you have **considerable risk** with respect to tariffs, **supply chain**, work stoppages at ports, those kinds of things.
NeoPhotonics Corp	April 30, 2020	While we believe there is immediate demand to increase network bandwidth capacity to handle the increased traffic, we continue to see **supply chain risks**. We have included approximately $10 million of impacts to Q2 revenue in our outlook due to **concerns about supplier shutdowns** as they comply with their local public health orders. We expect the **supply chain risks to continue** into the second half of the year.
SBE, Inc.	May 2006, 2005	Our customers don't provide much **forecast visibility** resulting in **hesitancy** throughout the **supply chain**.
Science Applications International Corp	December 08, 2016	The biggest **variability** this quarter, and in our portfolio as a whole, is in the **supply chain** and materials business.
Insteel Industries, Inc.	July 19, 2018	… **uncertainty** surrounding the availability of our **primary raw material**, hot-rolled steel wire rod, resulted in speculative purchasing throughout the **supply chain** and sharp price increases reflecting the 25% tariff that was eventually applied to practically all imports of carbon steel products.

Entegris, Inc	April 26, 2016	As I was mentioning in my prepared remarks, we are seeing **increased level of complexity, increased risk** of contamination of critical materials in the **supply chain** at the leading-edge.
IEC Electronics Corp	May 09, 2018	This brings me to another topic: the ongoing **global supply chain component constraints**. As you know, in fiscal 2018 Q1, we mentioned that one of our challenges, which is affecting the entire industry, was associated with difficult in producing -- in **procuring** certain electronic components and in some cases, facing long lead times or allocation restrictions due to **limited global supplies**. These **shortages** can impact our ability to fulfill our customers' orders and lengthen production times as well as add some amount of **unpredictability** as we wait for a specific component to complete a job.

Table 5. Variance decomposition of SCRisk and SCSentiment

This table reports Adjusted R-squared and R-squared from a projection of SCRisk and SCSentiment on various sets of fixed effects in Panel A and Panel B, respectively. Year, Industry, Industry times Year, and Industry times Year and Firm fixed effects are used in columns (1), (2), (3), and (4), respectively.

	(1)	(2)	(3)	(4)
		Panel A: SCRisk		
Year FE	Y			
Industry FE		Y		
Industry x year FE			Y	Y
Firm FE				Y
Adjusted R-squared	0.0593	0.0344	0.1196	0.2113
R-squared	0.0598	0.0405	0.1960	0.3722
		Panel B: SCSentiment		
Year FE	Y			
Industry FE		Y		
Industry x year FE			Y	Y
Firm FE				Y
Adjusted R-squared	0.0114	0.1311	0.1478	0.4187
R-squared	0.01119	0.1365	0.2223	0.5372

Table 6. Fama-MacBeth regressions

This table reports estimates of Fama-MacBeth regressions of firms' yearly realized volatility on SCRisk, SCSentiment, Political risk, and Climate risk during the year. The dependent variable is *Realized Volatility*, computed as a firm's standard deviation of daily returns in that year. The Political risk measure is taken from Hassan, Hollander, Van Lent, and Tahoun (2019). The Climate risk measure is taken from Sautner, Van Lent, Vilkov, and Zhang (2021). All variables are defined in Appendix A. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1) Realized Volatility	(2) Realized Volatility	(3) Realized Volatility
Supply chain risk	4.6674**	5.2526**	4.3746**
	(1.8656)	(1.8916)	(1.8212)
Supply chain sentiment		-0.7967***	-0.7648***
		(0.1213)	(0.1153)
Political Risk			27.9838***
			(8.5564)
Climate Risk			1.7479
			(1.8369)
Number of Firms	2,672	2,672	2,672
Number of Year	18	18	18

Table 7. Firm characteristics, SCRisk, and SCSentiment

This table reports estimates of the effects of a set of firm-level characteristics on SCRisk and SCSentiment in Panel A and Panel B, respectively. The main independent variable in columns (1) is *Different continents*, which is the fraction of a firm's suppliers who are located in a continent different from itself over the total number of suppliers. The additional independent variable in column (2) is *Relative Size*, which equals total assets of the firm scaled by the average total assets of its suppliers. The additional independent variable in column (3) is *Size*, which equals natural logarithm of the firm's total assets. The additional independent variable in column (4) is *Average number of suppliers in an input industry*, which equals natural logarithm of the firm's average number of suppliers in the same input industry. The additional independent variable in column (5) is *Market Share*, which equals the firm's sales scaled by the industry's total sales. The additional independent variable in column (6) is *Financial constraint*, which is an indicator variable that equals one if the firm's Whited-Wu (2006) proxy for financial constraints is above the median. The additional independent variable in column (7) is *Institutional ownership*, which is the fraction of the firm's shares owned by financial institutions. The additional independent variable in column (8) is *Tobin's Q*, which is assets minus cash and cash equivalent securities plus book value on equity scaled by assets. The unit of observation in each regression is a firm-year. Independent variables are scaled up by 1,000 for readability. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel A: Supply chain risk				
Different continents	0.7115***	0.7115***	0.6207**	0.6422**	0.6417**	0.6441**	0.6026**	0.6020**
	(0.2754)	(0.2754)	(0.2715)	(0.2705)	(0.2705)	(0.2704)	(0.2718)	(0.2706)
Relative size		-0.0039*	-0.0054***	-0.0050***	-0.0053***	-0.0053***	-0.0055***	-0.0055***
		(0.0020)	(0.0019)	(0.0018)	(0.0019)	(0.0019)	(0.0019)	(0.0018)
Size			0.0742*	0.1169***	0.0975**	0.0795	0.1205**	0.0913*
			(0.0401)	(0.0449)	(0.0458)	(0.0516)	(0.0533)	(0.0538)
Average number of suppliers				-0.3106**	-0.3057**	-0.2951**	-0.3347**	-0.2678*
by (input) industry				(0.1458)	(0.1460)	(0.1465)	(0.1469)	(0.1471)
Market share					0.3227	0.3111	0.2663	0.2589
					(0.3085)	(0.3089)	(0.3067)	(0.3064)
Financial constraint						-0.1156	-0.1286	-0.1302
						(0.1445)	(0.1441)	(0.1445)
Institutional ownership							-0.5971***	-0.4962***
							(0.1855)	(0.1879)
Tobin's Q								-0.1734***
								(0.0388)

Industry x year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	33,901	33,901	33,901	33,901	33,901	33,901	33,901	33,901
Adjusted R-squared	0.1048	0.1048	0.1050	0.1052	0.1053	0.1053	0.1057	0.1065

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				Panel B: Supply chain sentiment				
Different continents	0.0006	0.0006	-0.0042	-0.0042	-0.0043	-0.0043	-0.0040	-0.0040
	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0032)	(0.0032)
Relative size		0.0000	-0.0001*	-0.0001*	-0.0001**	-0.0001**	-0.0001**	-0.0001**
		(0.0001)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
Size			0.0039***	0.0037***	0.0029***	0.0030***	0.0028***	0.0029***
			(0.0006)	(0.0007)	(0.0007)	(0.0007)	(0.0008)	(0.0008)
Average number of suppliers				0.0010	0.0012	0.0012	0.0014	0.0012
by (input) industry				(0.0024)	(0.0024)	(0.0024)	(0.0024)	(0.0024)
Market share					0.0134**	0.0134**	0.0137**	0.0137**
					(0.0056)	(0.0056)	(0.0056)	(0.0056)
Financial constraint						0.0004	0.0005	0.0005
						(0.0023)	(0.0023)	(0.0023)
Institutional ownership							0.0033	0.0029
							(0.0033)	(0.0032)
Tobin's Q								0.0007
								(0.0007)
Industry x year FE	Y	Y	Y	Y	Y	Y	Y	Y
Observations	33,901	33,901	33,901	33,901	33,901	33,901	33,901	33,901
Adjusted R-squared	0.0981	0.0981	0.1026	0.1026	0.1034	0.1034	0.1034	0.1035

Table 8. SCRisk and firm policies

This table reports estimates of the effects of SCRisk and SCSentiment on firms' inventory, sales growth, investment, cost of goods sold, and employment. Firm controls include size, Tobin's Q, cash holdings, and cash flow. The unit of observation in each regression is a firm-year. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1) CapEx/K	(2) Inventory	(3) Sales Growth	(4) COGS	(5) Log(emp)
Supply chain risk	0.4935*	0.0807**	-0.4517*	0.7733	0.0266
	(0.2814)	(0.0374)	(0.2711)	(0.8783)	(0.1876)
Supply chain sentiment	0.0247	0.0073	0.0299	0.0348	0.0378
	(0.0212)	(0.0049)	(0.0215)	(0.0538)	(0.0230)
Size	-0.0363***	-0.0178***	-0.0418***	0.0199	0.3559***
	(0.0064)	(0.0014)	(0.0082)	(0.0362)	(0.0100)
Tobin's Q	0.0536***	0.0010***	0.0518***	-0.0046	0.0244***
	(0.0037)	(0.0004)	(0.0040)	(0.0252)	(0.0028)
Cash holdings	0.4001***	-0.0913***	0.1201***	0.6118***	-0.1298***
	(0.0288)	(0.0047)	(0.0323)	(0.1654)	(0.0234)
Cash flow	0.2780***	0.0044	-0.3486***	-1.1775***	-0.1305***
	(0.0243)	(0.0029)	(0.0388)	(0.2001)	(0.0145)
Firm FE	Y	Y	Y	Y	Y
Industry x year FE	Y	Y	Y	Y	Y
Observations	31,130	31,130	31,130	31,130	31,130
Adjusted R-squared	0.3927	0.9389	0.2111	0.5947	0.9768

Table 9. SCRisk and number of suppliers

This table reports estimates of the effects of SCRisk and SCSentiment on firms' number of suppliers. The dependent variables in columns 1 to 4 are number of suppliers, number of suppliers in the same continent, number of U.S. suppliers, and number of industry leader suppliers, respectively. Firm controls include size, Tobin's Q, cash holdings, and cash flow. The unit of observation in each regression is a firm-year. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1)	(2)	(3)	(4)
	Number of suppliers	Number of suppliers in the same continent	Number of U.S. suppliers	Number of industry leader suppliers
Supply chain risk	12.6021**	9.4728***	9.2587***	4.6798*
	(5.8838)	(3.3094)	(3.1661)	(2.6617)
Supply chain sentiment	0.8698	0.5228	0.6286*	0.4089
	(0.7005)	(0.3614)	(0.3451)	(0.2856)
Size	1.9314***	1.0597***	1.0011***	1.0127***
	(0.1969)	(0.0991)	(0.0926)	(0.0853)
Tobin's Q	0.0554	-0.0097	0.0158	0.0300
	(0.0586)	(0.0291)	(0.0269)	(0.0247)
Cash holdings	-0.0622	-0.5455*	-0.4832*	-0.5770**
	(0.5047)	(0.2931)	(0.2734)	(0.2365)
Cash flow	-1.6498***	-0.9261***	-0.9290***	-0.8932***
	(0.3047)	(0.1873)	(0.1759)	(0.1442)
Firm FE	Y	Y	Y	Y
Industry x year FE	Y	Y	Y	Y
Observations	31,130	31,130	31,130	31,130
Adjusted R-squared	0.8570	0.7989	0.8033	0.8590

Table 10. SCRisk and firms' M&As using a threshold of one percent

This table reports estimates of the effects of SCRisk on the probability that a firm is involved in M&As. The dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm that is not in an upstream or downstream industry. The unit of observation in each regression is a firm-year. Firm controls include size, Tobin's Q, cash holdings, and cash flow. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Supply chain risk	0.3591***	0.2793**	0.2501
	(0.1330)	(0.1236)	(0.3025)
Supply chain sentiment	-0.0174***	-0.0148**	0.0007
	(0.0064)	(0.0062)	(0.0294)
Size	-0.0026**	-0.0032***	0.0056
	(0.0012)	(0.0009)	(0.0067)
Tobin's Q	0.0006*	0.0005	0.0074***
	(0.0004)	(0.0003)	(0.0023)
Cash holdings	0.0015	0.0003	0.1740***
	(0.0033)	(0.0031)	(0.0272)
Cash flow	0.0048**	0.0049***	0.1293***
	(0.0020)	(0.0017)	(0.0152)
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	31,130	31,130	31,130
Adjusted R-squared	0.1168	0.1059	0.2109

Table 11. SCRisk and firms' M&As: financial constraints

This table reports estimates of the effects of SCRisk on firms' M&As using different measures of firms' financial constraints. Panel A and B use the Hadlock and Pierce (2010) and Whited-Wu (2006) measures, respectively, to define financial constraints. The dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm from neither an upstream nor a downstream industry. The unit of observation in each regression is a firm-year. Firm controls include supply chain sentiment, size, Tobin's Q, cash holdings, and cash flow. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Panel A: Hadlock-Pierce financial constraint measure			
Supply chain risk	0.5598***	0.4308**	0.6535
	(0.2071)	(0.1928)	(0.4137)
HP FC dummy	0.0020	0.0016	-0.0183*
	(0.0023)	(0.0023)	(0.0106)
Supply chain risk x HP FC dummy	-0.5072**	-0.3830*	-1.0116*
	(0.2213)	(0.2074)	(0.5653)
Firm controls	Y	Y	Y
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	31,130	31,130	31,130
Adjusted R-squared	0.1173	0.1062	0.2112
Panel B: Whited-Wu financial constraint measure			
Supply chain risk	0.5973***	0.4977**	0.5451
	(0.2254)	(0.2169)	(0.4544)
WW FC dummy	0.0003	0.0006	-0.0089
	(0.0019)	(0.0018)	(0.0084)
Supply chain risk x WW FC dummy	-0.4873**	-0.4471*	-0.5976
	(0.2462)	(0.2302)	(0.5894)
Firm controls	Y	Y	Y
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	31,130	31,130	31,130
Adjusted R-squared	0.1174	0.1064	0.2110

Table 12. SCRisk and firms' M&As and number of suppliers: control for political risk and climate risk

This table reports estimates of the effects of SCRisk on firms' M&As and number of suppliers in Panel A and Panel B, respectively, controlling for two other sources of risk, political risk and climate risk. The Political risk measure is taken from Hassan, Hollander, Van Lent, and Tahoun (2019). The Climate risk measure is taken from Sautner, Van Lent, Vilkov, and Zhang (2021). In Panel A, the dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm is neither from an upstream nor a downstream industry. In Panel B, the dependent variables in columns 1 to 4 are number of suppliers, number of suppliers in the same continent, number of U.S. suppliers, and number of industry leader suppliers, respectively. The unit of observation in each regression is a firm-year. Firm controls include size, Tobin's Q, cash holdings, and cash flow. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: SCRisk and firms' M&As

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Supply chain risk	0.3614***	0.2804**	0.2604
	(0.1328)	(0.1233)	(0.3027)
Supply chain sentiment	-0.0176***	-0.0150**	0.0003
	(0.0064)	(0.0061)	(0.0294)
Size	-0.0026**	-0.0032***	0.0057
	(0.0012)	(0.0009)	(0.0067)
Tobin's Q	0.0006*	0.0005	0.0074***
	(0.0004)	(0.0003)	(0.0023)
Cash holdings	0.0014	0.0003	0.1741***
	(0.0033)	(0.0031)	(0.0272)
Cash flow	0.0047**	0.0048***	0.1292***
	(0.0019)	(0.0017)	(0.0152)
Political risk	-0.4856	-0.2497	-2.1370
	(0.4881)	(0.4551)	(2.3332)
Climate risk	-0.1485*	-0.1408*	0.0418
	(0.0891)	(0.0755)	(0.3479)
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	31,130	31,130	31,130
Adjusted R-squared	0.1169	0.1060	0.2109

Panel B: SCRisk and firms' number of suppliers

	(1)	(2)	(3)	(4)
	Number of suppliers	Number of suppliers in the same continent	Number of U.S. suppliers	Number of industry leader suppliers
Supply chain risk	12.4817**	9.3635***	9.1420***	4.6009*
	(5.8746)	(3.3069)	(3.1636)	(2.6590)
Supply chain sentiment	0.8768	0.5274	0.6328*	0.4134
	(0.7007)	(0.3615)	(0.3451)	(0.2855)
Size	1.9301***	1.0592***	1.0008***	1.0118***
	(0.1969)	(0.0991)	(0.0925)	(0.0853)
Tobin's Q	0.0552	-0.0096	0.0160	0.0298
	(0.0586)	(0.0291)	(0.0269)	(0.0247)
Cash holdings	-0.0624	-0.5466*	-0.4848*	-0.5772**
	(0.5047)	(0.2931)	(0.2734)	(0.2365)
Cash flow	-1.6469***	-0.9249***	-0.9283***	-0.8914***
	(0.3047)	(0.1873)	(0.1758)	(0.1442)
Political risk	25.2149	22.5938	24.0107	16.5069
	(37.9486)	(23.7291)	(22.1246)	(16.4078)
Climate risk	2.3376	-1.3165	-2.6434	1.3297
	(6.3511)	(3.7087)	(3.2780)	(2.5213)
Firm FE	Y	Y	Y	Y
Industry x year FE	Y	Y	Y	Y
Observations	31,130	31,130	31,130	31,130
Adjusted R-squared	0.8570	0.7989	0.8033	0.8590

Table 13. Disasters and firms' M&As and number of suppliers

This table reports estimates of the effects of two disasters, the 2011 Great East Japan earthquake and the Thailand flood, which are believed to have exogenously increased supply chain risk, on firms' M&As and number of suppliers in Panel A and Panel B, respectively. In Panel A, the dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or a downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm from neither an upstream nor a downstream industry. In Panel B, the dependent variables in columns 1 to 4 are number of suppliers, number of suppliers in the same continent, number of U.S. suppliers, and number of industry leader suppliers, respectively. The independent variable, *Treated*, equals one for firms having a supplier in Japan or Thailand. The independent variable, *Post*, equals one for years between 2011 and 2014. Firm controls include supply chain sentiment, size, Tobin's Q, cash holdings, and cash flow. The unit of observation in each regression is a firm-year. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: Disasters and firms' M&As

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Treated x post	0.0062**	0.0058**	0.0113
	(0.0027)	(0.0026)	(0.0110)
Supply chain sentiment	-0.0232**	-0.0211**	0.0029
	(0.0105)	(0.0100)	(0.0443)
Size	0.0008	-0.0001	0.0098**
	(0.0009)	(0.0008)	(0.0045)
Tobin's Q	0.0000	0.0000	0.0000
	(0.0000)	(0.0000)	(0.0001)
Cash holdings	0.0001	0.0003	0.1003***
	(0.0019)	(0.0016)	(0.0134)
Cash flow	0.0000	0.0001	0.0004
	(0.0001)	(0.0001)	(0.0006)
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	28,026	28,026	28,026
Adjusted R-squared	0.1273	0.1024	0.2463

Panel B: Disasters and firms' number of suppliers

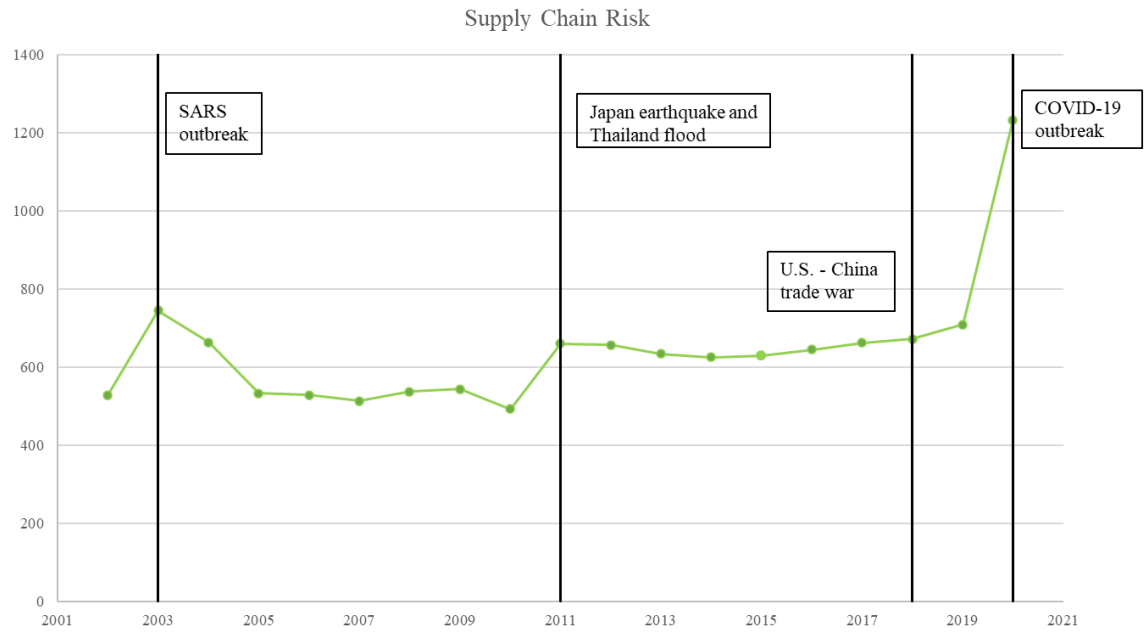
	(1)	(2)	(3)	(4)
	Number of suppliers	Number of suppliers in the same continent	Number of U.S. suppliers	Number of industry leader suppliers
Treated x post	2.1257***	0.4561**	0.3305*	0.6708***
	(0.6005)	(0.2224)	(0.1986)	(0.2183)
Supply chain sentiment	1.4477	0.1026	0.3243	0.0863
	(1.3542)	(0.7338)	(0.4655)	(0.6357)
Size	0.9063***	0.4638***	0.5081***	0.4535***
	(0.1747)	(0.0712)	(0.0678)	(0.0688)
Tobin's Q	0.0057***	0.0029***	0.0029***	0.0023***
	(0.0020)	(0.0008)	(0.0007)	(0.0007)
Cash holdings	-0.5740	-0.4155***	-0.4063***	-0.3323**
	(0.5694)	(0.1505)	(0.1421)	(0.1624)
Cash flow	-0.0380	-0.0313***	-0.0308***	-0.0312***
	(0.0257)	(0.0116)	(0.0091)	(0.0105)
Firm FE	Y	Y	Y	Y
Industry x year FE	Y	Y	Y	Y
Observations	28,026	28,026	28,026	28,026
Adjusted R-squared	0.8586	0.9396	0.9489	0.9154

Appendix A Variable definitions

Variables	Definition
SCRisk	Firm-level supply chain risk measure constructed from 8K filings
SCSentiment	Firm-level supply chain sentiment measure constructed from 8K filing
Realized Volatility	Firm's standard deviation of daily returns in a year
Different continents	Fraction of a firm's suppliers located in a continent different from that of the firm over the total number of suppliers
Relative size	Total assets of the focal firm scaled by the average total assets of its suppliers
Average number of suppliers in an input industry	Natural logarithm of the average number of suppliers in the same input industry
Market share	Firm's sales scaled by the 3-digit SIC industry's total sales
Financial constraint	Equals one if the firm is financially constrained at the sample median according the Whited-Wu (2006) measure
Institutional ownership	Fraction of shares owned by financial institutions
Size	Natural logarithm of total assets
Tobin's Q	Assets minus cash and cash equivalent securities plus book value on equity scaled by assets
Cash holdings	Cash and cash equivalent securities scaled by total assets
Cash flow	Operating cash flow scaled by total assets
Inventory	Inventory scaled by total assets
Sales growth	Growth rate of sales from year t-1 to year t
COGS	Cost of goods sold scaled by total sales
CapEx/K	Capital expenditures scaled by property, plant and equipment
Log(emp)	Natural logarithm of the number of employees
Number of suppliers	A firm's total number of suppliers
Number of suppliers in the same continent	A firm's total number of suppliers in the same continent
Number of U.S. suppliers	A firm's total number of suppliers in the U.S.
Number of industry leader suppliers	A firm's total number of suppliers who have above median sales in the same 3-digit SIC industry
M&A with supplier	Equals one if the firm conducts an M&A with a firm from an upstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables.
M&A with customer	Equals one if the firm conducts an M&A with a firm from a downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables.
Unrelated M&As	Equals one if the firm conducts an M&A with a firm from neither an upstream nor a downstream industry
Political risk	Political risk measure from Hassan, Hollander, Van Lent, and Tahoun (2019)
Climate risk	Climate risk measure is from Sautner, Van Lent, Vilkov, and Zhang (2021)

Internet Appendix
Figure IA.1
This figure shows the mean of SCRisk and SCSentiment along with indicators for key events related to supply chain shocks using 8-K data.

Panel A. SCRisk



Panel B. SCSentiment

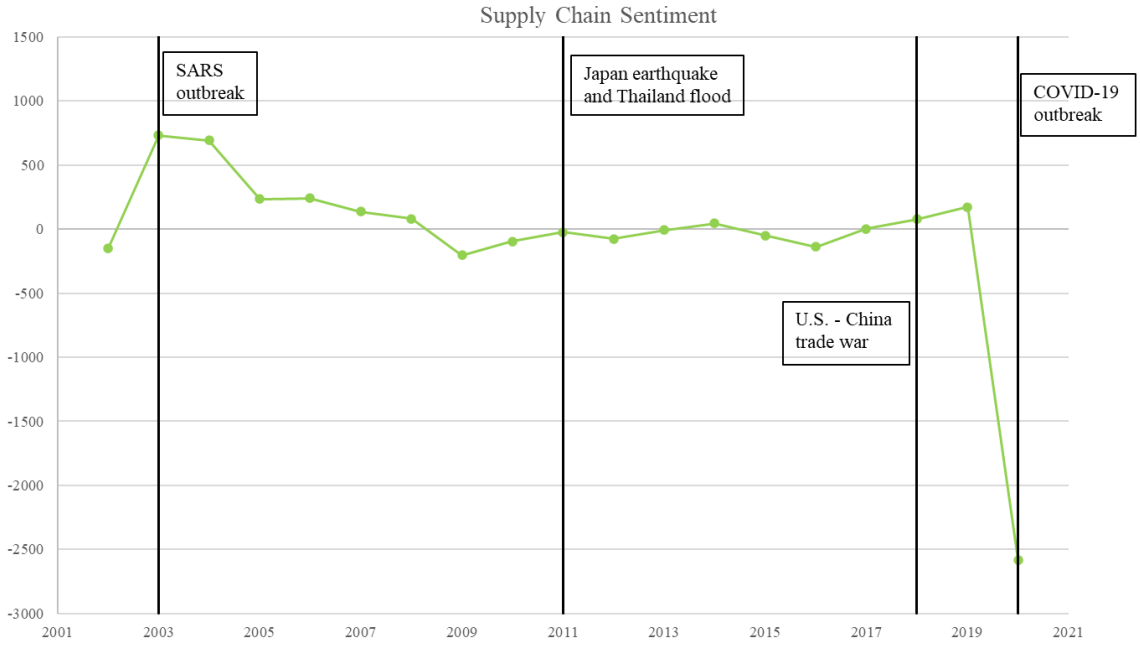


Table IA.1
Disasters and firms' M&As and number of suppliers controlling for sales

This table reports estimates of the effects of two disasters, the 2011 Great East Japan earthquake and the Thailand flood, which are believed to have exogenously increased supply chain risk, on firms' M&As and number of suppliers in Panel A and Panel B, respectively. In Panel A, the dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or a downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm from neither an upstream nor a downstream industry. In Panel B, the dependent variables in columns 1 to 4 are number of suppliers, number of suppliers in the same continent, number of U.S. suppliers, and number of industry leader suppliers, respectively. The independent variable, *Treated*, equals one for firms having a supplier in Japan or Thailand. The independent variable, *Post*, equals one for years between 2011 and 2014. Firm controls include supply chain sentiment, size, Tobin's Q, cash holdings, cash flow, and sales. The unit of observation in each regression is a firm-year. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: Disasters and firms' M&As

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Treated x post	0.0062**	0.0058**	0.0113
	(0.0027)	(0.0026)	(0.0110)
Supply chain sentiment	-0.0234**	-0.0212**	0.0016
	(0.0105)	(0.0100)	(0.0443)
Size	0.0003	-0.0004	0.0062
	(0.0008)	(0.0008)	(0.0049)
Tobin's Q	0.0000	-0.0000	0.0000
	(0.0000)	(0.0000)	(0.0001)
Cash holdings	0.0006	0.0006	0.1038***
	(0.0019)	(0.0017)	(0.0134)
Cash flow	0.0000	0.0001	0.0004
	(0.0001)	(0.0001)	(0.0006)
Sales	0.0008*	0.0005	0.0061*
	(0.0005)	(0.0004)	(0.0033)
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	28,026	28,026	28,026
Adjusted R-squared	0.1272	0.1024	0.2463

Panel B: Disasters and firms' number of suppliers

	(1)	(2)	(3)	(4)
	Number of suppliers	Number of suppliers in the same continent	Number of U.S. suppliers	Number of industry leader suppliers
Treated x post	2.1259***	0.4565**	0.3309*	0.6712***
	(0.6004)	(0.2224)	(0.1985)	(0.2183)
Supply chain sentiment	1.4202	0.0618	0.2842	0.0552
	(1.3572)	(0.7344)	(0.4647)	(0.6365)
Size	0.8269***	0.3462***	0.3924***	0.3637***
	(0.2009)	(0.0756)	(0.0715)	(0.0737)
Tobin's Q	0.0054***	0.0025***	0.0025***	0.0020***
	(0.0020)	(0.0008)	(0.0007)	(0.0007)
Cash holdings	-0.4957	-0.2995*	-0.2923**	-0.2439
	(0.6032)	(0.1559)	(0.1475)	(0.1692)
Cash flow	-0.0375	-0.0306***	-0.0301***	-0.0306***
	(0.0256)	(0.0116)	(0.0090)	(0.0104)
Sales	0.1335	0.1977***	0.1945***	0.1509***
	(0.1159)	(0.0508)	(0.0489)	(0.0442)
Firm FE	Y	Y	Y	Y
Industry x year FE	Y	Y	Y	Y
Observations	28,026	28,026	28,026	28,026
Adjusted R-squared	0.8586	0.9396	0.9490	0.9154

Table IA.2
SCRisk and firms' M&As

This table reports estimates of the effects of SCRisk on the probability that a firm is involved in M&As. The dependent variables in columns (1) and (2) are *M&A with supplier* and *M&A with customer*, which are indicator variables that equal one if the firm conducts an M&A with a firm from an upstream or downstream industry according to the Bureau of Economic Analysis's (BEA) Input-Output tables, respectively. A target firm is considered to be supplier or customer if the acquirer's industry purchases or sells at least one percent of its inputs or outputs from or to the target's industry, respectively. The dependent variable in column (3) is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm that is not in an upstream or downstream industry. The unit of observation in each regression is a firm-year. Firm controls include size, Tobin's Q, cash holdings, and cash flow. All variables are defined in Appendix A. Robust standard errors clustered by firm are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

	(1) M&A with supplier	(2) M&A with customer	(3) Unrelated M&As
Supply chain risk	0.2974**	0.1561*	0.0310
	(0.1261)	(0.0926)	(0.0405)
Supply chain sentiment	-0.0137**	-0.0107***	-0.0026*
	(0.0062)	(0.0041)	(0.0014)
Size	-0.0031***	-0.0012**	0.0001
	(0.0009)	(0.0005)	(0.0001)
Tobin's Q	0.0006	0.0006*	0.0000
	(0.0003)	(0.0003)	(0.0000)
Cash holdings	0.0020	-0.0027*	0.0001
	(0.0030)	(0.0014)	(0.0008)
Cash flow	0.0049**	0.0021**	0.0004
	(0.0019)	(0.0011)	(0.0004)
Firm FE	Y	Y	Y
Industry x year FE	Y	Y	Y
Observations	31,130	31,130	31,130
Adjusted R-squared	0.1000	0.0668	0.0587