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Abstract

We explore whether financial flows increase the stability of supply chains by studying the trade credit usage of firms that face operating difficulties due to natural disasters. We show that affected firms extend more trade credit, especially if their customers are difficult to replace. The suppliers of affected firms facilitate the trade credit provision by extending trade credit, especially if the relationship with the affected firm is important. On average, supply chains remain stable. Customers sever their relationships with the affected firms only when the affected firms and their suppliers are financially constrained and cannot extend trade credit

JEL Classification: D2, E23, G3

Keywords: Supply Chains, production networks, trade credit, Natural Disasters

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Trade Credit and the Stability of Supply Chains

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July 2022

We explore whether financial flows increase the stability of supply chains by studying the trade credit usage of firms that face operating difficulties due to natural disasters. We show that affected firms extend more trade credit, especially if their customers are difficult to replace. The suppliers of affected firms facilitate the trade credit provision by extending trade credit, especially if the relationship with the affected firm is important. On average, supply chains remain stable. Customers sever their relationships with the affected firms only when the affected firms and their suppliers are financially constrained and cannot extend trade credit.

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Most of studies of trade credit focus on bilateral supplier-customer relationships, thus considering firms as either a borrower or a lender. However, in the real world, firms are part of complex production networks and simultaneously act as borrowers and lenders. Technological complementarities, incentives, and hold up problems along the supply chain are crucial for the success of upstream and downstream companies. Financial claims and obligations interlocking firms along the supply chain could be used to improve incentives and enhance supply chain stability, as suggested by theoretical work by Kim and Shin (2012). Recent work by Gofman and Wu (2022) relating a firm's position in the supply chain to its use and provision of trade credit highlights that upstream firms (defined as firms that are further from the consumption goods sector) provide and receive more trade credit, and that they extend more trade credit than they receive. However, we still have scant knowledge of the mechanisms through which trade credit lubricates supply chain operations and enhances their stability.

This paper proposes a mechanism through which direct financial linkages between firms serve as a "glue" that enhances a supply chain's stability. Specifically, we explore how trade credit provision along the supply chain changes when negative shocks increase the fragility of the supply chain and the extent to which changes in trade credit provision depend on the characteristics of the supply chain (i.e., how important the specific supply chain is for its participants).

We conjecture that firms use trade credit to enhance the stability of the supply chain and explore the incentives and constraints firms face. Specifically, we hypothesize that temporary disruption to operations, caused by natural disasters, decreases the value of the relationships for the customers of the affected firms. This conjecture is supported by evidence that natural disasters disrupt firms' operations and propagate upstream and downstream (see, e.g., Acemoglu, Carvalho, Ozdaglar, and Tahbaz-Salehi, 2012; Barrot and Sauvagnat, 2016; Carvalho, Nirei, Saito, and Tahbaz-Salehi, 2021). Natural disasters may also be associated with

an increase in the perceived probability of future disruptions (Giglio et al., 2021), weakening the competitiveness of affected firms that may be perceived as less reliable.

The customers of affected firms may thus look for other suppliers to substitute or complement those experiencing operational difficulties. In the attempt to increase the customers' surplus and preserve the relationship, firms affected by natural disasters may provide more trade credit. Put differently, as their bargaining power weakens, firms experiencing operational difficulties may transfer surplus to their customers by means of trade credit, as in the model of Giannetti, Serrano-Velarde, and Tarantino (2021).

The suppliers of affected firms in turn are aware that relationships between the affected firms and their customers have a higher likelihood to be severed after a natural disaster, especially if the affected firms are not capable of transferring enough surplus. The interruption of the relationship between an affected firm and its customers would have a negative effect on the performance of suppliers of the affected firm. For this reason, to increase the odds of survival of the supply chain and ensure continued demand for inputs, upstream firms should provide more trade credit to the affected firms. This facilitates the affected firms' provision of trade credit to their customers, thus increasing the value of the relationship for the affected firms' customers and enhancing the stability of the supply chain.

Using data that contain customer-supplier linkages, we show that firms that are affected by natural disasters receive more trade credit from their suppliers. At the same time, we observe that affected firms provide more trade credit to their customers.[1] The finding that firms in operational difficulties receive and provide more trade credit is extremely robust. First, we exploit the fact that we observe affected firms, as well as affected firms' customers and suppliers. We can thus evaluate the consistency of our findings by considering three groups of

[1] We also ensure that before disasters, there is no statistically significant difference in the evolution of trade credit at treated and control firms, consistent with the parallel trends assumption.

firms. That is, not only do we consider the affected firms' accounts payable and receivable, but also confirm the interpretation of our results by showing that the accounts receivable of affected firms' suppliers and the accounts payable of affected firms' customers increase in a way that is consistent with our narrative that affected firms provide more trade credit to their customers and receive more trade credit from their suppliers.

Second, we use hand-collected trade credit data that allow us to observe trade credit flows between customers and suppliers in order to identify the effects of supply and demand on trade credit usage. Using an empirical strategy similar to Khwaja and Mian (2008), we absorb the demand for trade credit including interactions of time and customer fixed effects and show that customers receive more trade credit from their disaster-hit suppliers rather than from other suppliers. Similarly, we absorb the supply of trade credit by including interactions of supplier and time fixed effects in our empirical models and show that suppliers extend more trade credit to their disaster-hit customers relative to other customers.

The finding that the accounts payable and the accounts receivable of firms facing operational difficulties simultaneously increase would be hard to reconcile without considering supply chain operations, as we do. If trade credit were to flow from firms with easy access to finance to firms experiencing negative liquidity shocks, as theories based on the suppliers' financial advantage would suggest (see Petersen and Rajan (1997) for a review), we should observe that the accounts payable of affected firms increase while their accounts receivable do not vary or even decrease, as Amberg, Jacobson, von Schedvin, Townsend (2021) document for Swedish firms experiencing temporary liquidity shocks. However, affected firms simultaneously provide and use more trade credit indicating that firms obtain trade credit from their suppliers and pass it on to their customers, even if this behavior further drains their liquidity and may have negative consequences on investment (Murfin and Njoroge, 2015). We

argue that affected firms provide trade credit to cement the relationships imperiled by the shocks.

We perform a number of cross-sectional tests to provide support for the mechanisms behind our hypothesis. First, we analyze how the competitive environment faced by a firm affects the provision of trade credit. Customers purchasing products that are easy to substitute face lower switching costs (Cunat, 2007). Hence, firms supplying these products may have to transfer more surplus to maintain their customers when they face operational difficulties. We show that suppliers extend more trade credit to the affected firms and the affected firms extend more trade credit to their customers if the affected firms face a competitive market for their product, as captured by the proxy for market fluidity introduced by Hoberg, Phillips, and Prabhala (2014) or a measure of market concentration. These findings are consistent with empirical evidence that firms use trade credit to transfer surplus to their high-bargaining-power customers (Klapper, Laeven, and Rajan, 2012; Murfin and Njoroge, 2015; Barrot, 2016; Breza and Liberman, 2017; Giannetti, Serrano-Velarde and Tarantino, 2021). More importantly, the fact that not only the affected firms, but also their suppliers provide more trade credit indicates that firms' trade credit policies not only take into account direct customer relationships but also downstream customer-supplier linkages, which are essential for the survival of the supply chain.

Second, we consider how dependent firms are on their customers and suppliers. We begin by considering the dependence of the affected firms on their customers. Preserving the stability of the supply chain is particularly important for firms that depend heavily on a major customer. Accordingly, we find that affected firms that have a high dependence on their customers extend more trade credit if they are hit by a natural disaster; they also obtain more trade credit from their suppliers, who arguably internalize the need to preserve those customer relationships for the survival of the supply chain.

Furthermore, we consider firms that have strong relationships with one of their suppliers because they are partners in product distribution, development of new technologies, or joint ventures. We conjecture that suppliers with strong relationships with the affected firms should have particularly strong incentives to preserve the supply chain. Accordingly, we show that affected firms with strong relationships with their suppliers obtain more trade credit when they are hit by a natural disaster and are consequently able to extend more trade credit to their customers.

Overall, these findings suggest that firms internalize the negative spillovers associated with the instability of the supply chains and use trade credit to enhance their survivals even if they may lack ex ante incentives to limit the effects of negative shocks (Elliott and Golub, 2021).

To shed additional light on the mechanisms driving our findings, we investigate how the provision of trade credit and the stability of supply chains depend on the financial conditions of the affected firms and their suppliers. We find that following natural disasters, affected firms' accounts payable do not increase if their suppliers are financially constrained. Affected firms do not extend the payment terms to their customers if both they and their suppliers are financially constrained. Customers that do not receive more trade credit in turn become more likely to terminate their relationships with the affected firms and start new relationships.

On the contrary, supply chains remain stable when the affected firms' suppliers are financially unconstrained. In this case, thanks to the liquidity provided by their suppliers, the affected firms are able to extend more trade credit, even if they are financially constrained. Thus, pervasive financial constraints over the supply chain limit trade credit use and imperil the stability of supply chains.

This paper contributes to several strands of the literature. A growing body of influential papers documents how the transmission of shocks over production networks affects the performance of customers and suppliers and ultimately leads to shock propagation and aggregate fluctuations (see, e.g., Hertzel, Li, Officer, and Rodgers, 2008; Barrot and Sauvagnat, 2016; Giroux and Mueller, 2019; Carvalho et al., 2021). In this context, trade credit has been shown to help explain the propagation of negative shocks as firms default on their suppliers (Boissay and Gropp, 2013; Jacobson and van Schedvin, 2015).

However, the literature is silent on how the usage of the most important source of short-term financing that supports over 90% of trade transactions between firms (Rajan and Zingales, 1995; Petersen and Rajan, 1997; Giannetti, 2003; Giannetti, Burkart, and Ellingsen, 2011) varies following operating shocks. Several papers instead examine the role of trade credit when firms face negative liquidity shocks. Costello (2020) shows that firms experiencing a large decline in bank financing during the 2007-2008 financial crisis decreased the supply of trade credit to their downstream customers. Using bank-firm matched data in Spain, Alfaro, García-Santana, and Moral-Benito (2021) document a similar effect of credit supply shocks on the supply of trade credit by firms. We show that the effects of operating shocks that imperil a supply chain are different: Firms do not obtain liquidity by providing less trade finance to their customers, but they rather extend payment terms to avoid the termination of the relationships.

Other studies explore whether trade credit can provide an alternative source of liquidity that mitigates the effects of bank liquidity shocks. Love, Preve, and Sarria-Allende (2007) find that trade credit collapsed in the aftermath of the 1997 Asian crisis, while Garcia-Appendini and Montoriol-Garriga (2013) find that cash-rich suppliers extended more trade credit during the 2007-2009 global financial crisis credit slump. Restrepo, Cardona-Sosa, and Strahan (2019) show that firms rely less on short-term loans and more on cash and trade credit for liquidity management following an exogenous increase in the relative cost of short-term bank credit in

Colombia. We complement these studies by documenting that firms extend more trade credit when they face operational difficulties and their suppliers internalize the costs of the instability of the supply chain and provide more trade credit. To the best of our knowledge, we are the first to show that trade credit contributes to the stability of supply chains and to explore how firms' incentives to internalize negative shocks to clients vary depending on market structure.

By exploring trade credit usage in response to operating shocks, we contribute to the understanding of the nature of trade credit. The literature has so far focused on bilateral relationships between customers and suppliers and emphasized the role of financial constraints and customer bargaining power (see, e.g., Pertersen and Rajan, 1997; Cunat, 2007; Giannetti, Burkart and Ellingsen, 2011; Klapper, Laeven and Rajan, 2012). A notable exception is Gofman and Wu (2022), who document a number of stylized facts regarding a firm's position in the production network and trade credit provision. Our finding can help explain why Gofman and Wu (2022) find that central and upstream firms provide more trade credit: These firms are indirectly affected by more downstream shocks through their customers and extend trade credit to enhance the stability of their supply chains. In addition, while previous literature emphasizes that trade credit can emerge because a firm has strong relationships with its clients (Wilner, 2000; McMillan and Woodruff, 1999), we show that it also enhances the stability of direct and indirect customer-supplier links.

Finally, this paper adds to the literature studying how customer-supplier relationships affect firms' financial policies. A key result from earlier studies is that customers pay close attention to the financial conditions of their suppliers because switching costs in the event of supplier liquidation can be high (Titman, 1984; Banerjee, Dasgupta, and Kim, 2008). We contribute to this strand of research by explaining how suppliers' financial health affects firm performance. Financial flexibility on the supplier side not only allows customers to obtain

liquidity and extend trade credit to their own customers, but also helps indirect customers avoid switching costs, thus preserving the stability of the supply chain.

1. Data and Proxies

1.1. Supply Chains and Trade Credit

We obtain firms' financial and location of the headquarters information from Compustat North America Fundamentals Quarterly Database. We exclude firms in the utility industry (SIC code 4900 – 4999), the financial services industry (SIC code 6000 – 6999), and government entities (SIC code 9000 – 9999).

Starting from Compustat firms, we construct two datasets to study customer-supplier relationships and the use of trade credit, which have different advantages and limitations. The first dataset relies on supply chain relationships from Factset Revere Supply Chain Relationship database. Factset Revere collects relationship information from primary public sources such as SEC 10-K annual filings, investor presentations, and press releases, and classifies them by relationship types (e.g., customer, supplier, competitor, different types of partnerships). We identify supply chain relationships using companies' reported customers and suppliers.

Factset Revere spans the period 2003 – 2019. We merge the customer and supplier information with financial information from Compustat. Overall, we observe a total of 7,806 customers and 8,306 suppliers. For the average firm in the sample, we observe 21 customers and 20 suppliers.

Factset does not provide information on how much trade credit is used in a relationship. Therefore, similarly to Adelino, Ferreira, Giannetti, and Pires (2021), we proxy for the use of trade credit using information on accounts payable and accounts receivable that we obtain from Compustat for all firms in our dataset. We use this information to construct our key firm level

variables on the usage of trade credit funding (Payables) and provision of trade credit to the customers (Receivables). As is common in the literature (Petersen and Rajan, 1997), in the empirical analysis, we consider accounts payable scaled by the costs of goods sold and accounts receivable scaled by sales.

The second dataset relies on hand-collection of information on the amount of trade credit extended by a firm to its important customers as recorded in the 10-K disclosure to the SEC. Starting from 1990, the Financial Accounting Standard Board's (FASB) regulation No. 105 requires firms to disclose any concentration of credit risk. Typically, large amounts of accounts receivable to a major customer qualify as concentration of credit risk. As a result, firms may disclose the name of the customers and the accounts receivable balance, either as a dollar amount or as a percentage of total accounts receivable, in their annual reports (10-Ks).

To collect these data, we follow a procedure similar to that of Murfin and Njoroge (2015), Costello (2019), and Freeman (2020). Specifically, we first download Compustat Customer Segment files from 1991 to 2019. From the Compustat Segment files, we observe major customers defined as customers that account for at least 10% of the firm's sales, which companies are required to report according to the Statement of Financial Accounting Standard (SFAS) rule No.14. For each of these firms, we extract all available 10-K filings from EDGAR. We then read all 10-K filings and look for information regarding major customers and concentration of credit risk. We manually collect the name of the customer, the sales amount (or as a percentage of total sales) to the customer, and the accounts receivable balance (or as a percentage of total accounts receivable) from the customer. We require sales information between each customer and supplier pair to be non-missing to construct our variables of interest. Finally, we hand-match the customers to Compustat annual files by name to obtain their financial information.

We refer to this second dataset as the "SEC sample". The final SEC sample has an annual frequency and includes 729 firms (both customers and suppliers) from 1991 to 2019. We observe a total of 317 customers and 430 suppliers. On average, we observe 1.59 customers per firm. When we consider upstream relationships, we observe 2.15 suppliers per firm.

The final SEC sample is similar to the major customer data obtained from Compustat segment filings widely used in previous work without the information on bilateral trade credit flows (e.g., Murfin and Njoroge, 2015). While the SEC sample has limitations due to the small size and selection in firms' reporting, its advantage is that we observe the amount of trade credit to a given customer. As we explain below, this will allow us to absorb non-parametrically customer (or supplier) unobserved heterogeneity and to confirm the interpretation of our main findings.

1.2. Natural Disasters

Similar to Barrot and Sauvagnat (2016), we use the SHELDUS (Spatial Hazard and Loss Database for the United States) database by the Center for Emergency Management and Homeland Security at Arizona State University to identify the date and estimated damages in the dollar amount of each natural disaster as well as the FIPS codes of affected counties.[2] Following Barrot and Sauvagnat (2016), we consider a natural disaster major if the total estimated damages are more than 1 billion 2012 dollars. We require the disaster to last less than 30 days. The sample includes a total of 42 disasters, including blizzards, earthquakes, floods, and hurricanes. These disasters affect a broad range of U.S. states and counties over the sample period. However, they are generally very localized and affect on average 47 counties, and at most 156 counties in a quarter, which is less than 5% of the total number of counties in the U.S. Figure 1 shows the frequency of natural disasters over the sample period across

[2] See https://cemhs.asu.edu/sheldus

counties. Some counties are more frequently hit than others, especially those located along the southeast coast. In comparison, as evidenced in Figure 2, in our main sample based on Factset Revere, the location of the customers and suppliers of affected firms is much less localized and includes counties that are never, and counties that are often, hit by natural disasters.

1.3. Other information

We obtain all firms' financial information from Compustat. We also obtain a measure of product market fluidity, introduced by Hoberg, Phillips, and Prabhala (2014), from the Hoberg-Phillips Data Library. This proxy assesses the degree of competitive threat and product market change surrounding a firm. We use it to evaluate whether the reaction to natural disasters of firms facing different competitive threats varies in line with our hypotheses. We define all the variables in Appendix A. Table 1 presents the summary statistics of our sample.

2. Empirical methodology

Our objective is to explore how the use of trade credit in the supply chain varies when a firm is affected by a natural disaster. Specifically, we conjecture that following a natural disaster, the value of the relationship decreases for affected firms' customers not only because the affected firms face temporary disruption and may be temporarily unable to deliver as timely as before, but also because the salience of natural disasters and customers' attention to this type of risk increase (Giglio et al., 2021).

We start by investigating this hypothesis using the more comprehensive Factset/Compustat sample. We then sharpen our identification strategy by considering the bilateral trade credit flows in the narrower SEC sample, which allows us to identify demand and supply of trade credit.

Using the Factset-Revere sample, we can investigate how the use of trade credit varies for the affected firms using a difference-in-differences methodology. Specifically, we estimate a specification at the firm-quarter level similar to the one used by Barrot and Sauvagnat (2016):

$$\Delta Y_{i,t,t+4} = \beta_0 + \beta_1 Affected_{it} + \beta_2 \times X_{i,t} + \eta_i + \eta_t + \eta_{j(i),y(t)} + \eta_{g(i),y(t)} + \varepsilon_{i,t,} \quad (1)$$

where $Y_{i,t}$ is typically either the ratio of accounts payable to the cost of goods sold or the ratio of accounts receivable to sales, depending on whether we explore the firm's assets or liabilities. Our variable of interest, $Affected_{it}$, takes value equal to one if firm *i* is affected by a natural disaster in quarter *t*.[3] We explore how proxies for the use of trade credit and other firms' policies change in the following four quarters.

Throughout the analysis, we control for firm size, leverage, age, and profits. We also absorb unobserved heterogeneity by including firm (*i*) fixed effects, year-quarter (*t*) fixed effects, interactions of firm *i*'s industry (*j(i)*) and year (*y(t)*) fixed effects as well as interactions of the firm *i*'s state (*g(i)*) and year (*y(t)*) fixed effects. The inclusion of these fixed effects allows us to explore whether the behavior of firms in counties affected by natural disasters changes in the four quarters following the disaster in comparison to other firms in the same year, state, and industry. We cluster standard errors at the firm level, which is particularly important because our dataset includes overlapping quarters.

Our identifying assumption when using this empirical framework is that there are no other shocks contextual to the natural disasters that determine a change in behavior of the affected firms. We view our assumption as reasonable, especially because we are able to control non-parametrically for industry- and state-specific shocks as well as firm time-invariant characteristics. We test our identifying assumption by exploring whether there are any pre-

[3] Results are robust even if we consider the change in the dependent variable between t-1 and t+4 to address concerns that natural disasters occur during the quarters, while receivables and sales are measured at the end of the quarter. Since contracts for trade credit, sales and input purchases are likely to be outstanding when a natural disaster hits, it is unlikely that the end-of-period variables reflect the effects of the natural disaster. The robustness of the results in Table IA.1 provides full support for our argument.

existing differences in firm behavior that may suggest that the affected firms experience different demand for trade credit or have different capabilities to supply trade credit.

Besides testing for pre-existing trends, our empirical setting allows us to verify the empirical interpretation of our findings by considering how the use of trade credit by the customers and suppliers of affected firms varies. In particular, if the accounts payable of affected firms increase, we should observe a contextual increase in the accounts receivable of the affected firm's suppliers. To evaluate this, we estimate the following equation:

$$\Delta Receivables_{s,t,t+4} = \beta_0 + \beta_1 Supplier\ of\ Affected_{s,t} + \beta_2 \times X_{s,t} + \eta_s + \eta_t + \eta_{j(s),y(t)} + \eta_{g(s),y(t)} + \varepsilon_{s,t,} \quad (2)$$

where *s* stands for the supplier. As in the earlier tests, we control non parametrically, for yearly shocks affecting the industry, *j(s)*, or the state, *g(s)*, of the supplier, *s*.

Similarly, if the accounts receivable of affected firms increase, we should observe a corresponding increase in the accounts payable of the affected firms' customers when we estimate the following equation:

$$\Delta Payables_{c,t,t+4} = \beta_0 + \beta_1 Customer\ of\ Affected_{c,t} + \beta_2 \times X_{c,t} + \eta_c + \eta_t + \eta_{j(c),y(t)} + \eta_{g(c),y(t)} + \varepsilon_{c,t,} \quad (3)$$

where *c* stands for the customer. As in our earlier tests, we saturate the equations by including firm fixed effects, year-quarter fixed effects, interactions of the customer firm's industry and year fixed effects, and of the customer firm's state and year fixed effects.

Next, we differentiate between supply and demand effects on trade credit usage to identify the effects of natural disasters on firms' trade credit policies. For example, firms might demand more trade credit from their suppliers due to different shocks contextual to natural disasters, leading to an increase in trade credit. Our narrower but more detailed SEC sample

allows us to empirically demonstrate that a broad set of alternative explanations cannot drive our findings. We explore how affected firms obtain trade credit from their suppliers by evaluating the extent to which a supplier extends trade credit to affected firms relative to other customers during a given year. In these tests, in which we are able to rely on customer-supplier relationships, we estimate:

$$\Delta y_{i,s,y,y+1}^{Received} = \beta_0 + \beta_1 Affected_{iy} + \eta_{s,y} + \varepsilon_{i,y,} \quad (4)$$

where *i* denotes the firm, *s* the supplier, and *y* the year. The inclusion of interactions of supplier and year fixed effects ($\eta_{s,y}$) allows us to statistically demonstrate that the supplier's ability or need to provide trade credit does not drive our findings and that suppliers provide more trade credit to specific customers affected by natural disasters. Similar to Khwaja and Mian (2008), this within-supplier estimator allows us to identify customers' demand for trade credit.

Focusing on trade credit extended by firms affected by natural disasters and including different sets of fixed effects, we also explore the extent to which firm *i* extends trade credit to its customers following a negative shock:

$$\Delta y_{i,c,y,y+1}^{Extended} = \beta_0 + \beta_1 Affected_{iy} + \eta_{c,y} + \varepsilon_{i,y,} \quad (5)$$

The inclusion of interactions of customer and time fixed effects allows us to control for the customer's demand for trade credit and test whether firms affected by natural disasters provide more trade credit to a given customer in comparison to other firms. Put differently, this allows us to identify the affected firms' supply of trade credit.

3. Main Results

3.1. Affected firms

Natural disasters are negative shocks to firms' operations that may result in higher liquidity needs, for instance, because firms have to repair their facilities. Since suppliers are known to extend liquidity when firms experience liquidity shortfalls, we expect the payables

of firms hit by natural disasters to increase. This is precisely what we find in column 1 of Table 2 using the Factset Revere sample. In the year following a natural disaster, the ratio of accounts payable relative to the cost of goods sold increases by 8.4 percentage points, which corresponds to a 16% increase in the level of payables relative to the sample median (0.51).

Also consistent with our interpretation, negative shocks are associated with a decrease in the firms' cash holdings (column 2) and assets (column 3) and an increase in write-downs (column 4). Consistent with the findings of Barrot and Sauvagnat (2016), affected firms' sales drop (column 5). Overall, this evidence is consistent with prior work that firms use cash and short-term funding from suppliers to weather negative liquidity shocks (Amberg, Jacobson, von Schedvin, and Townsend, 2021). We do not find any evidence of changes in investment (columns 6). Firms also do not appear to change their use of external financing (columns 7 and 8).

Importantly, though, it emerges that firms extend more trade credit to their customers (column 9). This finding contrasts with evidence that firms that experience negative liquidity shocks require faster payments from customers (Amberg, Jacobson, von Schedvin, and Townsend, 2021). Since firms' leverage and cash-holdings do not increase, the increase in receivables cannot be attributed to the firms' desire to create collateral to access financial debt (Billett, Freeman, and Gao, 2021). Instead, firms appear to entirely pass to their customers the extra liquidity received from their suppliers, as shown by the fact that in column 10 the net receivables, defined as accounts receivable minus accounts payable scaled by sales, are neither statistically nor economically different from zero.

We conjecture that natural disasters decrease firms' bargaining power with their customers. In particular, the latter may consider switching or adding new suppliers to face

temporary shortages. Firms may thus react by providing more trade credit to avoid losing their customers, as the model of Giannetti, Serrano-Velarde, and Tarantino (2021) suggests.[4]

Below, we perform several mechanism tests that support our hypothesis that trade credit provision following natural disasters is related to changes in firms' bargaining power. However, we first carry out several tests to evaluate the robustness of our main results and the merit of alternative explanations. First, we show that the result is robust when we saturate the equation with an increasing set of fixed effects, including state and year and industry and year fixed effects. State and year fixed effects allow us to control for contemporaneous shocks at the state level that can affect receivables and payables. Industry times year fixed effects allow us to control for any factor related to the nature of transacted goods that could affect firms' trade credit policies (Giannetti, Burkart, and Ellingsen, 2011). Table 3 shows the estimates. The effects of natural disasters on the affected firms' payables and receivables are qualitatively and quantitatively invariant as we add to the specifications interactions of state and year fixed effects (columns 1 and 3) and of 2-digit industry codes and year fixed effects (columns 2 and 4).

Second, our empirical strategy essentially follows a difference-in-differences methodology. Our interpretation of the empirical evidence that natural disasters affect trade credit usage is warranted only if changes in trade credit between treated and control firms follow a parallel trend in the quarters preceding the natural disasters. To ensure that our results are valid, in Table 4, we estimate Equation (1) using pre-disaster changes in receivables (columns 1 to 4) and payables (columns 5 to 8) as dependent variables. The estimated coefficients are statistically insignificant, indicating that firms in the treated and control groups

[4] Table IA.2 in the Internet Appendix shows that the changes in trade credit usage are not reversed in the year following the natural disasters, suggesting that changes in payment terms are costly to reverse and have long-lasting effects on the functioning of the supply chain.

make similar use of trade credit before the event quarter. Hence, the parallel trend assumption appears to be satisfied.

Third, we conduct a placebo test, which helps to address the concern that a latent variable correlated with natural disasters, not captured by our control variables and fixed effects, may be driving our results. In this case, our identifying assumption that no other channels drive the changes in trade credit except for natural disasters would not be valid. To address this issue, we assume the natural disasters happen in nearby counties that are within 50 miles of the actual disaster counties. Table IA.3 shows that the receivables and payables of firms in counties that are close but unaffected by natural disasters do not change, suggesting that unobserved shocks correlated with natural disasters are unlikely to drive our findings.

The evidence that natural disasters are unrelated to trade credit policies of firms in nearby counties also allows us to understand why natural disasters matter. In principle, firms in nearby counties should be as likely as firms in the affected counties to be hit by natural disasters in the future (Dessaint and Matray, 2017). Thus, if affected firms' bargaining power with their customers decreases because natural disasters have become more salient, we should observe that nearby firms also change their trade credit policies at least to some extent. The fact that this is not the case suggests that firms have to provide trade credit to compensate their clients for the costs caused by temporary disruptions.[5]

Finally, Table IA.5 provides direct evidence that disruption of the operations is likely to drive the response of payables and receivables to natural disasters. Firms with production facilities spread out across locations should be less affected by natural disasters because they should be able to ship their products from plants in other locations. We use Dun & Bradstreet National Establishment Time Series (NETS) and capture the geographic dispersion of a firm's

[5] The explanation that natural disasters matter because of the actual disruption they cause is also supported by the evidence in Table IA.4, where we show that our estimates are not statistically different in counties that have experienced more natural disasters than average.

operations by counting the number of states in which a firm operates. The negative and significant coefficient on the interaction between the number of states in which a firm operates and the affected dummy indicates that the increase in trade credit usage is significantly smaller for firms that are likely to have been less disrupted by natural disasters thanks to more spread out operations.

3.2. Suppliers of affected firms

Given that we observe an increase in payables for the affected firms, the receivables of the affected firms' suppliers should increase as a result. Panel A of Table 5 tests this prediction by estimating Equation (2). The dependent variable is a firm's ratio of accounts receivable to sales. The positive and statistically significant coefficient on the dummy variable *Supplier of affected firm* confirms the earlier result that suppliers extend more trade credit to firms that have been affected by a natural disaster. The effect is qualitatively and quantitatively invariant as we saturate the equation with more fixed effects going from column 1 to column 3.

In column 4, we take into account that suppliers may be located near affected firms and have also experienced disruptions because of natural disasters. Only 5.85% of the sample firms are located in the same county as their customers. This is therefore unlikely to drive our findings. Nevertheless, we include the *Affected* dummy in the regression. The increase in receivables for affected firms' suppliers appears even larger once we control for this effect. Suppliers affected by natural disasters appear to increase the provision of trade credit to all their customers. In contrast, unaffected suppliers increase the provision of trade credit only if they have clients that have been affected by a natural disaster. This latter effect is not only statistically, but also economically significant. The coefficient in column 4 implies an increase in receivables of 1.6 percentage points, which is around 3% of the median receivables level. This is equivalent to a 19 million-dollar increase in accounts receivable for the average firm.

In Panel B, we rely on the SEC sample in which we observe the actual amount of trade credit in a relationship. As discussed in section 2, this sample allows us to differentiate between supply and demand effects on the amount of trade credit (Petersen and Rajan, 1997). We estimate Equation (4) to test whether suppliers of affected firms indeed discriminate between their customers by providing more trade credit to those that are affected by natural disasters. Columns 1 to 4 show that a firm receives more trade credit from a supplier in the year following a natural disaster, irrespective of the unobserved heterogeneity that we absorb by including fixed effects. In particular, in column 4, we include interactions of supplier and year fixed effects, which allows us to compare the trade credit provided by the *same* supplier to customers that have differential exposure to natural disasters. The positive and significant coefficient on the *Affected* dummy implies that a firm affected by natural disasters receives more trade credit in the following year in comparison to other customers of the same supplier. This result is economically meaningful, representing an 18% increase in trade credit to customers affected by a natural disaster.

3.3. Customers of affected firms

Following an argument similar to Subsection 3.2, if the receivables of the affected firms increase, we should observe a corresponding increase in the payables of the affected firms' customers. In Panel A of Table 6, we test this conjecture using the Factset Revere sample and estimate Equation (3). Regardless of the set of fixed effects we control for, we find a positive and statistically significant coefficient on the dummy variable *Customer of affected firm.* This implies that customers of firms affected by natural disasters have higher payables, suggesting that they are offered more trade credit. In column 4 of Panel A of Table 6, using the same approach as in column 4 of Panel A of Table 5, we take into account that customers may be located near affected firms and may have also experienced disruption due to natural disasters.

We thus control for the *Affected* dummy. The estimated coefficient on *Customer of affected firm* in column 4 shows that results in columns 1 to 3 are robust to controlling for whether the customer has also been affected by a natural disaster in quarter *t*.

In Panel B of Table 6, we test whether suppliers that have experienced a natural disaster extend trade credit to their major customers by estimating Equation (5). We exploit the fact that the same customer is reported by many suppliers and test whether affected suppliers provide more trade credit to a given firm than unaffected suppliers.

The estimates provide clear evidence that firms affected by natural disasters extend more trade credit to their customers in comparison to other suppliers. In particular, in column 4, we include interactions of customer and year fixed effects, which allows us to absorb a customer's demand for trade credit and to compare the trade credit offered by suppliers that have differential exposure to natural disasters to the *same* customer. The estimated coefficient on the *Affected* dummy in column 4 is statistically significant and economically meaningful, as it implies a 15% increase in trade credit extended by suppliers affected by natural disasters.

Taken together, our results in Table 5 and Table 6 confirm our benchmark results in Table 2 and Table 3: receivables of suppliers of affected firms and payables of customers of affected firms increase.

3.4. Effects of natural disasters on supply chain relationships

Table 7 explores whether natural disasters affect supply chain relationships using Factset Revere. In column 1, we find no evidence that the average firm's relationships with customers and suppliers are more likely to be severed following natural disasters, notwithstanding natural disasters have a negative effect on sales in our sample, as shown by Barrot and Sauvagnat (2016).

We conjecture that the increase in trade credit usage enhances the stability of supply chains after idiosyncratic shocks that would otherwise increase their fragility. Columns 2 and 3 support our conjecture. In about half of the sample, there is no increase in firms' provision of trade credit to customers during a year. In column 2, we consider this subsample. The estimates show that affected firms lose customers if they do not provide more trade credit following natural disasters. In column 3, we consider a subsample of firms that increased the provision of trade credit during the past year. We observe no change in the number of customers following natural disasters in this subsample.

Below, in Section 4, we explore whether firms are more inclined to offer trade credit when supply chains are particularly valuable for them. In Section 5, we also show that supply chains become more unstable after natural disasters when financial constraints prevent a firm and its suppliers from offering trade credit.

4. Cross-sectional effects

Having established that a firm receives and extends more trade credit if it is hit by a natural disaster, we perform several cross-sectional tests to understand the economic mechanisms leading to this finding. Our objective is to evaluate whether firms respond strategically in order to improve the stability of the supply chain through trade credit, when negative shocks would otherwise increase the fragility of their customer-supplier relationships.

First, we examine the competitive environment faced by the affected firm. The customers of the affected firm are likely to face lower switching costs if the input is easy to substitute, which is more likely to be the case if the affected firm faces high competition in the product market. In this case, customers may be particularly likely to terminate the relationship if a firm faces operating difficulties. Affected firms may thus have to increase the supply of

trade credit to a larger extent to maintain their customer relationships following natural disasters.

Table 8 considers how the competitive environment faced by the affected firm impacts the use of trade credit. We measure the extent of competition that a firm faces in the product market using the product market fluidity proxy developed by Hoberg, Phillips, and Prabhala (2014). Product fluidity measures the competitive threat faced by a firm in its product market using the products' descriptions from a firm's and its competitors' 10-K filings.

Column 1 shows that firms that are affected by natural disasters extend more trade credit if they face a more competitive environment, which is presumably associated with lower switching costs for the customers and therefore more unstable relationships. The estimated effect is economically significant: going from the bottom decile to the top decile of competition measured by fluidity increases receivables by 9%.

Suppliers of affected firms that face stronger competition in the product market are unlikely to be able to sell to their customers' competitors if affected firms exit or lose market share because the competitors may have different suppliers. Therefore, firms should internalize the risk associated with the instability of the supply chain to a larger extent when their customers face competitive markets. Consistent with this conjecture, suppliers appear to provide more trade credit because the payables of affected firms in competitive markets increase to a larger extent following negative shocks, as shown in column 2. The effect is similar to that estimated for receivables in magnitude: going from the bottom decile to the top decile in fluidity is associated with a 14% increase in payables.

We also consider an alternative measure of competition based on the Herfindahl-Hirschman index (HHI) of the industry sales. Presumably, customers of firms in concentrated industries encounter more difficulties in switching suppliers. Relationships should therefore be more stable even when firms experience operating difficulties. Columns 3 and 4 of Table 8

show that the increase in trade credit usage is less pronounced when the firms affected by natural disasters are in concentrated industries. Not only do the affected firms' receivables increase to a lower extent, suggesting that they offer less trade credit to their customers, but also their payables remain relatively lower, suggesting that the suppliers of affected firms, being aware that the supply chain is quite stable, do not provide as much trade credit. The estimated effects are both statistically and economically significant: going from the bottom decile to the top decile of the HHI is associated with a 4% and 12% decrease in receivables and payables, respectively. In sum, according to both competition proxies, the competitive threat faced by an affected firm appears to be an important driver of the provision of trade credit for both affected firms and their suppliers.

Preserving the stability of the supply chain may be particularly important for firms that depend, to a larger extent, on their customers and suppliers. Table 9 explores whether affected firms that are more dependent on a customer do more to preserve the relationship following negative shocks. In columns 1 and 2, we measure a firm's dependence on its customers using the intensity of the relationships. As discussed in section 1, Factset Revere provides information not only on supply chain relationships, but also on other types of relationships, such as partnerships and joint ventures. We measure a firm's relationship intensity with its customers as the total number of relationships of a firm with its customers, normalized by the number of customers.

In columns 3 and 4, a firm's dependence on its customers is measured using Compustat Customer Segment Files. The FASB regulation requires firms to report customers comprising at least 10% of their sales. Our measure of dependence, *Major customer*, is an indicator variable that equals one if the firm reports a major customer in the financial statements and zero otherwise.

According to both definitions, in columns 1 and 3, we observe that after being hit by a natural disaster, firms that are more dependent on their customers provide more trade credit. In addition, the affected firms' suppliers appear to be aware that for these firms it is particularly important to counter the risk of losing the customers. Accordingly, in columns 2 and 4, we estimate positive and statistically significant coefficients on the interaction terms, suggesting that firms that are highly dependent on their customers receive more trade credit from their suppliers when they are affected by natural disasters. Both definitions of customer dependence give economically significant estimates: going from the bottom decile to the top decile of the proxy for relationship intensity increases receivables and payables by 17% and 30%, respectively, while having a major customer increases receivables and payables by 10% and 5%, respectively.

Finally, we explore the characteristics of the firms that are more inclined to provide trade credit when their clients experience liquidity problems, due to natural disasters. Table 10 focuses on the suppliers' incentives to internalize the risk that the affected firm loses its customers. First, we consider how intense the affected firm's relationship with its suppliers is. We define the intensity of the relationships similarly to columns 1 and 2 of Table 9. In particular, a firm is likely to have a strong relationship with its suppliers if the number of relationships with its suppliers is large relative to the total number of suppliers we observe. These important suppliers are more likely to internalize that the affected firm's ability to maintain its customer relationships matters for the stability of the supply chain and, consequently, for both the affected firm's and their own future performance. We should thus observe that affected firms with close relationships with their suppliers experience a larger increase in payables following natural disasters and are consequently better able to extend trade credit to their own customers.

Columns 1 and 2 of Table 10 show that the affected firm's receivables and payables indeed increase to a larger extent in the year following a natural disaster if the firm has intense relationships with its suppliers. Going from the bottom decile to the top decile of the proxy for relationship intensity between the affected firm and its suppliers increases the affected firm's receivables and payables by 9% and 17%, respectively. The results are similar in columns 3 and 4, in which we consider whether the affected firm is cited as a major customer by at least one of its suppliers. Following a natural disaster, firms that are reported as major customers experience an increase in receivables and payables by 2% and 5%, respectively.

Taken together, results in Tables 9 and 10 indicate that the intensity of inter-firms relationships constitutes an important factor behind the provision of trade credit when firms face operational difficulties. The findings also support the causal mechanism behind our hypothesis because trade credit flows increase to a larger extent precisely when the termination of the relationships of the affected firm with its customers would have larger costs for upstream firms.

5. Financial constraints and the instability of supply chains

So far, we have shown that even though operational difficulties due to natural disasters propagate upstream and downstream, supply chains appear to be remarkably stable. We have also shown that the use of trade credit increases after a firm is affected by a natural disaster, and that the increase is particularly pronounced when the relationship with a customer is important for a firm. This is the case not only for the affected firm, but also for the affected firm's suppliers. Arguably, upstream firms provide trade credit to preserve important supply chains.

However, suppliers can extend more trade credit only if they have enough financial flexibility. In this section, we investigate what happens if a firm affected by a natural disaster

experiences financial constraints and how the provision of trade credit depends on the financial conditions of the affected firm's suppliers. We carry out the same analysis as in Table 3. In Panel A of Table 11, we measure firm-level financial constraints using the proxy of Hadlock and Pierce (2010); in Panel B, we perform the same set of tests as in Panel A using the Whited and Wu (2006) proxy for financial constraints.

Columns 1 and 2 of Panel A show that when an affected firm is financially constrained, but its suppliers are not, trade credit usage increases as in our baseline specifications in Table 3. In particular, the receivables increase by 13% relative to the sample median. Interestingly, though, the increase in payables is more pronounced: the average firm experiences a 42% increase in payables. This suggests that suppliers, aware of the customer's financial constraints and of the difficulties arising from the natural disaster, are willing to provide short-term liquidity through trade credit.

Columns 3 and 4 estimate the same specification as in columns 1 and 2, but in a subsample of firms that are financially constrained and have financially constrained suppliers. Not only the point estimates of the coefficient on the affected dummy are smaller than those in columns 1 and 2, but they are also statistically insignificant, indicating that financial constraints prevent the increase in the use of trade credit.

These conclusions are confirmed in Panel B, where we repeat the same tests as in Panel A, considering a Whited and Wu (2006) proxy for financial constraints. The point estimates are qualitatively similar to those reported in Panel A.

Overall, the results in Table 11 show that the financial constraints of a firm and its suppliers constitute an important factor limiting the provision of trade credit when idiosyncratic shocks occur. Next, we analyze whether the provision of trade credit helps to preserve the stability of supply chains. More specifically, we explore whether the customers of affected

firms are more likely to terminate the relationship with the affected firm following natural disasters, when financial constraints prevail in the supply chain.

Table 12 validates our interpretation that trade credit plays a crucial role in preserving the stability of supply chains. Panel A shows that firms affected by natural disasters lose customers when both the affected firm and its suppliers are financially constrained. We know from Table 11 that these firms are not able to provide more trade credit to their customers when they are hit by a natural disaster. This conclusion is qualitatively and quantitatively invariant when we use different proxies for financial constraints. The parameter estimates in columns 1 and 3 are not only statistically, but also economically significant. The affected firms on average lose more than 3% of their customers. On average, in our sample, firms experience a yearly increase in the number of customers of about 2%.

In columns 2 and 4, we consider firms that are financially constrained, but whose suppliers are not. Financially unconstrained suppliers can provide trade credit to the affected firms. We do not find any negative effects of natural disasters on these firms' number of customers, which lends support to our conjecture that the provision of trade credit helps to preserve the stability of supply chains. If a firm is financially constrained, but its suppliers are not, the increase in payables allows the firm to extend liquidity to its customers and maintain the relationships, indicating that a firm's financial constraints are unlikely to capture the desirability of its product. This finding thus helps to dismiss concerns that financially constrained firms lose their customers because their performance is deteriorating and may have done so independently from the natural disaster. In fact, the customer relationships of financially constrained firms are stable if their suppliers are able to extend trade credit.

In Panel B, we take the perspective of the customers of affected firms. We ask whether the customers add new suppliers in the industry of affected firms to avoid bottlenecks. Firms could also add suppliers if they fear the consequences of future natural disasters or want to

sever the relationship with the affected firms. In columns 1 and 3, we observe that the customers of affected firms start new relationships with the affected firm's competitors only if the affected firm and its suppliers are financially constrained. In columns 2 and 4, we find no evidence that this is the case if the affected firm is financially constrained, but its suppliers are not.

Overall, the evidence in Table 11 and Table 12 supports our conjecture that trade credit helps to preserve the stability of supply chains. The financial conditions of suppliers play a crucial role in the provision of trade credit and the resulting stability of the supply chain.

Finally, we explore whether the provision of trade credit has any effect on the profitability of firms. Table 13 provides evidence that the increase in trade credit usage following natural disasters helps to maintain the profitability of affected firms. In particular, columns 1 and 3 show a drop in profitability when both the affected firms and their suppliers are financially constrained, that is, when firms are unable to obtain and offer more trade credit and thus lose customers. In columns 2 and 4, the profitability of affected firms that are financially constrained is invariant following natural disasters if their suppliers are able to provide liquidity.

6. Conclusions

Supply chains are important for firms' performance, but operational difficulties due to idiosyncratic shocks such as natural disasters, cyberattacks, trade wars etc. threaten their stability and survival. We show that supply chains appear more stable than expected when natural disasters occur because affected firms use trade credit to increase the value of the relationship for their customers.

Not only affected firms appear to try to preserve the relationships with their customers, but also the suppliers of affected firms internalize the negative spillovers arising from the

instability of the supply chain and extend trade credit to the affected firms, especially if the latter are financially constrained and would otherwise be unable to provide short-term funding to their customers.

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Figure 1
The map shows the number of major disasters in each country between 2003 and 2019 using the SHELDUS database.

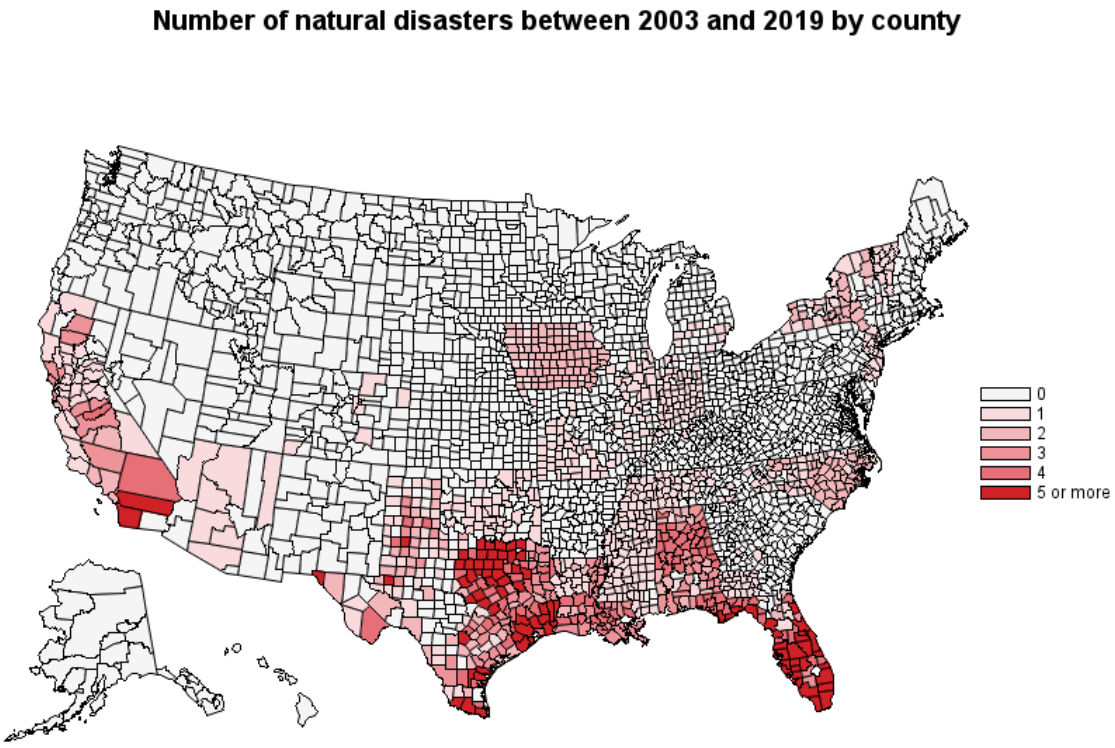
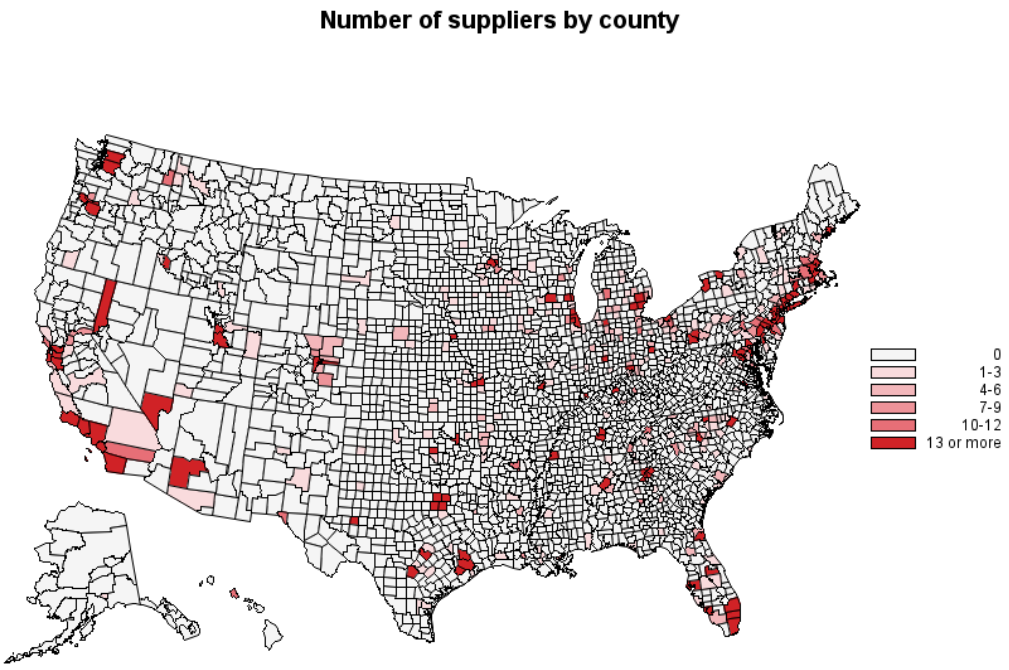


Figure 2
The maps at the top and the bottom of the page show the number of suppliers and customers, respectively, headquartered in each county between 2003 and 2019 using the merged Compustat and Factset Revere Databases.



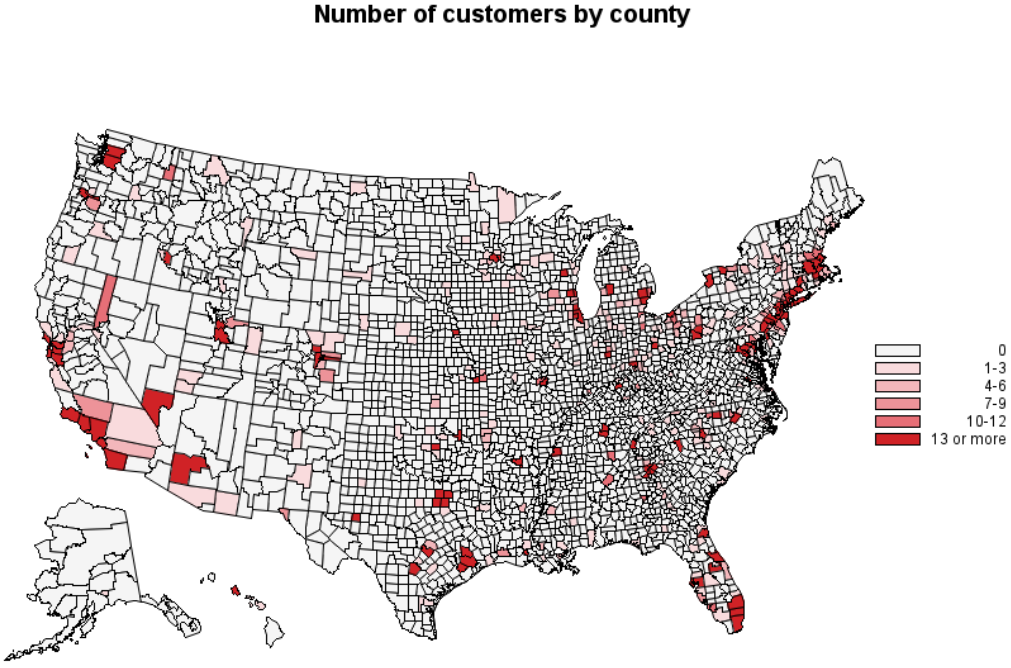


Table 1
Summary statistics

This table presents summary statistics for the two samples used in our analysis. Panel A reports summary statistics for the Factset Revere and Compustat merged sample. Panels B, C, and D report summary statistics for the SEC sample. Panel B focuses on the supplier-customer-year level sample. Panels C and D report summary statistics on suppliers and customers, respectively. Columns 1 to 6 report the sample size, mean, standard deviation, 25th percentile, 50th percentile, and 75th percentile, respectively. All variables are defined in Appendix A.

	N	Mean	SD	P25	P50	P75
	[1]	[2]	[3]	[4]	[5]	[6]
Panel A: Compustat-Factset Revere						
Change in payables	107,106	0.015	0.955	-0.070	0.003	0.076
Change in receivables	107,106	0.014	0.356	-0.052	0.001	0.058
Change in net trade credit	107,106	-0.001	0.473	-0.064	0.000	0.065
Change in cash	107,106	-0.003	0.075	-0.031	0.000	0.030
Change in assets	107,106	0.061	0.224	-0.045	0.040	0.144
Change in write down	107,106	0.000	0.027	0.000	0.000	0.000
Change in sales	107,106	0.061	0.231	-0.053	0.053	0.167
Change in investment	107,106	-0.047	0.793	-0.266	-0.002	0.213
Change in long-term debt	107,106	0.008	0.071	-0.021	0.000	0.029
Change in short-term debt	107,106	0.002	0.042	-0.004	0.000	0.007
Disaster dummy	107,106	0.022	0.148	0.000	0.000	0.000
Size	107,106	6.989	1.907	5.621	7.243	8.659
Leverage	107,106	0.240	0.220	0.041	0.209	0.362
Age	107,106	2.645	0.996	2.079	2.773	3.367
Profit	107,106	-0.007	0.064	-0.008	0.009	0.020
Change in number of customers	85,551	0.021	0.247	-0.118	0	0.154
Change in number of suppliers	85,869	0.014	0.291	-0.134	0	0.154
Fluidity	84,996	6.854	3.305	4.298	6.214	8.724
Herfindahl	107,106	0.144	0.119	0.055	0.101	0.196
Relationship intensity	107,106	0.829	0.668	0.286	0.643	1
Major customer	107,106	0.255	0.436	0	0	1
Panel B: SEC sample supplier-customer level						
Change in trade credit	2,252	-0.005	0.073	-0.038	-0.002	0.031
Disaster dummy	2,252	0.040	0.197	0.000	0.000	0.000
Panel C: SEC sample supplier level						
Size	1,720	5.770	1.780	4.450	5.671	7.082
Leverage	1,720	0.209	0.222	0.003	0.150	0.323
Age	1,720	2.551	0.860	1.946	2.639	3.178
Profit	1,720	-0.041	0.194	-0.077	0.024	0.069
Panel D: SEC sample customer level						
Size	1,530	9.878	1.596	8.840	10.072	11.018
Leverage	1,530	0.249	0.164	0.121	0.227	0.354
Age	1,530	3.210	0.810	2.708	3.401	3.892
Profit	1,530	0.042	0.058	0.017	0.045	0.078

Table 2
The impact of natural disasters on firms' policies

This table reports estimates of the effects of natural disasters on firms' policies. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in the firm's characteristics indicated on top of each column, defined as the difference between the value of the characteristic in quarter *t+4* and *t*. For example, we define the change in accounts payable as $AP_{t+4}/COGS_{t+4} - AP_t/COGS_t$. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in payables [1]	Change in cash [2]	Change in assets [3]	Change in write down [4]	Change in Sales [5]	Change in investment [6]	Change in long-term debt [7]	Change in short-term debt [8]	Change in receivables [9]	Change in net receivables [10]
Affected	0.084***	-0.005***	-0.013***	0.001*	-0.012**	-0.005	-0.002	0.001	0.023***	0.006
	(0.023)	(0.002)	(0.004)	(0.000)	(0.005)	(0.021)	(0.002)	(0.001)	(0.008)	(0.011)
Size	-0.006	-0.004***	-0.143***	0.000	-0.069***	-0.045***	0.003**	0.001	-0.010**	0.006
	(0.014)	(0.001)	(0.005)	(0.000)	(0.004)	(0.009)	(0.001)	(0.001)	(0.005)	(0.007)
Leverage	-0.053	0.024***	-0.135***	-0.001	-0.025**	0.060**	-0.180***	-0.025***	-0.024	0.032
	(0.062)	(0.004)	(0.014)	(0.002)	(0.011)	(0.030)	(0.006)	(0.002)	(0.019)	(0.030)
Age	0.018	0.009***	-0.009	0.000	-0.018***	0.053***	-0.002	0.001	-0.010	-0.026***
	(0.017)	(0.002)	(0.007)	(0.000)	(0.005)	(0.013)	(0.002)	(0.001)	(0.007)	(0.009)
Profit	-0.118	-0.076***	0.240***	-0.078***	-0.259***	0.311***	-0.034***	-0.013**	0.346***	-0.419***
	(0.165)	(0.009)	(0.033)	(0.009)	(0.028)	(0.076)	(0.008)	(0.005)	(0.045)	(0.078)
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES	YES	YES	YES	YES	YES	YES
Observations	107,106	107,106	107,106	107,106	107,106	107,106	107,106	107,106	107,106	107,106
R-squared	0.120	0.126	0.357	0.110	0.271	0.078	0.223	0.096	0.111	0.118

Table 3
The impact of natural disasters on firms' receivables and payables

This table reports estimates of the effects of natural disasters on firms' receivables and payables. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (columns 1 and 2) and payables (columns 3 and 4), defined as the difference between the value in quarter *t+4* and *t*. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in receivables [2]	Change in payables [3]	Change in payables [4]
Affected	0.020***	0.020***	0.081***	0.080***
	(0.007)	(0.007)	(0.024)	(0.024)
Size	-0.013***	-0.015***	-0.004	-0.003
	(0.005)	(0.005)	(0.015)	(0.015)
Leverage	-0.023	-0.022	-0.064	-0.091
	(0.021)	(0.021)	(0.068)	(0.070)
Age	-0.005	-0.006	0.016	0.010
	(0.006)	(0.007)	(0.020)	(0.021)
Profit	0.332***	0.340***	-0.098	-0.078
	(0.047)	(0.047)	(0.167)	(0.166)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	NO	YES	NO	YES
Observations	93,703	93,702	93,703	93,702
R-squared	0.122	0.133	0.124	0.136

Table 4
Dynamic effects of natural disasters on firms' receivables and payables

This table reports estimates of the dynamic effects of natural disasters on firms' receivables and payables. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (columns 1 to 4) and payables (columns 5 to 8), defined as the difference between the value in quarter *t* and *t-1* (columns 1 and 5), the value in quarter *t-1* and *t-2* (columns 2 and 6), the value in quarter *t-2* and *t-3* (columns 3 and 7), and the value in quarter *t-3* and *t-4* (columns 4 and 8). The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables (t, t-1) [1]	Change in receivables (t-1, t-2) [2]	Change in receivables (t-2, t-3) [3]	Change in receivables (t-3, t-4) [4]	Change in payables (t, t-1) [5]	Change in payables (t-1, t-2) [6]	Change in payables (t-2, t-3) [7]	Change in payables (t-3, t-4) [8]
Affected	-0.007	0.006	-0.008	0.001	-0.025	-0.004	0.011	-0.014
	(0.006)	(0.006)	(0.006)	(0.006)	(0.018)	(0.019)	(0.019)	(0.020)
Size	0.011***	0.009***	0.007***	0.004**	0.014***	0.014***	0.021***	0.013**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)	(0.005)	(0.006)
Leverage	-0.001	0.005	0.009	-0.016**	-0.030	-0.000	-0.021	-0.003
	(0.008)	(0.007)	(0.007)	(0.007)	(0.021)	(0.019)	(0.019)	(0.021)
Age	-0.006***	-0.003	-0.006**	-0.003	0.015***	0.008	0.003	-0.001
	(0.002)	(0.002)	(0.002)	(0.003)	(0.006)	(0.006)	(0.006)	(0.007)
Profit	-0.168***	-0.035	0.023	0.009	-0.084	0.041	-0.012	0.014
	(0.030)	(0.028)	(0.028)	(0.028)	(0.084)	(0.090)	(0.076)	(0.073)
Firm FE	YES	YES	YES	YES	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES	YES	YES	YES	YES
Observations	93,063	92,526	92,222	91,815	93,063	92,526	92,222	91,815
R-squared	0.042	0.042	0.042	0.040	0.043	0.046	0.045	0.048

Table 5
Natural disasters and suppliers of affected firms

This table reports estimates of the effects of natural disasters on the receivables of the suppliers of affected firms. Panel A uses the merged Compustat/Factset Revere sample, whereas Panel B uses the SEC sample. In Panel A, the unit of observation in each regression is a firm-quarter. In Panel B, the unit of observation is a supplier-customer-year. The dependent variable is the change in receivables defined as the difference between the value in quarter *t+4* and *t* and the value in year *t+1* and *t* in Panel A and Panel B, respectively. Receivables are always scaled by total sales as indicated in Appendix A. Specifically, in Panel B, the amount of trade credit granted by supplier *s* to firm *i* is scaled by the sales amount of supplier *s* to firm *i*. In Panel A, the main independent variable is $Supplier\ of\ affected\ firm$, which is an indicator variable that equals one if the firm is a supplier of a firm that is impacted by a natural disaster at time *t* and zero otherwise. In Panel B, the main independent variable is $Affected\ customer$, which is an indicator variable that equals one if a firm's customer is located in a county that is impacted by a natural disaster in year *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. Controls and fixed effects refer to the firm supplying trade credit. All variables are defined in Appendix A. Robust standard errors clustered by firm and customer firm in Panel A and Panel B, respectively, are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: Suppliers of affected firms				
Variables	Change in receivables [1]	Change in receivables [2]	Change in receivables [3]	Change in receivables [4]
Supplier of affected firm	0.014**	0.014**	0.013**	0.016**
	(0.006)	(0.007)	(0.007)	(0.008)
Affected				0.012*
				(0.007)
Size	-0.008	-0.011**	-0.014**	-0.014**
	(0.005)	(0.006)	(0.006)	(0.006)
Leverage	-0.022	-0.025	-0.027	-0.027
	(0.021)	(0.022)	(0.023)	(0.023)
Age	-0.005	-0.003	-0.003	-0.003
	(0.007)	(0.007)	(0.007)	(0.007)
Profit	0.730***	0.696***	0.706***	0.706***
	(0.075)	(0.074)	(0.075)	(0.075)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	NO	YES	YES	YES
Industry times year FE	NO	NO	YES	YES
Observations	98,381	85,374	85,372	85,372
R-squared	0.116	0.134	0.148	0.149

Panel B: SEC sample - suppliers of affected firms				
Variables	Change in trade credit [1]	Change in trade credit [2]	Change in trade credit [3]	Change in trade credit [4]
Affected customer	0.019**	0.025**	0.027**	0.025***
	(0.010)	(0.011)	(0.012)	(0.009)
Size	-0.010**	-0.011**	-0.007	
	(0.004)	(0.005)	(0.008)	
Leverage	-0.029*	-0.027	-0.049**	
	(0.017)	(0.023)	(0.025)	
Age	0.003	0.021*	0.046***	
	(0.007)	(0.011)	(0.013)	
Profit	0.021	0.019	0.036	
	(0.017)	(0.019)	(0.025)	
Firm FE	YES	YES	YES	Subsumed
Year FE	YES	Subsumed	Subsumed	Subsumed
State times year FE	NO	YES	YES	Subsumed
Industry times year FE	NO	NO	YES	Subsumed
Firm times year FE	NO	NO	NO	YES
Observations	2,167	1,884	1,685	856
R-squared	0.155	0.338	0.508	0.621

Table 6
Natural disasters and customers of affected firms

This table reports estimates of the effects of natural disasters on the customers of affected firms' payables. Panel A uses the merged Compustat/Factset Revere sample, whereas Panel B uses the SEC sample. In Panel A, the unit of observation in each regression is a firm-quarter. In Panel B, the unit of observation is a supplier-customer-year. The dependent variable is change in receivables defined as the difference between the value in quarter *t+4* and *t* and the value in year *t+1* and *t* in Panel A and Panel B, respectively. Receivables are always scaled by total sales as indicated in Appendix A. Specifically, in Panel B, the amount of trade credit granted by supplier *s* to firm *i* is scaled by the sales amount of supplier *s* to firm *i*. In Panel A, the main independent variable is $Customer\ of\ affected\ firm$, which is an indicator variable that equals one if the firm is a customer of a firm that is impacted by a natural disaster at time *t* and zero otherwise. In Panel B, the main independent variable is $Affected\ supplier$, which is an indicator variable that equals one if a firm's supplier is located in a county that is impacted by a natural disaster in year *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. In Panel B, controls and fixed effects refer to the firm receiving trade credit. All variables are defined in Appendix A. Robust standard errors clustered by firm and supplier firm in Panel A and Panel B, respectively, are in parentheses. Statistical significance at the 1%, 5%, and 10% level is denoted by ***, **, and *, respectively.

Panel A: Customers of affected firms				
Variables	Change in payables	Change in payables	Change in payables	Change in payables
	[1]	[2]	[3]	[4]
Customer of affected firm	0.033*	0.038**	0.036*	0.032*
	(0.018)	(0.019)	(0.019)	(0.019)
Affected				0.077***
				(0.025)
Size	-0.010	-0.009	-0.007	-0.007
	(0.014)	(0.015)	(0.015)	(0.015)
Leverage	-0.083	-0.092	-0.117	-0.117
	(0.068)	(0.076)	(0.078)	(0.078)
Age	0.027	0.028	0.022	0.022
	(0.017)	(0.020)	(0.021)	(0.021)
Profit	-0.162	-0.090	-0.036	-0.035
	(0.230)	(0.227)	(0.225)	(0.225)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	NO	YES	YES	YES
Industry times year FE	NO	NO	YES	YES
Observations	98,854	86,348	86,346	86,346
R-squared	0.130	0.134	0.147	0.147

Panel B: SEC sample - customers of affected firms				
Variables	Change in trade credit [1]	Change in trade credit [2]	Change in trade credit [3]	Change in trade credit [4]
Affected supplier	0.023***	0.018**	0.022**	0.021**
	(0.007)	(0.008)	(0.010)	(0.010)
Size	-0.004	-0.005	-0.001	
	(0.005)	(0.009)	(0.015)	
Leverage	-0.010	-0.028	-0.168***	
	(0.021)	(0.032)	(0.060)	
Age	0.001	0.002	0.024	
	(0.014)	(0.018)	(0.024)	
Profit	-0.035	-0.056	-0.103	
	(0.055)	(0.083)	(0.108)	
Firm FE	YES	YES	YES	Subsumed
Year FE	YES	Subsumed	Subsumed	Subsumed
State times year FE	NO	YES	YES	Subsumed
Industry times year FE	NO	NO	YES	Subsumed
Firm times year FE	NO	NO	NO	YES
Observations	2,191	1,747	1,536	1,023

Table 7
Natural disasters and number of customers

This table reports estimates of the effects of natural disasters on firms' number of customers. Column 2 and 3 report estimates for subsamples of firms reporting no increase and an increase in trade credit, respectively. The unit of observation in each regression is a firm-quarter. The dependent variable is the change in the logarithm of the number of customers. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Dependent Variable	Number of customers		
Subsample	Overall	No increase in trade credit	Increase in trade credit
Variables	[1]	[2]	[3]
Affected	-0.005	-0.014**	0.002
	(0.003)	(0.007)	(0.007)
Size	0.002	-0.000	0.003
	(0.005)	(0.006)	(0.007)
Leverage	-0.004	-0.007	0.004
	(0.016)	(0.020)	(0.020)
Age	-0.040***	-0.043***	-0.040***
	(0.009)	(0.011)	(0.011)
Profit	0.046*	0.053*	0.055
	(0.025)	(0.032)	(0.038)
Firm FE	YES	YES	YES
Year-quarter FE	YES	YES	YES
State times year FE	YES	YES	YES
Industry times year FE	YES	YES	YES
Observations	71,270	34,586	36,262
R-squared	0.260	0.336	0.335

Table 8
Natural disasters and competition

This table reports estimates of the effects of natural disasters on the receivables and payables of firms in different competitive environments. The unit of observation in each regression is a firm-quarter. The dependent variables are the changes in receivables (columns 1 and 2) and payables (columns 3 and 4), defined as the difference between the value in quarter *t+4* and *t*. In columns 1 and 2, the measure of competitive environment is the product market fluidity proxy developed by Hoberg, Phillips, and Prabhala (2014). In columns 3 and 4, the measure of competitive environment is the Herfindahl index (HHI) of the sales in the industry of the affected firm. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]	Change in receivables [3]	Change in payables [4]
Affected	-0.016	-0.013	0.032**	0.125***
	(0.017)	(0.061)	(0.012)	(0.035)
Fluidity	0.002	-0.004		
	(0.001)	(0.004)		
Affected*fluidity	0.004**	0.012*		
	(0.002)	(0.007)		
Herfindahl			-0.003	0.097
			(0.029)	(0.062)
Affected*HHI			-0.087*	-0.327***
			(0.050)	(0.112)
Size	-0.021***	-0.006	-0.015***	-0.003
	(0.006)	(0.017)	(0.005)	(0.015)
Leverage	-0.011	-0.096	-0.022	-0.091
	(0.025)	(0.073)	(0.021)	(0.070)
Age	0.001	0.008	-0.005	0.010
	(0.008)	(0.025)	(0.007)	(0.021)
Profit	0.330***	-0.228	0.341***	-0.078
	(0.052)	(0.172)	(0.047)	(0.166)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	78,176	78,176	93,702	93,702
R-squared	0.132	0.137	0.133	0.136

Table 9
Natural disasters and firm's dependence on customers

This table reports estimates of the effects of natural disasters on the receivables and payables of firms that depend on their customers to different extents. The unit of observation in each regression is a firm-quarter. The dependent variables are the changes in receivables (columns 1 and 2) and payables (columns 3 and 4), defined as the difference between the value in quarter *t+4* and *t*. In columns 1 and 2, the measure of dependence is the *Relationship Intensity*, calculated as the number of relationships of a firm with its customers scaled by its number of customers. In columns 3 and 4, the measure of dependence is *Major customer*, which is an indicator variable that equals one if the firm reports a major customer in its financial statements and zero otherwise. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]	Change in receivables [3]	Change in payables [4]
Affected	-0.025*	-0.004	0.006	-0.004
	(0.014)	(0.040)	(0.010)	(0.006)
Relationship intensity	-0.008*	-0.030*		
	(0.005)	(0.017)		
Affected*relationship intensity	0.060***	0.113*		
	(0.023)	(0.064)		
Major customer			0.009	0.003
			(0.006)	(0.004)
Affected*major customer			0.046**	0.021**
			(0.022)	(0.011)
Size	-0.016***	-0.006	-0.015***	-0.009***
	(0.005)	(0.015)	(0.005)	(0.003)
Leverage	-0.022	-0.092	-0.022	-0.013
	(0.021)	(0.070)	(0.021)	(0.010)
Age	-0.006	0.007	-0.005	0.004
	(0.007)	(0.021)	(0.007)	(0.004)
Profit	0.342***	-0.074	0.340***	-0.010
	(0.047)	(0.167)	(0.047)	(0.025)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	93,702	93,702	93,702	93,702
R-squared	0.133	0.136	0.133	0.136

Table 10
Natural disasters and suppliers' dependence on a firm

This table reports estimates of the effects of natural disasters on firms' receivables and payables using different measures of the suppliers' dependence on a firm. The unit of observation in each regression is a firm-quarter. The dependent variables are the changes in receivables (columns 1 and 2) and payables (columns 3 and 4), defined as the difference between the value in quarter *t+4* and *t*. In columns 1 and 2, the measure of dependence is the *Relationship Intensity with Suppliers*, calculated as the number of relationships of a firm with its suppliers scaled by its number of suppliers. In columns 3 and 4, the measure of dependence is *Supplier major customer*, which is an indicator variable that equals one if one of the suppliers reports the affected firm as a major customer in its financial statements and zero otherwise. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]	Change in receivables [3]	Change in payables [4]
Affected	-0.012	0.029	0.003	-0.001
	(0.011)	(0.030)	(0.004)	(0.006)
Relationship intensity with suppliers	0.003	0.007		
	(0.004)	(0.015)		
Affected*relationship intensity with suppliers	0.046**	0.074*		
	(0.020)	(0.045)		
Supplier major customer			0.001	0.006
			(0.003)	(0.005)
Affected*supplier major customer			0.012*	0.019*
			(0.007)	(0.011)
Size	-0.015***	-0.003	-0.008***	-0.009***
	(0.005)	(0.015)	(0.002)	(0.003)
Leverage	-0.021	-0.090	-0.016**	-0.012
	(0.021)	(0.070)	(0.007)	(0.010)
Age	-0.006	0.010	-0.002	0.004
	(0.007)	(0.021)	(0.003)	(0.004)
Profit	0.341***	-0.078	0.183***	-0.010
	(0.047)	(0.166)	(0.016)	(0.025)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	93,702	93,702	93,702	93,702
R-squared	0.133	0.136	0.122	0.122

Table 11
Financial constraints and trade credit

This table reports estimates of the effects of natural disasters on firms' receivables and payables using different measures of financial constraints for firms and their suppliers. Panel A and B use the Hadlock and Pierce (2010) and Whited-Wu (2006) measures, respectively, to classify firms and their suppliers as constrained or unconstrained. The unit of observation in each regression is a firm-quarter. The dependent variables are the changes in receivables (columns 1 and 2) and payables (columns 3 and 4), defined as the difference between the value in quarter *t+4* and *t*. In columns 1 and 2, disaster-hit firms are financially constrained and none of their suppliers is financially constrained. In columns 3 and 4, disaster-hit firms are financially constrained and at least one of their suppliers is financially constrained. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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: Hadlock-Pierce financial constraints measure				
Subsample	Affected are constrained and suppliers are not constrained		Both affected and suppliers are constrained	
Dependent variable	Change in receivables	Change in payables	Change in receivables	Change in payables
Variables	[1]	[2]	[3]	[4]
Affected	0.076**	0.215*	0.049	0.074
	(0.034)	(0.119)	(0.050)	(0.092)
Size	-0.019	0.056	-0.049	0.115
	(0.022)	(0.060)	(0.042)	(0.119)
Leverage	0.036	-0.422	0.096	-0.103
	(0.060)	(0.311)	(0.109)	(0.275)
Age	-0.051	-0.100	0.109*	-0.076
	(0.032)	(0.092)	(0.059)	(0.239)
Profit	0.300***	0.067	0.613***	0.856**
	(0.085)	(0.259)	(0.181)	(0.390)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	14,787	14,787	6,506	6,506
R-squared	0.273	0.334	0.335	0.382

Panel B: Whited-Wu financial constraints measure				
Subsample	Affected are constrained and suppliers are not constrained		Both affected and suppliers are constrained	
Dependent variable	Change in receivables	Change in payables	Change in receivables	Change in payables
Variables	[1]	[2]	[3]	[4]
Affected	0.072*	0.242*	0.018	-0.031
	(0.038)	(0.133)	(0.032)	(0.074)
Size	-0.044***	-0.015	-0.007	0.130***
	(0.015)	(0.052)	(0.025)	(0.048)
Leverage	0.033	-0.586***	-0.069	-0.099
	(0.050)	(0.222)	(0.063)	(0.146)
Age	-0.020	-0.086	0.001	-0.099
	(0.024)	(0.084)	(0.037)	(0.098)
Profit	0.266***	0.220	0.375***	-0.070
	(0.083)	(0.293)	(0.110)	(0.306)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	15,527	15,527	12,094	12,094
R-squared	0.276	0.251	0.256	0.298

Table 12
Financial constraints and changes in customer-supplier relationships

This table reports estimates of the effects of natural disasters on firms' number of customers (Panel A) and their customers' number of new suppliers (Panel B) using different measures of financial constraints for firms and their suppliers. Panel A and B use the Hadlock and Pierce (2010) and Whited-Wu (2006) measures, respectively, to classify firms and their suppliers as constrained or unconstrained. The unit of observation in each regression is a firm-quarter. In columns 1 and 2, disaster-hit firms are financially constrained and none of their suppliers is financially constrained. In columns 3 and 4, disaster-hit firms are financially constrained and at least one of their suppliers is financially constrained. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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: Change in number of customers for the affected firms

	Hadlock-Pierce financial constraints measure		Whited-Wu financial constraints measure	
Subsample	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained
Variables	[1]	[2]	[3]	[4]
Affected	-0.033**	-0.010	-0.031*	-0.010
	(0.016)	(0.013)	(0.017)	(0.019)
Size	0.012	0.008	0.006	0.003
	(0.029)	(0.019)	(0.012)	(0.013)
Leverage	-0.009	0.084*	0.022	0.037
	(0.077)	(0.050)	(0.040)	(0.038)
Age	-0.139***	0.020	-0.035	-0.013
	(0.054)	(0.030)	(0.025)	(0.025)
Profit	0.035	0.021	0.007	0.007
	(0.069)	(0.046)	(0.050)	(0.048)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	5,371	12,393	10,305	12,811
R-squared	0.679	0.555	0.463	0.465

Panel B: Change in number of new suppliers for the affected firms' customers				
	Hadlock-Pierce Financial Constraints Measure		Whited-Wu Financial Constraints Measure	
Subsample	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained
Variables	[1]	[2]	[3]	[4]
Customer of affected firm	0.036**	-0.023**	0.025**	-0.013
	(0.018)	(0.010)	(0.011)	(0.011)
Size	-0.022	-0.022**	-0.005	-0.011
	(0.016)	(0.011)	(0.006)	(0.009)
Leverage	0.104	0.076*	-0.020	0.013
	(0.054)	(0.041)	(0.031)	(0.035)
Age	0.023	-0.006	0.006	-0.012
	(0.032)	(0.019)	(0.013)	(0.014)
Profit	-0.017	-0.031	-0.149**	-0.082
	(0.119)	(0.114)	(0.070)	(0.102)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	8,970	16,281	18,752	16,637
R-squared	0.545	0.529	0.332	0.416

Table 13
Natural disasters, financial constraints, and affected firms' performance

This table reports estimates of the effects of natural disasters on firms' ROA using different measures of financial constraints for firms and their suppliers. Columns 1 and 2, and 3 and 4 use the Hadlock and Pierce (2010) and Whited-Wu (2006) measures, respectively, to classify firms and their suppliers as constrained or unconstrained. The unit of observation in each regression is a firm-quarter. The dependent variable is the change in ROA, defined as the difference between the value in quarter *t+4* and *t*. In columns 1 and 2, disaster-hit firms are financially constrained and none of their suppliers is financially constrained. In columns 3 and 4, disaster-hit firms are financially constrained and at least one of their suppliers is financially constrained. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

	Hadlock-Pierce Financial Constraints Measure		Whited-Wu Financial Constraints Measure	
Subsample	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained	Both affected and suppliers are constrained	Affected are constrained and suppliers are not constrained
Variables	Change in ROA [1]	Change in ROA [2]	Change in ROA [3]	Change in ROA [4]
Affected	-0.010**	-0.003	-0.005*	-0.001
	(0.004)	(0.003)	(0.003)	(0.003)
Size	0.001	0.000	0.000	0.006***
	(0.003)	(0.002)	(0.001)	(0.001)
Leverage	-0.006	0.010*	0.000	0.009**
	(0.009)	(0.005)	(0.005)	(0.004)
Age	0.007*	0.002	0.002	0.001
	(0.004)	(0.002)	(0.002)	(0.002)
Profit	-0.143***	-0.158***	-0.148***	-0.365***
	(0.017)	(0.010)	(0.011)	(0.017)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	YES	YES	YES	YES
Observations	6,506	14,787	12,094	15,527
R-squared	0.243	0.207	0.235	0.308

Appendix A
Variable definitions

Variables	Definition
Change in payables	Change in accounts payable, scaled by cost of goods sold, between time t+4 and t.
Change in cash	Change in cash and cash equivalents, scaled by total assets between time t+4 and t
Change in assets	Change in the natural logarithm of total assets between time t+4 and t
Change in write down	Change in write downs, scaled by total assets between time t+4 and t
Change in investment	Change in capital expenditures, scaled total assets between time t+4 and t
Change in long-term debt	Change in long-term debt, scaled by total assets between time t+4 and t
Change in short-term debt	Change in short-term debt, scaled by total assets between time t+4 and t
Change in sales	Change in the natural logarithm of total sales between time t+4 and t
Change in receivables	Change in accounts receivable, scaled by total sales, between time t+4 and t
Change in net receivables	Change in accounts receivable minus accounts payable scaled by sales, between time t+4 and t
Change in ROA	Change in operating income before depreciation, scaled by total assets between time t+4 and t
Affected	Equals one if a firm is headquartered in a county that is impacted by a natural disaster at time t and zero otherwise
Size	Natural logarithm of the total book value of assets
Leverage	The sum of long-term and short-term debt, scaled by total assets
Age	Natural logarithm of the difference in years between current year and the first year in Compustat
Profit	Income before extraordinary expenses, divided by total assets
Fluidity	The competitive and product market threat surrounding a firm, defined as in Hoberg, Phillips and Prabhala (2014)
HHI	Market concentration measured as the Herfindahl index of firm sales
Relationship intensity	The number of relationships between the firm and its suppliers (or customers), scaled by the total number of suppliers (or customers)
Major customer	Equals one if the firm reports a major customer with more than 10% of sales in the financial statements and zero otherwise.

Internet Appendix

Table IA.1
Redefining the change in receivables from quarter t-1 to quarter t+4

This table reports estimates of the effects of natural disasters on firms' receivables and payables. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (columns 1 to 3) and payables (columns 4 to 6), defined as the difference between the value in quarter *t+4* and *t-1*. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in receivables [2]	Change in receivables [3]	Change in payables [4]	Change in payables [5]	Change in payables [6]
Affected	0.024**	0.017*	0.018*	0.053**	0.053*	0.053*
	(0.011)	(0.010)	(0.010)	(0.027)	(0.028)	(0.028)
Size	0.002	-0.003	-0.005	0.001	0.001	0.004
	(0.006)	(0.006)	(0.006)	(0.019)	(0.019)	(0.020)
Leverage	-0.023	-0.026	-0.023	-0.113	-0.133	-0.165*
	(0.025)	(0.026)	(0.027)	(0.082)	(0.089)	(0.090)
Age	-0.017**	-0.012	-0.014*	0.037*	0.038	0.032
	(0.008)	(0.008)	(0.008)	(0.021)	(0.023)	(0.025)
Profit	0.127***	0.109**	0.111**	-0.243	-0.226	-0.226
	(0.048)	(0.050)	(0.050)	(0.192)	(0.198)	(0.199)
Firm FE	YES	YES	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES	YES	YES
State times Year FE	NO	YES	YES	NO	YES	YES
Industry times year FE	NO	NO	YES	NO	NO	YES
Observations	104,922	93,065	93,063	104,922	93,065	93,063
R-squared	0.128	0.139	0.149	0.122	0.128	0.139

Table IA.2
Long-term Effects

This table reports estimates of the effects of natural disasters on firms' receivables and payables two years after the shock. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (columns 1 and 2) and payables (columns 3 and 4) between quarter *t+8* and *t+4*. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in receivables [2]	Change in payables [3]	Change in payables [4]
Affected	-0.005	-0.005	-0.011	-0.012
	(0.008)	(0.008)	(0.021)	(0.021)
Size	-0.002	-0.003	0.014	0.010
	(0.005)	(0.005)	(0.016)	(0.016)
Leverage	-0.008	-0.008	0.003	-0.011
	(0.015)	(0.016)	(0.055)	(0.057)
Age	0.004	0.003	0.001	-0.002
	(0.007)	(0.007)	(0.021)	(0.022)
Profit	-0.107*	-0.131**	-0.016	0.036
	(0.057)	(0.058)	(0.156)	(0.155)
Firm FE	YES	YES	YES	YES
Year-quarter FE	YES	YES	YES	YES
State times year FE	YES	YES	YES	YES
Industry times year FE	NO	YES	NO	YES
Observations	82,615	82,611	82,701	82,697
R-squared	0.130	0.145	0.146	0.159

Table IA.3
Firms headquartered in counties near natural disasters

This table reports estimates of a placebo test using nearby counties. The unit of observation in each regression is a firm-quarter. The dependent variables are the changes in receivables (column 1) and payables (column 2), defined as the difference between the value in quarter *t+4* and *t*. The main independent variable is *Within 50 Affected,* which is an indicator variable that equals one if a firm is headquartered in a county that is located within 50 miles from one that is affected by a natural disaster in quarter *t* and zero otherwise. We exclude observations for firms headquartered in counties that are actually affected by a natural disaster. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]
Within 50 Affected	-0.005	-0.002
	(0.010)	(0.029)
Size	-0.015***	0.005
	(0.005)	(0.015)
Leverage	-0.025	-0.097
	(0.021)	(0.069)
Age	-0.006	0.008
	(0.006)	(0.020)
Profit	0.340***	-0.045
	(0.049)	(0.170)
Firm FE	YES	YES
Year-quarter FE	YES	YES
State times year FE	YES	YES
Industry times year FE	YES	YES
Observations	91,352	91,352
R-squared	0.134	0.139

Table IA.4
Firms experiencing multiple natural disasters

This table reports estimates of the effects of natural disasters on the receivables and payables of firms experiencing different frequencies of natural disasters. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (column 1) and payables (column 2), defined as the difference between the value in quarter *t+4* and *t*. *Above Median* is an indicator variable that equals one if the cumulative number of natural disasters in a county up to quarter *t* is above the sample median in year *t* and zero otherwise. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]
Affected	0.023*	0.072*
	(0.013)	(0.038)
Affected*above median	-0.004	0.011
	(0.016)	(0.043)
Size	-0.015***	-0.003
	(0.005)	(0.015)
Leverage	-0.022	-0.091
	(0.021)	(0.070)
Age	-0.006	0.010
	(0.007)	(0.021)
Profit	0.340***	-0.078
	(0.047)	(0.166)
	0.023*	0.072*
Firm FE	YES	YES
Year-quarter FE	YES	YES
State times year FE	YES	YES
Industry times year FE	YES	YES
Observations	93,702	93,702
R-squared	0.132	0.136

Table IA.5
Firms and geographic dispersion of operations

This table reports estimates of the effects of natural disasters on the receivables and payables of firms with different geographic dispersion of operations. The unit of observation in each regression is a firm-quarter. The dependent variables are changes in receivables (column 1) and payables (column 2), defined as the difference between the value in quarter *t+4* and *t*. *Number of states* indicates the number of states in which a firm operates. The main independent variable is $Affected$, which is an indicator variable that equals one if a firm is located in a county that is impacted by a natural disaster in quarter *t* and zero otherwise. Firm controls include size, leverage, age, and profitability. 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.

Variables	Change in receivables [1]	Change in payables [2]
Affected	0.030***	0.113***
	(0.011)	(0.037)
Number of states	0.001	0.002*
	(0.000)	-0.001
Affected*number of states	-0.001**	-0.003**
	(0.000)	(0.001)
Size	-0.016***	-0.005
	(0.005)	(0.015)
Leverage	-0.022	-0.092
	(0.021)	(0.070)
Age	-0.006	0.007
	(0.007)	(0.021)
Profit	0.342***	-0.074
	(0.047)	(0.166)
Firm FE	YES	YES
Year-quarter FE	YES	YES
State times year FE	YES	YES
Industry times year FE	YES	YES
Observations	93,702	93,702
R-squared	0.133	0.136