Online Appendix

Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks

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This Online Appendix includes the full derivation of the theoretical framework (Section A.1), supplementary tables including tests of parallel trends and variants of the baseline regression (Section A.2), a replication of our results using an alternative firm-level network structure obtained from Capital IQ (Section A.3), and a replication of our results at the industry and industry $\times$ state level (Section A.4).

A.1 Theoretical framework

To build intuition about the propagation of shocks in production networks, we start from a standard network model, the static version of the general equilibrium model in Long and Plosser (1983) analyzed by Acemoglu et al. (2012).[37] We model natural disaster disruptions as a destruction rate: a fraction τ of the output of the firm hit by a natural disaster is destroyed. This allows us to derive the pass-through of natural disaster shocks in the clearest fashion. However, considering natural disaster disruptions as negative Hicks-neutral productivity shocks would deliver the same pass-throughs. Throughout the Appendix, vectors and matrices are presented in bold. We denote the transpose of a matrix $\mathbf{X}$ by $\mathbf{X}'$, and the $N \times N$ identity matrix by $\mathbf{I}$.

A.1A. The model

The representative household is endowed with one unit of labor, supplied inelastically, and maximizes utility:

$$u(c_1, \dots, c_N) = \Big(\sum_{i=1}^{N} \beta_i^{\frac{1}{\theta}} c_i^{\frac{\theta-1}{\theta}} \Big)^{\frac{\theta}{\theta-1}}, \tag{A.1}$$

where c_i is the consumption of good $i \in \{1, 2, \dots, N\}$, θ is the elasticity of substitution across goods, and the weights $\beta_i \geq 0$ represent household tastes for the different goods. Without loss of generality, we normalize the sum of the β_i's to one, $\sum_{i=1}^{N} \beta_i = 1$. We also set the market wage to 1, without loss of generality.

Each good in the economy is produced by a competitive firm and can either be consumed or used by other firms as input for production. Each firm i produces output, denoted by y_i, with a constant-returns-to-scale CES technology:

$$y_i = (1 - \tau_i)\Big((1-\alpha)^{\frac{1}{\rho}} l_i^{\frac{\rho-1}{\rho}} + \alpha^{\frac{1}{\rho}} M_i^{\frac{\rho-1}{\rho}} \Big)^{\frac{\rho}{\rho-1}}, \tag{A.2}$$

y_i denotes output, τ_i is the destruction rate, l_i is the amount of labor hired by firm i, M_i is an index of intermediate inputs used in the production of good i, ρ is the elasticity of substitution between labor and intermediate inputs and α indicates the importance of intermediate inputs in production.

M_i is a CES aggregate with elasticity of substitution σ of the goods produced by firms in the economy and used as inputs by firm i:

$$M_i = \Big(\sum_{j=1}^{N} \omega_{ij}^{\frac{1}{\sigma}} x_{ij}^{\frac{\sigma-1}{\sigma}} \Big)^{\frac{\sigma}{\sigma-1}}, \tag{A.3}$$

[37] Note that we use a CES structure for both utility and production functions, whereas Acemoglu et al. (2012) consider the Cobb-Douglas case.

where x_{ij} is the quantity of each good j used in the production of good i and the parameters ω_{ij} indicate the importance of each input j in M_i. In particular, $\omega_{ij} = 0$ if firm i does not use good j as input for production. As we consider constant-returns-to-scale production functions, it must be the case that $\sum_{j=1}^{N} \omega_{ij} = 1$. The $N \times N$ matrix of ω_{ij}, denoted by $\mathbf{W}$, determines the network structure of this economy. We also define $\mathbf{H} \equiv (\mathbf{I} - \alpha\mathbf{W})^{-1}$ as the *Leontief inverse* of the input-output matrix $\mathbf{W}$, and denote its (i, j) entry by h_{ij}.

Our objective is to compare our reduced-form estimates with sales pass-throughs obtained in a calibrated network model. In Section A.1C, we first derive the competitive equilibrium of this economy in the absence of a natural disaster (that is, when τ_i is equal to 0 for all i). We then measure the propagation of shocks in the network when one firm, by convention firm s (s stands for shock), is hit by a natural disaster. For this, we provide a linear approximation around the equilibrium in the presence of a small increase in τ_s for firm s (while keeping $\tau_i = 0$ for all $i \neq s$). Proposition A.1 in Section A.1C provides the expression of the effect of a small increase in τ_s on the sales of any firm i for any network structure $\mathbf{W}$ and any preference weights β_i's. This allows us to compute the expression of sales pass-throughs for the network structure specified below as a function of the model's parameters.

Network structure. We consider an economy in which the position of each firm in the supply chain is well defined. The network consists of $L + 1$ layers of n firms in which firms located in layer $\tilde{L} \in \{1, \ldots, L\}$ use in equal proportion as inputs, goods produced by firms located in the layer upstream, $\tilde{L} - 1$. Denoting $\tilde{L}_i$ (respectively $\tilde{L}_j$), the layer of firm i (respectively firm j), the network is represented in matrix form by $\mathbf{W_V}$ (where V stands for vertical), whose entries (i, j) are such that:

for $i \in \{\tilde{L}_i = 0\}$, $\omega_{ij} = 1$ for $i = j$, and 0 otherwise

for $i \in \{\tilde{L}_i = 1, \ldots, L\}$, $\omega_{ij} = \frac{1}{n}$ for $j \in \{\tilde{L}_j = \tilde{L}_i - 1\}$, and 0 otherwise.

Firm s, which is hit by the shock, is assumed to be located in layer $\tilde{L} = 1$. The parameter L then provides a measure of the upstreamness of firm s.[38] Finally, we assume that each good produced by the $n \times (L + 1)$ firms of our economy have equal consumption value, i.e. $\beta_i = \frac{1}{n(L+1)}$ for all i.

In the following calibration exercise, we present the predicted value of: i) the dowstream sales pass-through, which is defined as $\frac{\hat{\text{SALE}}_{i\in\{\tilde{L}=2\}}}{\hat{\text{SALE}}_{s\in\{\tilde{L}=1\}}}$, ii) the horizontal pass-through, defined as $\frac{\hat{\text{SALE}}_{(i\neq s)\in\{\tilde{L}=1\}}}{\hat{\text{SALE}}_{s\in\{\tilde{L}=1\}}}$, and iii) the ratio of the horizontal over downstream pass-throughs, where $\hat{\text{SALE}}_i$ denote sales log deviations from the competitive equilibrium characterized in Section A.1C in the presence of a small increase in the destruction rate τ_s for firm s.[39]

[38] We have introduced layer $\tilde{L} = 0$ to ensure that firm s production function has the same structure than firms' production functions in any layer downstream.

[39] Sales are adjusted for inflation in our regressions. In our model, we thus measure firm i (real) sales by $\text{SALE}_i \equiv \frac{p_i y_i}{P}$, where p_i is the price of good i, and P, the consumer price index, is $P \equiv \left(\sum_{k=1}^{N} \beta_k p_k^{1-\theta}\right)^{\frac{1}{1-\theta}}$.

A.1B. Calibration exercise

This section presents the result of a simple calibration exercise where we use standard values for model parameters to infer sales pass-throughs. The model parameters are $(\alpha, \sigma, \rho, \theta, n, L)$. This exercise allows us to check that the reduced-form estimates obtained in the paper fall within the range of a reasonably calibrated network model.

Values for model parameters. We follow Acemoglu et al. (2012) and set the intermediate input share, α, to 0.55 and the elasticity of substitution between labor and intermediates, ρ, to 1. The existing empirical literature provides little guidance for the cross-firm elasticity demand, θ. We set it equal to $\theta = 2$, based on the estimates in Bernard et al. (2003) and Broda and Weinstein (2006). We set the number of firms per layer in our vertical network to $n = 10$, and the number of layers to $L = 3$. This falls within the range of upstreamness measures computed by Antràs et al. (2012) based on the U.S. input-output structure. Below, we discuss the sensitivity of predicted pass-throughs to these parameter values.

Pass-throughs and sensitivity analysis. Table A.1 shows the model predictions for the downstream and horizontal sales pass-throughs as well as the ratio between the horizontal and downstream pass-throughs. In Panel A, we present these predictions as a function of σ, the elasticity of substitution across intermediate inputs, for values ranging from 0 to 2.8. First, it is striking that both pass-throughs are decreasing with σ. The propagation of a shock is therefore largely conditioned by the degree of complementarity between intermediate inputs. The downstream pass-through decreases sharply with σ; for our baseline parameter values $(\alpha, \rho, \theta, n, L)$, the downstream pass-through equals 0.31 for $\sigma = 0$, but only 0.08 in the Cobb-Douglas case ($\sigma = 1$). As we prove formally in Proposition A.2 below, for any parameter values $(\alpha > 0, \rho, \theta, n > 1, L > 1)$, the downstream pass-through tends to 0 for arbitrarily large values of σ.

The horizontal pass-through is also sharply decreasing in σ: while it equals 0.46 for $\sigma = 0$, its value drops to 0.04 in the Cobb-Douglas case ($\sigma = 1$). Moreover, for sufficiently high values of σ, the horizontal pass-through becomes negative. Indeed, the negative shock to a given supplier can lead to an increase in sales of other suppliers in the same layer, when their common customers can more easily substitute across them. This is true for any parameter values $(\alpha > 0, \rho, \theta, n > 1, L > 1)$: we prove below that the horizontal pass-through becomes negative for arbitrarily large values of σ.

We then compare these pass-throughs to the ratio of the estimates we obtain from Table VI and XI, namely, a downstream pass-through close to $2\%/4\% = 0.5$, a horizontal pass-through close to $3.8\%/4\% = 0.95$, and a ratio of $0.95/0.5 = 1.9$. Our empirical estimates are comparable, yet slightly higher, to the predictions of the model for values of σ nearing 0, the Leontief limit, which are 0.3 (downstream pass-through), 0.5 (horizontal pass-through) and 1.5 (ratio between the two). Our reduced-form coefficients are therefore consistent with the predictions of a network model with high levels of complementarity across intermediate input suppliers.

In Panel B, we show the sensitivity of model predictions to parameter values, after setting σ to 0. Both pass-throughs are decreasing with θ. When θ is higher – goods are more substitutable –, a negative shock on firm s makes households willing to consume more of all the other goods, thereby reducing both the downstream and horizontal pass-throughs. Next, it appears that downstream propagation is fairly insensitive to the value of ρ, whereas horizontal propagation becomes stronger with higher values for ρ. This is consistent with the idea that when customers can more easily substitute labor for intermediate inputs, this increases the penalty to other suppliers. Third, pass-throughs increase slightly with the share of intermediate inputs in production, α, which is what one should expect given that the shock we consider affects intermediate input providers. Fourth, pass-throughs are decreasing with n, reflecting that each supplier represents a smaller share of total intermediate inputs when n is large. Conversely, pass-throughs increase with L: a larger number of downstream layers leads to additional negative downstream effects, which feedback upstream, thereby inflating pass-throughs.

Finally, note that the ratio of pass-throughs remains fairly stable across the parameter ranges we consider. In particular, it seems insensitive to the values chosen for α and n. This is a reassuring confirmation that the relative magnitudes of the downstream and horizontal propagation we document in reduced form are indeed consistent with the predictions of a network model with high levels of complementarity across intermediate input suppliers.

TABLE A.1

SALES PASS-THROUGH IN THE NETWORK MODEL

This table presents the downstream and horizontal pass-through predicted by the static general equilibrium network model, and where we have set the share of intermediate input in production to $\alpha = 0.55$, the elasticity of substitution between labor and intermediate inputs to $\rho = 1$, the cross-firm elasticity of demand to $\theta = 2$, the number of firms $n = 10$, and the number of layers to $L = 3$. The pass-through of supply disruptions to any given firm is computed as the ratio of its sales percentage drop to the disrupted supplier's sales percentage drop. We show the downstream pass-through, horizontal pass-through, as well as the ratio of horizontal over downstream pass-through. In Panel A, we present them as a function of the elasticity of substitution across intermediate inputs, σ, for values falling between 0 and 2.8. In Panel B, we show how the model predictions vary with parameter values, after setting σ to 0.

Calibrated Values

θ	ρ	α	n	L
2	1	0.55	10	3

Panel A: Sensitivity to σ

	σ														
	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2	2.4	2.6	2.8
Downstream	0.31	0.20	0.15	0.12	0.10	0.08	0.07	0.06	0.06	0.05	0.05	0.04	0.04	0.04	0.04
Horizontal	0.46	0.25	0.16	0.10	0.06	0.04	0.02	0.00	-0.01	-0.02	-0.03	-0.03	-0.04	-0.04	-0.05
Ratio	1.46	1.26	1.06	0.86	0.66	0.46	0.26	0.06	-0.14	-0.34	-0.54	-0.73	-0.93	-1.13	-1.33

Panel B: Sensitivity to other parameter values (for $\sigma = 0$)

	θ			ρ			α			n			L		
	2	2.5	3	0.5	1	1.5	0.5	0.55	0.6	10	20	30	2	3	4
Downstream	0.31	0.11	0.07	0.31	0.31	0.32	0.20	0.31	0.54	0.31	0.20	0.15	0.16	0.31	0.67
Horizontal	0.46	0.14	0.06	0.41	0.46	0.50	0.30	0.46	0.78	0.46	0.30	0.22	0.16	0.46	1.15
Ratio	1.46	1.19	0.92	1.31	1.46	1.57	1.46	1.46	1.45	1.46	1.46	1.46	1.00	1.46	1.72

A.1C. Proofs

We first describe the competitive equilibrium of this economy, and derive equilibrium prices and quantities in the absence of a natural disaster (that is, when τ_i is equal to 0 for all i). We then measure the propagation of shocks in the network when one firm, by convention firm s (s stands for shock), is hit by a natural disaster. For this, we provide a linear approximation around the equilibrium in the presence of a small increase in τ_s for firm s (while keeping $\tau_i = 0$ for all $i \neq s$). We use variables with hats, e.g. $\hat{p}_i$, to denote log deviation from the competitive equilibrium characterized above, that is $\left.\frac{\partial \hat{p}_i}{\partial \tau_s}\right|_{\tau_s=0}$. Proposition A.1 provides an expression for the effect of a natural disaster shock hitting firm s on the sales of any firm i for any network structure. Then, we apply Proposition A.1 for the network structure $\mathbf{W_V}$ specified above to derive the expression of pass-throughs used in our calibration exercise and sensitivity analysis. Finally, we prove that for any parameter values ($\alpha > 0, \rho, \alpha, n > 1, L > 1$), as σ tends to $+\infty$, the downstream pass-through tends to 0 and the horizontal pass-through tends to $-c$ with $c > 0$.

Competitive equilibrium. An equilibrium of this economy consists of prices $(p_1, p_2, \ldots, p_N)$, consumption bundle $(c_1, c_2, \ldots, c_N)$, and quantities $(l_i, y_i, (x_{ij}))$ such that: (i) the representative consumer maximizes her utility, (ii) each firm $i = 1, 2, \ldots, N$, maximizes profits, (iii) labor and goods markets clear, that is,

$$y_i = c_i + \sum_{j=1}^{N} x_{ji} \quad \forall i = 1, 2, \ldots, N, \tag{A.4}$$

$$\sum_{i=1}^{N} l_i = 1 \tag{A.5}$$

Firm i has profits:

$$\pi_i = p_i y_i - \sum_{j=1}^{N} p_j x_{ij} - l_i \tag{A.6}$$

The first-order conditions of firm i maximization problem with respect to l_i and x_{ij} yield:

$$x_{ij} = \alpha \omega_{ij} (1 - \tau_i)^{\rho - 1} \Big(\frac{p_i}{p_j}\Big)^{\sigma} \Big(\sum_{k=1}^{N} \omega_{ik} (\frac{p_i}{p_k})^{\sigma - 1}\Big)^{\frac{\rho - \sigma}{\sigma - 1}} y_i$$

$$l_i = (1 - \alpha)(1 - \tau_i)^{\rho - 1} p_i^{\rho} y_i$$

where the market wage is normalized to one, and p_j denotes the price of good j. Substituting these values into firm i production function implies:

$$(p_i(1-\tau_i))^{1-\rho} = 1-\alpha+\alpha\Big(\sum_{j=1}^{N}\omega_{ij}p_j^{1-\sigma}\Big)^{\frac{1-\rho}{1-\sigma}} \tag{A.7}$$

Utility maximization implies that household demand for good i is:

$$c_i = \beta_i p_i^{-\theta}\Big(\sum_{k=1}^{N}\beta_k p_k^{1-\theta}\Big)^{-1}$$

By plugging consumption level for good i, c_i, and input demands, x_{ij}'s, into the market clearing condition (A.4) for good i, we obtain:

$$y_i = \beta_i p_i^{-\theta}\Big(\sum_{k=1}^{N}\beta_k p_k^{1-\theta}\Big)^{-1} + \alpha p_i^{-\sigma}\sum_{j=1}^{N}\omega_{ji}(1-\tau_j)^{\rho-1}p_j^{\rho}\Big(\sum_{k=1}^{N}\omega_{jk}p_k^{1-\sigma}\Big)^{\frac{\rho-\sigma}{\sigma-1}}y_j \tag{A.8}$$

Equation (A.7) implies that in the absence of natural disasters ($\forall i\ \tau_i = 0$), equilibrium prices, p_i^*, equal 1 for all i. By plugging equilibrium prices into (A.8), we get:

$$\forall i, y_i - \alpha\sum_{j=1}^{N}\omega_{ji}y_j = \beta_i \tag{A.9}$$

Therefore, using the Leontief inverse $\mathbf{H}$, we find that output at equilibrium is such that:

$$\forall i,\ y_i = \sum_{k=1}^{N}\beta_k h_{ki} \tag{A.10}$$

Denoting firm i real sales by $\text{SALE}_i \equiv \frac{p_i y_i}{P}$, where $P \equiv \Big(\sum_{k=1}^{N}\beta_k p_k^{1-\theta}\Big)^{\frac{1}{1-\theta}}$ is the consumer price index, we also have at equilibrium when $\tau_i = 0$ for all i:

$$\forall i,\ \text{SALE}_i = \sum_{k=1}^{N}\beta_k h_{ki} \tag{A.11}$$

We provide in the following Proposition A.1 a linear approximation around the equilibrium in the presence of a small increase in τ_s for firm s (while keeping $\tau_i = 0$ for all $i \neq s$). We use lowercase variables with hats, e.g. $\hat{\text{SALE}}_i$, to denote log deviation from the competitive equilibrium characterized above, that is $\frac{\partial \hat{\text{SALE}}_i}{\partial \tau_s}\Big|_{\tau_s=0}$.

Propostion A.1 To a first-order approximation, the effect of a small increasing in τ_s on the sales of any firm i is given by:

(A.12)

$$\hat{\text{SALE}}_i = \sigma\Big(\frac{\sum_{k=1}^N \beta_k h_{ks} h_{ki}}{\sum_{k=1}^N \beta_k h_{ki}} + \frac{1-\alpha}{\alpha}\frac{\sum_{k=1}^N (\sum_{t=1}^N \beta_t h_{tk}) h_{ks} h_{ki}}{\sum_{k=1}^N \beta_k h_{ki}} - \frac{1}{\alpha}h_{is} - \frac{\sum_{k=1}^N \beta_k h_{ks}}{\alpha \sum_{k=1}^N \beta_k h_{ki}}(h_{si} - 1_{i=s})\Big)$$
$$+\theta\Big(\sum_{k=1}^N \beta_k h_{ks} - \frac{\sum_{k=1}^N \beta_k h_{ks} h_{ki}}{\sum_{k=1}^N \beta_k h_{ki}}\Big) + \rho\Big(\frac{1-\alpha}{\alpha}\Big)\Big(h_{is} - \frac{\sum_{k=1}^N (\sum_{t=1}^N \beta_t h_{tk}) h_{ks} h_{ki}}{\sum_{k=1}^N \beta_k h_{ki}} + \frac{\sum_{k=1}^N \beta_k h_{ks}}{\sum_{k=1}^N \beta_k h_{ki}}(h_{si} - 1_{i=s})\Big)$$
$$+h_{is} - 2\sum_{k=1}^N \beta_k h_{ks} + \frac{\sum_{k=1}^N \beta_k h_{ks}}{\sum_{k=1}^N \beta_k h_{ki}}(h_{si} - 1_{i=s})$$

Proof. Let $\mathbf{e_i}$ denote the column vector whose i^{th} element is equal to 1, and 0 otherwise; and $\hat{\mathbf{p}}$, the column vector whose i^{th} element is equal to $\hat{p}_i$. Log-linearizing (A.7) gives in matrix form:

$$\hat{\mathbf{p}} - \mathbf{e_s} = \alpha \mathbf{W} \hat{\mathbf{p}} \tag{A.13}$$

Rearranging yields $\hat{\mathbf{p}} = (\mathbf{I} - \alpha \mathbf{W})^{-\mathbf{1}} \mathbf{e_s} = \mathbf{H} \mathbf{e_s}$, that is:

$$\hat{p}_i = h_{is}, \ \forall i = 1, \ldots, N \tag{A.14}$$

Equation (A.8) for sales rewrites:

(A.15)

$$\text{SALE}_i = \beta_i p_i^{1-\theta}\Big(\sum_{k=1}^N \beta_k p_k^{1-\theta}\Big)^{-1-\frac{1}{1-\theta}} + \alpha p_i^{1-\sigma}\sum_{j=1}^N \omega_{ji}(1-\tau_j)^{\rho-1} p_j^{\rho-1}\Big(\sum_{k=1}^N \omega_{jk} p_k^{1-\sigma}\Big)^{\frac{\rho-\sigma}{\sigma-1}} \text{SALE}_j$$

Log-linearizing (A.15) gives:

(A.16)

$$(\sum_{k=1}^N \beta_k h_{ki})\hat{\text{SALE}}_i = (1-\theta)\beta_i \hat{p}_i + (\theta - 2)\beta_i \sum_{k=1}^N \beta_k \hat{p}_k + \alpha(1-\sigma)\hat{p}_i \sum_{j=1}^N \omega_{ji}(\sum_{k=1}^N \beta_k h_{kj})$$
$$+\alpha \sum_{j=1}^N \omega_{ji}(\sum_{k=1}^N \beta_k h_{kj})\hat{\text{SALE}}_j + \alpha(1-\rho)\omega_{si}\sum_{k=1}^N \beta_k h_{ks} + \alpha(\rho-1)\sum_{j=1}^N \omega_{ji}(\sum_{k=1}^N \beta_k h_{kj})\hat{p}_j$$
$$+\alpha(\sigma-\rho)\sum_{j=1}^N \omega_{ji}(\sum_{k=1}^N \beta_k h_{kj})\sum_{t=1}^N \omega_{jt}\hat{p}_t$$

The definition of the Leontief inverse $\mathbf{H}$ implies that:

$$\alpha \sum_{j=1}^{N} \omega_{ji} (\sum_{k=1}^{N} \beta_k h_{kj}) = \sum_{k=1}^{N} \beta_k h_{ki} - \beta_i \tag{A.17}$$

and:

$$\alpha \sum_{k=1}^{N} \omega_{jk} h_{ki} = h_{ji} \text{ if } j \neq i \text{ and } \alpha \sum_{k=1}^{N} \omega_{jk} h_{kj} = h_{jj} - 1 \text{ otherwise} \tag{A.18}$$

Using (A.14), (A.17) and (A.18), (A.16) can be rewritten as:

(A.19)

$$(\sum_{k=1}^{N} \beta_k h_{ki}) \hat{\text{SALE}}_i - \alpha \sum_{j=1}^{N} \omega_{ji} (\sum_{k=1}^{N} \beta_k h_{kj}) \hat{\text{SALE}}_j = (\sigma - \theta) \beta_i h_{is} + (1 - \sigma) \sum_{k=1}^{N} \beta_k h_{ki} h_{is}$$
$$+ (\theta - 2) \beta_i \sum_{k=1}^{N} \beta_k h_{ks} + \Big(\alpha(1-\rho) + \rho - \sigma\Big) \Big(\omega_{si} \sum_{k=1}^{N} \beta_k h_{ks} - \sum_{j=1}^{N} \omega_{ji} (\sum_{k=1}^{N} \beta_k h_{kj}) h_{js}\Big)$$

Using the Leontief inverse, (A.18) and rearranging, we find the following expression for $\hat{\text{SALE}}_i$:

$$\begin{aligned}(\sum_{k=1}^{N} \beta_k h_{ki}) \hat{\text{SALE}}_i &= (\sigma - \theta) \sum_{k=1}^{N} \beta_k h_{ks} h_{ki} + (\frac{1-\alpha}{\alpha})(\sigma - \rho) \sum_{k=1}^{N} (\sum_{t=1}^{N} \beta_t h_{tk}) h_{ks} h_{ki} \\ &+ (\theta - 2)(\sum_{k=1}^{N} \beta_k h_{ki})(\sum_{k=1}^{N} \beta_k h_{ks}) + (\alpha(1-\rho) + \rho - \sigma)(\sum_{k=1}^{N} \omega_{sk} h_{ki})(\sum_{k=1}^{N} \beta_k h_{ks}) \\ &+ (1 - \rho + \frac{\rho - \sigma}{\alpha})(\sum_{k=1}^{N} \beta_k h_{ki}) h_{is}\end{aligned} \tag{A.20}$$

Dividing by $(\sum_{k=1}^{N} \beta_k h_{ki})$, using (A.18) and rearranging lead to equation (A.12).

We now apply Proposition A.1 to the network structure and preference weights used in our calibration exercise. For this, we first compute the value of each element $h_{i,j}$ of the Leontief inverse associated to the matrix $\mathbf{W_V}$. Remember that the entries (i, j) of matrix $\mathbf{W_V}$ are such that:

for $i \in \{\tilde{L}_i = 0\}$, $\omega_{ij} = 1$ for $i = j$, and 0 otherwise

for $i \in \{\tilde{L}_i = 1, \dots, L\}$, $\omega_{ij} = \frac{1}{n}$ for $j \in \{\tilde{L}_j = \tilde{L}_i - 1\}$, and 0 otherwise.

where $\tilde{L}_i$ (respectively $\tilde{L}_j$) denotes firm i's (respectively firm j's) layer.

Simple computations yield that the elements $h_{i,j}$ of the associated Leontief inverse are such that:

for $i \in \{\tilde{L}_i = 0\}$, $h_{ij} = \frac{1}{1-\alpha}$ if $i = j$, and 0 otherwise,

for $i \in \{\tilde{L}_i = 1, \ldots, L\}$,

$h_{ij} = \frac{\alpha^{\tilde{L}_i}}{n(1-\alpha)}$ for $j \in \{\tilde{L}_j = 0\}$,
$h_{ij} = \frac{\alpha^{\tilde{L}_i - \tilde{L}_j}}{n}$ for $j \in \{0 < \tilde{L}_j < \tilde{L}_i\}$,
$h_{ij} = 1$ if $i = j$, and 0 otherwise, for $j \in \{\tilde{L}_j = \tilde{L}_i\}$,
$h_{ij} = 0$ for $j \in \{\tilde{L}_j > \tilde{L}_i\}$.

Using Proposition A.1 and the expression of the elements $h_{i,j}$ given above, we can show after some computations that:

(A.21)

$$\hat{\text{SALE}}_{s\in\{\tilde{L}=1\}} = \sigma\Big(\frac{1+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\sum_{i=0}^{L-1}\alpha^i + \frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i} - \frac{1}{\alpha}\Big)$$
$$+\theta\Big(\frac{1}{n(L+1)}\sum_{i=0}^{L-1}\alpha^i - \frac{1+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i}\Big) + \rho\Big(\frac{1-\alpha}{\alpha}\Big)\Big(1 - \frac{\sum_{i=0}^{L-1}\alpha^i + \frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i}\Big)$$
$$+1 - \frac{2}{n(L+1)}\sum_{i=0}^{L-1}\alpha^i$$

$$\hat{\text{SALE}}_{i\in\{\tilde{L}=2\}} = \sigma\Big(\frac{\frac{1}{\alpha n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-2}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\frac{1}{\alpha n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-2}\alpha^i} - \frac{1}{n}\Big)$$
$$+\theta\Big(\frac{1}{n(L+1)}\sum_{i=0}^{L-2}\alpha^i - \frac{\frac{1}{\alpha n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-2}\alpha^i}\Big) + \rho\Big(\frac{1-\alpha}{\alpha}\Big)\Big(\frac{\alpha}{n} - \frac{\frac{\alpha}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-2}\alpha^i}\Big) \tag{A.22}$$
$$+\frac{\alpha}{n} - \frac{2}{n(L+1)}\sum_{i=0}^{L-2}\alpha^i$$

(A.23)

$$\hat{\text{SALE}}_{(i\neq s)\in\{\tilde{L}=1\}} = \sigma\Big(\frac{\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i}\Big)$$
$$+\theta\Big(\frac{1}{n(L+1)}\sum_{i=0}^{L-1}\alpha^i - \frac{\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i}\Big) - \rho\Big(\frac{1-\alpha}{\alpha}\Big)\Big(\frac{1}{n}\frac{\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i}\Big) - \frac{2}{n(L+1)}\sum_{i=0}^{L-1}\alpha^i$$

(A.21), (A.22) and (A.23) allow us to compute the downstream sales pass-through and horizontal pass-through for any parameter values $(\alpha, \sigma, \rho, \theta, n, L)$.

PROPOSTION A.2 Consider the network $\mathbf{W_V}$ defined above, and that all goods have equal consumption value. Then, denoting the downstream sales pass-through, $\Lambda_{\text{DOWNSTREAM}} = \frac{\hat{\text{SALE}}_{i\in\{\tilde{L}=2\}}}{\hat{\text{SALE}}_{s\in\{\tilde{L}=1\}}}$, and the horizontal pass-through $\Lambda_{\text{HORIZONTAL}} = \frac{\hat{\text{SALE}}_{(i\neq s)\in\{\tilde{L}=1\}}}{\hat{\text{SALE}}_{i\in\{\tilde{L}=1\}}}$, we have for any set of parameters $(\alpha > 0, \rho, \theta, L > 1, n > 1)$:

- When $\sigma \to \infty$, $\Lambda_{\text{DOWNSTREAM}} \to 0$ and $\Lambda_{\text{HORIZONTAL}} \to -c$ with $c > 0$.

Proof. When $\sigma \to \infty$, we have:

$$\Lambda_{\text{DOWNSTREAM}} \to \frac{\frac{\frac{1}{\alpha n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-2}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\frac{1}{\alpha n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-2}\alpha^i} - \frac{1}{n}}{\frac{1+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\sum_{i=0}^{L-1}\alpha^i+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i} - \frac{1}{\alpha}} \tag{A.24}$$

After multiplying by $n\alpha^2\sum_{i=0}^{L-2}\alpha^i \neq 0$, the numerator of (A.24) can be rewritten as:

$$\alpha(\frac{\alpha^2-\alpha^{2L}}{1-\alpha^2}) + \frac{\alpha^2-\alpha^{2L}}{1-\alpha^2} - \frac{\alpha^{L+1}-\alpha^{2L}}{1-\alpha} - \alpha^2\frac{1-\alpha^{L-1}}{1-\alpha}$$

Observe that this expression simplifies to 0.

To complete the proof, let us show that the denominator of (A.24) is different from 0 for all $n > 1$. Observe that for $n = 1$, the denominator of (A.24) can be rewritten after multiplying by $\sum_{i=0}^{L-1}\alpha^i \neq 0$ as:

$$\frac{1-\alpha^{2L}}{1-\alpha^2} + \frac{1}{\alpha}(\frac{\alpha^2-\alpha^{2L}}{1-\alpha^2} - \frac{\alpha^{L+1}-\alpha^{2L}}{1-\alpha}) - \frac{1-\alpha^L}{1-\alpha}$$

It is easy to show that this expression is equal to 0. As the denominator of (A.24) is decreasing in n (strictly for $n > 1$), it is then strictly negative for all $n > 1$.

When $\sigma \to \infty$, we have:

$$\Lambda_{\text{HORIZONTAL}} \to \frac{\frac{\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i}}{\frac{1+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i}{\sum_{i=0}^{L-1}\alpha^i} + \frac{1-\alpha}{\alpha}\frac{\sum_{i=0}^{L-1}\alpha^i+\frac{1}{n}\sum_{i=1}^{L-1}(\alpha^2)^i\sum_{j=0}^{L-1-i}\alpha^j}{\sum_{i=0}^{L-1}\alpha^i} - \frac{1}{\alpha}} \tag{A.25}$$

We have already shown that the denominator of (A.25) is strictly negative for all $n > 1$. To complete the proof, let us show that the numerator of (A.25) is strictly positive. After multiplying by $n\alpha\sum_{i=0}^{L-1}\alpha^i \neq 0$, the numerator of (A.25) can be rewritten as:

$$\alpha(\frac{\alpha^2-\alpha^{2L}}{1-\alpha^2}) + \frac{\alpha^2-\alpha^{2L}}{1-\alpha^2} - \frac{\alpha^{L+1}-\alpha^{2L}}{1-\alpha}$$

This expression simplifies to:

$$\frac{\alpha^2 - \alpha^{L+1}}{1 - \alpha}$$

which is strictly positive for $L > 1$.

A.2 Robustness tests

TABLE A.2

Test of Parallel Trends

Customer sample	F-tests on fixed effects for Year Quarter×__						
	Size	Age	ROA	Nb Suppliers	Eventually Treated	N	Adj R^2
Sales Growth					0.92 (0.6144, 40)	22021	0.28
Sales Growth	2.91 (<0.0001, 82)				0.93 (0.5909, 40)	22021	0.30
Sales Growth	2.86 (<0.0001, 82)	1.85 (<0.0001, 75)			0.98 (0.5075, 40)	22021	0.30
Sales Growth	2.92 (<0.0001, 82)		1.31 (0.0357, 82)		0.99 (0.4920, 40)	22021	0.30
Sales Growth	2.85 (<0.0001, 82)			1.47 (0.0099, 63)	0.98 (0.5032, 40)	22021	0.30
Sales Growth	2.76 (<0.0001, 82)	1.76 (<0.0001, 75)	1.25 (0.0669, 82)	1.51 (0.0066, 63)	1.04 (0.4105, 40)	22021	0.30

Notes. This table reports the results of F-tests for the joint significance of fixed effects in regressions of firms' sales growth in our customer sample, over year-quarters for which no major natural disaster has hit the U.S. territory in the current or previous four quarters. All specifications include year-quarter fixed effects, fiscal-quarter fixed effects, firm fixed effects, terciles of the number of suppliers, the full set of year-quarter fixed effects interacted with a dummy which equals one for eventually treated firms, and standard errors clustered at the firm level. Rows (2) to (6) also include the full set of year-quarter fixed effects interacted with terciles of firm size. Rows (3) and (6) also include the full set of year-quarter fixed effects interacted with terciles of firm age. Rows (4) and (6) also include the full set of year-quarter fixed effects interacted with terciles of firm return on assets. Rows (5) and (6) also include the full set of year-quarter fixed effects interacted with terciles of the number of suppliers. Each cell reports for groups of fixed effects the value of the F-statistic and, in parentheses, the p-value, and number of constraints. The sample period is from 1978 to 2013.

TABLE A.3

DOWNSTREAM PROPAGATION – EVENTUALLY TREATED CUSTOMERS

	Sales Growth $(t-4,t)$			
Disaster hits one supplier (t-4)	-0.037***	-0.033***	-0.030***	-0.019**
	(0.009)	(0.009)	(0.009)	(0.009)
Disaster hits firm (t-4)	-0.016	-0.018	-0.003	0.002
	(0.015)	(0.015)	(0.013)	(0.013)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	31051	31051	31051	31051
R^2	0.175	0.231	0.310	0.396

Notes. This table presents a variant of the regressions in Table V where the sample is restricted to eventually treated customers. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.4

Downstream Propagation – Heterogeneous Trends

	Sales Growth $(t-4,t)$			
Disaster hits one supplier (t-4)	-0.030***	-0.027***	-0.029***	-0.019**
	(0.009)	(0.009)	(0.009)	(0.009)
Disaster hits firm (t-4)	-0.030***	-0.028***	-0.005	-0.002
	(0.011)	(0.011)	(0.009)	(0.009)
Number of Suppliers × Year-Quarter FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	80574	80574	80574	80574
R^2	0.237	0.263	0.302	0.344

Notes. This table presents variants of the regressions in Table V. Regressions include year-quarter fixed effects interacted with terciles of the number of firms' suppliers. In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.5

Downstream Propagation – Additional Robustness Tests

	Sales Growth $(t-4, t)$			
Disaster hits one supplier (t-4) × Large nb of affected firms	0.002	0.017		
	(0.021)	(0.021)		
Disaster hits one supplier (t-4) × $>50\%$ sales abroad			0.002	-0.001
			(0.020)	(0.019)
Disaster hits one supplier (t-4)	-0.031***	-0.029***	-0.031***	-0.027***
	(0.009)	(0.009)	(0.010)	(0.009)
Disaster hits firm (t-4)	-0.031***	-0.030***	-0.031***	-0.029***
	(0.011)	(0.011)	(0.011)	(0.011)
$>50\%$ sales abroad			-0.003	0.001
			(0.013)	(0.012)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	80574	80574	80574	80574
R^2	0.234	0.262	0.234	0.262

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether (at least) one of their suppliers is hit by a major disaster in the same quarter of the previous year. *Large nb of affected firms* is a dummy equal to one for disasters that lie in the top half of the distribution of the number of directly affected Compustat firms. $>50\%$ *sales abroad* is a dummy that equals one if the firm reports sales abroad that represent more than 50% of its total sales in the two years prior to any given quarter. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) and (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Standard errors presented in parentheses are clustered at the firm-level. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.6

Downstream Propagation – Industry Concentration

	Sales Growth $(t-4,t)$					
Disaster hits one supplier (t-4)	-0.019*	-0.014	-0.032***	-0.025***	-0.028***	-0.023**
	(0.011)	(0.011)	(0.010)	(0.009)	(0.010)	(0.009)
Disaster hits one supplier (t-4) × > 10% supplier's SIC4 industry sales	-0.028*	-0.032**				
	(0.015)	(0.015)				
Disaster hits one supplier (t-4) × > 30% supplier's SIC4 industry sales			0.003	-0.008		
			(0.017)	(0.016)		
Disaster hits one supplier (t-4) × > 50% supplier's SIC4 industry sales					-0.016	-0.021
					(0.018)	(0.018)
Disaster hits firm (t-4)	-0.031***	-0.029***	-0.031***	-0.029***	-0.031***	-0.030***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Number of Suppliers	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes	No	Yes
	Mean	SD	Median	p75	p90	p95
% supplier's SIC4 industry sales hit	19%	24.7%	7.8%	27%	57%	73%
Observations	80574	80574	80574	80574	80574	80574
R^2	0.234	0.262	0.234	0.262	0.234	0.262

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether (at least) one supplier is hit in the same quarter of the previous year. This dummy is interacted with dummies indicating whether more than 10% (columns (1) and (2)), 30% (columns (3) and (4)), and 50% (columns (5) and (6)) of the supplier's industry is hit in this quarter. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter in the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2), (4), and (6), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.7

Downstream Propagation – Varying Distance

	Sales Growth $(t-4, t)$									
	0 miles		100 miles		200 miles		400 miles		500 miles	
Disaster hits one supplier (t-4)	-0.038***	-0.033***	-0.034***	-0.030***	-0.030***	-0.026***	-0.032***	-0.029***	-0.031***	-0.027***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.009)	(0.009)	(0.009)	(0.009)
Disaster hits firm (t-4)	-0.026**	-0.025**	-0.030***	-0.028***	-0.030***	-0.029***	-0.032***	-0.030***	-0.032***	-0.030***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Number of Suppliers	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
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
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Observations	80574	80574	80574	80574	80574	80574	80574	80574	80574	80574
R^2	0.234	0.262	0.234	0.262	0.234	0.262	0.234	0.262	0.234	0.261

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether (at least) one of their suppliers is hit by a major disaster in the same quarter of the previous year. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions control for the number of suppliers (dummies indicating terciles of the number of suppliers). The sample is restricted to relationships where the supplier-customer distance is larger than 0 miles (columns (1) and (2)), 100 miles (columns (3) and (4)), 200 miles (columns (5) and (6)), 400 miles (columns (7) and (8)), and 500 miles (columns (9) and (10)). In columns (2), (4), (6), (8) and (10) we also control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.8

Downstream Propagation – Never Jointly Hit Relationships

	Sales Growth $(t-4, t)$			
Disaster hits one supplier (t-4)	-0.035***	-0.029***	-0.032***	-0.022**
	(0.009)	(0.009)	(0.009)	(0.009)
Disaster hits firm (t-4)	-0.033***	-0.031***	-0.007	-0.004
	(0.011)	(0.011)	(0.009)	(0.009)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	80574	80574	80574	80574
R^2	0.234	0.262	0.300	0.342

Notes. This table presents variants of the regressions in Table V where we only consider treatments when the customer and the supplier are never jointly hit in the same quarter during the sample period. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.9

Downstream Propagation – Controlling for Linkages

	Sales Growth $(t-4, t)$					
Disaster hits one supplier (t-4)	-0.032***	-0.028***	-0.030***	-0.027***	-0.030***	-0.026***
	(0.009)	(0.008)	(0.009)	(0.008)	(0.009)	(0.008)
Disaster hits firm (t-4)	-0.003	0.001	-0.016	-0.014	-0.024*	-0.022*
	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)
Disaster hits more than 10% SIC4 customer's industry sales (t-4)	-0.023***	-0.027***				
	(0.009)	(0.009)				
Disaster hits more than 10% of employment located within 300 miles (t-4)	-0.036***	-0.038***				
	(0.010)	(0.010)				
Disaster hits more than 30% SIC4 customer's industry sales (t-4)			-0.034***	-0.035***		
			(0.012)	(0.012)		
Disaster hits more than 30% of employment located within 300 miles (t-4)			-0.010	-0.011		
			(0.012)	(0.012)		
Disaster hits more than 50% SIC4 customer's industry sales (t-4)					-0.050***	-0.049***
					(0.017)	(0.016)
Disaster hits more than 50% of employment located within 300 miles (t-4)					0.021	0.023
					(0.019)	(0.018)
Number of Suppliers	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes	No	Yes
Observations	80574	80574	80574	80574	80574	80574
R^2	0.234	0.262	0.234	0.262	0.234	0.262

Notes. This table presents variants of the regressions in Table V, controlling for whether more than 10% (columns (1) and (2)), 30% (columns (3) and (4)), and 50% (columns (5) and (6)) of the customer's industry is hit in the same quarter of the previous year, and whether more than 10% (columns (1) and (2)), 30% (columns (3) and (4)), and 50% (columns (5) and (6)) of total employment within a distance of 300 miles around the firm's headquarters is hit in the same quarter of the previous year. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2), (4), and (6), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.10

Downstream Propagation – Size-Weighted Regressions

	Sales Growth $(t-4, t)$	
Disaster hits one supplier (t-4)	-0.022**	-0.020**
	(0.010)	(0.008)
Disaster hits firm (t-4)	-0.024*	-0.022**
	(0.013)	(0.011)
Number of Suppliers	Yes	Yes
Firm FE	Yes	Yes
Year-Quarter FE	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes
Observations	80160	80160
R^2	0.154	0.213

Notes. This table presents size-weighted variants of the regressions in Table V, using customer sales (adjusted for inflation) as weights. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). All regressions include fiscal-quarter, year-quarter, and firm fixed effects. In column (2), we also control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.11

Downstream Propagation – Alternative Dependent Variable

	Δ Ln(Sales) $(t-4, t)$			
Disaster hits one supplier (t-4)	-0.028***	-0.024***	-0.026***	-0.015**
	(0.008)	(0.008)	(0.008)	(0.007)
Disaster hits firm (t-4)	-0.038***	-0.035***	-0.014	-0.011
	(0.011)	(0.011)	(0.010)	(0.010)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	80496	80496	80496	80496
R^2	0.188	0.212	0.250	0.297

Notes. This table presents variants of the regressions in Table V, using the difference in the logarithm of sales as an alternative definition of the dependent variable. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.12

Sample Composition

Panel A:	Customer and Supplier Samples					
	Supplier Sample		Customer Sample		All Compustat	
48FF Industry	N	%	N	%	N	%
Agriculture	400	(0.3%)	109	(0.1%)	2039	(0.3%)
Food Products	2513	(1.8%)	1538	(1.9%)	10324	(1.7%)
Candy & Soda	281	(0.2%)	162	(0.2%)	1196	(0.2%)
Beer & Liquor	126	(0.1%)	461	(0.6%)	2019	(0.3%)
Tobacco Products	82	(0.1%)	111	(0.1%)	773	(0.1%)
Recreation	1906	(1.4%)	602	(0.7%)	5972	(1.0%)
Entertainment	1017	(0.7%)	932	(1.2%)	11713	(1.9%)
Printing and Publishing	611	(0.4%)	1023	(1.3%)	6087	(1.0%)
Consumer Goods	3279	(2.3%)	1797	(2.2%)	12096	(1.9%)
Apparel	2975	(2.1%)	697	(0.9%)	7489	(1.2%)
Healthcare	487	(0.3%)	1092	(1.4%)	12467	(2.0%)
Medical Equipment	4442	(3.2%)	2035	(2.5%)	22601	(3.6%)
Pharmaceutical Products	11009	(7.9%)	5130	(6.4%)	36739	(5.9%)
Chemicals	2221	(1.6%)	2810	(3.5%)	12568	(2.0%)
Rubber and Plastic Products	2221	(1.6%)	287	(0.4%)	6944	(1.1%)
Textiles	1589	(1.1%)	255	(0.3%)	4507	(0.7%)
Construction Materials	2822	(2.0%)	1284	(1.6%)	14661	(2.4%)
Construction	1173	(0.8%)	600	(0.7%)	8602	(1.4%)
Steel Works	2592	(1.9%)	1521	(1.9%)	10255	(1.6%)
Fabricated Products	630	(0.5%)	73	(0.1%)	2857	(0.5%)
Machinery	5541	(4.0%)	2158	(2.7%)	22056	(3.5%)
Electrical Equipment	2499	(1.8%)	1131	(1.4%)	10154	(1.6%)
Automobiles and Trucks	3690	(2.6%)	1784	(2.2%)	9175	(1.5%)
Aircraft	1403	(1.0%)	1065	(1.3%)	3562	(0.6%)
Shipbuilding, Railroad Equipment	285	(0.2%)	240	(0.3%)	1598	(0.3%)
Defense	253	(0.2%)	309	(0.4%)	1187	(0.2%)
Precious Metals	302	(0.2%)	68	(0.1%)	4805	(0.8%)
Non-Metallic and Industrial Metal Mining	320	(0.2%)	119	(0.1%)	3915	(0.6%)
Coal	534	(0.4%)	44	(0.1%)	1465	(0.2%)
Petroleum and Natural Gas	12276	(8.8%)	6528	(8.1%)	36826	(5.9%)
Utilities	5505	(3.9%)	9398	(11.7%)	44510	(7.1%)
Communication	5799	(4.1%)	3439	(4.3%)	24557	(3.9%)
Personal Services	722	(0.5%)	497	(0.6%)	6705	(1.1%)
Business Services	15651	(11.2%)	4631	(5.7%)	74593	(12.0%)
Computers	9677	(6.9%)	4508	(5.6%)	29459	(4.7%)
Electronic Equipment	16144	(11.5%)	6299	(7.8%)	37938	(6.1%)
Measuring and Control Equipment	4074	(2.9%)	1493	(1.9%)	15236	(2.4%)
Business Supplies	1519	(1.1%)	1734	(2.2%)	9120	(1.5%)
Shipping Containers	553	(0.4%)	446	(0.6%)	2281	(0.4%)
Transportation	3776	(2.7%)	3220	(4.0%)	20200	(3.2%)
Wholesale	4634	(3.3%)	4492	(5.6%)	27102	(4.4%)
Retail	852	(0.6%)	2682	(3.3%)	19147	(3.1%)
Restaraunts, Hotels, Motels	166	(0.1%)	913	(1.1%)	13102	(2.1%)
Almost Nothing	1425	(1.0%)	857	(1.1%)	12240	(2.0%)
Total	139976		80574		622842	

TABLE A.12 (continued)

Panel B:	Treated vs. Unaffected							
	Supplier Sample				Customer Sample			
	Hit		Unaffected		Treated		Unaffected	
48FF Industry	N	%	N	%	N	%	N	%
Agriculture	5	(0.2%)	395	(0.3%)	0	(0.0%)	109	(0.1%)
Food Products	52	(2.3%)	2461	(1.8%)	7	(0.6%)	1531	(1.9%)
Candy & Soda	5	(0.2%)	276	(0.2%)	1	(0.1%)	161	(0.2%)
Beer & Liquor	2	(0.1%)	124	(0.1%)	15	(1.3%)	446	(0.6%)
Tobacco Products	0	(0.0%)	82	(0.1%)	2	(0.2%)	109	(0.1%)
Recreation	34	(1.5%)	1872	(1.4%)	3	(0.3%)	599	(0.8%)
Entertainment	12	(0.5%)	1005	(0.7%)	6	(0.5%)	926	(1.2%)
Printing and Publishing	14	(0.6%)	597	(0.4%)	15	(1.3%)	1008	(1.3%)
Consumer Goods	67	(2.9%)	3212	(2.3%)	27	(2.4%)	1770	(2.2%)
Apparel	34	(1.5%)	2941	(2.1%)	9	(0.8%)	688	(0.9%)
Healthcare	10	(0.4%)	477	(0.3%)	13	(1.1%)	1079	(1.4%)
Medical Equipment	74	(3.2%)	4368	(3.2%)	20	(1.8%)	2015	(2.5%)
Pharmaceutical Products	249	(10.8%)	10760	(7.8%)	85	(7.5%)	5045	(6.4%)
Chemicals	32	(1.4%)	2189	(1.6%)	37	(3.2%)	2773	(3.5%)
Rubber and Plastic Products	58	(2.5%)	2163	(1.6%)	0	(0.0%)	287	(0.4%)
Textiles	28	(1.2%)	1561	(1.1%)	1	(0.1%)	254	(0.3%)
Construction Materials	39	(1.7%)	2783	(2.0%)	4	(0.4%)	1280	(1.6%)
Construction	22	(1.0%)	1151	(0.8%)	3	(0.3%)	597	(0.8%)
Steel Works	32	(1.4%)	2560	(1.9%)	9	(0.8%)	1512	(1.9%)
Fabricated Products	9	(0.4%)	621	(0.5%)	0	(0.0%)	73	(0.1%)
Machinery	83	(3.6%)	5458	(4.0%)	26	(2.3%)	2132	(2.7%)
Electrical Equipment	46	(2.0%)	2453	(1.8%)	6	(0.5%)	1125	(1.4%)
Automobiles and Trucks	39	(1.7%)	3651	(2.7%)	62	(5.4%)	1722	(2.2%)
Aircraft	33	(1.4%)	1370	(1.0%)	33	(2.9%)	1032	(1.3%)
Shipbuilding, Railroad Equipment	13	(0.6%)	272	(0.2%)	7	(0.6%)	233	(0.3%)
Defense	5	(0.2%)	248	(0.2%)	16	(1.4%)	293	(0.4%)
Precious Metals	1	(0.0%)	301	(0.2%)	0	(0.0%)	68	(0.1%)
Non-Metallic and Industrial Metal Mining	4	(0.2%)	316	(0.2%)	0	(0.0%)	119	(0.1%)
Coal	5	(0.2%)	529	(0.4%)	0	(0.0%)	44	(0.1%)
Petroleum and Natural Gas	197	(8.5%)	12079	(8.8%)	97	(8.5%)	6431	(8.1%)
Utilities	93	(4.0%)	5412	(3.9%)	85	(7.5%)	9313	(11.7%)
Communication	72	(3.1%)	5727	(4.2%)	125	(11.0%)	3314	(4.2%)
Personal Services	14	(0.6%)	708	(0.5%)	4	(0.4%)	493	(0.6%)
Business Services	275	(11.9%)	15376	(11.2%)	55	(4.8%)	4576	(5.8%)
Computers	137	(5.9%)	9540	(6.9%)	63	(5.5%)	4445	(5.6%)
Electronic Equipment	196	(8.5%)	15948	(11.6%)	96	(8.4%)	6203	(7.8%)
Measuring and Control Equipment	61	(2.6%)	4013	(2.9%)	9	(0.8%)	1484	(1.9%)
Business Supplies	32	(1.4%)	1487	(1.1%)	16	(1.4%)	1718	(2.2%)
Shipping Containers	10	(0.4%)	543	(0.4%)	0	(0.0%)	446	(0.6%)
Transportation	78	(3.4%)	3698	(2.7%)	43	(3.8%)	3177	(4.0%)
Wholesale	92	(4.0%)	4542	(3.3%)	71	(6.2%)	4421	(5.6%)
Retail	16	(0.7%)	836	(0.6%)	48	(4.2%)	2634	(3.3%)
Restaraunts, Hotels, Motels	0	(0.0%)	166	(0.1%)	11	(1.0%)	902	(1.1%)
Almost Nothing	30	(1.3%)	1395	(1.0%)	9	(0.8%)	848	(1.1%)
Total	2310	(100.0%)	137666	(100.0%)	1139	(100.0%)	79435	(100.0%)

Notes. This table presents the industry distribution of firm-quarter observations. Panel A presents the industry distribution of firms in the supplier sample, in the customer sample, and in Compustat. In Panel B, firms in the supplier sample are categorized as "Hit" if the county where their headquarters is located is hit by a natural disaster in a given quarter, and "Unaffected" otherwise. Firms in the customer sample are categorized as "Treated" if at least one of the firm's suppliers is located in a county hit by a natural disaster, and "Unaffected" otherwise.

TABLE A.13

Natural Disaster Disruptions - High versus Low Inventory Suppliers

	Sales Growth $(t-4,t)$			
	High inventory		Low inventory	
Disaster hits firm (t)	-0.015	-0.015	-0.003	0.001
	(0.019)	(0.020)	(0.031)	(0.031)
Disaster hits firm (t-1)	-0.029	-0.030	-0.059**	-0.056**
	(0.020)	(0.019)	(0.025)	(0.025)
Disaster hits firm (t-2)	-0.055**	-0.052**	-0.014	-0.011
	(0.021)	(0.021)	(0.032)	(0.031)
Disaster hits firm (t-3)	-0.033	-0.031	-0.046	-0.038
	(0.023)	(0.023)	(0.033)	(0.033)
Disaster hits firm (t-4)	-0.027	-0.025	-0.040	-0.026
	(0.023)	(0.024)	(0.032)	(0.032)
Disaster hits firm (t-5)	-0.005	-0.000	-0.017	-0.009
	(0.026)	(0.026)	(0.032)	(0.033)
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	65991	65991	72316	72316
R^2	0.224	0.242	0.223	0.238

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicated whether the firm is hit by a major disaster in the current and each of the previous five quarters. In columns (1) and (2), the regression is run on firms' whose ratio of inventories to sales lies above the median in their 2-digit industry three years prior to a given quarter. In columns (3) and (4), the regression is run on firms' whose ratio of inventories to sales lies below the median in their 2-digit industry three years prior to a given quarter. Columns (2) to (4) control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Standard errors presented in parentheses are clustered at the firm-level. Regressions contain firm-quarters of our supplier sample (described in Table II, Panel B) between 1978 and 2013. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.14

Downstream Propagation – High versus Low Inventory Suppliers

	Sales Growth $(t-4, t)$			
Disaster hits high inventory supplier (t)	-0.002	-0.004	0.000	0.001
	(0.012)	(0.012)	(0.012)	(0.011)
Disaster hits high inventory supplier (t-1)	0.004	0.003	0.008	0.010
	(0.010)	(0.010)	(0.011)	(0.011)
Disaster hits high inventory supplier (t-2)	-0.012	-0.012	-0.012	-0.008
	(0.010)	(0.010)	(0.011)	(0.011)
Disaster hits high inventory supplier (t-3)	-0.015	-0.013	-0.013	-0.007
	(0.011)	(0.011)	(0.011)	(0.012)
Disaster hits high inventory supplier (t-4)	-0.023**	-0.019**	-0.021**	-0.019*
	(0.009)	(0.009)	(0.010)	(0.011)
Disaster hits high inventory supplier (t-5)	-0.025**	-0.023**	-0.023*	-0.025**
	(0.012)	(0.012)	(0.012)	(0.012)
Disaster hits low inventory supplier (t)	-0.013	-0.005	-0.004	0.001
	(0.012)	(0.011)	(0.011)	(0.011)
Disaster hits low inventory supplier (t-1)	-0.015	-0.012	-0.013	-0.004
	(0.012)	(0.012)	(0.012)	(0.013)
Disaster hits low inventory supplier (t-2)	-0.009	-0.003	-0.005	0.009
	(0.012)	(0.012)	(0.013)	(0.013)
Disaster hits low inventory supplier (t-3)	-0.026**	-0.020*	-0.024*	-0.009
	(0.012)	(0.012)	(0.013)	(0.013)
Disaster hits low inventory supplier (t-4)	-0.024**	-0.020*	-0.027**	-0.014
	(0.012)	(0.011)	(0.012)	(0.012)
Disaster hits low inventory supplier (t-5)	-0.003	-0.001	-0.006	0.005
	(0.013)	(0.013)	(0.014)	(0.014)
Disaster hits firm (t)	0.015	0.016	0.015	0.011
	(0.012)	(0.011)	(0.012)	(0.012)
Disaster hits firm (t-1)	-0.002	-0.003	0.001	-0.002
	(0.011)	(0.010)	(0.011)	(0.012)
Disaster hits firm (t-2)	-0.023**	-0.022**	-0.002	0.002
	(0.011)	(0.011)	(0.013)	(0.013)
Disaster hits firm (t-3)	-0.042***	-0.043***	-0.022*	-0.016
	(0.011)	(0.011)	(0.013)	(0.013)
Disaster hits firm (t-4)	-0.034***	-0.032***	-0.010	-0.006
	(0.012)	(0.011)	(0.013)	(0.013)
Disaster hits firm (t-5)	-0.026**	-0.027**	-0.010	-0.006
	(0.012)	(0.012)	(0.012)	(0.012)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	80574	80574	80574	80574
R^2	0.234	0.262	0.300	0.342

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on dummies indicating whether (at least) one high-inventory supplier and whether (at least) one low-inventory supplier is hit by a major disaster in the previous five quarters. A supplier is considered as *high inventory* if its ratio of inventory to sales is above the sample median. All regressions include dummies indicating whether the firm itself is hit by a major disaster the five previous quarters as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.15

DOWNSTREAM PROPAGATION – RISKY COUNTIES

	Sales Growth $(t-4,t)$			
Disaster hits one supplier in a low-risk county (t-4)	-0.033***	-0.031***	-0.029***	-0.027**
	(0.011)	(0.011)	(0.011)	(0.011)
Disaster hits one supplier in a high-risk county (t-4)	-0.022**	-0.016	-0.022**	-0.007
	(0.011)	(0.011)	(0.011)	(0.010)
Disaster hits firm (t-4)	-0.031***	-0.029***	-0.005	-0.003
	(0.011)	(0.011)	(0.009)	(0.009)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	80574	80574	80574	80574
R^2	0.234	0.262	0.300	0.342

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether (at least) one of their suppliers is hit by a major disaster in the same quarter of the previous year. A county is considered as risky if it is hit at least four times over the sample period. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. In columns (3) and (4), we include state dummies interacted with year dummies. In column (4), we include 48 Fama-French industry dummies interacted with year dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.16

Downstream Propagation – Capacity Utilization

	Panel A: PPE and Employment growth			
	PPE growth $(t-4,t)$		Emp growth $(t-4,t)$	
Disaster hits one supplier (t)	-0.004	-0.003	-0.006	-0.005
	(0.009)	(0.009)	(0.006)	(0.006)
Disaster hits one supplier (t-1)	-0.001	-0.002	-0.011**	-0.008
	(0.009)	(0.009)	(0.006)	(0.006)
Disaster hits one supplier (t-2)	-0.006	-0.004	-0.009	-0.008
	(0.009)	(0.009)	(0.006)	(0.006)
Disaster hits one supplier (t-3)	-0.014	-0.010	-0.014**	-0.012**
	(0.009)	(0.009)	(0.006)	(0.006)
Disaster hits one supplier (t-4)	-0.011	-0.006	-0.013**	-0.011*
	(0.009)	(0.009)	(0.006)	(0.006)
Disaster hits one supplier (t-5)	-0.008	-0.001	-0.006	-0.003
	(0.010)	(0.010)	(0.007)	(0.007)
Disaster hits firm (t)	0.020*	0.020*	0.003	0.003
	(0.011)	(0.011)	(0.007)	(0.007)
Disaster hits firm (t-1)	0.011	0.011	-0.002	-0.001
	(0.011)	(0.011)	(0.007)	(0.007)
Disaster hits firm (t-2)	0.016	0.016	-0.003	-0.003
	(0.012)	(0.012)	(0.007)	(0.007)
Disaster hits firm (t-3)	0.007	0.006	-0.008	-0.008
	(0.011)	(0.011)	(0.007)	(0.007)
Disaster hits firm (t-4)	0.000	0.000	-0.008	-0.009
	(0.011)	(0.011)	(0.007)	(0.007)
Disaster hits firm (t-5)	0.006	0.006	-0.002	-0.001
	(0.011)	(0.011)	(0.007)	(0.007)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	79954	79954	79107	79107
R^2	0.262	0.304	0.253	0.289

TABLE A.16 (continued)

	Panel B: Change in log capacity utilization			
	Δ Log (Sales/PPE)		Δ Log (Sales/Emp)	
Disaster hits one supplier (t)	-0.009	-0.010	-0.006	-0.005
	(0.008)	(0.009)	(0.008)	(0.008)
Disaster hits one supplier (t-1)	-0.015	-0.017*	-0.002	-0.006
	(0.009)	(0.010)	(0.008)	(0.009)
Disaster hits one supplier (t-2)	-0.013	-0.013	-0.008	-0.007
	(0.009)	(0.009)	(0.009)	(0.009)
Disaster hits one supplier (t-3)	-0.018**	-0.019**	-0.016**	-0.017**
	(0.008)	(0.009)	(0.008)	(0.008)
Disaster hits one supplier (t-4)	-0.021**	-0.021**	-0.018**	-0.018**
	(0.009)	(0.009)	(0.007)	(0.008)
Disaster hits one supplier (t-5)	-0.008	-0.009	-0.007	-0.006
	(0.011)	(0.011)	(0.009)	(0.010)
Disaster hits firm (t)	-0.010	-0.009	0.000	0.000
	(0.012)	(0.012)	(0.010)	(0.010)
Disaster hits firm (t-1)	-0.019	-0.020*	-0.011	-0.013
	(0.011)	(0.011)	(0.010)	(0.010)
Disaster hits firm (t-2)	-0.040***	-0.039***	-0.025**	-0.024**
	(0.012)	(0.012)	(0.011)	(0.011)
Disaster hits firm (t-3)	-0.049***	-0.048***	-0.031***	-0.031***
	(0.013)	(0.013)	(0.011)	(0.011)
Disaster hits firm (t-4)	-0.038***	-0.037***	-0.037***	-0.033***
	(0.013)	(0.013)	(0.012)	(0.012)
Disaster hits firm (t-5)	-0.031**	-0.031**	-0.026**	-0.025**
	(0.013)	(0.013)	(0.013)	(0.013)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	79448	79448	77979	77979
R^2	0.128	0.144	0.108	0.118

Notes. This table presents estimates from panel regressions of firms' growth of property, plants and equipment (PPE) and employment growth (Panel A), and change in the log sales to PPE and log sales to employees (Panel B) on a dummy indicating whether (at least) one supplier is hit by a major disaster in the same quarter of the previous year. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter in the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) and (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. Regressions contain all firm-quarters of our customer sample (described in Table II, Panel A) between 1978 and 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

A.3 Alternative network structure

This section studies the implications of sample selection for our results. The supplier-customer data is built from regulation SFAS No. 131, which requires firms to report selected information about operating segments in interim financial reports issued to shareholders. In particular, firms are required to disclose certain financial information for any industry segment that comprises more than 10% of consolidated yearly sales, assets, or profits, and the identity of any customer representing more than 10% of the total reported sales. As a result, a supplier-customer link is only observed for publicly listed suppliers and customers, provided that the supplier's sales to the customer amount to more than 10% of their sales. We are thus likely to observe links where the supplier is small and the customer is large. Given that our main interest lies in the reaction of customers, the fact that we are missing some of their suppliers introduces noise, which is likely to bias the results against finding any sort of propagation. Nonetheless, we go one step further to ensure that this selection issue is not driving the results.

We start by comparing the network characteristics of our main sample to the Japanese supplier-customer network exploited by Carvalho, Nirei and Saito (2014) and Bernard, Moxnes and Saito (2014), which is the only other detailed firm-to-firm network structure that has been studied so far, to the best of our knowledge. This Japanese network is built from Tokyo Shoko Research, a credit report agency. In order to obtain credit reports on potential suppliers and customers or when attempting to qualify as a supplier, firms provide the list of their 24 most important suppliers and customers. The sample used in Bernard, Moxnes and Saito (2014) includes close to 3.8 million relationships. The average and median in-degrees are 4.9 and 2, while the average and median out-degrees are 5.6 and 1. The estimated Pareto shape parameter is -1.32 for the in-degree distribution and -1.50 for the out-degree distribution. In our main sample, the average and median in-degrees are 6 and 1, and the average and median out-degrees are 2.8 and 2, and we estimate the Pareto shape parameter to be -1.25 for the in-degree distribution and -1.44 for the out-degree distribution. Hence overall, our network structure does not dramatically differ from the Japanese sample, with the exception of the average out-degree, which is apparent from Figure A.3.

Next, we replicate our results using an alternative network structure that is less prone to the selection issues highlighted. We build it from Capital IQ, a subsidiary of Standards and Poor's. Capital IQ collects firm-to-firm supplier-customer relationships from various sources including press reports and publicly listed firms' financial statements. As a result, the coverage of Capital IQ is wider than our main sample. We observe links between firms of all size, and between publicly listed and privately held firms. This allows us not only to check that our results hold in this alternative sample but also whether there is any difference in the intensity of propagation when the supplier that is hit is privately held rather than publicly listed. The main drawback of this data set is that we only observe a cross-section of these links, and that there is uncertainty as to when any relationship in this data was formed or broken.

Our Capital IQ sample includes a little over 120,000 firm-to-firm relationships, with

38,032 distinct customers and 29,830 suppliers. This is much larger than the main sample used in the paper, which includes 21,528 relationships, with 3,556 distinct customers and 7,674 distinct suppliers between 1978 and 2013. We compare the distribution of customer and supplier size in three samples: the Compustat universe, firms in our main sample ("SFAS" firms), and firms in the Capital IQ universe. In Figure A.1, we start by comparing the distribution of supplier size in 2013, namely the log of sales (Panel A) and the log of assets (Panel B). We note that the distribution of both SFAS suppliers and Capital IQ suppliers is very close to the distribution of firm size in the Compustat universe. This suggests that the SFAS 10% threshold does not lead to a selection of suppliers based on size in the main sample used in the paper. In Figure A.2, we then consider the distribution of customer size in 2013. It is striking from both panels that the size distribution of SFAS customers is tilted to the right, with a much higher mean. This is the reflection of the fact that SFAS customers are only reported if they represent more than 10% of the sales of one of their publicly listed suppliers. By contrast, the distribution of Capital IQ customers is very close to the distribution of Compustat firms. Hence, running our analysis on the sample of Capital IQ customers allows us to check that our main results are not biased by the selection of SFAS customers within the Compustat universe.

We then go one step further and compare our main sample with the sample obtained from Capital IQ along a number of usual network metrics, and in particular the distribution of in- and out-degrees, namely, the distribution of the number of suppliers and the number of customers per firm, respectively. In Panel A of Figure A.3, we plot the cumulative distribution of out-degrees for (i) SFAS firms, (ii) Capital IQ firms with public customers, and (iii) all Capital IQ firms. Given that SFAS firms only report customers that represent more than 10% of their sales, it is not surprising that the maximum out-degree is only slightly above ten.[40] Consequently, the distribution of out-degrees of Capital IQ firms lies to the right of the distribution of the out-degrees of SFAS firms. A similar picture emerges from the analysis of Panel B, which plots the distribution of in-degrees in the same three samples.

We now turn to the analysis of the direct and indirect effect of natural disasters on firms' sales growth, using the network structure obtained from Capital IQ and restricting the sample period to 2009-2013. In columns (1) and (2) of Table A.17, we run our baseline regression of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether at least one of its suppliers is hit in one of the four previous quarters as well as a dummy indicating whether the firm itself is hit in one of the previous quarters. Both regressions include year-quarter and firm fixed effects as well as controls for the number of suppliers. In the specification presented in column (2), we also include firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. The coefficients are negative and significant and range between -0.04 and -0.045. This is somewhat higher than our baseline estimates, but this compares well with the estimates we obtain in unreported tests when running the same regression in our main sample restricted to 2009-2013, which range from -0.035 to -0.039. In columns (1) and (2) of Panel B of Table A.17, we analyze horizontal propagation in the Capital IQ

[40] As mentioned above, some firms voluntarily report customers that represent less than 10% of their sales.

universe, namely, the effect on firms' sales growth of disruptions affecting their customers' other suppliers. We estimate that these disruptions lead to a drop in sales growth by 2.7%, which is close to the estimates obtained in our main sample. Overall, these findings indicate that the downstream and horizontal propagation we document in our main sample are not biased by the selection of SFAS customers within the Compustat universe.

One limitation of our main sample is that, by construction, it only includes publicly listed suppliers and their publicly listed customers. One concern is that propagation might be different in the universe of privately held firms. Although we show below that our results go through when we consider the input-output tables or the commodity flow survey that comprise both publicly listed and privately held firms, we can also use the richness of the Capital IQ to test this more directly. We first present in Table A.18 the distribution of publicly listed and private suppliers in the sample across Fama-French industries. Overall, these distributions are similar, with some exceptions like Communication, Electronic Equipment, Measuring and Control Equipment, and Utilities that comprise a larger share of publicly listed than private firms, or Construction and Retail that comprise more private firms. We next formally test whether propagation differs significantly across listing status. In columns (3) and (4) of Table A.17, Panel A, we complement the main variable of interest, namely, the dummy indicating whether at least one supplier is hit by a natural disaster, with a dummy indicating whether at least one publicly listed supplier is hit. The coefficient on this additional variable is insignificant, which indicates that the downstream propagation is similar for publicly listed and private suppliers. We then ask whether horizontal propagation between suppliers of a given customer depends on whether the customer itself is publicly listed or privately held. In columns (3) and (4) of Table A.17, Panel B, we complement our main variable, a dummy indicating whether one of the firm's customers' suppliers is hit by a natural disaster in the four previous quarters, with a dummy indicating whether (at least) one of the firm's publicly listed customers' suppliers is hit. The coefficient on this interaction term is positive but insignificant, which confirms that our estimates of horizontal propagation are not restricted to publicly listed firms only. Taken together, these analyses suggest that the restriction of our main sample to publicly listed firms cannot in itself explain the results.

We also use the richness of the data to explore downstream propagation further, to firms' customer's customers. We cannot run this analysis using our main sample due to the lack of observations: given that a customer is only reported when it accounts for more than 10% of the sales of one of their suppliers, there are almost no cases where we observe a firm's suppliers' suppliers. We can, however, run this analysis using the Capital IQ sample. In Table A.19, we augment our baseline specification with a dummy indicating whether at least one suppliers' supplier is hit by a natural disaster in the previous four quarters. The coefficient on this additional dummy is negative but insignificant. Hence, these findings point to an attenuation of downstream propagation beyond the first supplier-customer relationship.

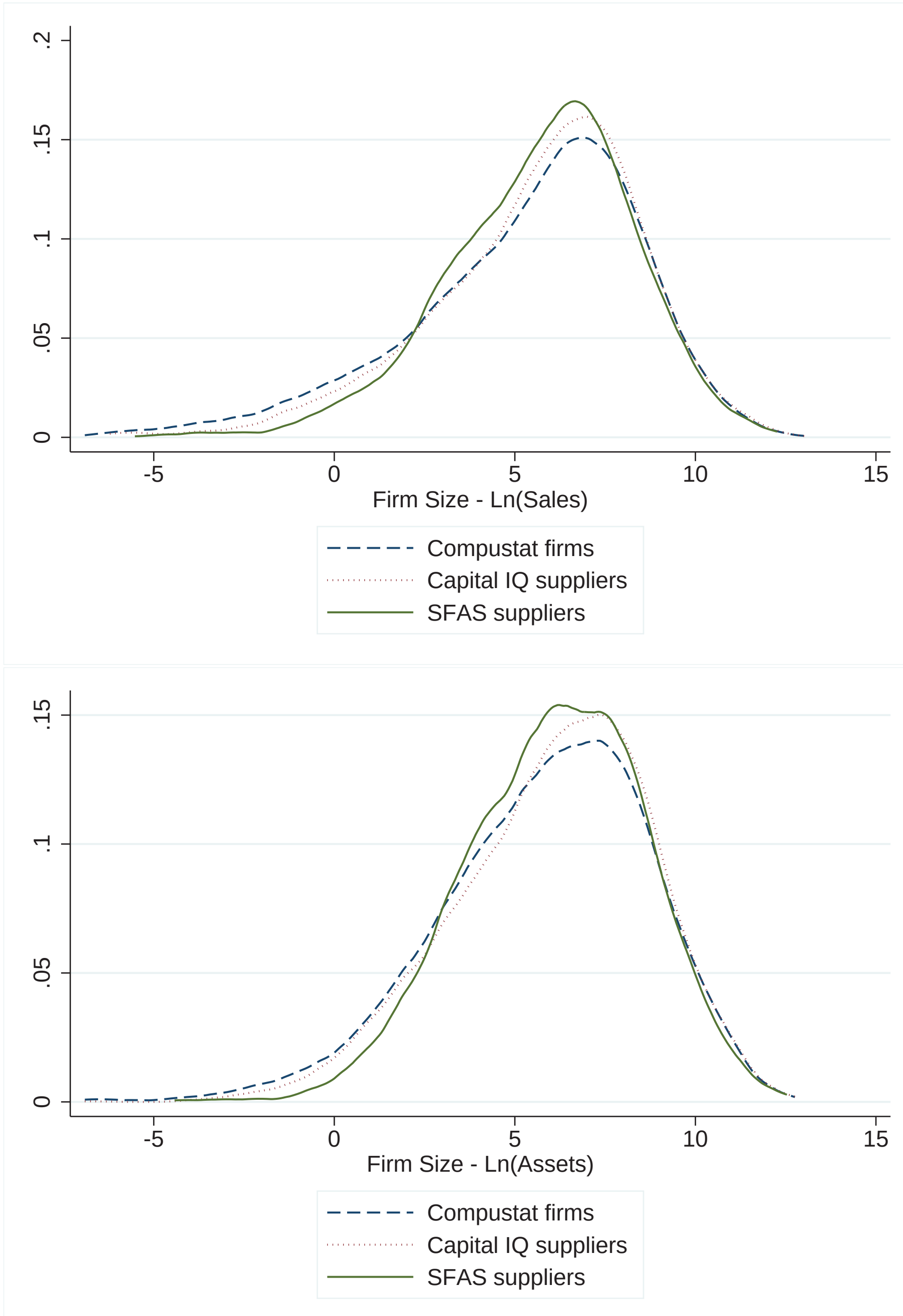
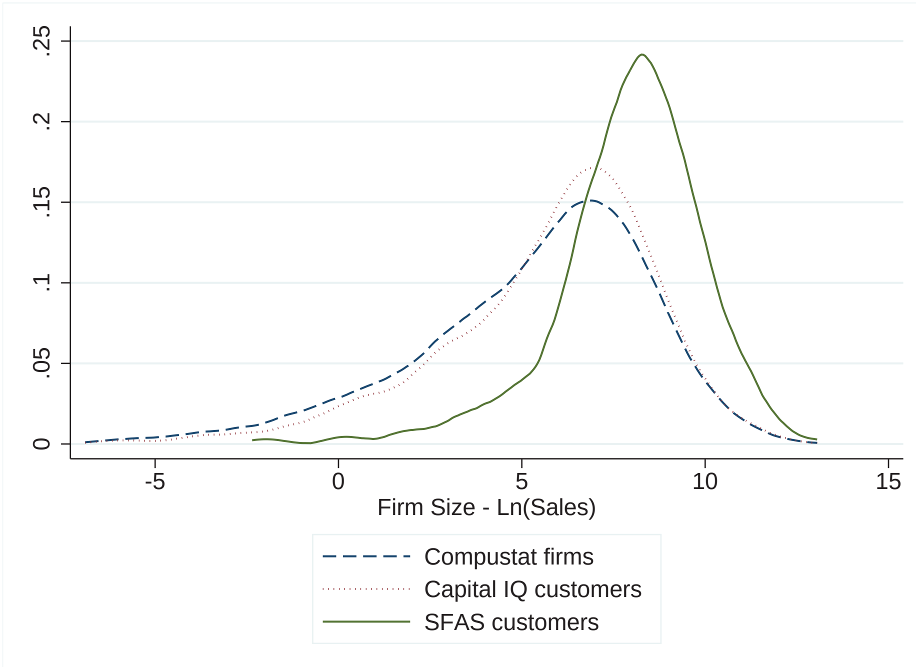


FIGURE A.1
Supplier Size Distribution

Notes. This figure presents the distribution of suppliers' sales (Panel A) and assets (Panel B) across three groups of firms in 2013: "SFAS" firms, which are the suppliers in our main sample, Capital IQ firms with public customers, and all Compustat firms.



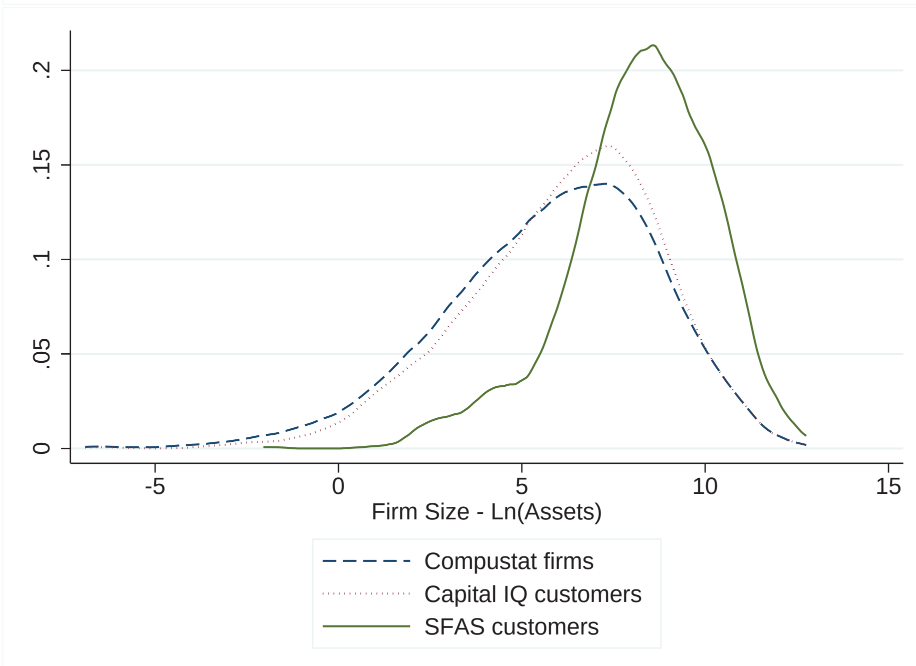


FIGURE A.2
Customer Size Distribution

Notes. This figure presents the distribution of customers' sales (Panel A) and assets (Panel B) across three groups of firms in 2013: "SFAS" firms, which are the customers in our main sample, Capital IQ customers, and all Compustat firms.

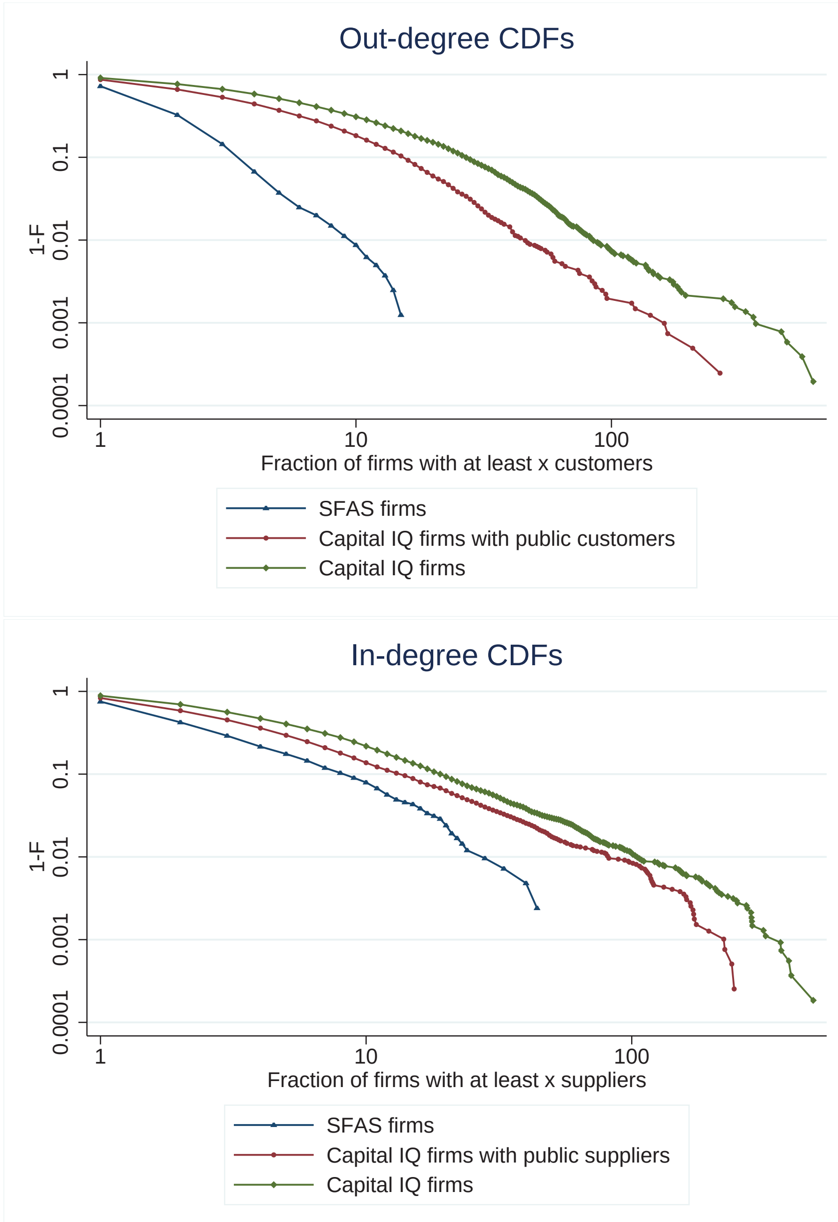


FIGURE A.3

Distribution of Out-degrees and In-degrees

Notes. This figure presents the in- and out-degrees of firms in the network of firms obtained from the main sample in 2013, which we compare to Capital IQ. Panel A presents the cumulative distribution functions (CDFs) of the out-degrees of three groups of firms: "SFAS" firms which are the suppliers in our main sample, Capital IQ firms with public customers, and all Capital IQ firms. Panel B presents the CDFs of the in-degrees of three groups of firms: "SFAS" firms, which are the customers in our main sample, Capital IQ firms with public suppliers, and all Capital IQ firms.

TABLE A.17

Alternative Network Structure - Capital IQ

	Sales Growth $(t-4,t)$			
	Panel A: Downstream propagation			
Disaster hits one supplier (t-1,t-4)	-0.040***	-0.045***	-0.035**	-0.037**
	(0.013)	(0.013)	(0.017)	(0.017)
Disaster hits one public supplier (t-1,t-4)			-0.009	-0.017
			(0.017)	(0.016)
Disaster hits firm (t-1,t-4)	-0.038**	-0.035**	-0.038**	-0.036**
	(0.015)	(0.015)	(0.015)	(0.015)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	42908	42908	42908	42908
R^2	0.262	0.267	0.262	0.267
	Panel B: Horizontal propagation			
Disaster hits one customer's supplier (t-1,t-4)	-0.027**	-0.027**	-0.032*	-0.032*
	(0.013)	(0.013)	(0.018)	(0.018)
Disaster hits one public customer's supplier (t-1,t-4)			0.007	0.007
			(0.019)	(0.019)
Disaster hits one customer (t-1,t-4)	-0.008	-0.009	-0.005	-0.003
	(0.012)	(0.012)	(0.017)	(0.018)
Disaster firm (t-1,t-4)	-0.028**	-0.025**	-0.028**	-0.025**
	(0.013)	(0.013)	(0.013)	(0.013)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	41807	41807	41807	41807
R^2	0.283	0.288	0.283	0.288

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on a dummy indicating whether (at least) one of their suppliers is hit by a major disaster in the four previous quarters. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. The sample period is 2009 to 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

TABLE A.18

Capital IQ: Distribution of Suppliers across Industries

48 FF Industry	Capital IQ & Private		Capital IQ & Public	
Agriculture	60	(0.24%)	19	(0.37%)
Food Products	217	(0.88%)	79	(1.54%)
Candy & Soda	73	(0.30%)	26	(0.51%)
Beer & Liquor	50	(0.20%)	16	(0.31%)
Tobacco Products	11	(0.04%)	6	(0.12%)
Recreation	162	(0.66%)	48	(0.94%)
Entertainment	239	(0.97%)	69	(1.35%)
Printing and Publishing	211	(0.85%)	39	(0.76%)
Consumer Goods	212	(0.86%)	78	(1.52%)
Apparel	140	(0.57%)	64	(1.25%)
Healthcare	246	(1.00%)	76	(1.48%)
Medical Equipment	339	(1.37%)	230	(4.49%)
Pharmaceutical Products	407	(1.65%)	400	(7.81%)
Chemicals	306	(1.24%)	136	(2.66%)
Rubber and Plastic Products	173	(0.70%)	50	(0.98%)
Textiles	71	(0.29%)	17	(0.33%)
Construction Materials	212	(0.86%)	68	(1.33%)
Construction	534	(2.16%)	46	(0.90%)
Steel Works	148	(0.60%)	56	(1.09%)
Fabricated Products	79	(0.32%)	8	(0.16%)
Machinery	362	(1.46%)	163	(3.18%)
Electrical Equipment	245	(0.99%)	95	(1.86%)
Automobiles and Trucks	66	(0.27%)	56	(1.09%)
Aircraft	187	(0.76%)	93	(1.82%)
Shipbuilding, Railroad Equipment	123	(0.50%)	28	(0.55%)
Defense	38	(0.15%)	10	(0.20%)
Precious Metals	29	(0.12%)	14	(0.27%)
Non-Metallic and Industrial Metal Mining	13	(0.05%)	13	(0.25%)
Coal	46	(0.19%)	20	(0.39%)
Petroleum and Natural Gas	47	(0.19%)	18	(0.35%)
Utilities	366	(1.48%)	314	(6.13%)
Communication	462	(1.87%)	278	(5.43%)
Personal Services	666	(2.70%)	191	(3.73%)
Business Services	303	(1.23%)	29	(0.57%)
Computers	4547	(18.40%)	943	(18.42%)
Electronic Equipment	570	(2.31%)	236	(4.61%)
Measuring and Control Equipment	615	(2.49%)	385	(7.52%)
Business Supplies	194	(0.79%)	122	(2.38%)
Shipping Containers	79	(0.32%)	44	(0.86%)
Transportation	40	(0.16%)	12	(0.23%)
Wholesale	417	(1.69%)	129	(2.52%)
Retail	1779	(7.20%)	160	(3.13%)
Restaraunts, Hotels, Motels	484	(1.96%)	152	(2.97%)
Almost Nothing	106	(0.43%)	55	(1.07%)
Total	24710		5120	

Notes. This table presents the distribution of public and private suppliers obtained from Capital IQ across 48 Fama-French industries.

TABLE A.19

Capital IQ - Downstreamness

	Sales Growth $(t-4,t)$			
Disaster hits one supplier's supplier (t-1,t-4)	-0.003	-0.008		
	(0.015)	(0.015)		
Disaster hits one supplier's supplier (t)			0.002	0.000
			(0.012)	(0.012)
Disaster hits one supplier's supplier (t-1)			0.000	-0.004
			(0.013)	(0.013)
Disaster hits one supplier's supplier (t-2)			0.000	-0.006
			(0.013)	(0.013)
Disaster hits one supplier's supplier (t-3)			-0.013	-0.021
			(0.014)	(0.014)
Disaster hits one supplier's supplier (t-4)			-0.020	-0.012
			(0.015)	(0.014)
Disaster hits one supplier's supplier (t-5)			0.001	0.004
			(0.013)	(0.013)
Disaster hits one supplier (t-1,t-4)	-0.035***	-0.040***	-0.034***	-0.038***
	(0.012)	(0.012)	(0.012)	(0.012)
Disaster hits firm (t-1,t-4)	-0.037**	-0.035**	-0.038**	-0.035**
	(0.015)	(0.015)	(0.015)	(0.015)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA × Year-Quarter FE	No	Yes	No	Yes
Observations	42908	42908	42908	42908
R^2	0.262	0.267	0.262	0.267

Notes. This table presents estimates from panel regressions of firms' sales growth relative to the same quarter in the previous year on dummies indicating whether (at least) one of their customers is hit by a major disaster in the current and five previous quarters. All regressions include a dummy indicating whether the firm itself is hit by a major disaster in the same quarter of the previous year as well as fiscal-quarter, year-quarter, and firm fixed effects. All regressions also control for the number of suppliers (dummies indicating terciles of the number of suppliers). In columns (2) to (4), we control for firm-level characteristics (dummies indicating terciles of size, age, and ROA respectively) interacted with year-quarter dummies. The sample period is 2009 to 2013. Standard errors presented in parentheses are clustered at the firm-level. *, **, and *** denote significance at the 10%, 5%, and 1%, respectively.

A.4 Industry level results

A.4A. Index of industrial production

We study the direct and indirect effect of natural disasters on 6-digit industry output growth, following Foerster, Sarte and Watson (2011). Relationships between industries are obtained by using the 2007 U.S. Input-Output Table produced by the BEA, disaggregated into 388 NAICS sectors. The main advantage of using this network structure rather than the main source used in the paper is that it covers the entire economy. In particular, it is not restricted to any declaration threshold. It comprises both publicly listed and privately held firms. Its main drawback is that relationships are observed at the sector level, and that we only observe a cross-section of these links.

Sector-level real output growth is given by the Federal Reserve Board's Index of Industrial Production (IP), a quarterly index of real output disaggregated into 233 NAICS manufacturing sectors. We use the County Business Pattern data from the U.S. Census Bureau to obtain the number of employees per 6-digit NAICS×county×year. In each quarter, we compute the proportion of employees in a given sector located in counties that are hit by a natural disaster. We then run similar regressions as those we ran on firm-level data by considering in turn shocks that affect counties where more than 40%, 50%, 60%, 70% ,and 80% of employees in a given 6-digit NAICS industry are located. We present the results in Table A.20. The baseline specification shown in Panel A indicates that when a disaster affects areas comprising more than 60%, 70%, or 80% of employees in a given 6-digit sector, this leads to a drop by 1 to 3.5 percentage points in real output growth. In addition, the indirect effect of natural disasters through upstream sectors ranges from -0.9 to -1.6 percentage points. In Panel B, we further split the explanatory variables into specific and non-specific sectors, using the classification in Rauch (1999). We find that the propagation from upstream to downstream sectors is only observed when specific upstream sectors are hit.

While our main analysis focuses on sales growth, which combines price and quantities, these findings confirm that natural disasters have both direct and indirect effects on real output growth. This also suggests that our estimates are not the mechanical outcome of the selected nature of our main sample.

TABLE A.20

Index of Industrial Production

	Panel A: Baseline Output Growth $(t-4, t)$				
Cutoff (% of 6-digit industry employment hit)	40%	50%	60%	70%	80%
Disaster hits upstream industry (t-4,t-1)	-0.003	-0.002	-0.009*	-0.015***	-0.016***
	(0.007)	(0.007)	(0.005)	(0.005)	(0.006)
Disaster hits industry (t-4,t-1)	0.010	0.009	-0.009	-0.018*	-0.035***
	(0.014)	(0.017)	(0.016)	(0.009)	(0.012)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	18837	18837	18837	18837	18837
R^2	0.222	0.222	0.222	0.222	0.223

	Panel B: Specificity Output Growth $(t-4, t)$				
Cutoff (% of 6-digit industry employment hit)	40%	50%	60%	70%	80%
Disaster hits specific upstream industry (t-4,t-1)	-0.004	-0.003	-0.019**	-0.018**	-0.021**
	(0.008)	(0.007)	(0.008)	(0.008)	(0.009)
Disaster hits non-specific upstream industry (t-4,t-1)	-0.002	-0.002	0.005	0.006	0.007
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)
Disaster hits industry (t-4,t-1)	-0.039***	-0.039***	-0.037***	-0.037***	-0.037***
	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Industry FE	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	18837	18837	18837	18837	18837
R^2	0.222	0.222	0.223	0.223	0.223

Notes. This table presents estimates from panel regressions of the 6-digit industry real output growth relative to the same quarter in the previous year on a dummy indicating whether at least one of the upstream industries of the indsutry is hit by a natural disaster in the previous four quarters. All regressions include a dummy indicating whether the industry itself is hit by a major disaster in the previous four quarters as well as year-quarter and industry fixed effects. In columns (1) to (5), a 6-digit sector is considered to be hit in a given quarter if more than 40, 50, 60, 70, or 80% of employees in this sector are located in counties that are hit by a disaster in this quarter. Panel A presents the baseline regression. Panel B splits industries into specific and non-specific industries. An industry is considered as specific if it lies above the median of the share of differentiated goods according to the classification provided by Rauch (1999). The sample period is 1978 to 2013. Standard errors presented in parentheses are clustered at the sector level. *, **, and *** denote significance at the 10, 5, and 1%, respectively.

A.4B. State $\times$ industry real GDP growth

We then study the direct and indirect effect of natural disasters on real GDP growth at the state $\times$ 2-digit NAICS level using the Commodity Flow Survey (CFS). The CFS, undertaken through a partnership between the Census Bureau and the Bureau of Transportation Statistics (BTS) is conducted every five years (years ending in "2" and "7") as part of the Economic Census. The CFS produces data on the movement of goods in the United States. It provides information on commodities shipped, their value, weight, and mode of transportation as well as the origin and destination of shipments of commodities from manufacturing, mining, wholesale, and selected retail and services establishments. We use the publicly available version of the 2007 CFS to track where each U.S. State sources the 42 commodities covered by the survey. As is the case with the Input-Output Table, the main advantage of using this network structure, rather than the main source used in the paper, is that it covers the entire economy, is not restricted to any declaration threshold, and comprises both publicly listed and privately held firms. In addition, it is more precise than the Input-Output Table, given that it includes relationships across regions. Moreover, while the analysis of real output growth conducted in Table A.20 only covers manufacturing, we consider the real GDP growth of all sectors here. As is the case with the Input-Output Table, the main drawback of this data is that relationships are not observed at the firm level, and that we only observe a cross-section of these links.

Quarterly real GDP growth at the state $\times$ 2-digit NAICS sector is available from the Bureau of Economic Analysis (BEA) from 2005 to 2013. We use the County Business Pattern data from the U.S. Census Bureau to obtain the number of employees per County $\times$ 2-digit NAICS $\times$ year. In each quarter, we compute the proportion of employees in a given sector located in counties that are hit by a natural disaster. To compute our main dummy, which measures whether an upstream sector is hit, we consider all areas from which a given state sources a given commodity, and we compute in each quarter the share of employees from these areas located in counties which are hit by a natural disaster, weighted by the given commodity's dollar value purchased from the state from each of these areas. We then run similar regressions as those we ran on firm-level data. We present the results in Table A.21. In the baseline specification shown in Panel A, we do not find any direct or indirect effect of natural disasters on real GDP growth. In Panel B, we further split the explanatory variables into specific and non-specific sectors, using the classification in Rauch (1999). We find evidence of propagation from upstream to downstream sectors only when specific upstream sectors are hit. Looking at the direct effect, we find that natural disasters have a negative effect on real GDP growth in manufacturing but a positive and significant effect on construction, retail, and wholesale sectors, which is consistent with anecdotal evidence that natural disasters boost sales in these sectors.

Taken together, these results confirm that natural disasters have an effect on downstream value added, something we were not able to observe precisely using Compustat data. These findings also confirm that our estimates are not the mechanical outcome of the selected nature of our main sample.

TABLE A.21

State × industry real GDP Growth

	Panel A: Baseline State × industry real GDP Growth $(t-4,t)$				
Cutoff	40%	50%	60%	70%	80%
Disaster hits upstream industry (t-4,t-1)	-0.001	-0.000	-0.000	-0.002	-0.001
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)
Disaster hits industry (t-4,t-1)	0.002	0.002	0.001	0.001	0.001
	(0.004)	(0.004)	(0.005)	(0.004)	(0.005)
Industry × Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	24308	24308	24308	24308	24308
R^2	0.272	0.272	0.272	0.272	0.272

	Panel B: Specificity State × industry real GDP Growth $(t-4,t)$				
Cutoff	40%	50%	60%	70%	80%
Disaster hits specific upstream industry (t-4,t-1)	-0.013***	-0.013***	-0.015***	-0.019***	-0.020***
	(0.004)	(0.003)	(0.005)	(0.003)	(0.003)
Disaster hits non-specific upstream industry (t-4,t-1)	0.001	0.002	0.001	0.000	0.001
	(0.003)	(0.004)	(0.004)	(0.004)	(0.004)
Disaster hits manufacturing industry (t-4,t-1)	-0.018	-0.014	-0.029**	-0.036***	-0.032**
	(0.012)	(0.013)	(0.012)	(0.012)	(0.015)
Disaster hits retail/wholesale industry (t-4,t-1)	0.008**	0.008**	0.010**	0.009*	0.008*
	(0.003)	(0.004)	(0.004)	(0.005)	(0.005)
Disaster hits construction industry (t-4,t-1)	0.032***	0.032***	0.043***	0.050***	0.052***
	(0.010)	(0.011)	(0.011)	(0.013)	(0.014)
Disaster hits other industries (t-4,t-1)	0.005	0.004	0.005	0.005	0.004
	(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Industry × Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	24308	24308	24308	24308	24308
R^2	0.272	0.272	0.273	0.273	0.273

Notes. This table presents estimates from panel regressions of state × 2-digit industry real GDP growth relative to the same quarter in the previous year on a dummy indicating whether the state × 2-digit's upstream industry is hit by a natural disaster in the previous four quarters. All regressions include a dummy indicating whether the state × 2-digit industry is hit itself by a natural disaster in the previous four quarters. In columns (1) to (5), a state × 2-digit industry is considered to be hit in a given quarter if more than 40, 50, 60, 70, or 80% of employees in this state × 2-digit industry are located in counties that are hit by a disaster in this quarter. An upstream industry is considered to be hit in a given quarter if more than 40, 50, 60, 70, or 80% of employees in areas from which the state × 2-digit industry sourced this intermediate input as of 2007 are hit by a disaster in this quarter. Panel A presents the baseline regression. Panel B splits industries into specific and non-specific industries. The classification of industries into differentiated and non-differentiated is based on Rauch (1999). The sample period is 2005 to 2013. Standard errors presented in parentheses are clustered at the sector level. *, **, and *** denote significance at the 10, 5, and 1%, respectively.