

Supply Chain Risk: Changes in Supplier Composition and Vertical Integration

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Abstract

Using textual analysis of earnings conference calls, we quantify firms' supply chain risk and its sources. Our proxy for supply chain risk exhibits large cross-sectional and time-series variation that aligns with reasonable priors and is unprecedentedly high during the Covid-19 pandemic. In addition, a firm exhibits high supply chain risk when its suppliers also do so. We find that firms that experience an increase in supply chain risk establish relationships with closer and domestic suppliers and with suppliers that are industry leaders, but also continue to work with suppliers in other continents. In addition, firms that do not face financial constraints become more likely to engage in vertical mergers and acquisitions.

Keywords: Supply chains, nearshoring, fragmentation, textual analysis, topic modeling, vertical integration, M&As

JEL Classifications: G31, G34, F15

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Using textual analysis of earnings conference calls, we quantify firms' supply chain risk and its sources. Our proxy for supply chain risk exhibits large cross-sectional and time-series variation that aligns with reasonable priors and is unprecedently high during the Covid-19 pandemic. In addition, a firm exhibits high supply chain risk when its suppliers also do so. We find that firms that experience an increase in supply chain risk establish relationships with closer and domestic suppliers and with suppliers that are industry leaders, but also continue to work with suppliers in other continents. In addition, firms that do not face financial constraints become more likely to engage in vertical mergers and acquisitions.

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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, and the 2011 Japanese earthquake, tend to disrupt supply chains and production. Existing literature has widely documented that even small negative shocks, such as bankruptcies or natural disasters, are transmitted to firms upstream and downstream (Hertzel, Li, Officer, and Rogers, 2008; Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi, 2012; Barrot and Sauvagnat, 2016; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2021).

However, even though both the academic literature and recent events highlight that supply chain shocks are an important source of disruption, we know little about whether firms systematically update their investors about the ex-ante probability that such shocks may occur and any perceived changes in this source of risk. We are also unable to quantify the effects of supply chain risk 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. These concerns are heightened by evidence that low diffusion speed of information along the supply chain can help explain lead-lag effects in the stock returns of customers and suppliers (Cohen and Frazzini, 2008; Menzly and Ozbas, 2010; Cen, Hertzel, and Schiller, 2020).

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, or the suppliers of 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 are useful for quantifying the effects of shocks propagation, they do not allow us to gauge how firms perceive 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 using textual analysis, and to study which firms are most 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 conference calls to construct a measure of supply chain risk faced by U.S. listed companies, using a methodology introduced by Hassan, Hollander, Van Lent, and Tahoun (2019) to quantify firm-level political risk. The focus on U.S. companies allows us to verify, using corporate filings, that our newly developed supply chain risk proxy does not depend on idiosyncrasies of the language of earnings conference calls. We measure supply chain risk using the discussion of supply chain issues related to words capturing risk and uncertainty. We also use topic modeling analysis to ascertain the sources of supply chain risk and construct a measure of the sentiment of supply chain discussions to capture negative realizations of supply chain shocks. To the extent that supply chain shocks are correlated over time, supply chain sentiment can also help us capture news about the conditional mean of supply chain shocks (see Hassan, Hollander, Van Lent, and Tahoun (2019, 2020a, b) for a similar interpretation of political sentiment).

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

Basically, all U.S. companies between 2002 and 2020 discuss topics related to supply chains in connection to risk and uncertainty. This indicates that supply chain risk is important and so far neglected in the economics and finance literature. Importantly, supply chain risk is positively correlated with stock price volatility, while supply chain sentiment is associated with positive returns. Consistent with studies that highlight that measured uncertainty in aggregate data tends to increase when the economy is affected by adverse shocks (Berger, Dew-Becker, and Giglio, 2017), 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 et al., 2021). The increase in supply chain risk and the drop in supply chain sentiment appear unprecedented during the Covid-19 pandemic. However, while supply chain risk and supply chain sentiment are negatively correlated, the actual correlation across firms over time is only -4%, suggesting that we can independently measure negative realizations of supply chain shocks and supply chain uncertainty. Furthermore, supply chain risk appears to be higher for firms in industries that use differentiated products as inputs, consistent with the intuition that these goods are hard to substitute and any delays and bottlenecks cause severe disruption.

Even though macroeconomic and industry level uncertainty matters, 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. We provide a battery of tests showing that this idiosyncratic variation is unlikely to be noise and that it largely depends on firm characteristics affecting exposure to supply chain risk. Supply chain risk is higher for firms that have suppliers in different continents and are small relative 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 and lack of diversification in input sources magnify supply chain uncertainty. Large firms, possibly having more complex supply chains, are more exposed to supply chain risk.

Having established that our proxy for supply chain risk exhibits cross-sectional and time-series variation that aligns with reasonable priors, we investigate what actions firms take to manage supply chain risk. First, firms appear to actively manage supply chain risk by increasing the number of their suppliers. This finding is consistent with the theory of Elliott, Golub, and Leduc (2022), which predicts that firms multisource to reduce their dependence on specific suppliers and minimize the risk of production disruption. We also explore the characteristics of new suppliers. We find that firms that communicate more uncertainty about their supply chain subsequently establish relationships with suppliers that can be considered industry leaders and with nearby suppliers, suggesting that these firms attempt to increase the reliability of their supplier network. However, we find no evidence that firms sever their relationships with suppliers in other continents, suggesting that supply chain diversification and nearshoring do not necessarily imply more fragmentation.

In addition, we find that supply chain risk affects the boundaries of the firm and industrial structure. The benefits of common ownership of different stages of the production process are expected to increase when there is uncertainty about the availability of inputs (Williamson, 1971). Accordingly, firms that report high supply chain risk are involved in more vertical mergers and acquisitions (M&As). These results are robust when we use alternative definitions of vertically related industries. This indicates that firms tend to acquire customers and suppliers when supply chain risk increases. Financial constraints limit firms' ability to perform M&As, potentially hampering their long-term competitive advantage.

Interestingly, changes in corporate policies are driven by supply chain risk and not by supply chain sentiment. Supply chain sentiment, which is presumably more closely related to the negative shocks affecting a firm's suppliers, has different or no effects on supplier composition and vertical M&As. This is consistent with Ersahin, Giannetti, and Huang (2021), who find that supply chains are overall stable following negative shocks and suggest that financially flexible firms react when uncertainty increases, not when negative shocks occur.

Our results are robust to a battery of tests and alternative specifications. First, we address the concern that firms may discuss supply chain risk to justify vertical M&As and changes in their supplier composition. To do so, we instrument our textual measure of supply chain risk using the supply chain risk experienced by a firm's suppliers, which can be considered exogenous to a firm's plans. Consistent with our main findings, we document increases in M&As between customers and suppliers as well as in the number of suppliers that are geographically closer or industry leaders, when we use exogenous variation in a firm's supply chain risk arising from its suppliers.

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 et al., 2019, 2020a, b; Sautner, Van Lent, Vilkov, and Zhang, 2022). These findings indicate that our measure of supply chain risk captures a different source of shocks and uncertainty. More importantly, while firms appear to decrease investment when they face political risk and other sources of macroeconomic uncertainty (Baker, Bloom, and Terry, 2022), they increase investment by acquiring customers and suppliers when uncertainty arises from the availability of inputs, suggesting that supply chain risk deserves independent investigation.

Last, we show that results are robust if we perturb the definition of supply chain risk using regulatory filings or eliminating observations in which our proxy for supply chain risk may present

more potential noise, which we identify from our topic modeling analysis. We also show that our results are invariant whether we control for supply chain sentiment or not and when we control for the overall sentiment of the conference call, alleviating any concerns that supply chain risk may be correlated with negative shocks or with changes in the conditional mean of supply chain shocks.

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 on the decision to integrate different stages of production (e.g., Antràs and Chor, 2013; Alfaro, Antràs, Chor, and Conconi, 2019), but neglects the effects of risk. While it is well recognized that mergers facilitate collaboration especially in innovative industries (Bena and Li, 2014; Hsu, Li, Liu, and Wu, 2022), 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 in subsequent investigations of vertical M&As, 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 et al., 2019). Textual analysis has also been widely used in measuring geopolitical risk (Caldara and Iacoviello, 2022), climate risk and climate risk disclosure (Sautner et al., 2022; Li, Shan, Tang, and Yao, 2021), and cyber risk (Florackis, Louca, Michaely, and Weber, 2023). To the best of our knowledge, we are the first to construct a measure of supply chain risk based on textual analysis. We also show that this source of risk warrants independent investigation not only because it is not subsumed by earlier proxies of uncertainty, but also because it has a different effect on corporate policies.

Finally, the literature on networks highlights the importance of complementarities between different phases of the production process (Kremer, 1993).¹ 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 may lead to a decline in output and is not necessarily socially optimal (Bimpikis, Fearing, and Tahbaz-Salehi, 2018; Kopytov, Mishra, Nimark, Taschereau-Dumouchel, 2022). To the best of our knowledge, we are the first to 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 et al., 2021), credit shocks (Alfaro, Garcia-Santana, and Moral-Benito, 2021; Costello, 2020), data breaches (Crosignani, Macchiavelli, and Silva, 2023), or pandemic closures (Bonadio, Huo, Levchenko, and Pandalai-Nayar, 2021; Aral, Giambona, Lopez Aliouchkin, and Phillips, 2021). Using our newly developed proxy for supply chain risk, we capture firm-level perceived supply chain uncertainty potentially arising from any

¹ Cen and Dasgupta (2021) provide a review of supply chain linkages.

of the above shocks, while controlling for supply chain negative shock realizations using supply chain sentiment and other proxies.

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) 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 et al., 2019), Covid-19 (Hassan et al., 2020a), Brexit (Hassan et al., 2020b), cyber risk (Florackis et al., 2023), and climate risk (Sautner et al., 2022; Li et al., 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 et al. (2019).

While our approach can be easily extended to an international sample, by focusing on U.S. companies and using regulatory filings as robustness checks, we are able to verify that our measurements and findings are not driven by the idiosyncratic nature of questions and answers and the ambiguity of the language during earnings conference calls.

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 2002 – 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) Mergers and Acquisitions database for M&As. 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 all the links between industries, regardless of the size of the flows between industries. We show that our results are robust when we only consider vertically integrated industries with significant flows.

Finally, we use Compustat and CRSP for firm-level variables. We also construct control variables, including size, Tobin's Q, cash holdings, cash flow, and Whited-Wu (2006), and Hadlock-Pierce (2010) financial constraints measures. To evaluate whether the variation in our supply chain risk and supply chain sentiment is meaningful, we correlate them with firms' stock returns and stock price volatility.

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 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, transportation costs, and geopolitical events. 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 et al., 2019, 2020a, b). Instead of using predefined dictionaries of significant words about supply chains to process source documents, we adopt methods developed in computational

linguistics and natural language processing to endogenously capture word combinations that are indicative of discourse about a given topic. These methods identify the discussion of a topic using a pattern-based-sequence-classification approach, which has been developed in computational linguistics (Song and Wu, 2008; Manning, Raghavan, and Schutze, 2008) and is widely used in economics (Hassan et al., 2019, 2020a, b).

Specifically, we follow Hassan et al. (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.² 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). The textbook, born from a course on supply chain management taught at Northwestern University's Kellogg School of Management, focuses on the economics and management of supply chains, rather than on the mathematics of inventories optimization, and ranks among the top books in supply chain management in a variety of reviews.³

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 finance 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

² We consider bigrams, as opposed to single words, that can be considered related to discussion of supply chain issues because previous research suggests that text-classification results generally improve by applying n-grams (usually bigrams) of words as opposed to single words (unigrams) (Tan, Wang, and Lee 2002; Bekkerman and Allan 2004).

³ See for instance <https://insights.btoes.com/top-10-supply-chain-books>, and <https://www.linkedin.com/pulse/top-4-supply-chain-books-every-student-should-read-mohammed-boualam/>

financial accounting texts (after removing all punctuation, numbers, pronouns, shortened pronouns, adverbs, and single letters except for “a”).

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 at least 30 times more frequent in the supply chain book. Given the small number of bigrams that overlap in the training libraries S and N , excluding bigrams that are 30 times more frequent in the supply chain textbook does not affect our findings. Interestingly, almost all firms discuss supply chain topics, indicating that this is an important issue, so far largely neglected in the literature. Having identified the relevant bigrams, we decompose all the conference calls of firm i in year t into a list of bigrams contained in the filings, $b = 1, \dots, B_{it}$, and assign a score to each quarterly earnings call transcript based on the recurrence of bigrams that are more frequently used to discuss supply chains, as opposed to other financial matters.

We construct our scores at a yearly frequency 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 a higher frequency would be likely to just increase noise. 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:

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

where $I[\bullet]$ 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 ten 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 . In Table IA.1, we report the list of synonyms of risk words derived from the Oxford Dictionary following Hassan et al. (2019). Table 2 lists the top 100 supply chain bigrams in the training library, which appear more often in conjunction with synonymous for risk and uncertainty, along with their weights. “Safety Inventory,” “Product Availability,” and “Transportation Cost(s)” figure among the top 100 bigrams together with bigrams related to inventory management and demand uncertainty. A challenge for any measure of risk and uncertainty is that news about the variance of shocks may be correlated with negative shocks or shocks to their conditional mean (e.g., Bloom, 2014). For this reason, following a procedure similar to that for the construction of $SCRisk$, we construct a proxy for 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:

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

where $S(c)$ is a function that assigns a value of +1 if bigram c is associated with positive sentiment and a value of -1 if bigram c is associated with negative sentiment; $S(c)$ takes value zero otherwise. $\sum_{c=b-10}^{b+10} S(c)$ calculates the net sentiment among the ten words surrounding bigram b . Also, in this case, we weigh words based on their frequency in the training library.

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 8-K filings and construct our firm-level proxies for supply chain risk and supply chain sentiment 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 8-K 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.

Finally, we address the concern that supply chain risk may appear higher in the later part of the sample period because the textbook that we use to construct the list of bigrams related to supply chains is recent and the vocabulary may have changed. For this reason, we use an older version of the supply chain textbook, *Supply Chain Management: Strategy, Planning, and Operation* (3rd edition; Chopra and Meindl, 2006) to create the list of supply chain bigrams. We find that the supply chain risk and sentiment measures constructed from the older textbook are highly correlated (correlation coefficient of 0.99) with our main measures. The plots of SCRisk and SCSentiment using the older textbook in Figure IA.2 clearly show that changes in language are unlikely to affect our findings.

2.2 Properties of SCRisk and SCSentiment

Based on existing literature (Hassan et al., 2019, 2020a, b), we view SCSentiment and SCRisk as proxies for the first and the second moment of a firm's supply chain shocks during a year, respectively. However, the interpretation of our findings is unchanged if we, more informally, consider SCRisk as uncertainty and fear of future supply chain shocks, and SCSentiment as capturing the realization of shocks related to the supply chain during a year; in this case, to the extent that supply chain shocks are correlated over time for the same firm, SCSentiment could also capture the conditional mean of supply chain shocks.

The mean SCRisk is 6; 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, given that measures of uncertainty typically increase when adverse shocks occur (Berger, Dew-Becker, and Giglio, 2017; Bloom, 2014), SCRisk and SCSentiment appear to be negatively correlated. When a firm receives news that the provision of

some inputs is disrupted, it simultaneously faces higher uncertainty on the future stability of its supply chain. However, the correlation between SCSentiment and SCRisk is low at around -4%, indicating that these two proxies have independent sources of variation.

Table 3, Panel A lists excerpts from the conference calls of firms that exhibit the highest SCRisk and also considers episodes predating the Covid-19 pandemic. 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. Concerns are driven by the potential for supply disruptions, rather than by actual negative shocks.

Tariffs and the inability to predict customers' demand also figure prominently in the excerpts in Table 3, Panel A. Selected Interior Concepts, Inc., a company providing building products and services, mentions the risks arising from the fragmentation of its supply chain. Besides concerns arising from the Covid-19 pandemic, suppliers' financial reliability, hesitancy in expanding operations, and shortages of components also feature prominently in our sample.

Panel B of Table 3 presents excerpts of earnings call transcripts with high and low SCSentiment. The excerpts state positive or negative realized events in connection with supply chains indicating that SCSentiment can help to capture negative realizations of supply chain shocks and the effects of shock propagation. Specifically, firms frequently state realized supply chain disruptions, shortages, or disasters. However, supply chain shocks are not one-sided. For instance, Hanesbrands, Inc. mentions strategic acquisitions and self-owned supply chains as important factors behind increasing earnings in the second fiscal quarter of 2014. Offshoring can also

decrease costs and improve performance (Hoberg and Moon, 2019), thus leading to positive supply chain sentiment.

2.3 How do Firms Discuss Supply Chain Risk?

To provide a more systematic understanding of the determinants of supply chain risk, we consider the snippets in which firms discuss supply chain risk and classify the topics that firms discuss together with supply chain risk using machine learning. Specifically, we use topic modeling analysis, which has been used in similar contexts to explore the determinants of risks (see, e.g., Li, Liu, Mai, and Zhang, 2021; Dasgupta, Harford, Ma, Wang, and Xie, 2020).

We apply a probabilistic modeling approach, which is a type of unsupervised machine learning, to snippets that are within 50 words from one of our supply chain bigrams if the latter have been mentioned in association with at least one synonym of risk and uncertainty.

Topic modeling does not rely on predetermined keywords to search for specific topics, but rather uncovers thematic structures and determines topics based on how words are distributed in the documents and their correlation. It requires assuming a number of potential topics, an assumption that typically trades-off between the interpretability of the topic outcomes and the statistical goodness-of-fit (Chang, Gerrish, Wang, Boyd-Graber, and Blei, 2009). While interpretability usually favors fewer topics, statistical fitness in general favors more. We experiment with varying the number of topics from 5 to 35 and, ultimately, settle for 30.

Applying the above algorithm, we obtain (1) a list of the words most likely to be related to a given topic, from which we can infer the source of exposure to supply chain risk, and (2) the topic prevalence, that is, how much of a document is devoted to a topic.

We assign meaningful labels to the topics by inspecting the list of words and discounting common words that appear across topics. Since some of the identified topics share a common theme, we consolidate them to obtain seven word-clouds, which allows us to illustrate how firms discuss enhanced supply chain risk.

We present the word clouds in Figure 1. Importantly, uncertainty appears to matter for many of the reasons that have been explored in the extensive literature on shock propagation. Supply chain risk is linked to uncertainty about commodity price risks and more generally input costs, technology and cyberattacks, the environment, climate risk, and the pandemics.

Firms also discuss supply chain risk in conjunction with investment policies providing an idea of how they attempt to manage supply chain risk and the constraints they face. Investment and acquisitions feature in two distinct topics, suggesting that firms manage this source of risk by updating their lines of production to accommodate new suppliers and even consider vertical integration. While firms appear to attempt to increase their resiliency to supply chain shocks, they also face constraints when managing supply chain risk: Low liquidity, difficult access to loans and other financial issues may constrain their ability to invest and vertically integrate thus leaving firms more exposed to supply chain disruptions.

Finally, firms appear to discuss supply chain risk in conjunction to general financial issues, which are common in earnings conference calls. This indicates that supply chain risk is important for earnings, but it can also capture noise associated with general discussions in earnings conference calls. For this reason, in what follows, we will show that our conclusions are qualitatively invariant if we abstract from discussions of supply chain risk that are associated with high probability to general analysts and financial issues.

Table 4 relates SCRisk and SCSentiment of a firm over a year to the probabilities of each of the seven topics in the supply chain discussions, which we obtain from the probabilistic modeling algorithm (for each firm and year). To be able to evaluate the relevance of each of the topics, we standardize each topic probability by subtracting its mean and dividing by the standard deviation. Interestingly, increases in supply chain risk are predominantly explained by cost uncertainty and climate risk and the pandemics. Technology and cyberattacks risk, which are more recent concerns, have a lower weight. Periods of high supply chain risk are also accompanied by discussions of liquidity and financial issues, suggesting that financial constraints may heighten supply chain uncertainty. More encouragingly though, heightened supply chain risk is also accompanied by discussions of investment and acquisitions that may increase a firm's resilience to supply chain shocks.

Throughout the rest of the paper, we exploit the insights that we obtain from topic modeling to guide our empirical analysis of how firms manage supply chain risk.

3. Validation

3.1 Variation across Industries

To validate our newly developed proxies, we start exploring whether they exhibit cross-sectional and time-series variation, which aligns with reasonable priors. Table 5 lists the industries in which firms appear to have higher SCRisk during our sample period. 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 5 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 5. 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.

Table 6 provides more systematic evidence that SCRisk exhibits meaningful variation across industries. We conjecture that firms that require specialized inputs for their production process should be more exposed to supply chain risk. Differentiated products are more likely to be specialized and hard to substitute (Giannetti, Burkart, and Ellingsen, 2011; Barrot and Sauvagnat, 2016). Following the same methodology in Barrot and Sauvagnat (2016), we compute the share of differentiated goods purchased by firms in an industry. We use Rauch (1999) inputs classifications and Input-Output (IO) tables provided by the Bureau of Economic Analysis (BEA). Rauch (1999) sorts inputs produced by different industries into three groups: those that are traded in an organized exchange, goods with a reference price, and differentiated inputs. The IO tables provide dollar flows between producing and purchasing industries in the U.S.

Consistent with our conjecture, Panel A of Table 6 shows that firms that purchase more differentiated inputs, which are presumably hard to substitute, tend to have higher supply chain risk. In Panel B, the share of differentiated goods purchased by firms in an industry does not appear to be associated with supply chain sentiment, providing further evidence that we are able to measure supply chain uncertainty and realized or expected supply chain shocks independently.

3.2 Variation over Time

Figure 2 describes how the means 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 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 et al., 2021), supply chain risk is not one-sided. Specifically, there are firms and periods with positive supply chain sentiment. As discussed in Subsection 2.2., these instances largely refer to firms that exploit opportunities for outsourcing to reduce costs. There are also periods of negative sentiment when concerns about bottlenecks and the reliability of the supply chain emerge.

Figure 3 relates the yearly 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 2020 because the results we report hereafter are robust if we exclude 2020 or exploit cross-sectional differences between firms by including year fixed effects.

3.3 Residual Variation in Supply Chain Risk

So far, we have shown that 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 7 presents the variance decomposition of SCRisk and SCSentiment. Economy-wide shocks, as captured by time-fixed effects, overall explain very little of SCRisk and SCSentiment, as the R-squared is about 6 percent for supply chain uncertainty and 1 percent for the sentiment measure. Three-digit SIC industry fixed effects and, more relevantly, interactions of three-digit industry and time fixed effects explain about 10 to 20 percent of SCRisk and SCSentiment, suggesting that firms within an industry may perform very differently in response to widespread supply chain disruptions.⁴ 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. Yet, the largest component of SCRisk appears to consist of firm-specific shocks. This feature of SCRisk is common to similarly constructed proxies for political risk and climate risk.

To evaluate whether the idiosyncratic variation in our proxies is meaningful, in Section 4, we explore how SCRisk and SCSentiment depend on firm characteristics. Here, we relate our two measures to the firm's stock price volatility and SCSentiment to the firm's stock performance. We

⁴ We also use 2-digit and 4-digit SIC codes to define industry and report the results in Table IA.2. The R-squared varies from 13% when we consider interactions of 2-digit SIC codes and time dummies to 27% when we consider interactions of 4-digit SIC codes and time dummies.

measure a firm's realized volatility as a firm's standard deviation of daily returns during a given year. Table 8, Panel A presents estimates of Fama-MacBeth regressions of a firm's realized volatility on contemporaneous 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 2.69% of the standard deviation. In column 2, we control for SCSentiment, which is negatively related to stock price volatility. Thus, negative supply chain shocks increase stock price volatility, as is commonly observed for other types of negative shocks (e.g., Berger, Dew-Becker, and Giglio, 2017).

Finally, in column 3, we evaluate whether our proxy for supply chain risk captures an independent source of risk, by running a horse race with the firm-level proxy for political risk of Hassan et al. (2019) and the proxy for climate risk of Sautner et al. (2022). This is particularly important because supply chain risk partially arises from events increasing political risk and natural disasters, which in turn depend on climate risk. Our proxy remains statistically significant and its coefficient is barely affected, indicating that we are capturing a genuinely different source of risk by isolating the effects of political and climate risks that go through a company's supply chain. 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. (2022).

We also investigate whether supply chain sentiment is associated with lower returns. Since earnings conference calls focus on the determinants of earnings and are therefore backward looking, we test how sentiment is associated with past stock returns. It is also plausible that the conversation is focused on the latest shocks. For this reason, in Panel B of Table 8, the dependent variable is *30-day average return*, computed as the average market model abnormal stock returns for the 30 days prior to the earnings call date, which we average over the year. We again run Fama-

MacBeth regressions. In column 1, we find a positive and significant relationship between average returns and SCSentiment. In column 2, we control for supply chain risk, while in column 3, we control for political risk and climate risk. We continue to find that higher supply chain sentiment is associated with higher stock returns.

4. Firms' Exposure to Supply Chain Risk

Table 9 relates SCRisk and SCSentiment to contemporaneous firm characteristics to understand which firms are relatively more exposed. This test also allows us to evaluate whether the idiosyncratic firm-level variation in SCRisk indeed captures different levels of supply chain uncertainty or is an artifact of the algorithm we apply. For this reason, throughout the analysis, we control for interactions of industry and year fixed effects thus capturing that inputs in some industries may at times be hard to source, leading to more supply chain shocks. Also, by controlling for industry-specific shocks, we hold constant that the number and type of suppliers of a firm depend on the industry's demand for different inputs.

The estimates indicate that the idiosyncratic variation in SCRisk is related to firm characteristics in a meaningful way and assuage concerns that it is just noise. Supply chain risk is higher for firms that report a higher fraction of 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 3.7% increase in supply chain risk. These findings suggesting that distance and supply chain complexity increase 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 a firm's average number of suppliers by input industry. Presumably, these firms have multiple providers of the same input and can more easily switch and substitute suppliers, suggesting that supply chain diversification decreases supply chain risk. The effect is not only statistically but also economically significant: On average, one more supplier by input industry decreases a firm's supply chain risk by 4.8% relative to the sample median.

Financial constraints do not appear to affect supply chain risk, while firms with higher growth opportunities, which possibly rely more on knowledge and services 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, 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 small firms and firms that face a more competitive environment as proxied by a low market share, suggesting that these firms have more unstable supply chains and may more easily lose suppliers as well as customers. The estimated coefficient is not only statistically significant but also economically significant: a 10% decrease in market share is associated with a 3.5% decrease in supply chain sentiment.

Overall, our validation exercise shows that not only snippets identified as having high SCRisk indeed center on the discussions of supply chain risk, but also that our proxy exhibits variation in the time-series, cross-section, and between firms that intuitively lines up with higher

supply chain uncertainty. Importantly, SCRisk is positively correlated with firms' stock price volatility, even after controlling for other commonly used proxies for firm level risk. In addition, SCSentiment appears to capture positive and negative news about supply chains and to be positively related to stock returns.

Bolstered by the results of our validation exercises, in the rest of the paper, we proceed to explore how firms adapt their supply chains and production processes to heightened supply chain risk.

5. How Firms Manage Supply Chain Risk

Since the early 1980s, U.S. firms have increasingly used foreign parts and components in their production processes. Consequently, production was relying on complex global value chains (Antràs and Chor, 2022), which have been defined by some commentators as the fiber of globalization.⁵ Geopolitical tensions between the U.S. and China, the war in Ukraine, and the Covid-19 pandemic are increasingly mentioned in the press as leading to more fragmentation and reshoring of global supply chains. Systematic evidence is however missing. In principle, firms could achieve more resilience by diversifying their suppliers, rather than relying on closer suppliers.

Using our proxy for firm level supply chain risk, we can provide the first systematic evidence about how firms organize their supply chains and their production processes in response to an increase in supply chain risk.

5.1 Supplier Composition

⁵ See "The structure of the world's supply chains is changing" The Economist, June 16, 2022.

To shed light on how firms manage supply chain risk, we investigate how characteristics of the supply chain vary when firms face heightened supply chain risk. Specifically, we relate characteristics of a firm's supply chain to the one-year lag of the proxy for supply chain risk, while including firm fixed effects. In this way, we study how changes in supply chain risk affect how firms decide to source their inputs. We also absorb industry shocks that could drive changes in policies by including interactions of industries and year fixed effects.

Panel A of Table 10 explores the effect of supply chain risk on the composition of the supply chain and provides evidence that firms attempt to reduce the probability of a supply chain disruption by changing their supplier pool.

Bimpikis, Fearing, and Tahbaz-Salehi (2018) and Elliott, Golub, and Leduc (2022) 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. 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 6.0% increase in the number of suppliers.⁶

Firms address supply chain risk not only through the quantity but also through the quality of their suppliers. Elliott, Golub, and Leduc (2022) 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

⁶ The results are robust to the use of Poisson regressions.

consistent product quality (Giroud, 2013). Finally, better monitoring 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 on SCRisk 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. In column 4, we see no change in the number of suppliers in different continents, indicating that nearshoring increases the diversification of a firm's supply chains but does not necessarily lead to more fragmentation of the supply chains.

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.⁷ We test this conjecture in column 5. We classify firms as industry leaders if their sales are above the median within their 3-digit industry. 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, these findings show 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

⁷ 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.”

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, 2022). Supply chain diversification and nearshoring (reliance on close suppliers) thus appear complementary mechanisms to address supply chain risk.

A possible concern with the interpretation of these results is that we capture the effect of negative shocks that propagate over the supply chain. The fact that we absorb industry shocks through interaction of industry and time fixed effects and control for a firm's cash flow at $t-1$ should mitigate these concerns. Yet, in columns 6 to 10 of Panel A we control for supply chain sentiment. Unsurprisingly, given the very small correlation between our SCRisk and SCSentiment, our estimates remain qualitatively invariant. Interestingly, decreases in SCSentiment are not associated with greater supply chain diversification, suggesting that if anything, shocks to the conditional mean have different effects from supply chain uncertainty. Firms appear to expand the number of close suppliers when they experience positive supply chain shocks, possibly to increase production when facing favorable conditions. To the extent that supply chain sentiment captures (the inverse of) negative realizations of supply chain shocks, the finding that supply chains are stable following negative shocks is consistent with evidence in Ersahin, Giannetti, and Huang (2021).

Panel B addresses the concern that discussions of supply chain risk could be endogenous. In particular, companies that are experiencing difficulties with their suppliers and have to switch, possibly resulting in higher costs, could strategically discuss supply chain uncertainty. We conjecture that strategic discussions of supply chain risk are less likely if a firm's suppliers are also discussing supply chain risk. We thus use as an instrument for a firm's SCRisk the maximum SCRisk of all its suppliers (whether domestic or international) that we observe from Factset Revere

and for which we can obtain earnings conference calls from Eikon. By considering the maximum SCRisk of a firm's suppliers, we take into account that inputs are complementary, and a firm's production is likely to be disrupted even if only one of the suppliers experiences problems.

Panel B reports the instrumental variable estimates. The effect of the instrument on a firm's SCRisk in the first stage is positive and significant as we expect.⁸ Furthermore, the F-test of the excluded instrument indicates that our instrument is not weak. The second stage estimates continue to support our earlier findings that following increases in supply chain risk, firms increase their number of suppliers, relying especially on suppliers that are in the same continent or domestic and are industry leaders. Importantly, it appears that firms also add suppliers in other continents, even though to a lower extent, confirming that supply chain uncertainty does not lead to more supply chain fragmentation. Also, in this case, controlling for supply chain sentiment leaves our estimates unaffected.

Importantly, the coefficient estimate on SCRisk is much larger. For instance, in column 1, going from the median to the 95th percentile of the predicted SCRisk leads to a 44.9% increase in the number of suppliers. The larger parameter estimate in the instrumental variable regressions is likely to depend on two factors. First, SCRisk contains measurement error. To the extent that the measurement error is uncorrelated with firms' supply chain characteristics and just depends on idiosyncrasies of the conference calls languages, it may drive down the coefficient estimates in the ordinary least squares regressions. Second, and more importantly, when we use the SCRisk of the suppliers as an instrument, we are likely to capture disproportionately large increases in SCRisk, which warrant discussions by several firms in the supply chain. Thus, the local average treatment effect that we capture in the instrumental variable estimate is necessarily larger.

⁸ Table IA.3 reports the full first-stage estimates.

5.2 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 chain 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. Specifically, we expect a firm experiencing heightened supply chain risk to have a higher probability of acquiring firms in an upstream industry to better control the access to inputs. We expect the probability of the acquisition of firms in downstream industries to increase as well because the identity of the acquirer and the target depends on technological reasons affecting their relative size and on their liquid holdings and access to external finance. For a firm to integrate with a supplier, it may just be optimal to become a target because, theoretically, what matters is the common ownership of different stages of the production process.

Table 11 explores whether firms engage in more vertical M&As when supply chain risk increases. Throughout the analysis, we include interactions of two-digit SIC industry and year fixed effects to control for industry shocks, which are known to lead to merger waves (e.g., Ahern and Harford, 2014). As in our previous specifications, we also include firm fixed effects thus capturing how changes in supply chain risk change a firm's propensity to vertically integrate. Finally, as in Table 10, we report ordinary least squares and instrumental variable specifications, in which we use the maximum SCRisk of a firm's suppliers as the instrument.

In Panel A, 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&As 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, a one-standard-deviation increase in SCRisk increases the probability of an M&A with a supplier or a customer by 32.5% and 38.6% relative to the baseline merger probability of 0.51% and 0.43%, respectively. 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, indicating that we are not just capturing firms' general propensity to make acquisitions.

Also, in columns 4 to 6, the estimates are qualitatively invariant when we control for SCSentiment, which appears unrelated to firms' propensity to vertically integrate. 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. This in turn should limit the possibility of engaging in M&As.

In Panel B, we address the concern that firms discuss supply chain risk because they wish to integrate vertically. The estimated effects of SCRisk on firms' propensity to vertically integrate are significantly larger in the instrumental variable estimates, suggesting that episodes of large increases in supply chain risk, as those that we capture when we exploit variation due to the SCRisk of the suppliers, are followed by a much higher propensity of firms to vertically integrate. In particular, a one-standard-deviation increase in SCRisk increases the probability of an M&A with a supplier or a customer by 64.1% and 83%, respectively.

So far, we have defined upstream and downstream industries considering input-output tables. Specifically, any industry that exhibits a bilateral flow is considered vertically related. In this way, we capture that limited availability of any input can cause bottlenecks in the presence of production complementarities. One may think however that inputs that are larger proportions of

an industry's costs of production matter most. In Table IA.4, we repeat our tests considering as vertically related only upstream (downstream) industries that account for at least one percent of purchases (sales) as Garfinkel and Hankins (2011) do to define vertical M&As. Our results are qualitatively invariant.

Table 12 tests another implication of the vertical integration theories. Vertical integration is expected to generate a larger surplus when supply assurance concerns are severe. Therefore, we expect the announcement of a vertical M&A to generate higher abnormal returns when firms are experiencing high supply chain risk. This is precisely what we find when we regress a firm's cumulative abnormal returns (CAR), obtained by estimating the market model over the [-255, -31] day estimation window, around merger announcements on the interaction of SCRisk and an indicator for vertical mergers. In column 1, for example, the coefficient on the interaction term is positive and significant. The effect is also economically large. When SCRisk increases from the 50th percentile to the 90th percentile, the vertical merger CAR increases by 1 percentage point, representing a 50% increase in CAR compared to the mean of 2%. In columns 2 and 3, we saturate the model with firm level controls and industry and year fixed effects that could have an independent effect on the value created by a merger. Our results are qualitatively invariant and quantitatively larger.

To further corroborate our interpretation of the empirical evidence that supply chain risk leads to more vertical integration, we also exploit that financial constraints prevent companies from engaging in vertical M&As. If SCRisk captures an actual increase in supply chain uncertainty, we should observe that its effect on the probability to vertically integrate is reduced for financially constrained firms. Put differently, financially constrained firms should be affected as much as other firms by supply chain shocks and risk but should be less able to react to them.

In Table 13, we use two measures of financial constraints to test this conjecture: 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 financial constraints hamper firms' ability 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). Importantly, this mechanism appears relevant not only for the financial hedges highlighted in previous literature but also for operational hedges as vertical integration involves even larger costs.

5.3 Robustness

Table 14 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 10 and Table 11 are robust to the inclusion of the political and climate risk proxies developed by Hassan et al. (2019) and Sautner et al. (2022), respectively. Furthermore, we see that contrary to supply chain risk, political and climate risks have a negative or no effect on vertical integration and supplier composition. Not only does this confirm 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.

In Table IA.5, we report results controlling for the overall sentiment of the transcripts. One might be concerned that when times are bad or the firm performs poorly, managers blame supply chain issues. If this were true, the supply chain risk could capture general negative conditions. However, when we control for the overall sentiment of a firm's earnings call, we continue to find similar results suggesting that SCRisk does not capture general negative sentiment.

Another potential concern is that SCRisk is measured with noise from the earnings call transcripts. While using the SCRisk of a firm's suppliers helps to address this concern, we also exploit that, as noted in Subsection 2.3, one of the topics identifies discussions of supply chain risks in the context of general financial and analyst-related issues that are typical of earnings conference calls. These snippets might not reflect an actual increase in supply chain risk, but rather noise. As a result, potential noise could contaminate our findings. Taking advantage of the topic analysis, we consider supply chain risk to be measured with noise for a firm if during a year more than half of the snippets that incorporate supply chain risk discussions are associated with a probability of discussing general financial and analyst issues in the top quartile.

We implement two strategies to account for this potential noise. First, we replace SCRisk that we identify as potential noise with the two-digit SIC industry median SCRisk during the same year. We find qualitatively similar results in Table IA.6. Second, we drop the observation if SCRisk is identified as measured with potential noise. In Table IA.7, we again report similar findings to our main results.

Finally, we perform the main analysis on firm policies as in Tables 10 and 11 using the supply chain risk and sentiment measures constructed from 8-K filings. We report the results in

Table IA.8. The supplier composition and vertical integration findings are robust, confirming that earnings calls are a reliable source of information on firms' supply chains.

6. 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, but do not decrease their reliance on suppliers in other continents. 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

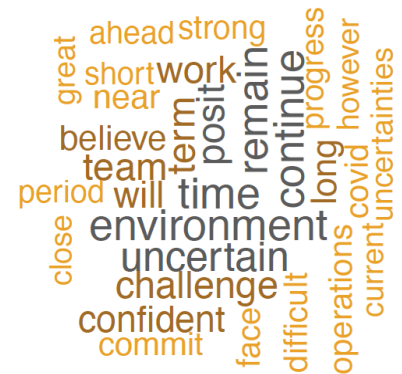
This figure presents the word cloud for the nine topics derived from supply chain risk related snippets. For each topic, we create a word cloud that shows the words with the highest frequencies.



Costs and commodity price risk



Technology and Cyber Attacks Risk



Climate Risk and Pandemics



Market Uncertainty and Regions



Liquidity



Analysts and Financial Issues

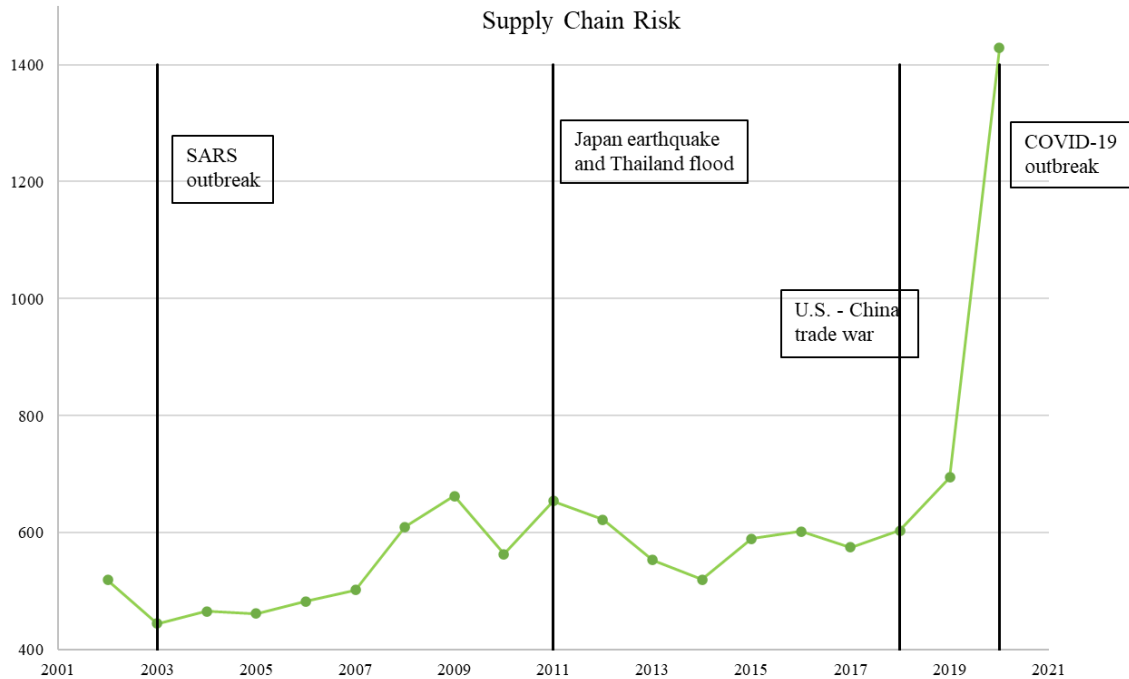


Acquisitions

Figure 2

This figure shows the mean of SCRisk and SCSentiment along with indicators for key events related to supply chain shocks. SCRisk and SCSentiment are scaled up by a factor of 100.

Panel A. SCRisk



Panel B. SCSentiment

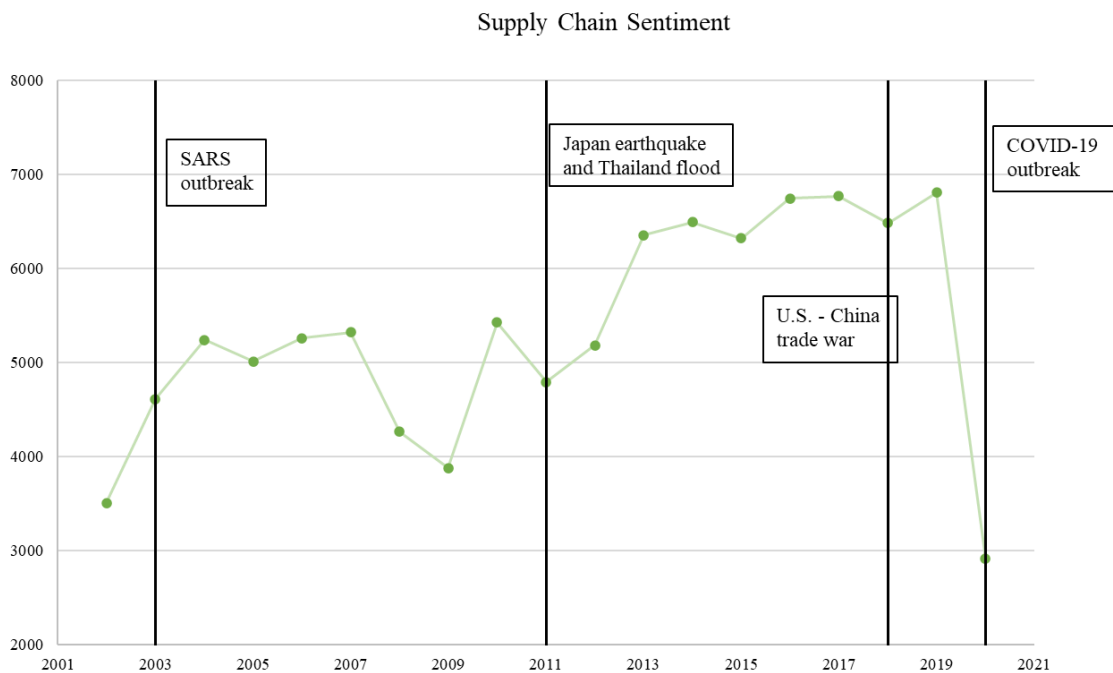


Figure 3

This figure shows the mean of SCRisk and the global transportation costs index (transportation costs) developed by Benigno et al. (2022).

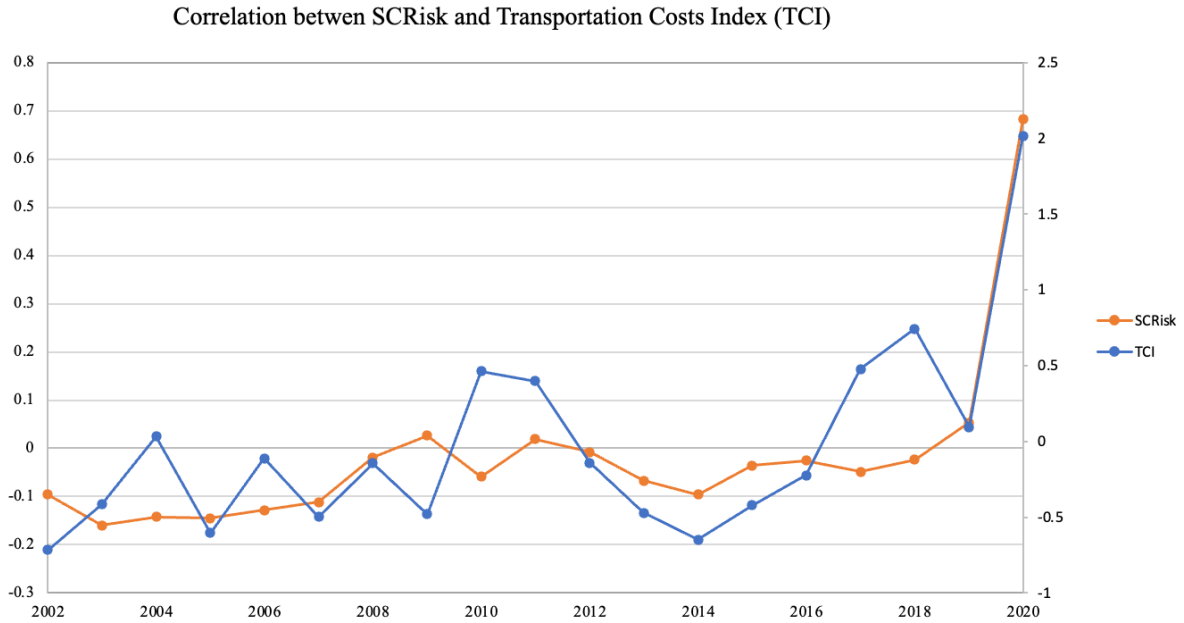


Table 1. Summary statistics

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 | 6.0002 | 8.2963 | 2.2919 | 3.6500 | 6.0512 |
| SCSentiment | 33,920 | 61.1992 | 96.8289 | 14.9943 | 37.7357 | 73.1374 |
| 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 | 0.1597 | 0.2643 | 0.0036 | 0.0307 | 0.1811 |
| 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 | 6.7510 | 1.8502 | 5.4331 | 6.6771 | 7.9526 |
| Tobin's Q | 33,920 | 2.1894 | 1.5287 | 1.2302 | 1.6799 | 2.5542 |
| Cash holdings | 33,920 | 0.2262 | 0.2353 | 0.0454 | 0.1364 | 0.3334 |
| Cash flow | 33,920 | -0.0143 | 0.1959 | -0.0223 | 0.0375 | 0.0782 |
| 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 suppliers in different continents | 33,920 | 2.0717 | 5.6053 | 0 | 0 | 2 |
| 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 |
| Overall sentiment | 33,920 | 0.0905 | 0.0939 | 0.0334 | 0.0841 | 0.1404 |
| Input Specificity | 30,899 | 3.2097 | 6.1299 | 0.3664 | 0.6080 | 2.8234 |
| Realized volatility | 23,635 | 2.7530 | 1.3971 | 1.7707 | 2.4034 | 3.3444 |
| SCRisk of suppliers | 25,317 | 11.6416 | 10.4246 | 2.6827 | 8.6230 | 19.4293 |
| 30-day average abnormal return | 23,635 | 0.0000 | 0.0028 | -0.0013 | 0.0000 | 0.0012 |

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. Excerpts from earnings calls

This table reports firm name, earnings call date, and excerpts from earnings calls with high SCRisk and SCSentiment (both positive and negative) in panels A and B, respectively.

| Firm Name | Date of Report | Text |
|---|-----------------------|---|
| Panel A: Excerpts based on SCRisk | | |
| 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 |

| | | |
|----------------------|----------------|---|
| Entegris, Inc | April 26, 2016 | increases reflecting the 25% tariff that was eventually applied to practically all imports of carbon steel products. 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. |

Panel B: Excerpts based on SCSentiment

| | | |
|---------------------------------|------------------|---|
| <i>Positive sentiment</i> | | |
| LightInTheBox Holding Co., Ltd. | April 21, 2016 | Stronger than expected holiday sales were primarily a result of our improved supply chain management and the stronger support of our suppliers with discounts and sourcing prices for the holiday season. |
| Coty Inc. | November 9, 2020 | Third, our focus and enhancements over the last year to our supply chain continue to support our growth while allowing us to successfully navigate the COVID-19 pandemic. We added another co-packer to our network during the third quarter, providing further capacity, flexibility and the ability to service our customers. |
| Vitria Technology, Inc. | October 24, 2006 | Second, one of our customers, MasterBrands won "Network World's" 2006 Enterprise All-Star Award for its innovative supply chain management application. Powered primarily by Vitria's BusinessWare products, MasterBrands was able to dramatically speed order fulfillment, provide exceptional handling and enable visibility across the supply chain , earning the company an Enterprise All-Star Award |
| Tuniu Corporation | August 28, 2019 | In the travel industry, the supply chain is the vital component that connects the supply and demand. We made strong progress during the last few years in further strengthening our supply chain . We continue to consolidate procurement across the company in order to maximize our bargaining power with suppliers and minimize risk, while better sharing inventory across our various business units. |

| | | |
|----------------------------|------------------|--|
| Hanesbrands, Inc. | July 23, 2014 | Q2 was another great quarter for Hanesbrands. We expanded operating margins by 210 basis points and grew our earnings 44% to \$1.71 per share, providing further evidence that when you combine our Innovate-to-Elevate strategy, our self-owned supply chain , and strategic acquisitions, we have a great formula for creating shareholder value . |
| Newell Brands Inc. | May 1, 2020 | <i>Negative sentiment</i> In the month of April, the supply chain disruptions , the retail closures and the consumer purchase pattern shifts contributed to an estimated sales decline in the 25% sales range, which has informed our call out for a challenging second quarter. |
| Reed's, Inc. | November 7, 2018 | First quarter revenues declined 7.7% on a like-for-like basis, as we encountered temporary supply chain headwinds . Alongside the previously flagged supply chain issues affecting Consumer Beauty and Professional Beauty, our Luxury division was also impacted in Q1 by a disruption in European warehouse, by the U.S. hurricane and by component shortages at certain external suppliers . |
| Micrel Semiconductor, Inc. | April 21, 2011 | Consistent with our pre-announcement of preliminary first quarter results on April 11, our top line was impacted by an unanticipated reduction in sales to a Korean wireless handset and consumer electronic device manufacturer which moderated product deliveries during the quarter to control inventory levels. The Company also experienced a reduction in overall demand toward the end of the quarter related to disruptions in the worldwide electronics supply chain as a result of the earthquake and tsunami in Japan in March. |
| Corning, Inc. | January 27, 2009 | The supply chain actually reacted faster and more severely than we anticipated in quarter four. We had thought the supply chain would reduce 75 million square feet in Q4 with the risk of the additional 50. The reality turned out to be far bigger. Supply chain reduced 230 million square feet of glass in quarter for. When you combine the retail weakness and supply chain contraction , you will understand why our glass volumes were down so much in Q4. And by the way, these numbers I'm discussing here were for the entire industry. So it was a difficult and disappointing quarter. |
| Ocean freight, Inc. | May 27, 2011 | Let's shift gears now and look at the recent developments in the dry bulk market . The market for the first quarter of 2011 resulted in a very low freight rate environment, in many cases, even below breakeven levels . Let's see why... Second reason is events in Japan have disrupted the supply chain on both raw and finished materials. |

Table 4. Components of supply chain risk and sentiment

This table reports the components that contribute to SCRisk and SCSentiment using topic analysis. We calculate the probability of each topic and regress SCRisk and SCSentiment on the topics' probabilities in columns (1) and (2), respectively. The topic probabilities are standardized by subtracting from each topic probability the mean and dividing by the standard deviation for ease of comparison. 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.

| Topics | (1) SCRisk | (2) SCSentiment |
|-----------------------------------|-----------------------|------------------------|
| Costs and commodity price risk | 0.7743*** (0.0566) | 0.1746 (0.6324) |
| Technology and cyber attacks risk | 0.3025*** (0.0707) | 0.8884 (0.7119) |
| Climate risk and pandemics | 0.7248*** (0.0661) | -0.5839 (0.6846) |
| Market uncertainty and regions | 0.6851*** (0.0620) | 1.1863* (0.7186) |
| Liquidity | 0.2360*** (0.0603) | -0.0071 (0.6999) |
| Analysts and financial issues | 0.2378*** (0.0469) | -2.1457*** (0.5812) |
| Acquisitions | 0.2903*** (0.0575) | -1.0600* (0.6132) |
| Firm FE | Y | Y |
| Industry x year FE | Y | Y |
| Observations | 34,210 | 34,210 |
| Adjusted R-squared | 0.2278 | 0.4029 |

Table 5. 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 6. Input specificity

This table reports the effects of input specificity on SCRisk and SCSentiment in Panels A and B, respectively. The main independent variable is Input Specificity, which is constructed based on input-output tables and Rauch (1999). 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) | (2) | (3) | (4) | (5) |
|---|-----------------------|-----------------------|-----------------------|-----------------------|-------------------------|
| Panel A: Dependent variable - SCRisk | | | | | |
| Input Specificity | 0.0825*** (0.0156) | 0.0786*** (0.0156) | 0.2025*** (0.0396) | 0.3356*** (0.0398) | 0.1993*** (0.0395) |
| Size | | | | | 0.0560 (0.0470) |
| Tobin's Q | | | | | -0.1228*** (0.0422) |
| Cash holdings | | | | | -0.4653 (0.3423) |
| Cash flow | | | | | 1.0116*** (0.3108) |
| Year FE | | Y | | Y | Y |
| Industry FE | | | Y | Y | Y |
| Observations | 30,878 | 30,878 | 30,878 | 30,878 | 30,878 |
| Adjusted R-squared | 0.0035 | 0.0658 | 0.0879 | 0.0256 | 0.0896 |
| Panel B: Dependent variable - SCSentiment | | | | | |
| Input Specificity | 1.0952*** (0.2570) | 1.0336*** (0.2597) | -0.8239 (0.5926) | 0.5636 (0.5899) | -0.8079 (0.5859) |
| Size | | | | | 3.4033*** (0.7081) |
| Tobin's Q | | | | | 0.6441 (0.6858) |
| Cash holdings | | | | | -19.1755*** (4.8732) |
| Cash flow | | | | | -13.0484*** (4.9748) |
| Year FE | | Y | | Y | Y |
| Industry FE | | | Y | Y | Y |
| Observations | 30,878 | 30,878 | 30,878 | 30,878 | 30,878 |
| Adjusted R-squared | 0.0046 | 0.0160 | 0.0924 | 0.0796 | 0.0975 |

Table 7. Variance decomposition of SCRisk and SCSentiment

This table reports adjusted R-squared and R-squared from the projection of SCRisk and SCSentiment in Panel A and Panel B, respectively, on various sets of fixed effects, as indicated in the table. Industries are classified at the three-digit SIC code level.

| | (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 | 0.0119 | 0.1365 | 0.2223 | 0.5372 |

Table 8. Supply chain risk, firm volatility, and returns

This table reports estimates of Fama-MacBeth regressions of firms' yearly realized volatility and 30-day average abnormal return on SCRisk and SCSentiment during the year in Panels A and B, respectively. The dependent variable in Panel A is *Realized Volatility*, computed as a firm's standard deviation of daily returns in that year. The dependent variable in Panel B is *30-day average abnormal return*, computed as the average abnormal stock return for the 30 days prior to the earnings call date, then averaged within the year. In panel B only, we multiply the dependent variable in Panel B by a factor of 1,000 for presentation. Firm-level abnormal returns are obtained by estimating the market model over the [-255, -31] day interval. The Political risk measure is from Hassan et al. (2019). The Climate risk measure is from Sautner et al. (2022). All variables are defined in Appendix A. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

| | (1) | (2) | (3) |
|--|-----------------------|------------------------|------------------------|
| Panel A: Dependent variable - realized volatility | | | |
| SCRisk | 0.0045** (0.0020) | 0.0051** (0.0020) | 0.0042** (0.0019) |
| SCSentiment | | -0.0008*** (0.0001) | -0.0008*** (0.0001) |
| Political Risk | | | 28.4057*** (9.0611) |
| Climate Risk | | | 1.8034 (1.8126) |
| Number of Firms | 2,672 | 2,672 | 2,672 |
| Number of Years | 18 | 18 | 18 |
| Panel B: Dependent variable – 30-day average abnormal return | | | |
| SCSentiment | 0.0008*** (0.0002) | 0.0008*** (0.0002) | 0.0008*** (0.0002) |
| SCRisk | | -0.0043* (0.0024) | -0.0048** (0.0020) |
| Political Risk | | | 13.5769 (22.1891) |
| Climate Risk | | | -0.3344 (3.6581) |
| Number of Firms | 2,672 | 2,672 | 2,672 |
| Number of Years | 18 | 18 | 18 |

Table 9. Firm characteristics, supply chain risk, and supply chain sentiment

This table relates SCRisk and SCSentiment in Panel A and Panel B, respectively, to contemporaneous firm characteristics in an annual panel. The main independent variable in columns (1) is *Different continents*, which is the fraction of a firm's suppliers who are located in a different continent over the total number of suppliers. The additional independent variable in column (2) is *Relative Size*, defined as a firm's total assets divided by the average total assets of its suppliers. The additional independent variable in column (3) is *Size*, defined as the natural logarithm of the firm's total assets. The additional independent variable in column (4) is *Average number of suppliers by industry*, defined as the average of a firm's number of suppliers within each of the three-digit SIC industries for which we observe suppliers from Factset Revere. The additional independent variable in column (5) is *Market Share*, defined as a firm's sales divided by the total sales in the firm's industry. The additional independent variable in column (6) is *Financial constraint*, which is an indicator variable that equals one if the Whited-Wu (2006) proxy for firm-level financial constraints is above the median of our sample. The additional independent variable in column (7) is *Institutional ownership*, which is the fraction of the firm's shares owned by financial institutions, which we obtain from 13F filings. The additional independent variable in column (8) is *Tobin's Q*, defined as assets minus cash and cash equivalent securities plus book value on equity scaled by assets. We scale up the dependent variable in Panel A, SCRisk, by a factor of 1,000 for readability. The unit of observation is a firm-year. Industries are classified at the two-digit SIC code level. 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: SCRisk | | | | | | | | |
| Different continents | 0.7115*** (0.2754) | 0.7115*** (0.2754) | 0.6216** (0.2715) | 0.6255** (0.2714) | 0.6255** (0.2713) | 0.6285** (0.2712) | 0.5848** (0.2726) | 0.5878** (0.2715) |
| Relative size | | -0.0039* (0.0020) | -0.0055*** (0.0019) | -0.0048*** (0.0018) | -0.0051*** (0.0019) | -0.0051*** (0.0018) | -0.0053*** (0.0019) | -0.0053*** (0.0018) |
| Size | | | 0.0732* (0.0401) | 0.1133** (0.0444) | 0.0936** (0.0450) | 0.0755 (0.0506) | 0.1160** (0.0524) | 0.0902* (0.0527) |
| Average number of suppliers by industry | | | | -0.1757** (0.0697) | -0.1750** (0.0698) | -0.1698** (0.0699) | -0.1941*** (0.0702) | -0.1645** (0.0704) |
| Market share | | | | | 0.3360 (0.3079) | 0.3236 (0.3084) | 0.2805 (0.3063) | 0.2700 (0.3060) |
| Financial constraint | | | | | | -0.1195 (0.1442) | -0.1342 (0.1438) | -0.1329 (0.1442) |
| Institutional ownership | | | | | | | -0.6033*** (0.1856) | -0.5028*** (0.1881) |
| Tobin's Q | | | | | | | | -0.1750*** (0.0390) |

| | | | | | | | | |
|--|--------------------|--------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|-----------------------|
| 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 | 0.1066 |
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
| Panel B: SCSentiment | | | | | | | | |
| Different continents | 0.5753 (3.2470) | 0.5754 (3.2469) | -4.1811 (3.2296) | -4.2020 (3.2275) | -4.2043 (3.2319) | -4.2127 (3.2270) | -3.9591 (3.2241) | -3.9706 (3.2226) |
| Relative size | | 0.0206 (0.0610) | -0.0640* (0.0356) | -0.0675* (0.0349) | -0.0806** (0.0377) | -0.0807** (0.0376) | -0.0795** (0.0376) | -0.0797** (0.0378) |
| Size | | | 3.8703*** (0.5989) | 3.6577*** (0.6547) | 2.8789*** (0.6600) | 2.9281*** (0.7179) | 2.6931*** (0.7535) | 2.7947*** (0.7564) |
| Average number of suppliers by (input) industry | | | | 0.9311 (1.3551) | 0.9592 (1.3492) | 0.9451 (1.3474) | 1.0857 (1.3492) | 0.9694 (1.3467) |
| Market share | | | | | 13.2548** (5.5442) | 13.2885** (5.5815) | 13.5384** (5.5640) | 13.5796** (5.5684) |
| Financial constraint | | | | | | 0.3257 (2.3540) | 0.4112 (2.3505) | 0.4059 (2.3509) |
| Institutional ownership | | | | | | | 3.5014 (3.2779) | 3.1064 (3.2128) |
| Tobin's Q | | | | | | | | 0.6878 (0.6903) |
| 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 | 0.1035 | 0.1036 |

Table 10. Supply chain risk and the composition of supply chains

This table reports estimates of the effects of a firm's SCRisk and SCSentiment at $t-1$ on its number of suppliers at t . The dependent variables in columns (1) and (6), (2) and (7), (3) and (8), (4) and (9), and (5) and (10) are the number of suppliers, the number of suppliers in the same continent as the firm, the number of U.S. suppliers, the number of suppliers in different continents, and the number of suppliers that are industry leaders, respectively. Industry leaders are defined as suppliers with sales above the median of their 3-digit SIC industry. Firm controls include size, Tobin's Q, cash holdings, and cash flow. The unit of observation is a firm-year. Industries are classified at the two-digit SIC code level. Panel A reports OLS regression results. Panel B uses the supply chain risk of its suppliers as an instrument. 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) | (9) | (10) |
|--------------------------|------------------------|--|--------------------------------|--|--|------------------------|--|--------------------------------|--|--|
| | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| Panel A: OLS regressions | | | | | | | | | | |
| SCRisk | 0.0164** (0.0072) | 0.0127*** (0.0040) | 0.0125*** (0.0038) | 0.0061 (0.0051) | 0.0059* (0.0032) | 0.0162** (0.0072) | 0.0126*** (0.0041) | 0.0123*** (0.0038) | 0.0060 (0.0051) | 0.0058* (0.0032) |
| SCSentiment | | | | | | 0.0011 (0.0008) | 0.0009** (0.0004) | 0.0010** (0.0004) | 0.0001 (0.0005) | 0.0005 (0.0003) |
| Size | 2.1992*** (0.2435) | 1.1972*** (0.1241) | 1.1245*** (0.1150) | 0.6366*** (0.1611) | 1.1383*** (0.1069) | 2.1978*** (0.2434) | 1.1962*** (0.1239) | 1.1234*** (0.1146) | 0.6365*** (0.1610) | 1.1376*** (0.1068) |
| Tobin's Q | 0.0770 (0.0718) | -0.0236 (0.0353) | 0.0196 (0.0322) | 0.0225 (0.0407) | 0.0361 (0.0295) | 0.0768 (0.0718) | -0.0237 (0.0353) | 0.0194 (0.0322) | 0.0225 (0.0407) | 0.0360 (0.0295) |
| Cash holdings | 0.1135 (0.6458) | -0.6710* (0.3654) | -0.6507* (0.3389) | 0.5100 (0.4024) | -0.6490** (0.2992) | 0.1171 (0.6457) | -0.6682* (0.3651) | -0.6476* (0.3385) | 0.5104 (0.4024) | -0.6473** (0.2990) |
| Cash flow | -2.0341*** (0.3872) | -1.1455*** (0.2331) | -1.1182*** (0.2172) | -0.8608*** (0.2450) | -1.0460*** (0.1768) | -2.0413*** (0.3868) | -1.1510*** (0.2330) | -1.1244*** (0.2171) | -0.8615*** (0.2451) | -1.0495*** (0.1768) |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.8246 | 0.7534 | 0.7589 | 0.6076 | 0.8261 | 0.8247 | 0.7535 | 0.7590 | 0.6076 | 0.8261 |

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
|-------------------------|------------------------|--|--------------------------------|--|--|------------------------|--|--------------------------------|--|--|
| | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| Panel B: IV regressions | | | | | | | | | | |
| SCRisk | 5.4716*** (1.7981) | 2.5905*** (0.8532) | 2.3541*** (0.7741) | 1.1001*** (0.3998) | 2.5348*** (0.8283) | 5.5022*** (1.8251) | 2.6034*** (0.8654) | 2.3648*** (0.7848) | 1.1068*** (0.4053) | 2.5489*** (0.8407) |
| SCSentiment | | | | | | -0.0063 (0.0070) | -0.0027 (0.0033) | -0.0022 (0.0030) | -0.0014 (0.0014) | -0.0029 (0.0032) |
| Size | 2.2470*** (0.8576) | 1.2199*** (0.4073) | 1.1450*** (0.3677) | 0.6462*** (0.2272) | 1.1604*** (0.3879) | 2.2546*** (0.8614) | 1.2231*** (0.4089) | 1.1477*** (0.3691) | 0.6479*** (0.2278) | 1.1639*** (0.3897) |
| Tobin's Q | 0.9518** (0.4164) | 0.3898** (0.1962) | 0.3951** (0.1780) | 0.1980** (0.0976) | 0.4416** (0.1907) | 0.9577** (0.4206) | 0.3923** (0.1981) | 0.3972** (0.1797) | 0.1992** (0.0984) | 0.4444** (0.1926) |
| Cash holdings | -9.6333** (4.5748) | -5.2767** (2.1758) | -4.8344** (1.9759) | -1.4448 (1.0024) | -5.1675** (2.1208) | -9.7065** (4.6279) | -5.3074** (2.1991) | -4.8601** (1.9963) | -1.4607 (1.0131) | -5.2012** (2.1452) |
| Cash flow | -2.5649 (2.4991) | -1.3963 (1.1814) | -1.3461 (1.0726) | -0.9672* (0.5522) | -1.2920 (1.1364) | -2.5275 (2.5106) | -1.3806 (1.1861) | -1.3329 (1.0765) | -0.9591* (0.5547) | -1.2749 (1.1416) |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) |
| First-stage F-stat | 13.316 | 13.316 | 13.316 | 13.316 | 13.316 | 13.145 | 13.145 | 13.145 | 13.145 | 13.145 |

Table 11. Supply chain risk and vertical M&As

This table reports estimates of the effects of SCRisk at $t-1$ on the probability that a firm is involved in M&As at t . The dependent variables in columns (1) and (4) and (2) and (5) 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 in an upstream or downstream industry, respectively. The dependent variable in columns (3) and (6) 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. Industries are classified at the two-digit SIC code level. Panel A reports OLS regression results. Panel B uses the supply chain risk of its suppliers as an instrument. 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: OLS regressions | | | | | | |
|--------------------------|-----------------------------|-----------------------------|--------------------------|-----------------------------|-----------------------------|--------------------------|
| | (1) M&A with supplier | (2) M&A with customer | (3) Unrelated M&As | (4) M&A with supplier | (5) M&A with customer | (6) Unrelated M&As |
| SCRisk | 0.0002** (0.0001) | 0.0002** (0.0001) | 0.0003 (0.0004) | 0.0002** (0.0001) | 0.0002** (0.0001) | 0.0003 (0.0004) |
| SCSentiment | | | | -0.0000 (0.0000) | -0.0000 (0.0000) | 0.0000 (0.0000) |
| Size | -0.0026*** (0.0010) | -0.0025*** (0.0009) | 0.0054 (0.0080) | -0.0026*** (0.0010) | -0.0025*** (0.0009) | 0.0054 (0.0080) |
| Tobin's Q | 0.0002 (0.0003) | 0.0002 (0.0003) | 0.0087*** (0.0027) | 0.0002 (0.0003) | 0.0002 (0.0003) | 0.0087*** (0.0027) |
| Cash holdings | -0.0002 (0.0034) | -0.0012 (0.0033) | 0.1751*** (0.0339) | -0.0002 (0.0034) | -0.0013 (0.0033) | 0.1752*** (0.0339) |
| Cash flow | 0.0047** (0.0021) | 0.0046** (0.0020) | 0.1560*** (0.0176) | 0.0048** (0.0022) | 0.0046** (0.0020) | 0.1560*** (0.0176) |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.1038 | 0.0850 | 0.2153 | 0.1038 | 0.0850 | 0.2153 |

| Panel B: IV regressions | | | | | | |
|-------------------------|-----------------------------|-----------------------------|--------------------------|-----------------------------|-----------------------------|--------------------------|
| | (1) M&A with supplier | (2) M&A with customer | (3) Unrelated M&As | (4) M&A with supplier | (5) M&A with customer | (6) Unrelated M&As |
| SCRisk | 0.0076** (0.0037) | 0.0083** (0.0038) | 0.0075 (0.0153) | 0.0077** (0.0038) | 0.0084** (0.0038) | 0.0076 (0.0154) |
| SCSentiment | | | | -0.0000 (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) |
| Size | -0.0025* (0.0015) | -0.0025 (0.0016) | 0.0055 (0.0082) | -0.0025* (0.0015) | -0.0024 (0.0016) | 0.0055 (0.0082) |
| Tobin's Q | 0.0014* (0.0008) | 0.0015* (0.0008) | 0.0099*** (0.0036) | 0.0014* (0.0008) | 0.0015* (0.0008) | 0.0099*** (0.0036) |
| Cash holdings | -0.0133 (0.0094) | -0.0157 (0.0096) | 0.1622*** (0.0442) | -0.0135 (0.0095) | -0.0159 (0.0097) | 0.1622*** (0.0443) |
| Cash flow | 0.0040 (0.0040) | 0.0038 (0.0042) | 0.1553*** (0.0180) | 0.0041 (0.0041) | 0.0039 (0.0042) | 0.1553*** (0.0180) |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0222*** (0.0072) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) |
| First-stage F-stat | 13.316 | 13.316 | 13.316 | 13.145 | 13.145 | 13.145 |

Table 12. Stock market reaction to vertical M&A announcements

This table reports OLS regression results for firms' cumulative abnormal returns (CAR) around M&A announcements. The dependent variable is the CAR over a three-day event window [-1, +1] around an M&A announcement, obtained by estimating the market model over a [-255, -31] day estimation window. Vertical merger is a dummy variable that equals one if the firm conducts an M&A with a firm from an upstream or a downstream industry and zero 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 at the deal level. Firm controls include size, Tobin's Q, cash holdings, and cash flow. All variables are defined in Appendix A. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

| | (1) | (2) | (3) |
|--------------------------|------------------------|------------------------|------------------------|
| | CAR [-1, +1] | | |
| SCRisk | -0.2883*** (0.1046) | -0.2808*** (0.1040) | -0.3770*** (0.1117) |
| Vertical merger | -0.0005 (0.0082) | -0.0044 (0.0082) | -0.0064 (0.0092) |
| SCRisk * Vertical merger | 1.8096** (0.9131) | 2.1406** (0.9072) | 2.2743** (0.9352) |
| Size | | -0.0044*** (0.0005) | -0.0049*** (0.0005) |
| Tobin's Q | | -0.0011 (0.0007) | -0.0008 (0.0008) |
| Cash holdings | | -0.0232*** (0.0052) | -0.0195*** (0.0057) |
| Cash flow | | -0.0066 (0.0076) | -0.0027 (0.0079) |
| Year FE | N | N | Y |
| Industry FE | N | N | Y |
| Observations | 6,300 | 6,300 | 6,300 |
| Adjusted R-squared | 0.0017 | 0.0164 | 0.0244 |

Table 13. Supply chain risk, financial constraints, and vertical integration

This table reports OLS estimates of the effects of SCRisk at $t-1$ on firms' M&As at t 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, 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 | | | |
| SCRisk | 0.0004** (0.0002) | 0.0004** (0.0002) | 0.0007 (0.0005) |
| HP FC dummy | -0.0026 (0.0021) | -0.0023 (0.0020) | -0.0381*** (0.0117) |
| SCRisk x HP FC dummy | -0.0005*** (0.0002) | -0.0004*** (0.0002) | -0.0009 (0.0006) |
| Firm controls | Y | Y | Y |
| Firm FE | Y | Y | Y |
| Industry x year FE | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.1046 | 0.0858 | 0.2158 |
| Panel B: Whited-Wu financial constraint measure | | | |
| SCRisk | 0.0004** (0.0002) | 0.0004** (0.0002) | 0.0006 (0.0005) |
| WW FC dummy | -0.0007 (0.0018) | -0.0004 (0.0018) | -0.0097 (0.0101) |
| SCRisk x WW FC dummy | -0.0005** (0.0002) | -0.0004** (0.0002) | -0.0007 (0.0007) |
| Firm controls | Y | Y | Y |
| Firm FE | Y | Y | Y |
| Industry x year FE | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.1045 | 0.0857 | 0.2153 |

Table 14. Supply chain risk vs political risk and climate risk

This table reports estimates of the effects of SCRisk at $t-1$ on firms' M&As and number of suppliers at t 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 et al. (2019). The Climate risk measure is taken from Sautner et al. (2022). The dependent variables in columns (1) and (2) of Panel A 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, respectively. The dependent variable in column (3) of Panel A is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm that is neither in an upstream nor a downstream industry. The dependent variables in columns 1 to 5 of Panel B are number of suppliers, number of suppliers in the same continent as the firm, number of U.S. suppliers, number of suppliers in different continents, 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. We instrument for firm's supply chain risk with the supply chain risk of its suppliers. 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: Firms' M&As | | | |
|----------------------|-----------------------------|-----------------------------|--------------------------|
| | (1) M&A with supplier | (2) M&A with customer | (3) Unrelated M&As |
| SCRisk | 0.0076** (0.0037) | 0.0083** (0.0038) | 0.0075 (0.0153) |
| SCSentiment | -0.0000* (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) |
| Size | -0.0024 (0.0015) | -0.0024 (0.0015) | 0.0056 (0.0082) |
| Tobin's Q | 0.0014* (0.0008) | 0.0015* (0.0008) | 0.0098*** (0.0036) |
| Cash holdings | -0.0133 (0.0093) | -0.0156 (0.0096) | 0.1626*** (0.0439) |
| Cash flow | 0.0040 (0.0040) | 0.0038 (0.0042) | 0.1551*** (0.0180) |
| Political risk | -1.7535 (1.0666) | -1.9390* (1.0756) | -2.7559 (4.2869) |
| Climate risk | -0.0823 (0.1462) | -0.0321 (0.1458) | -0.0003 (0.4174) |
| Firm FE | Y | Y | Y |
| Industry x year FE | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0222*** (0.0073) | 0.0222*** (0.0073) | 0.0222*** (0.0073) |
| First-stage F-stat | 13.324 | 13.324 | 13.324 |

| Panel B: Supply chain composition | | | | | |
|-----------------------------------|------------------------|--|--------------------------------|--|---|
| | (1) | (2) | (3) | (4) | (5) |
| | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| SCRisk | 5.4685*** (1.8022) | 2.5868*** (0.8543) | 2.3492*** (0.7746) | 1.1038*** (0.4022) | 2.5339*** (0.8303) |
| SCSentiment | -0.0065 (0.0070) | -0.0027 (0.0033) | -0.0023 (0.0030) | -0.0014 (0.0014) | -0.0030 (0.0032) |
| Size | 2.2950*** (0.8514) | 1.2420*** (0.4040) | 1.1653*** (0.3645) | 0.6529*** (0.2270) | 1.1822*** (0.3849) |
| Tobin's Q | 0.9431** (0.4134) | 0.3857** (0.1946) | 0.3911** (0.1765) | 0.1970** (0.0974) | 0.4377** (0.1893) |
| Cash holdings | -9.5146** (4.5475) | -5.2206** (2.1609) | -4.7805** (1.9611) | -1.4317 (1.0003) | -5.1131** (2.1085) |
| Cash flow | -2.5916 (2.4890) | -1.4106 (1.1761) | -1.3608 (1.0672) | -0.9671* (0.5530) | -1.3039 (1.1320) |
| Political risk | -1.1211** (0.4998) | -0.5084** (0.2353) | -0.4666** (0.2141) | -0.1674 (0.1112) | -0.5142** (0.2295) |
| Climate risk | 0.0191 (0.0641) | 0.0046 (0.0302) | 0.0029 (0.0275) | 0.0094 (0.0152) | 0.0102 (0.0297) |
| Firm FE | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0222*** (0.0073) | 0.0222*** (0.0073) | 0.0222*** (0.0073) | 0.0222*** (0.0073) | 0.0222*** (0.0073) |
| First-stage F-stat | 13.324 | 13.324 | 13.324 | 13.324 | 13.324 |

Appendix A Variable definitions

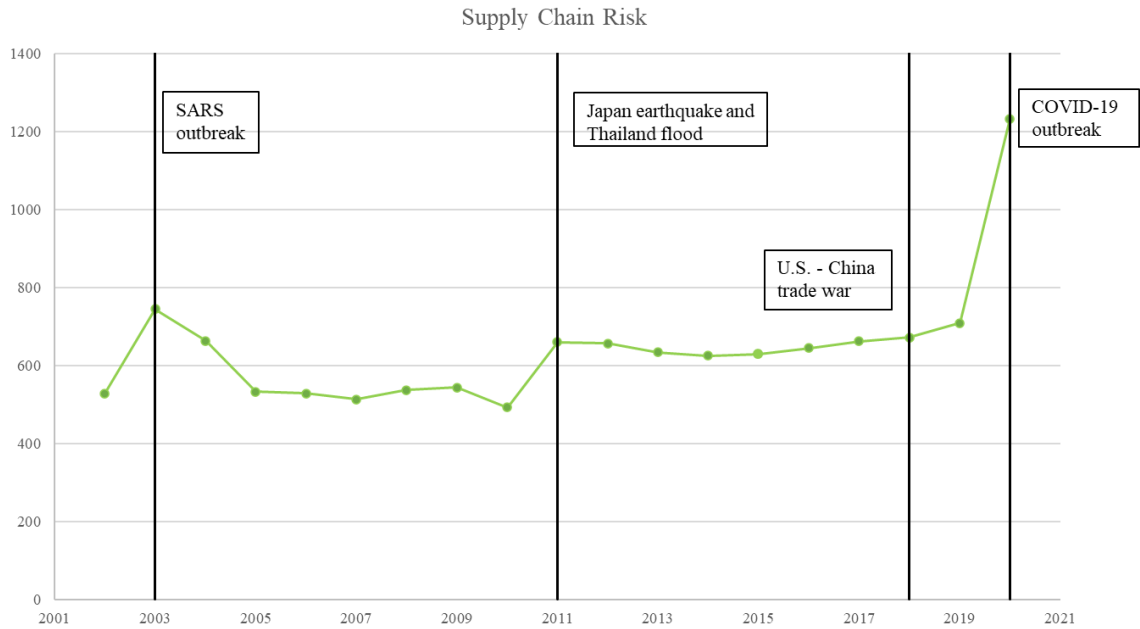
| Variables | Definition |
|---|---|
| SCRisk | Firm-level supply chain risk measure constructed from 8K filings |
| SCSentiment | Firm-level supply chain sentiment measure constructed from 8K filings |
| SCRisk of suppliers | The maximum SCRisk of a firm's suppliers |
| Realized Volatility | Firm's standard deviation of daily returns in a year |
| 30-day average abnormal return | Average abnormal stock return in the 30 days before the earnings call date |
| 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 | Focal firm's total assets scaled by its suppliers' average total assets |
| Average number of suppliers by industry | The average of a firm's number of suppliers by input industry |
| Market share | Firm's sales scaled by the 3-digit SIC industry's total sales |
| Financial constraint | A dummy variable that equals one if the firm's Whited-Wu (2006) measure for financial constraints is above sample median |
| 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 |
| Number of suppliers | A firm's total number of suppliers |
| Number of suppliers in the same continent | The total number of suppliers in the same continent as the firm |
| Number of U.S. suppliers | A firm's total number of suppliers in the U.S. |
| Number of suppliers in different continents | The total number of suppliers in different continents as the firm |
| Number of industry leader suppliers | A firm's total number of suppliers with sales above the median of their 3-digit SIC industry |
| M&A with supplier | A dummy variable that 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 | A dummy variable that 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 | A dummy variable that 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 et al. (2019) |
| Climate risk | Climate risk measure from Sautner et al. (2022) |
| Input specificity | Input-flow-weighted average of the share of differentiated goods purchased by a firm |

Internet Appendix

Figure IA.1

This figure shows the mean of SCRisk and SCSentiment, constructed using the 8K filings, along with indicators for key events related to supply chain shocks. SCRisk and SCSentiment are scaled up by a factor of 100.

Panel A. SCRisk



Panel B. SCSentiment

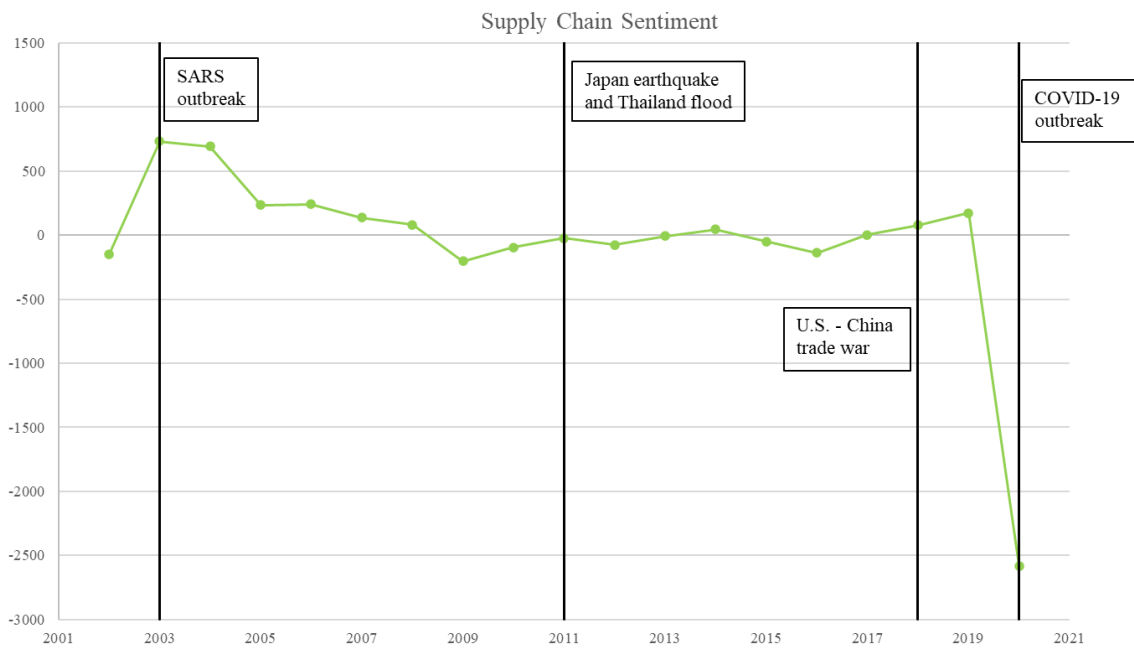
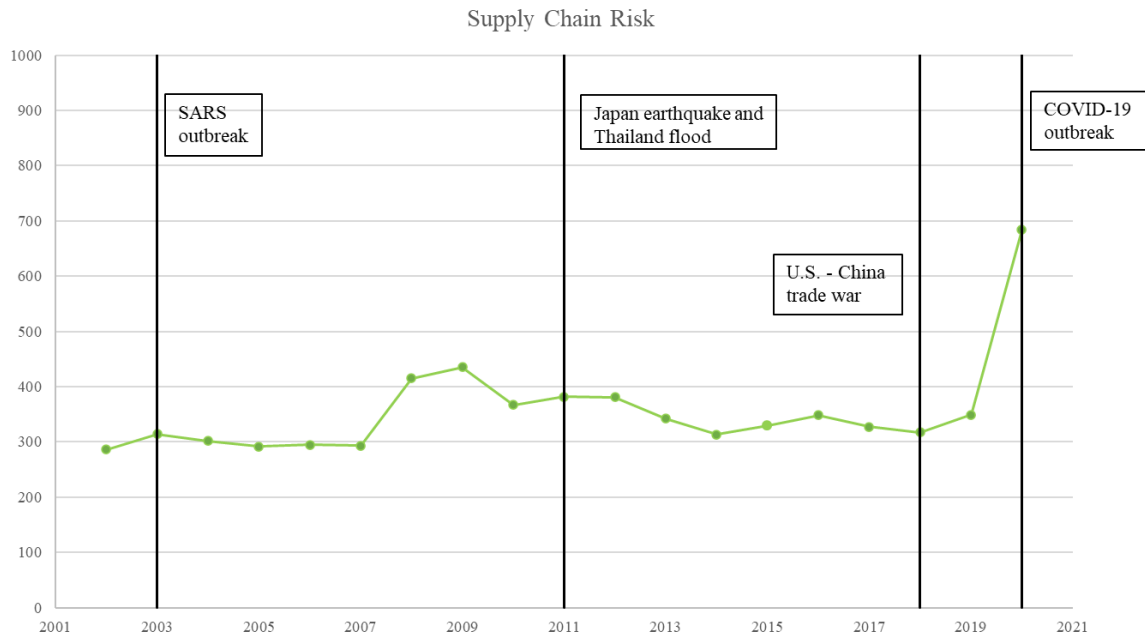


Figure IA.2

This figure shows the mean of SCRisk and SCSentiment, constructed using bigrams from the 3rd edition of the supply chain textbook, along with indicators for key events related to supply chain shocks. SCRisk and SCSentiment are scaled up by a factor of 100.

Panel A. SCRisk



Panel B. SCSentiment

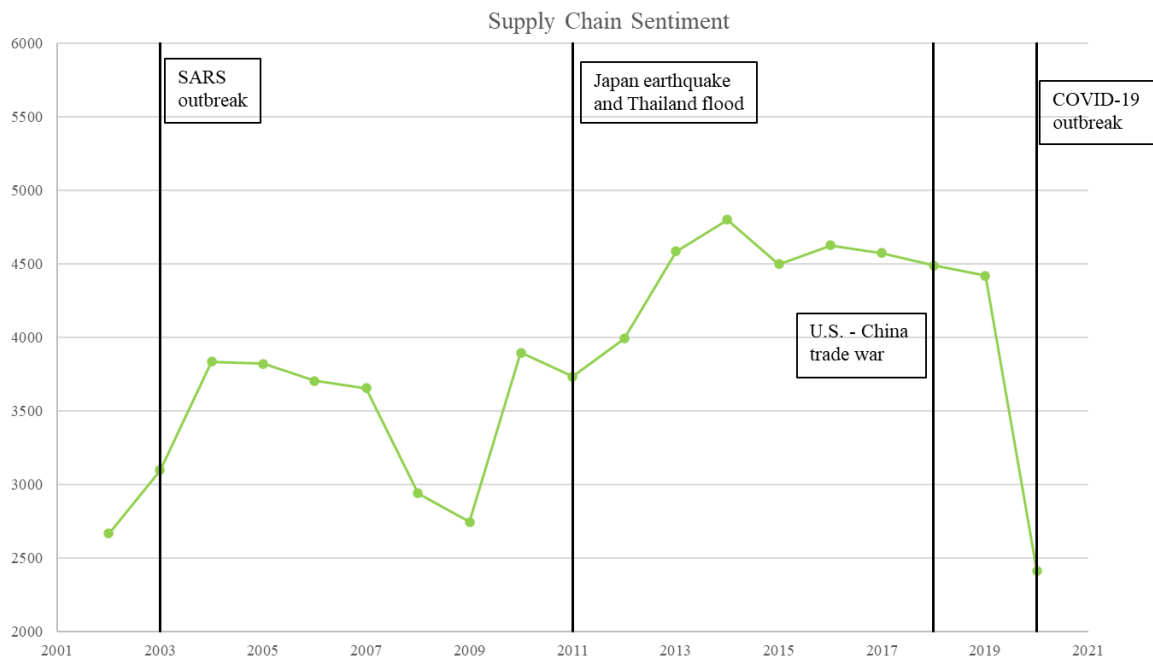


Table IA.1. Synonyms of risk words

This table reports all synonyms of “risk,” “risky,” “uncertain,” and “uncertainty” found when constructing SCRisk. Oxford Dictionary is used to identify the synonyms following Hassan et al. (2019).

| Synonyms of risk words | | | |
|------------------------|--------------|----------------|------------------|
| ambivalence | fear | niggle | treacherous |
| ambivalent | fickleness | oscillating | tricky |
| apprehension | fitful | parlous | uncertain |
| bet | fitfulness | pending | uncertainties |
| chance | fluctuant | peril | uncertainty |
| chanciness | fluctuating | perilous | unclear |
| chancy | gamble | perilousness | unconfident |
| changeability | gnarly | possibility | undecided |
| changeable | hairy | precarious | undependable |
| changeableness | halting | precariousness | undetermined |
| changeeful | hazard | probability | unforeseeable |
| chariness | hazardous | prospect | unknown |
| danger | hazy | qualm | unpredictability |
| dangerous | hesitancy | quandary | unpredictable |
| debatable | hesitant | queries | unreliability |
| defenseless | hesitating | query | unreliable |
| dicey | iffy | reservation | unresolved |
| diffidence | imperil | risk | unsafe |
| diffident | incalculable | risked | unsettled |
| dilemma | incertitude | riskier | unstable |
| disquiet | inconstancy | riskiest | unsure |
| disquietude | indecision | riskiness | unsureness |
| dodgy | indecisive | risking | untrustworthy |
| doubt | insecure | risks | vacillating |
| doubtful | insecurity | risky | vacillation |
| doubtfulness | instability | scruple | vague |
| dubiety | irregular | skepticism | vagueness |
| dubious | irresolute | speculative | variability |
| endanger | irresolution | sticky | variable |
| equivocating | jeopardize | suspicion | varying |
| equivocation | jeopardy | tentative | venture |
| erratic | likelihood | tentativeness | wager |
| exposed | menace | threat | wariness |
| faltering | misgiving | torn | wavering |

Table IA.2. Variance decomposition of SCRisk and SCSentiment – alternative industry definitions

This table reports adjusted R-squared and R-squared from the projection of SCRisk and SCSentiment in Panel A and Panel B, respectively, on various sets of fixed effects, as indicated in the table. Industries are classified at the two-digit SIC code level in Panels A and B, and at the four-digit SIC code level in Panels C and D.

| | (1) | (2) | (3) | (4) |
|------------------------------------|--------|--------|--------|--------|
| Panel A: SCRisk – 2-digit SIC | | | | |
| Year FE | Y | | | |
| Industry FE | | Y | | |
| Industry x year FE | | | Y | Y |
| Firm FE | | | | Y |
| Adjusted R-squared | 0.0593 | 0.0241 | 0.1013 | 0.2022 |
| R-squared | 0.0598 | 0.0257 | 0.1272 | 0.3169 |
| Panel B: SCSentiment – 2-digit SIC | | | | |
| Year FE | Y | | | |
| Industry FE | | Y | | |
| Industry x year FE | | | Y | Y |
| Firm FE | | | | Y |
| Adjusted R-squared | 0.0114 | 0.0831 | 0.1001 | 0.4016 |
| R-squared | 0.0119 | 0.0846 | 0.1259 | 0.4876 |
| Panel C: SCRisk – 4-digit SIC | | | | |
| Year FE | Y | | | |
| Industry FE | | Y | | |
| Industry x year FE | | | Y | Y |
| Firm FE | | | | Y |
| Adjusted R-squared | 0.0593 | 0.0409 | 0.1381 | 0.2250 |
| R-squared | 0.0598 | 0.0502 | 0.2470 | 0.4143 |
| Panel D: SCSentiment – 4-digit SIC | | | | |
| Year FE | Y | | | |
| Industry FE | | Y | | |
| Industry x year FE | | | Y | Y |
| Firm FE | | | | Y |
| Adjusted R-squared | 0.0114 | 0.1467 | 0.1640 | 0.4277 |
| R-squared | 0.0119 | 0.1550 | 0.2696 | 0.5675 |

Table IA.3. First-stage regressions

This table reports estimates of the first-stage regressions. We regress the firm's SCRisk on its suppliers' SCRisk, which is our instrumental variable. 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) SCRisk | (2) SCRisk |
|--------------------|------------------------|------------------------|
| Supplier's SCRisk | 0.0222*** (0.0072) | 0.0220*** (0.0073) |
| SCSentiment | | 0.0013 (0.0011) |
| Size | -0.0371 (0.1508) | -0.0385 (0.1506) |
| Tobin's Q | -0.1585*** (0.0554) | -0.1587*** (0.0554) |
| Cash holdings | 1.8129*** (0.6142) | 1.8166*** (0.6139) |
| Cash flow | 0.1412 (0.4499) | 0.1324 (0.4498) |
| Firm FE | Y | Y |
| Industry x year FE | Y | Y |
| Observations | 23,804 | 23,804 |
| Adjusted R-squared | 0.1355 | 0.1357 |
| First-stage F-stat | 13.316 | 13.145 |

Table IA.4. SCRisk and vertical M&As – alternative definitions of upstream and downstream industries

This table reports estimates of the effects of SCRisk on the probability that a firm is involved in an M&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, respectively. A target firm is considered to be a supplier (customer) if the acquirer's industry purchases (sells) at least one percent of its inputs (outputs) from (to) the target's industry. 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. We instrument for firm's supply chain risk with the supply chain risk of its suppliers. 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 |
|--------------------|-----------------------------|-----------------------------|--------------------------|
| SCRisk | 0.0066** (0.0034) | 0.0026* (0.0015) | 0.0003 (0.0006) |
| SCSentiment | -0.0000 (0.0000) | -0.0000* (0.0000) | -0.0000 (0.0000) |
| Size | -0.0025* (0.0014) | -0.0010 (0.0007) | -0.0001 (0.0001) |
| Tobin's Q | 0.0012* (0.0007) | 0.0006 (0.0004) | 0.0001 (0.0001) |
| Cash holdings | -0.0105 (0.0083) | -0.0072* (0.0039) | -0.0013 (0.0010) |
| Cash flow | 0.0041 (0.0036) | 0.0021 (0.0016) | 0.0007 (0.0005) |
| Firm FE | Y | Y | Y |
| Industry x year FE | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0222*** (0.0073) | 0.0222*** (0.0073) | 0.0222*** (0.0073) |
| First-stage F-stat | 13.145 | 13.145 | 13.145 |

Table IA.5. Supply chain risk vs overall sentiment

This table reports instrumental variable estimates of the effects of SCRisk at $t-1$ on firms' M&As and number of suppliers at t in Panel A and Panel B, respectively, controlling for the overall sentiment of a firm's earnings calls during year $t-1$. Overall sentiment is constructed by calculating the net sentiment in the whole earnings call transcript. The dependent variables in columns (1) and (2) of Panel A 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, respectively. The dependent variable in column (3) of Panel A is *Unrelated M&A*, which is an indicator variable that equals one if the firm conducts an M&A with a firm that is neither in an upstream nor a downstream industry. The dependent variables in columns 1 to 4 of Panel B are number of suppliers, number of suppliers in the same continent as the firm, number of U.S. suppliers, number of suppliers in different continents, 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. We instrument for firm's supply chain risk with the supply chain risk of its suppliers. 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: Firms' M&As | | | |
|----------------------|-----------------------------|-----------------------------|-----------------------|
| | (1) M&A with supplier | (2) M&A with customer | (3) Unrelated M&As |
| SCRisk | 0.0076** (0.0037) | 0.0083** (0.0037) | 0.0067 (0.0151) |
| SCSentiment | -0.0000* (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) |
| Size | -0.0021 (0.0015) | -0.0021 (0.0016) | 0.0083 (0.0082) |
| Tobin's Q | 0.0015* (0.0008) | 0.0016* (0.0008) | 0.0106*** (0.0037) |
| Cash holdings | -0.0130 (0.0093) | -0.0154 (0.0095) | 0.1665*** (0.0435) |
| Cash flow | 0.0040 (0.0040) | 0.0038 (0.0042) | 0.1540*** (0.0180) |
| Overall sentiment | 0.0076** (0.0037) | 0.0083** (0.0037) | 0.0067 (0.0151) |
| Firm FE | Y | Y | Y |
| Industry x year FE | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0223*** (0.0073) | 0.0223*** (0.0073) | 0.0223*** (0.0073) |
| First-stage F-stat | 13.485 | 13.485 | 13.485 |

| Panel B: Supply chain composition | | | | | |
|-----------------------------------|------------------------|--|--------------------------------|--|---|
| | (1) | (2) | (3) | (4) | (5) |
| | Number of suppliers | Number of suppliers in the same continent | Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| SCRisk | 5.4398*** (1.7823) | 2.5725*** (0.8448) | 2.3380*** (0.7666) | 1.0987*** (0.3981) | 2.5187*** (0.8205) |
| SCSentiment | -0.0072 (0.0071) | -0.0031 (0.0034) | -0.0026 (0.0030) | -0.0015 (0.0015) | -0.0033 (0.0032) |
| Size | 2.4673*** (0.8588) | 1.3280*** (0.4067) | 1.2391*** (0.3677) | 0.6754*** (0.2304) | 1.2667*** (0.3880) |
| Tobin's Q | 1.0110** (0.4288) | 0.4186** (0.2019) | 0.4201** (0.1833) | 0.2061** (0.1009) | 0.4701** (0.1964) |
| Cash holdings | -9.3781** (4.4931) | -5.1454** (2.1345) | -4.7191** (1.9388) | -1.4182 (0.9893) | -5.0425** (2.0814) |
| Cash flow | -2.6230 (2.4855) | -1.4277 (1.1740) | -1.3739 (1.0663) | -0.9715* (0.5522) | -1.3210 (1.1296) |
| Overall sentiment | 11.1982* (6.0056) | 5.5265* (2.8542) | 4.8121* (2.5882) | 1.4483 (1.3606) | 5.4098* (2.7923) |
| Firm FE | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| First-stage coeff | 0.0223*** (0.0073) | 0.0223*** (0.0073) | 0.0223*** (0.0073) | 0.0223*** (0.0073) | 0.0223*** (0.0073) |
| First-stage F-stat | 13.485 | 13.485 | 13.485 | 13.485 | 13.485 |

Table IA.6. Supply chain risk – replace noise with industry median

This table reports estimates of the effects of SCRisk at $t-1$, replacing firm-year observations with potential noise with the 2-digit SIC industry median of SCRisk, on firms' M&As and number of suppliers at t in Panel A and Panel B, respectively. Columns (1) – (3) in Panel A report the OLS results while the columns (4) – (6) report the IV results. Columns (1) – (5) in Panel B report the OLS results while columns (6) – (10) report the IV results. The unit of observation in each regression is a firm-year. We instrument for firm's supply chain risk with the supply chain risk of its suppliers. 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: Firms' M&As | | | | | |
|--------------------|------------------------|-----------------------------|-----------------------|-----------------------|----------------------------|-----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | M&A with supplier | OLS M&A with customer | Unrelated M&As | M&A with supplier | IV M&A with customer | Unrelated M&As |
| SCRisk | 0.0002* (0.0001) | 0.0002* (0.0001) | 0.0003 (0.0004) | 0.0077** (0.0038) | 0.0084** (0.0038) | 0.0076 (0.0154) |
| SCSentiment | -0.0000 (0.0000) | -0.0000 (0.0000) | 0.0000 (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) |
| Size | -0.0026*** (0.0010) | -0.0025*** (0.0009) | 0.0054 (0.0080) | -0.0025* (0.0015) | -0.0024 (0.0016) | 0.0055 (0.0082) |
| Tobin's Q | 0.0002 (0.0003) | 0.0002 (0.0003) | 0.0087*** (0.0027) | 0.0014* (0.0008) | 0.0015* (0.0008) | 0.0099*** (0.0036) |
| Cash holdings | -0.0001 (0.0034) | -0.0012 (0.0033) | 0.1751*** (0.0339) | -0.0135 (0.0095) | -0.0159 (0.0097) | 0.1622*** (0.0443) |
| Cash flow | 0.0048** (0.0022) | 0.0046** (0.0020) | 0.1559*** (0.0176) | 0.0041 (0.0041) | 0.0039 (0.0042) | 0.1553*** (0.0180) |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.1036 | 0.0848 | 0.2153 | - | - | - |
| First-stage coeff | - | - | - | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) |
| First-stage F-stat | - | - | - | 13.145 | 13.145 | 13.145 |

| Panel B: IV regressions | | | | | | | | | | |
|-------------------------|------------------------|--|---------------------------------------|--|--|------------------------|--|--------------------------------------|--|--|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | Number of suppliers | Number of suppliers in the same continent | OLS Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers | Number of suppliers | Number of suppliers in the same continent | IV Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| SCRisk | 0.0200*** (0.0076) | 0.0146*** (0.0042) | 0.0139*** (0.0041) | 0.0077 (0.0054) | 0.0074** (0.0034) | 5.5022*** (1.8251) | 2.6034*** (0.8654) | 2.3648*** (0.7848) | 1.1068*** (0.4053) | 2.5489*** (0.8407) |
| SCSentiment | 0.0011 (0.0008) | 0.0009** (0.0004) | 0.0010** (0.0004) | 0.0001 (0.0005) | 0.0005 (0.0003) | -0.0063 (0.0070) | -0.0027 (0.0033) | -0.0022 (0.0030) | -0.0014 (0.0014) | -0.0029 (0.0032) |
| Size | 2.1988*** (0.2434) | 1.1969*** (0.1240) | 1.1240*** (0.1147) | 0.6369*** (0.1611) | 1.1380*** (0.1068) | 2.2546*** (0.8614) | 1.2231*** (0.4089) | 1.1477*** (0.3691) | 0.6479*** (0.2278) | 1.1639*** (0.3897) |
| Tobin's Q | 0.0775 (0.0718) | -0.0233 (0.0353) | 0.0197 (0.0322) | 0.0228 (0.0407) | 0.0363 (0.0295) | 0.9577** (0.4206) | 0.3923** (0.1981) | 0.3972** (0.1797) | 0.1992** (0.0984) | 0.4444** (0.1926) |
| Cash holdings | 0.1127 (0.6455) | -0.6702* (0.3648) | -0.6488* (0.3383) | 0.5083 (0.4023) | -0.6493** (0.2989) | -9.7065** (4.6279) | -5.3074** (2.1991) | -4.8601** (1.9963) | -1.4607 (1.0131) | -5.2012** (2.1452) |
| Cash flow | -2.0418*** (0.3866) | -1.1513*** (0.2330) | -1.1247*** (0.2170) | -0.8618*** (0.2451) | -1.0497*** (0.1767) | -2.5275 (2.5106) | -1.3806 (1.1861) | -1.3329 (1.0765) | -0.9591* (0.5547) | -1.2749 (1.1416) |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 | 23,804 |
| Adjusted R-squared | 0.8247 | 0.7535 | 0.7590 | 0.6076 | 0.8261 | - | - | - | - | - |
| First-stage coeff | - | - | - | - | - | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) | 0.0220*** (0.0073) |
| First-stage F-stat | - | - | - | - | - | 13.145 | 13.145 | 13.145 | 13.145 | 13.145 |

Table IA.7. Supply chain risk – omit noise

This table reports estimates of the effects of SCRisk at $t-1$, omitting firm-year observations in which SCRisk is more likely to be measured with noise, on firms' M&As and number of suppliers at t in Panel A and Panel B, respectively. Columns (1) – (3) in Panel A report the OLS results while the columns (4) – (6) report the IV results. Columns (1) – (5) in Panel B report the OLS results while columns (6) – (10) report the IV results. The unit of observation in each regression is a firm-year. We instrument for firm's supply chain risk with the' supply chain risk of its suppliers. 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: Firms' M&As | | | | | |
|--------------------|-----------------------|-----------------------------|-----------------------|-----------------------|----------------------------|-----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | M&A with supplier | OLS M&A with customer | Unrelated M&As | M&A with supplier | IV M&A with customer | Unrelated M&As |
| SCRisk | 0.0002* (0.0001) | 0.0002* (0.0001) | 0.0003 (0.0004) | 0.0067* (0.0035) | 0.0074** (0.0036) | 0.0167 (0.0164) |
| SCSentiment | -0.0000 (0.0000) | -0.0000 (0.0000) | 0.0000 (0.0000) | -0.0000 (0.0000) | -0.0000 (0.0000) | 0.0000 (0.0000) |
| Size | -0.0021** (0.0010) | -0.0020** (0.0010) | 0.0060 (0.0083) | -0.0017 (0.0015) | -0.0016 (0.0016) | 0.0069 (0.0088) |
| Tobin's Q | 0.0002 (0.0003) | 0.0002 (0.0003) | 0.0100*** (0.0028) | 0.0014* (0.0008) | 0.0015* (0.0008) | 0.0130*** (0.0040) |
| Cash holdings | -0.0008 (0.0038) | -0.0021 (0.0035) | 0.1658*** (0.0354) | -0.0129 (0.0096) | -0.0156 (0.0098) | 0.1350*** (0.0486) |
| Cash flow | 0.0038* (0.0022) | 0.0039** (0.0020) | 0.1582*** (0.0184) | 0.0032 (0.0039) | 0.0032 (0.0041) | 0.1566*** (0.0202) |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y |
| Observations | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 |
| Adjusted R-squared | 0.1062 | 0.0853 | 0.2149 | - | - | - |
| First-stage coeff | - | - | - | 0.0231*** (0.0079) | 0.0231*** (0.0079) | 0.0231*** (0.0079) |
| First-stage F-stat | - | - | - | 12.333 | 12.333 | 12.333 |

| Panel B: IV regressions | | | | | | | | | | |
|-------------------------|------------------------|--|---------------------------------------|--|--|------------------------|--|--------------------------------------|--|--|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | Number of suppliers | Number of suppliers in the same continent | OLS Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers | Number of suppliers | Number of suppliers in the same continent | IV Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| SCRisk | 0.0191** (0.0077) | 0.0130*** (0.0043) | 0.0134*** (0.0041) | 0.0076 (0.0055) | 0.0068* (0.0035) | 5.3933*** (1.8456) | 2.6019*** (0.8931) | 2.3532*** (0.8060) | 1.0634*** (0.4046) | 2.4980*** (0.8498) |
| SCSentiment | 0.0010 (0.0009) | 0.0007 (0.0005) | 0.0009* (0.0004) | -0.0000 (0.0005) | 0.0005 (0.0004) | -0.0059 (0.0072) | -0.0026 (0.0035) | -0.0021 (0.0032) | -0.0014 (0.0015) | -0.0027 (0.0033) |
| Size | 2.1824*** (0.2423) | 1.1799*** (0.1278) | 1.0929*** (0.1178) | 0.6807*** (0.1652) | 1.1146*** (0.1056) | 2.4805*** (0.9264) | 1.3235*** (0.4483) | 1.2226*** (0.4025) | 0.7393*** (0.2386) | 1.2528*** (0.4183) |
| Tobin's Q | 0.0598 (0.0725) | -0.0417 (0.0365) | 0.0091 (0.0327) | 0.0197 (0.0421) | 0.0275 (0.0297) | 1.0233** (0.4437) | 0.4225** (0.2137) | 0.4286** (0.1926) | 0.2090** (0.1027) | 0.4742** (0.2032) |
| Cash holdings | 0.1981 (0.6547) | -0.7092* (0.3779) | -0.6701* (0.3506) | 0.5330 (0.4271) | -0.6327** (0.3016) | -9.8552** (4.8410) | -5.5522** (2.3451) | -5.0473** (2.1203) | -1.4421 (1.0444) | -5.2930** (2.2466) |
| Cash flow | -2.1308*** (0.3968) | -1.1574*** (0.2434) | -1.1018*** (0.2242) | -0.9296*** (0.2575) | -1.0317*** (0.1793) | -2.6546 (2.6212) | -1.4097 (1.2630) | -1.3299 (1.1385) | -1.0325* (0.5709) | -1.2745 (1.1886) |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 | 21,107 |
| Adjusted R-squared | 0.8247 | 0.7517 | 0.7545 | 0.6086 | 0.8264 | - | - | - | - | - |
| First-stage coeff | - | - | - | - | - | 0.0231*** (0.0079) | 0.0231*** (0.0079) | 0.0231*** (0.0079) | 0.0231*** (0.0079) | 0.0231*** (0.0079) |
| First-stage F-stat | - | - | - | - | - | 12.333 | 12.333 | 12.333 | 12.333 | 12.333 |

Table IA.8. Supply chain risk – measured by 8-K filings

This table reports estimates of the effects of supply chain risk and supply chain sentiment, measured from 8-K filings, at $t-1$ on firms' M&As and number of suppliers at t in Panel A and Panel B, respectively. Columns (1) – (3) in Panel A report the OLS results while the columns (4) – (6) report the IV results. Columns (1) – (5) in Panel B report the OLS results while columns (6) – (10) report the IV results. The unit of observation in each regression is a firm-year. We instrument for firm's supply chain risk with the supply chain risk, also measured using 8-K data, of the firm's suppliers. 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: Firms' M&As | | | | | |
|--------------------|-----------------------|-----------------------------|-----------------------|-----------------------|----------------------------|-----------------------|
| | (1) | (2) | (3) | (4) | (5) | (6) |
| | M&A with supplier | OLS M&A with customer | Unrelated M&As | M&A with supplier | IV M&A with customer | Unrelated M&As |
| SCRisk | 0.0002** (0.0001) | 0.0002** (0.0001) | 0.0002 (0.0003) | 0.0157** (0.0068) | 0.0144** (0.0063) | -0.0000 (0.0173) |
| SCSentiment | -0.0000 (0.0000) | -0.0000 (0.0000) | 0.0000 (0.0000) | 0.0001* (0.0000) | 0.0001* (0.0000) | 0.0000 (0.0001) |
| Size | -0.0012** (0.0005) | -0.0013*** (0.0004) | 0.0079* (0.0047) | -0.0041* (0.0025) | -0.0040* (0.0023) | 0.0080 (0.0055) |
| Tobin's Q | 0.0000 (0.0000) | 0.0001 (0.0000) | 0.0038*** (0.0007) | -0.0006 (0.0005) | -0.0006 (0.0004) | 0.0038*** (0.0011) |
| Cash holdings | 0.0021 (0.0020) | 0.0008 (0.0019) | 0.1286*** (0.0193) | -0.0107 (0.0097) | -0.0108 (0.0089) | 0.1287*** (0.0238) |
| Cash flow | 0.0005 (0.0003) | 0.0006* (0.0003) | 0.0247*** (0.0043) | -0.0012 (0.0020) | -0.0010 (0.0018) | 0.0247*** (0.0048) |
| Firm FE | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y |
| Observations | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 |
| Adjusted R-squared | 0.1132 | 0.1052 | 0.1988 | - | - | - |
| First-stage coeff | - | - | - | 0.0122*** (0.0045) | 0.0122*** (0.0045) | 0.0122*** (0.0045) |
| First-stage F-stat | - | - | - | 11.285 | 11.285 | 11.285 |

| Panel B: IV regressions | | | | | | | | | | |
|-------------------------|------------------------|--|---------------------------------------|--|--|------------------------|--|--------------------------------------|--|--|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) |
| | Number of suppliers | Number of suppliers in the same continent | OLS Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers | Number of suppliers | Number of suppliers in the same continent | IV Number of U.S. suppliers | Number of suppliers in different continents | Number of industry leader suppliers |
| SCRisk | 0.0168*** (0.0049) | 0.0076** (0.0031) | 0.0062** (0.0029) | 0.0079** (0.0037) | 0.0065*** (0.0023) | 8.3527*** (3.0901) | 4.8462*** (1.7882) | 4.7399*** (1.7494) | 1.9191** (0.7497) | 4.8174*** (1.7776) |
| SCSentiment | -0.0017** (0.0008) | 0.0006 (0.0005) | 0.0006 (0.0005) | -0.0013* (0.0007) | -0.0003 (0.0004) | 0.0496** (0.0235) | 0.0304** (0.0136) | 0.0297** (0.0133) | 0.0105* (0.0057) | 0.0293** (0.0135) |
| Size | 1.4581*** (0.1036) | 0.7386*** (0.0600) | 0.7129*** (0.0552) | 0.4642*** (0.0689) | 0.7327*** (0.0525) | -0.1171 (1.2262) | -0.1758 (0.7088) | -0.1817 (0.6931) | 0.1030 (0.2930) | -0.1764 (0.7074) |
| Tobin's Q | 0.0074 (0.0115) | -0.0204*** (0.0063) | -0.0147** (0.0060) | 0.0038 (0.0074) | -0.0042 (0.0058) | -0.3618 (0.2461) | -0.2347* (0.1420) | -0.2243 (0.1390) | -0.0808 (0.0571) | -0.2172 (0.1412) |
| Cash holdings | -0.8082*** (0.3130) | -0.8123*** (0.1795) | -0.8215*** (0.1691) | 0.2508 (0.1803) | -0.7062*** (0.1576) | -7.6216 (4.8559) | -4.7673* (2.8138) | -4.6906* (2.7474) | -1.3114 (1.1301) | -4.6385* (2.7889) |
| Cash flow | -0.4880*** (0.0758) | -0.3307*** (0.0453) | -0.3050*** (0.0430) | -0.1601*** (0.0456) | -0.2347*** (0.0397) | -1.4265 (1.0217) | -0.8755 (0.5925) | -0.8379 (0.5800) | -0.3753 (0.2388) | -0.7763 (0.5910) |
| Firm FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Industry x year FE | Y | Y | Y | Y | Y | Y | Y | Y | Y | Y |
| Observations | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 | 40,133 |
| Adjusted R-squared | 0.8273 | 0.7836 | 0.7901 | 0.6623 | 0.8230 | - | - | - | - | - |
| First-stage coeff | - | - | - | - | - | 0.0122*** (0.0045) | 0.0122*** (0.0045) | 0.0122*** (0.0045) | 0.0122*** (0.0045) | 0.0122*** (0.0045) |
| First-stage F-stat | - | - | - | - | - | 11.285 | 11.285 | 11.285 | 11.285 | 11.285 |

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