

Input Specificity and the Propagation of Idiosyncratic Shocks in Production Networks

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Research question

Resilience of supply chains

- ▶ Are shocks absorbed or amplified in production networks?
- ▶ How much does this depend on input specificity?

Empirical challenges

- ▶ Isolating firm-specific / localized shocks
- ▶ Tracking these shocks in the supply chain

This paper

1. Considers disruptions caused by natural disasters in the US from 1980 to 2013
2. Quantifies the propagation of input shocks in supplier-customer networks of U.S. publicly listed firms
3. Contrasts the magnitude of propagation with the specificity of disrupted suppliers

Not in this paper:

- ▶ Network formation, in particular relative to specificity
- ▶ Propagation within / outside the boundaries of the firm

Preview of main findings

- ▶ Substantial *vertical* propagation
 - ▶ Customers' sales growth drop by 2 pp when one supplier hit by a natural disaster
 - ▶ Translate into value losses
- ▶ Substantial *horizontal* propagation (spillovers)
 - ▶ Other linked suppliers' sales growth drops by 3.8 pp
- ▶ Effects driven by specific inputs
 - ▶ Propagation only when supplier produces differentiated goods, does R&D expenses, or holds patents
- ▶ **Interpretations**
 - ▶ Significant switching costs between trade partners
 - ▶ Strong complementarity between intermediate inputs

Literature review

- ▶ Input-output linkages and aggregate volatility
 - ▶ Long Plosser (1983), Horvath (1998, 2000), Foerster et al (2011), Jones (2011), Acemoglu et al (2012), Atalay (2015), ...
- ▶ Specificity and trade
 - ▶ Grossman Hart (1986), Antras (2003), Antras Helpman (2004), Nunn (2007), ...
- ▶ Switching costs and the propagation of financial shocks
 - ▶ Khwaja Mian (2008), Fernando et al. (2012), Chodorow-Reich (2014), Amiti Weinstein (2014)
- ▶ Stock return comovement in supplier-customer networks
 - ▶ Hertzel al. (2008), Cohen Frazzini (2008), Menzly Ozbas (2010), Boone Ivanov (2012)

Outline

1. Identification
2. Data
3. Results
4. Discussion

Outline

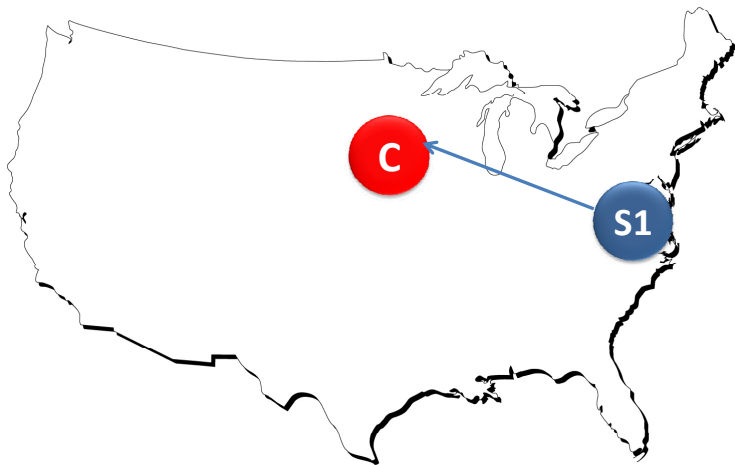
1. **Identification**
2. Data
3. Results
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Source of identification

- ▶ Treatment: a supplier's HQ county location is hit by a major natural disaster.
 - ▶ 60% of employees located at headquarters in our sample
- ▶ How do natural disasters disrupt production?
 - ▶ Power outages
 - ▶ Destruction of fixed assets or inventories
 - ▶ Workforce/management can't reach the workplace
- ▶ Empirically: suppliers' sales growth drops significantly following the disaster

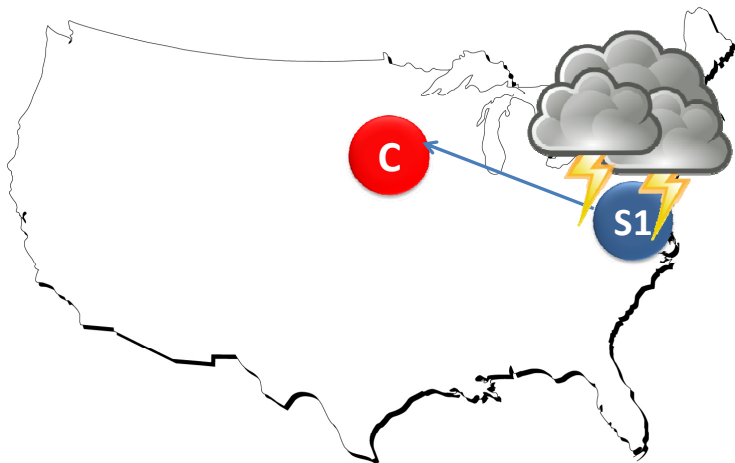
Identification strategy

- C purchases input from S1



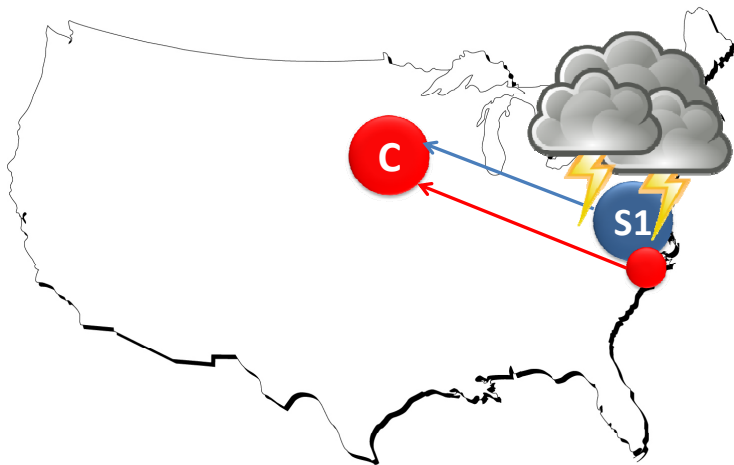
Identification strategy

- Effect on C of disruption at S1 (Hurricane Fran, 1996)



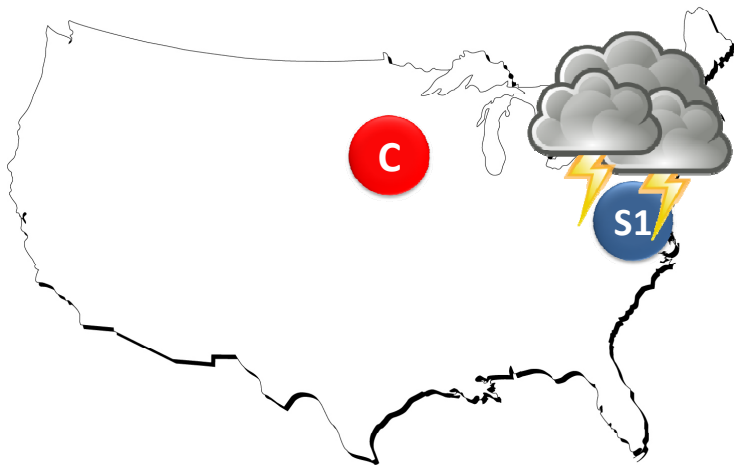
Identification strategy

- Controlling for the location of C's establishments



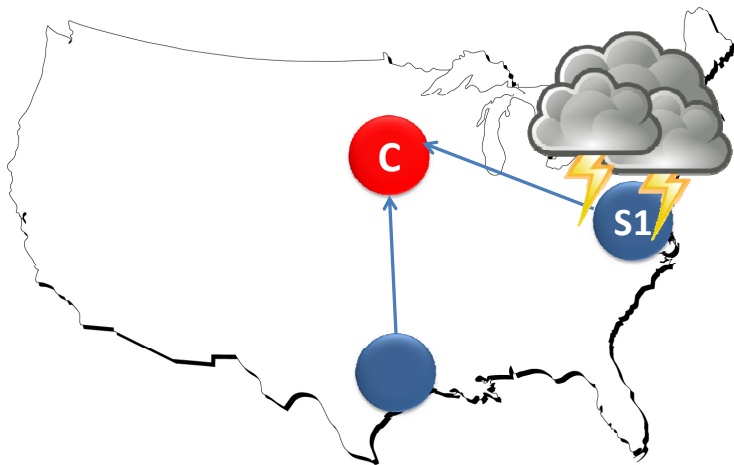
Identification strategy

- Effect when C and S1 are not in a relationship?



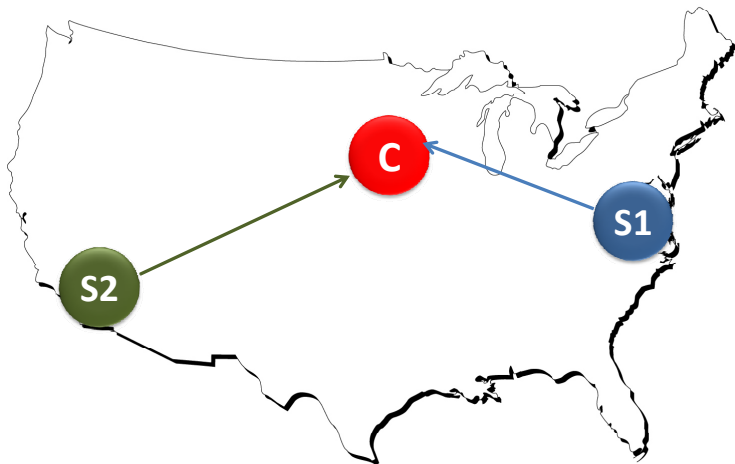
Identification strategy

- Effect should vary with input specificity



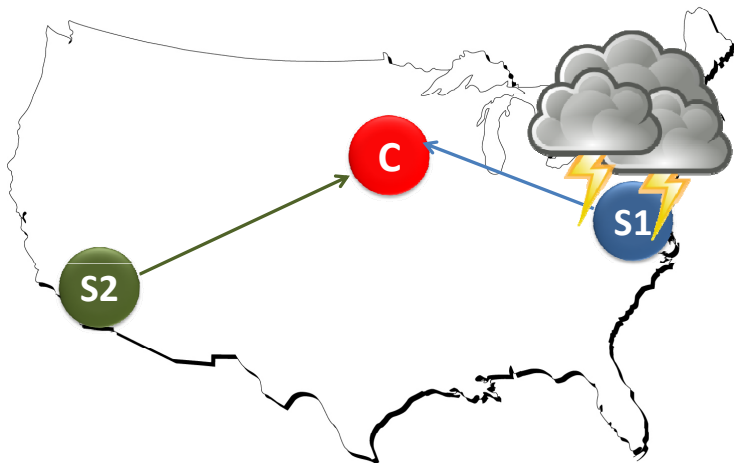
Identification strategy

- C purchases input from S1 and S2



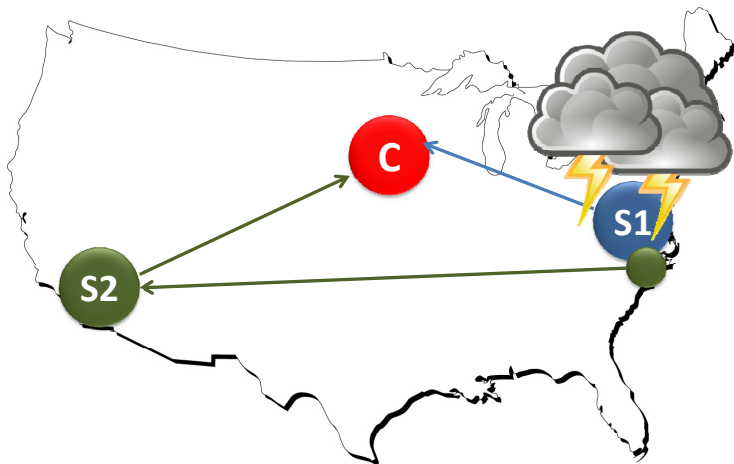
Identification strategy

- Effect on S2 of disruption at S1 (Hurricane Fran, 1996)



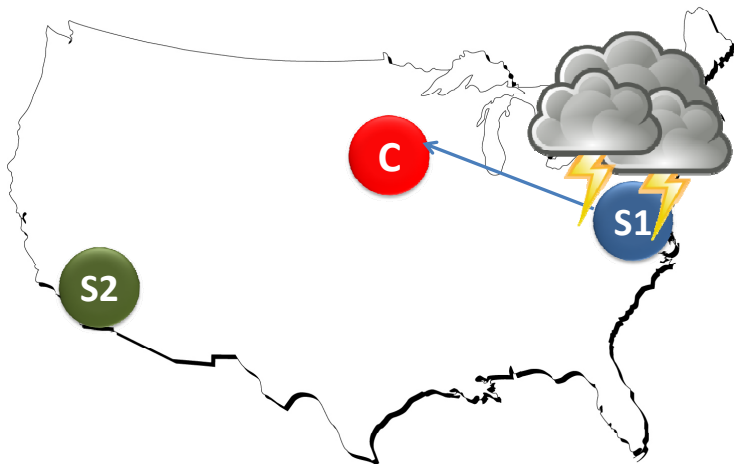
Identification strategy

- Controlling for the location of S2's establishments



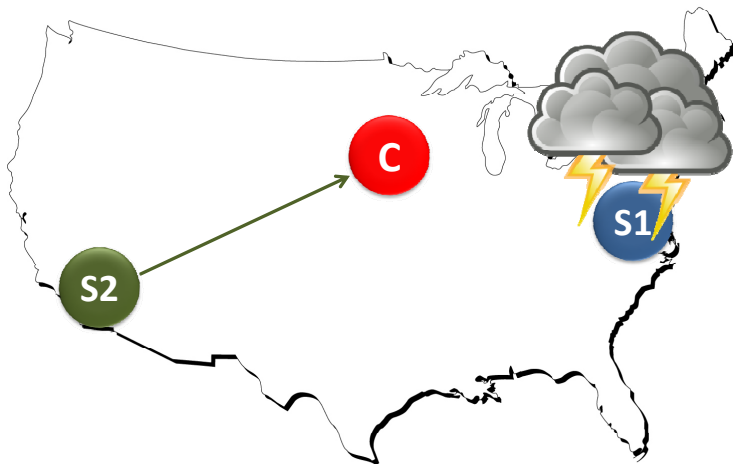
Identification strategy

- Effect when C and S2 are not in a relationship?



Identification strategy

- Effect when C and S1 are not in a relationship?



Identification strategy

- ▶ Difference-in-differences approach:

$$\Delta Y_{i,t-4,t} = \alpha_0 + \alpha_1 \text{HitSupplier}_{i,t-4} + \alpha_2 \text{HitFirm}_{i,t-4} + \alpha_3 X_{i,t-8} + \eta_t + \delta_i + \epsilon_{i,t}$$

- ▶ Identifying assumptions
 - ▶ **Parallel trends:** customer's sales growth flat in the absence of treatment
 - ▶ Effect temporary and posterior to the shock
 - ▶ Test of difference between treated and controls Test
 - ▶ **Exclusion restriction:** disaster should affect customer only through disruptive effect on supplier
 - ▶ Controls for establishment location
 - ▶ Effect conditional on the relationship being active
 - ▶ Controls for other possible linkages

Outline

1. Identification
2. **Data**
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Data

- ▶ Major natural disasters
 - ▶ SHELDUS (Spatial Hazard and Loss Database for the US)
 - ▶ Information at county level
 - ▶ 40 events [List](#)
- ▶ Firms
 - ▶ Compustat Quarterly, 1978-2013
 - ▶ Supplier-customer links from regulation SFAS No. 131 (customer representing more than 10% of sales)
 - ▶ Headquarters and establishments' location (Compustat and Infogroup)
- ▶ Input specificity
 - ▶ Industry classification in differentiated/homogenous/services (Rauch, 1999)
 - ▶ R&D expenses
 - ▶ Data from Google patents (Kogan et al., 2012)

Descriptive statistics

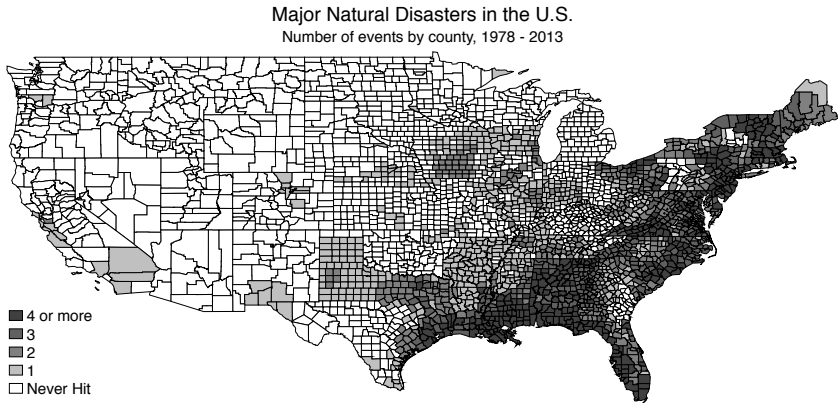
Customer sample

	Obs.	Mean	Std. Dev.	p1	p50	p99
Sales growth (t-4,t)	80574	0.102	0.375	-0.606	0.040	1.927
Cogs growth (t-4,t)	79358	0.106	0.411	-0.651	0.038	2.193
Disaster hits firm (t)	80574	0.016	0.126	0.000	0.000	1.000
Disaster hits one supplier (t)	80574	0.014	0.118	0.000	0.000	1.000
Number of suppliers	80574	1.383	4.162	0.000	0.000	19.000
	DIFF.		R&D		PATENT	
	S	NS	S	NS	S	NS
Av. duration of relationships	7.125	6.692	6.373	8.335	7.821	6.618
Av. sup-cust HQs distance	1332	1210	1502	1214	1388	1219
Av. suppliers' input share	0.022	0.025	0.017	0.023	0.025	0.022

Supplier Sample

Descriptive statistics

Disaster location

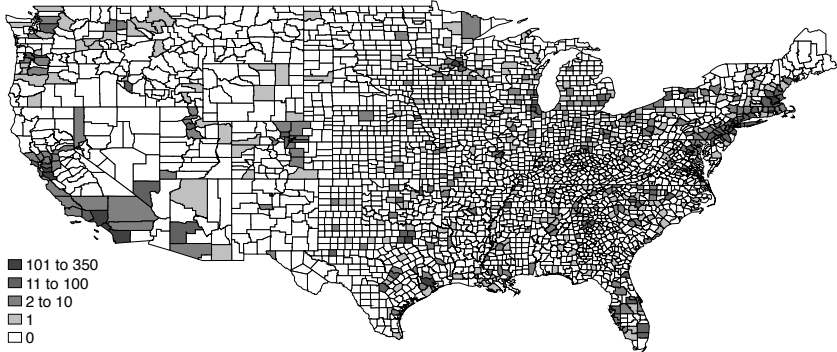


Descriptive statistics

Supplier location

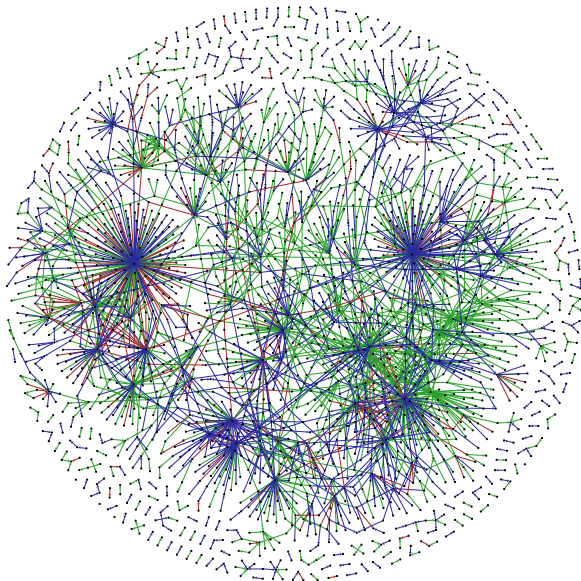
Location of Sample Suppliers' Headquarters in the U.S.

Total number by county



Descriptive statistics

Changes in network structure 1995-2000



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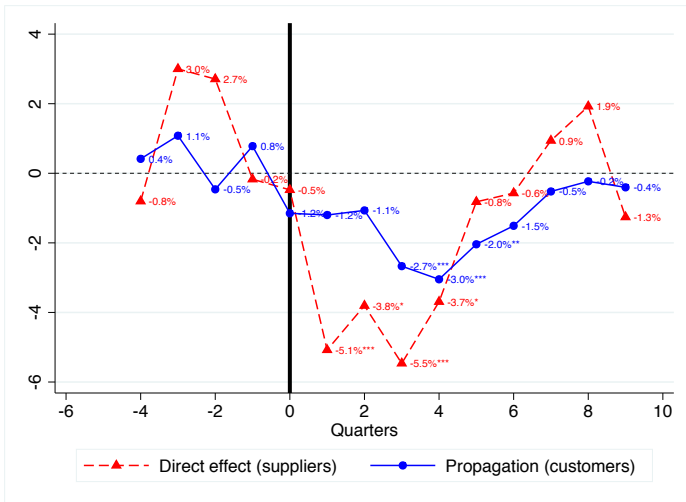
Direct effect of disasters

- Large temporary drop in supplier's sales growth

	Sales Growth (t-4,t)			
Disaster hits firm (t)	-0.006 (0.018)	-0.004 (0.018)	-0.001 (0.018)	-0.011 (0.018)
Disaster hits firm (t-1)	-0.045*** (0.016)	-0.045*** (0.016)	-0.032* (0.017)	-0.039** (0.018)
Disaster hits firm (t-2)	-0.033* (0.018)	-0.032* (0.018)	-0.024 (0.021)	-0.026 (0.021)
Disaster hits firm (t-3)	-0.042** (0.019)	-0.040** (0.019)	-0.032 (0.022)	-0.029 (0.023)
Disaster hits firm (t-4)	-0.031 (0.020)	-0.028 (0.020)	-0.029 (0.022)	-0.024 (0.023)
Disaster hits firm (t-5)	-0.007 (0.020)	-0.005 (0.020)	-0.022 (0.023)	-0.019 (0.023)
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA \times Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes
Observations	139976	139976	139976	139976
R^2	0.177	0.192	0.212	0.233

Vertical propagation - Main result

- Significant drop in firm's sales growth



Vertical propagation - Main result

► Firms sales growth drops by 2 pp

	Sales growth (t-4,t)			
Disaster hits one supplier (t)	-0.012 (0.008)	-0.010 (0.008)	-0.007 (0.008)	-0.003 (0.008)
Disaster hits one supplier (t-1)	-0.013 (0.008)	-0.013 (0.009)	-0.011 (0.009)	-0.004 (0.009)
Disaster hits one supplier (t-2)	-0.013 (0.009)	-0.009 (0.009)	-0.010 (0.010)	0.002 (0.010)
Disaster hits one supplier (t-3)	-0.028*** (0.009)	-0.025*** (0.009)	-0.025*** (0.009)	-0.013 (0.009)
Disaster hits one supplier (t-4)	-0.031*** (0.009)	-0.027*** (0.009)	-0.030*** (0.009)	-0.020** (0.009)
Disaster hits one supplier (t-5)	-0.016* (0.010)	-0.013 (0.010)	-0.014 (0.010)	-0.007 (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	80574	80574	80574	80574
R ²	0.234	0.262	0.300	0.342

Vertical propagation - Robustness

- ▶ Robust to controlling for the location of firm's establishments Location
- ▶ No effect when C and S1 not in a relationship Placebo
- ▶ Effect not driven by shocks affecting many firms Large shocks
- ▶ Effect also found for exporting firms Exporting
- ▶ Robust to controlling for heterogeneous trends Heterogeneous
- ▶ Robust to restricting the sample to eventually treated firms Eventually treated
- ▶ Robust to restricting the sample to never hit jointly relationships Never hit jointly
- ▶ Robust to controlling for linkages Linkages
- ▶ Robust to varying distance Varying distance

Vertical propagation - Input specificity

► Effects driven by specific inputs

	Sales Growth (t-4,t)					
	DIFF.		R&D		PATENT	
Supplier specificity:						
hits one non-specific supplier (t-4)	-0.002 (0.012)	-0.002 (0.011)	-0.018 (0.011)	-0.011 (0.011)	-0.020* (0.011)	-0.016 (0.010)
hits one specific supplier (t-4)	-0.050*** (0.010)	-0.043*** (0.010)	-0.039*** (0.014)	-0.032** (0.014)	-0.039*** (0.011)	-0.034*** (0.012)
hits firm (t-4)	-0.031*** (0.011)	-0.029*** (0.011)	-0.031*** (0.011)	-0.029*** (0.011)	-0.031*** (0.011)	-0.029*** (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 \times Year-Quarter FE	No	Yes	No	Yes	No	Yes
Observations	80574	80574	80574	80574	80574	80574
R ²	0.234	0.262	0.234	0.261	0.234	0.262

Vertical propagation - Role of inventories

- Inventories delay the direct effect by one quarter

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

Vertical propagation - Role of inventories

- Inventories delay vertical propagation by one quarter

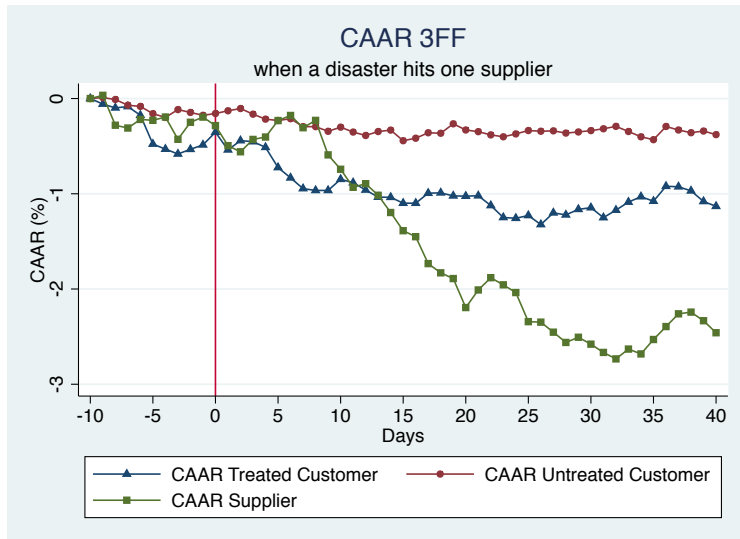
	Sales Growth ($t - 4, t$)			
Disaster hits high inventory supplier (t)	-0.002 (0.012)	-0.004 (0.012)	0.000 (0.012)	0.001 (0.011)
Disaster hits high inventory supplier ($t-1$)	0.004 (0.010)	0.003 (0.010)	0.008 (0.011)	0.010 (0.011)
Disaster hits high inventory supplier ($t-2$)	-0.012 (0.010)	-0.012 (0.010)	-0.012 (0.011)	-0.008 (0.011)
Disaster hits high inventory supplier ($t-3$)	-0.015 (0.011)	-0.013 (0.011)	-0.013 (0.011)	-0.007 (0.012)
Disaster hits high inventory supplier ($t-4$)	-0.023** (0.009)	-0.019** (0.009)	-0.021** (0.010)	-0.019* (0.011)
Disaster hits high inventory supplier ($t-5$)	-0.025** (0.012)	-0.023** (0.012)	-0.023* (0.012)	-0.025** (0.012)
Disaster hits low inventory supplier (t)	-0.013 (0.012)	-0.005 (0.011)	-0.004 (0.011)	0.001 (0.011)
Disaster hits low inventory supplier ($t-1$)	-0.015 (0.012)	-0.012 (0.012)	-0.013 (0.012)	-0.004 (0.013)
Disaster hits low inventory supplier ($t-2$)	-0.009 (0.012)	-0.003 (0.012)	-0.005 (0.013)	0.009 (0.013)
Disaster hits low inventory supplier ($t-3$)	-0.026** (0.012)	-0.020* (0.012)	-0.024* (0.013)	-0.009 (0.013)
Disaster hits low inventory supplier ($t-4$)	-0.024** (0.012)	-0.020* (0.011)	-0.027** (0.012)	-0.014 (0.012)
Disaster hits low inventory supplier ($t-5$)	-0.003 (0.013)	-0.001 (0.013)	-0.006 (0.014)	0.005 (0.014)

Vertical propagation - Value losses

- ▶ Event-study on firm-disaster pairs satisfying:
 - ▶ (at least) one supplier is hit by disaster
 - ▶ firm is not hit by disaster
 - ▶ firm and its suppliers not hit by another disaster in the previous or following 30 trading days
- ▶ Estimate daily abnormal stock returns using three-factor model (over 260 to 11 trading days before the event):

$$R_{it} = \alpha_i + \beta_i R_{M,t} + s_i SMB_t + h_i HML_t + \epsilon_{it}$$

Vertical propagation - Value losses



Vertical propagation - Value losses

Customers' CAAR when disaster hits at least one supplier						
Supplier specificity:	DIFF.		R&D		PATENT	
	N=628	N=454	N=318	N=764	N=375	N=707
At least one specific supplier	Yes	No	Yes	No	Yes	No
[−10, −1]	-0.885 (-1.567)	0.064 (-0.288)	-0.321 (-0.568)	-0.556 (-1.243)	-0.096 (0.164)	-0.694* (-1.731)
[0, 10]	-0.636*** (-2.757)	0.018 (-0.022)	-0.621 (-1.395)	-0.253 (-1.542)	-0.651*** (-2.585)	-0.208 (-0.742)
[11, 20]	-0.168 (-0.608)	-0.189 (0.250)	0.181 (1.482)	-0.326 (-1.021)	0.177 (0.479)	-0.365 (-0.674)
[21, 30]	-0.460 (-1.017)	0.348 (0.192)	-1.351** (-2.349)	0.391 (0.564)	-0.560 (-0.502)	0.112 (-0.421)
[31, 40]	-0.219 (-0.331)	0.337 (0.006)	-0.340 (-0.896)	0.162 (0.213)	-0.391 (-0.381)	0.229 (-0.038)
[−10, 40]	-2.368*** (-2.939)	0.578 (0.080)	-2.452* (-1.769)	-0.582 (-1.412)	-1.519 (-1.285)	-0.926* (-1.690)

Horizontal propagation - Baseline

- Drop in the sales of growth of other suppliers

		Sales Growth (t-4,t)		
Supplier specificity:		DIFF.	R&D	PATENT
Disaster hits firm (t-4,t-1)	-0.040*** (0.013)	-0.040*** (0.013)	-0.041*** (0.013)	-0.040*** (0.013)
Disaster hits one customer (t-4,t-1)	0.002 (0.021)	0.001 (0.021)	0.001 (0.021)	0.002 (0.021)
Disaster hits one customer's supplier (t-4,t-1)	-0.038*** (0.010)			
Disaster hits one customer's specific supplier (t-4,t-1)		-0.047*** (0.013)	-0.048*** (0.014)	-0.040*** (0.013)
Disaster hits one customer's non-specific supplier (t-4,t-1)		-0.011 (0.013)	-0.013 (0.013)	-0.015 (0.013)
Firm FE	Yes	Yes	Yes	Yes
Year Quarter FE	Yes	Yes	Yes	Yes
Size, Age, Roa \times Year Quarter FE	Yes	Yes	Yes	Yes
Observations	139976	139976	139976	139976
R ²	0.192	0.192	0.192	0.192

Horizontal propagation - Robustness

Robustness tests:

- ▶ Effects robust to controlling for S2's plant location

Location

- ▶ Effects only found when S1 and C are in a relationship

Location

- ▶ Effects only found when S2 and C are in a relationship

Location

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1. Identification
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General equilibrium network model

- ▶ Present a GE network model based on Long Plosser 1983
- ▶ Model disruptions as destruction of a portion of output
- ▶ Express the pass-through to any given firm as the ratio of its sales drop to the disrupted supplier's sales drop

	σ											
	0	0.2	0.4	0.6	0.8	1	1.2	1.4	1.6	1.8	2	2.2
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
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
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

- ▶ Compare this to our reduced form pass-throughs
 - ▶ (a) Vertical: $2\%/4\%=0.5$
 - ▶ (b) Horizontal: $3.8\%/4\%=0.95$
 - ▶ Ratio of (b) to (a): 1.9

Sample representativeness

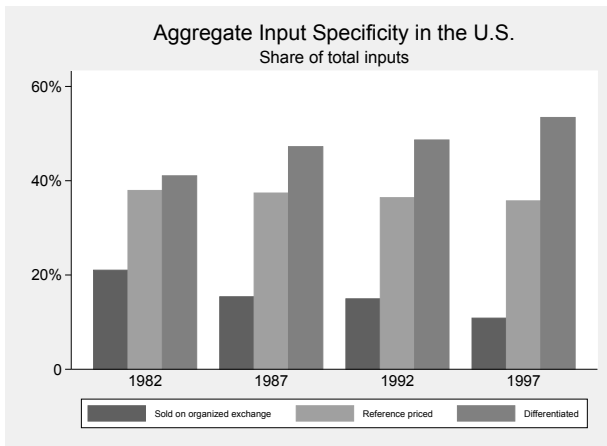
- ▶ We replicate our results on a sample of relationships including privately held firms Capital IQ
 - ▶ Results do not depend on the 10% cutoff
 - ▶ Results do not depend on whether firms are listed or not
- ▶ We replicate our results at the Sector and State*Sector level Sector
 - ▶ Find similar baseline results
 - ▶ Confirm role of input specificity

Economic significance

- ▶ How large is the aggregate amplification?
 - ▶ Sum the sales lost by firms and suppliers in the sample
 - ▶ Obtain a multiplier of approximately 2.4x

	Suppliers	Firms
Total lost sales (\$bn)	-246	-579
% of total (quarterly) sales	-27.8%	-5.8%

Trends in input specificity



Source: Nunn (QJE, 2007)

External validity

- ▶ Endogenous location of firms and their suppliers
 - ▶ Response to shock larger when not anticipated

	Sales Growth ($t - 4, t$)			
Disaster hits one supplier in a low-risk county (t-4)	-0.033*** (0.011)	-0.031*** (0.011)	-0.029*** (0.011)	-0.027** (0.011)
Disaster hits one supplier in a high-risk county (t-4)	-0.022** (0.011)	-0.016 (0.011)	-0.022** (0.011)	-0.007 (0.010)
Disaster hits firm (t-4)	-0.031*** (0.011)	-0.029*** (0.011)	-0.005 (0.009)	-0.003 (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 \times 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

Conclusion

- ▶ Networks matter: rigidities in supply relationships lead to substantial propagation of firm-level shocks
- ▶ Next steps: determinants of network formation

Supplementary tables

Test of Parallel Trends

Customer sample	F-tests on fixed effects for Year Quarter \times _____				
	Size	Age	ROA	Nb Suppliers	Eventually
Sales Growth					0.92 (0.62)
Sales Growth	2.91 (<0.0001, 82)				0.93 (0.59)
Sales Growth	2.86 (<0.0001, 82)	1.85 (<0.0001, 75)			0.98 (0.50)
Sales Growth	2.92 (<0.0001, 82)		1.31 (0.0357, 82)		0.99 (0.49)
Sales Growth	2.85 (<0.0001, 82)			1.47 (0.0099, 63)	0.98 (0.50)
Sales Growth	2.76 (<0.0001, 82)	1.76 (<0.0001, 75)	1.25 (0.0669, 82)	1.51 (0.0066, 63)	1.04 (0.47)

[Back](#)

Controlling for firms' plant location

	Sales Growth (t-4,t)			
Disaster hits more than 10% of firm's workforce (t-4)	-0.006 (0.010)	-0.005 (0.010)	0.002 (0.010)	0.009 (0.010)
Disaster hits one supplier (t-4)	-0.031*** (0.009)	-0.027*** (0.009)	-0.030*** (0.009)	-0.020** (0.008)
Disaster hits firm (t-4)	-0.027** (0.012)	-0.026** (0.012)	-0.006 (0.011)	-0.009 (0.011)
	Sales growth (t-4,t)			
Disaster hits <i>any eventually linked suppliers'</i> location (t-4)	0.003 (0.007)	0.004 (0.007)	0.004 (0.007)	0.005 (0.007)
Disaster hits one supplier (t-4)	-0.033*** (0.010)	-0.029*** (0.010)	-0.032*** (0.010)	-0.023** (0.010)
Disaster hits firm (t-4)	-0.031*** (0.011)	-0.029*** (0.011)	-0.005 (0.009)	-0.003 (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

Confounding demand factors

	Sales Growth (t-4,t)			
Disaster hits one supplier (t-4) × Large nb of affected firms	0.002 (0.021)	0.017 (0.021)		
Disaster hits one supplier (t-4) × > 50% sales abroad			0.002 (0.020)	-0.001 (0.019)
Disaster hits one supplier (t-4)	-0.031*** (0.009)	-0.029*** (0.009)	-0.031*** (0.010)	-0.027*** (0.009)
Disaster hits firm (t-4)	-0.031*** (0.011)	-0.030*** (0.011)	-0.031*** (0.011)	-0.029*** (0.011)
> 50% sales abroad			-0.003 (0.013)	0.001 (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

Heterogeneous trends

	Heterogeneous Trends Sales Growth (t-4,t)			
Disaster hits one supplier (t-4)	-0.030*** (0.009)	-0.027*** (0.009)	-0.029*** (0.009)	-0.019** (0.009)
Disaster hits firm (t-4)	-0.030*** (0.011)	-0.028*** (0.011)	-0.005 (0.009)	-0.002 (0.009)
Number of Suppliers \times Year-Quarter FE	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA \times 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

Table

Eventually treated firms

	Eventually Treated Customers Only Sales Growth (t-4,t)			
Disaster hits one supplier (t-4)	-0.037*** (0.009)	-0.033*** (0.009)	-0.030*** (0.009)	-0.019** (0.009)
Disaster hits firm (t-4)	-0.016 (0.015)	-0.018 (0.015)	-0.003 (0.013)	0.002 (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 \times 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

Relationships Never Hit Jointly Only

Panel A:	Relationships Never Hit Jointly Only			
	Sales Growth (t-4,t)			
Disaster hits one supplier (t-4)	-0.035*** (0.009)	-0.029*** (0.009)	-0.032*** (0.009)	-0.022** (0.009)
Disaster hits firm (t-4)	-0.033*** (0.011)	-0.031*** (0.011)	-0.007 (0.009)	-0.004 (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 \times 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

Back

Size-weighted regressions

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

Controlling for linkages

	Sales Growth ($t - 4, t$)				
hits one supplier (t-4)	-0.032*** (0.009)	-0.028*** (0.008)	-0.030*** (0.009)	-0.027*** (0.008)	-0.030*** (0.009)
hits firm (t-4)	-0.003 (0.012)	0.001 (0.012)	-0.016 (0.012)	-0.014 (0.012)	-0.024* (0.013)
hits more than 10% SIC4 industry sales (t-4)	-0.023*** (0.009)	-0.027*** (0.009)			
hits more than 10% of emp. with. 300 miles (t-4)	-0.036*** (0.010)	-0.038*** (0.010)			
hits more than 30% SIC4 industry sales (t-4)			-0.034*** (0.012)	-0.035*** (0.012)	
hits more than 30% of emp. with. 300 miles (t-4)			-0.010 (0.012)	-0.011 (0.012)	
hits more than 50% SIC4 industry sales (t-4)					-0.050*** (0.017)
hits more than 50% of emp. with. 300 miles (t-4)					0.021 (0.019)
Number of Suppliers	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Size, Age, ROA \times Year-Quarter FE	No	Yes	No	Yes	No
Observations	80574	80574	80574	80574	80574
R^2	0.234	0.262	0.234	0.262	0.234

Varying distance

	Sales Growth ($t - 4, t$)				
	0 miles	100 miles	200 miles	400 miles	500 miles
hits one supplier (t-4)	-0.033*** (0.008)	-0.030*** (0.008)	-0.026*** (0.008)	-0.029*** (0.009)	-0.027*** (0.009)
hits firm (t-4)	-0.025** (0.011)	-0.028*** (0.011)	-0.029*** (0.011)	-0.030*** (0.011)	-0.030*** (0.011)
Number of Suppliers	Yes	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Size, Age, ROA \times Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
Observations	80574	80574	80574	80574	80574
R^2	0.262	0.262	0.262	0.262	0.261

Back

Capacity constraints

	Panel A: PPE and Employment growth			
	PPE growth ($t - 4, t$)		Emp growth ($t - 4, t$)	
Disaster hits one supplier (t)	-0.004 (0.009)	-0.003 (0.009)	-0.006 (0.006)	-0.005 (0.006)
Disaster hits one supplier (t-1)	-0.001 (0.009)	-0.002 (0.009)	-0.011** (0.006)	-0.008 (0.006)
Disaster hits one supplier (t-2)	-0.006 (0.009)	-0.004 (0.009)	-0.009 (0.006)	-0.008 (0.006)
Disaster hits one supplier (t-3)	-0.014 (0.009)	-0.010 (0.009)	-0.014** (0.006)	-0.012** (0.006)
Disaster hits one supplier (t-4)	-0.011 (0.009)	-0.006 (0.009)	-0.013** (0.006)	-0.011* (0.006)
Disaster hits one supplier (t-5)	-0.008 (0.010)	-0.001 (0.010)	-0.006 (0.007)	-0.003 (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 \times Year-Quarter FE	No	Yes	No	Yes
Observations	79954	79954	79107	79107
R^2	0.262	0.304	0.253	0.289

Risky counties

	Sales Growth ($t - 4, t$)			
Disaster hits one supplier in a low-risk county (t-4)	-0.033*** (0.011)	-0.031*** (0.011)	-0.029*** (0.011)	-0.027** (0.011)
Disaster hits one supplier in a high-risk county (t-4)	-0.022** (0.011)	-0.016 (0.011)	-0.022** (0.011)	-0.007 (0.010)
Disaster hits firm (t-4)	-0.031*** (0.011)	-0.029*** (0.011)	-0.005 (0.009)	-0.003 (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 \times 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

High versus Low Inventory Suppliers (1/2)

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

High versus Low Inventory Suppliers (2/2)

	Sales Growth ($t - 4, t$)			
Disaster hits high inventory supplier (t)	-0.002 (0.012)	-0.004 (0.012)	0.000 (0.012)	0.001 (0.011)
Disaster hits high inventory supplier (t-1)	0.004 (0.010)	0.003 (0.010)	0.008 (0.011)	0.010 (0.011)
Disaster hits high inventory supplier (t-2)	-0.012 (0.010)	-0.012 (0.010)	-0.012 (0.011)	-0.008 (0.011)
Disaster hits high inventory supplier (t-3)	-0.015 (0.011)	-0.013 (0.011)	-0.013 (0.011)	-0.007 (0.012)
Disaster hits high inventory supplier (t-4)	-0.023** (0.009)	-0.019** (0.009)	-0.021** (0.010)	-0.019* (0.011)
Disaster hits high inventory supplier (t-5)	-0.025** (0.012)	-0.023** (0.012)	-0.023* (0.012)	-0.025** (0.012)
Disaster hits low inventory supplier (t)	-0.013 (0.012)	-0.005 (0.011)	-0.004 (0.011)	0.001 (0.011)
Disaster hits low inventory supplier (t-1)	-0.015 (0.012)	-0.012 (0.012)	-0.013 (0.012)	-0.004 (0.013)
Disaster hits low inventory supplier (t-2)	-0.009 (0.012)	-0.003 (0.012)	-0.005 (0.013)	0.009 (0.013)
Disaster hits low inventory supplier (t-3)	-0.026** (0.012)	-0.020* (0.012)	-0.024* (0.013)	-0.009 (0.013)
Disaster hits low inventory supplier (t-4)	-0.024** (0.012)	-0.020* (0.011)	-0.027** (0.012)	-0.014 (0.012)
Disaster hits low inventory supplier (t-5)	-0.003 (0.013)	-0.001 (0.013)	-0.006 (0.014)	0.005 (0.014)
Number of Suppliers	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes
Size, Age, ROA \times Year-Quarter FE	No	Yes	Yes	Yes
State-Year FE	No	No	Yes	Yes
Industry-Year FE	No	No	No	Yes

Alternative network structure: Capital IQ

Panel A: Downstream propagation

Disaster hits one supplier (t-1,t-4)	-0.040*** (0.013)	-0.045*** (0.013)	-0.035** (0.017)	-0.037** (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** (0.015)	-0.035** (0.015)	-0.038** (0.015)	-0.036** (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 \times 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** (0.013)	-0.027** (0.013)	-0.032* (0.018)	-0.032* (0.018)
Disaster hits one public customer's supplier (t-1,t-4)			0.007 (0.019)	0.007 (0.019)
Disaster hits one customer (t-1,t-4)	-0.008 (0.012)	-0.009 (0.012)	-0.005 (0.017)	-0.003 (0.018)
Disaster firm (t-1,t-4)	-0.028** (0.013)	-0.025** (0.013)	-0.028** (0.013)	-0.025** (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 \times Year-Quarter FE	No	Yes	No	Yes
Observations	41807	41807	41807	41807
R^2	0.283	0.288	0.283	0.288

Sector-level results: Index of Industrial Production

Panel A: Baseline
Output Growth ($t - 4, t$)

Cutoff (% of 6-digit industry employment hit)	40%	50%	60%	70%	80%
hits upstream industry ($t-4, t-1$)	-0.003 (0.007)	-0.002 (0.007)	-0.009* (0.005)	-0.015*** (0.005)	-0.016*** (0.006)
hits industry ($t-4, t-1$)	0.010 (0.014)	0.009 (0.017)	-0.009 (0.016)	-0.018* (0.009)	-0.035*** (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%
hits specific upstream industry ($t-4, t-1$)	-0.004 (0.008)	-0.003 (0.007)	-0.019** (0.008)	-0.018** (0.008)	-0.021** (0.009)
hits non-specific upstream industry ($t-4, t-1$)	-0.002 (0.006)	-0.002 (0.006)	0.005 (0.005)	0.006 (0.005)	0.007 (0.005)
hits industry ($t-4, t-1$)	-0.039*** (0.012)	-0.039*** (0.013)	-0.037*** (0.013)	-0.037*** (0.013)	-0.037*** (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

Sector-level results: State \times Sector real GDP Growth

Panel A: Baseline - State \times industry real GDP Growth ($t - 4, t$)

Cutoff	40%	50%	60%	70%	80%
hits upstream industry ($t-4, t-1$)	-0.001 (0.003)	-0.000 (0.003)	-0.000 (0.004)	-0.002 (0.004)	-0.001 (0.004)
hits industry ($t-4, t-1$)	0.002 (0.004)	0.002 (0.004)	0.001 (0.005)	0.001 (0.004)	0.001 (0.005)
Industry \times Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	24308	24308	24308	24308	24308

Panel B: Specificity - State \times industry real GDP Growth ($t - 4, t$)

Cutoff	40%	50%	60%	70%	80%
hits specific upstream industry ($t-4, t-1$)	-0.013*** (0.004)	-0.013*** (0.003)	-0.015*** (0.005)	-0.019*** (0.003)	-0.020*** (0.003)
hits non-specific upstream industry ($t-4, t-1$)	0.001 (0.003)	0.002 (0.004)	0.001 (0.004)	0.000 (0.004)	0.001 (0.004)
hits manufacturing industry ($t-4, t-1$)	-0.018 (0.012)	-0.014 (0.013)	-0.029** (0.012)	-0.036*** (0.012)	-0.032** (0.015)
hits retail/wholesale industry ($t-4, t-1$)	0.008** (0.003)	0.008** (0.004)	0.010** (0.004)	0.009* (0.005)	0.008* (0.005)
hits construction industry ($t-4, t-1$)	0.032*** (0.010)	0.032*** (0.011)	0.043*** (0.011)	0.050*** (0.013)	0.052*** (0.014)
hits other industries ($t-4, t-1$)	0.005 (0.004)	0.004 (0.004)	0.005 (0.004)	0.005 (0.004)	0.004 (0.005)
Industry \times Year-Quarter FE	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes
Observations	24308	24308	24308	24308	24308

Theoretical framework

- How does a constraint on one intermediate input translate into a drop in customer's output?

Calibrated Values

θ	ρ	α	n
2	1	0.55	10

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
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
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
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

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

	θ			ρ			α			n		
	2	2.5	3	0.5	1	1.5	0.5	0.55	0.6	10	20	30
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
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
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

Power outages

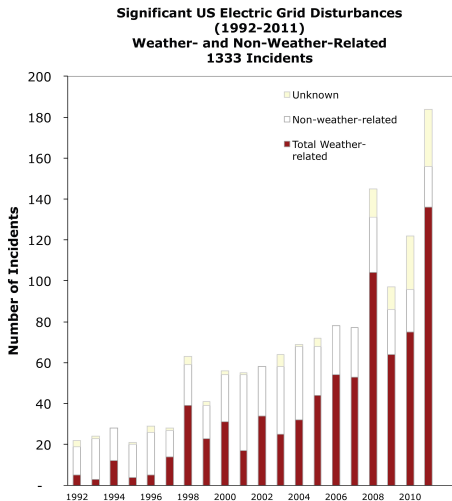
Flooded nuclear plant in Nebraska



SOURCE: KETV

Power outages

Sources of electric grid disruptions



List of major disasters

Disaster	Date	% U.S. Emp	Location
Helen Eruption	May 80	0.03	WA
Alicia	Aug 83	4.72	TX
Elena	Aug 85	0.54	AL, FL, LA, MS
Juan	Oct 85	3.58	AL, FL, LA, MS, TX
Hugo	Sep 89	1.43	NC, SC, VA
Loma Earthquake	Oct 89	2.56	CA
Bob	Aug 91	7.06	MA, ME, NC, NH, NY, RI
Oakfland Hills Firestorm	Oct 91	0.54	CA
Andrew	Aug 92	2.67	AL, FL, LA, MS
Iniki	Sep 92	0.02	HI
Blizzard	Mar 93	11.15	AL, CT, FL, GA, MA, MD, NJ, OH, SC, VA, VT
Northridge Earthquake	Jan 94	3.69	CA
Alberto	Jul 94	0.66	AL, FL, GA
Severe Storms	May 95	5.21	LA, MS, OK, TX
Opal	Oct 95	6.43	AL, FL, GA, LA, MS, NC, SC
Blizzard	Jan 96	14.50	CT, DE, IN, KY, MA, MD, NC, NJ, NY, PA, VA, WV
Fran	Sep 96	2.02	NC, SC, VA, WV
Ice Storm	Jan 98	1.09	ME, NH, NY, VT
Bonnie	Aug 98	1.26	NC, VA
Georges	Sep 98	3.68	AL, FL, LA, MS
Floyd	Sep 99	15.70	CT, DC, DE, FL, MD, ME, NC, NH, NJ, NY, PA, SC, VA, VT
Alison	Jun 01	4.56	AL, FL, GA, LA, MS, PA, TX
Isabel	Sep 03	4.99	DE, MD, NC, NJ, NY, PA, RI, VA, VT, WV
California Wildfires	Oct 03	1.78	CA
Charley	Aug 04	3.94	FL, GA, NC, SC
Frances	Sep 04	4.61	AL, FL, GA, KY, MD, NC, NY, OH, PA, SC, VA, WV
Ivan	Sep 04	5.82	AL, FL, GA, KY, MD, NC, NY, OH, PA, SC, VA, WV
Jeanne	Sep 04	6.06	AL, FL, GA, KY, LA, MA, MD, MS, NC, NH, NJ, NY, PA, SC, TN, WV
Dennis	Jul 05	5.38	AL, FL, GA, MS, NC
Katrina	Aug 05	9.21	AL, AR, FL, GA, IN, KY, LA, MI, MS, OH, TN
Rita	Sep 05	3.75	AL, AR, FL, LA, MS
Wilma	Oct 05	3.55	FL
Midwest Floods	Jun 08	5.25	IA, IL, IN, MN, MO, NE, WI
Gustav	Sep 08	0.66	AL, AR, LA, MS
Ike	Sep 08	5.44	AR, IL, IN, KY, LA, MI, MO, MS, OH, PA, TN, TX

Sample composition

Panel A:	Customer and Supplier Samples					
	Supplier Sample		Customer Sample		All Compustat	
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%)
Restaurants, Hotels, Motels	166	(0.1%)	913	(1.1%)	13102	(2.1%)
Almost Nothing	1425	(1.0%)	857	(1.1%)	12240	(2.0%)

Sample composition

	Supplier Sample				Customer Sample			
	N	Hit %	N	Unaffected %	N	Treated %	N	Unaffected %
48FF Industry								
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%)
Restaurants, 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%)

Value losses

	CAAR		
	Customers	Suppliers	Customers
	(N=1082)	(Direct effect) (N=2004)	(Control group) (N=6379)
[-10, -1]	-0.487 (-1.283)	-0.195 (-0.819)	-0.176** (-2.310)
[0, 10]	-0.361* (-1.911)	-0.548** (-2.215)	-0.124 (-0.302)
[11, 20]	-0.177 (-0.269)	-1.452*** (-3.340)	-0.029 (-0.205)
[21, 30]	-0.121 (-0.583)	-0.385 (-1.088)	-0.006 (0.392)
[31, 40]	0.014 (-0.215)	0.120 (1.123)	-0.042 (-1.208)
[-10, 40]	-1.132** (-1.982)	-2.459*** (-3.029)	-0.379 (-1.563)

Specific vs. non-specific suppliers

	Sales Growth (t-4,t)					
Supplier specificity:	DIFF.		R&D		PATENT	
hits firm (t-4,t-1)	-0.050*** (0.017)	-0.044*** (0.016)	-0.048*** (0.012)	-0.048*** (0.012)	-0.046*** (0.016)	-0.041*** (0.015)
hits specific firm (t-4,t-1)	0.023 (0.026)	0.013 (0.026)	0.038 (0.040)	0.044 (0.039)	0.020 (0.028)	0.011 (0.028)
Specific firm			0.099*** (0.021)	0.090*** (0.021)	-0.060*** (0.014)	-0.030** (0.013)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Year-Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Size, Age, ROA \times Year-Quarter FE	No	Yes	No	Yes	No	Yes
Observations	139976	139976	139976	139976	139976	139976
R^2	0.177	0.192	0.177	0.192	0.177	0.192

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Descriptive statistics

Supplier sample

	Obs.	Mean	Std. Dev.	p1	p50	p99
Sales growth (t-4,t)	139976	0.188	0.814	-0.876	0.045	4.568
Disaster hits firm (t)	139976	0.017	0.127	0.000	0.000	1.000
Disaster hits a customer (t)	139976	0.008	0.088	0.000	0.000	0.000
Disaster hits a customer's supplier (t)	139976	0.042	0.200	0.000	0.000	1.000
Number of customers	139976	0.711	0.964	0.000	0.000	4.000
% Employees at HDQs' county	102279	0.597	0.365	0.000	0.667	1.000

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Horizontal propagation - Robustness

► Controlling for S2's plant location

		Sales Growth (t-4,t)		
Supplier specificity:		DIFF.	R&D	PATENT
Disaster hits at least 10% of firm's workforce (t-4,t-1)	-0.007 (0.016)	-0.007 (0.016)	-0.008 (0.016)	-0.007 (0.016)
Disaster hits firm (t-4,t-1)	-0.035* (0.018)	-0.035** (0.018)	-0.035* (0.018)	-0.035** (0.018)
Disaster hits one customer (t-4,t-1)	0.002 (0.021)	0.001 (0.021)	0.001 (0.021)	0.002 (0.021)
Disaster hits one customer's supplier (t-4,t-1)	-0.038*** (0.010)			
Disaster hits one customer's specific supplier (t-4,t-1)		-0.047*** (0.013)	-0.048*** (0.014)	-0.040*** (0.013)
Disaster hits one customer's non-specific supplier (t-4,t-1)		-0.011 (0.013)	-0.013 (0.013)	-0.015 (0.013)
Firm FE	Yes	Yes	Yes	Yes
Year Quarter FE	Yes	Yes	Yes	Yes
Size, Age, Roa \times Year Quarter FE	Yes	Yes	Yes	Yes

Horizontal propagation - Robustness

- No effect when C and S1 not in a relationship

Supplier specificity:		Sales Growth (t-4,t)		
		DIFF.	R&D	PATENT
hits <i>any customers' eventually linked suppliers'</i> location (t-4,t-1)	-0.022* (0.013)	-0.022* (0.013)	-0.022 (0.013)	-0.022* (0.013)
hits firm (t-4,t-1)	-0.040*** (0.013)	-0.041*** (0.013)	-0.041*** (0.013)	-0.041*** (0.013)
hits one customer (t-4,t-1)	0.002 (0.021)	0.002 (0.021)	0.001 (0.021)	0.002 (0.021)
hits one customer's supplier (t-4,t-1)	-0.038*** (0.010)			
hits one customer's specific supplier (t-4,t-1)		-0.047*** (0.013)	-0.048*** (0.014)	-0.039*** (0.013)
hits one customer's non-specific supplier (t-4,t-1)		-0.011 (0.013)	-0.013 (0.013)	-0.015 (0.013)
Firm FE	Yes	Yes	Yes	Yes
Year Quarter FE	Yes	Yes	Yes	Yes
Size, Age, Roa \times Year Quarter FE	Yes	Yes	Yes	Yes
Observations	139976	139976	139976	139976
R ²	0.192	0.192	0.192	0.192

Horizontal propagation - Robustness

- No effect when S2 and C not in a relationship

		Sales Growth (t-4,t)		
Supplier specificity:		DIFF.	R&D	PATENT
hits <i>any eventually linked customer's</i> supplier (t-4,t-1)	-0.008 (0.016)	-0.005 (0.014)	-0.019 (0.012)	-0.012 (0.014)
hits firm (t-4,t-1)	-0.039*** (0.013)	-0.040*** (0.013)	-0.038*** (0.013)	-0.039*** (0.013)
hits one customer (t-4,t-1)	0.003 (0.021)	0.002 (0.021)	0.004 (0.021)	0.004 (0.021)
hits one customer's supplier (t-4,t-1)	-0.032* (0.016)			
hits one customer's specific supplier (t-4,t-1)		-0.044*** (0.014)	-0.041*** (0.015)	-0.036*** (0.013)
hits one customer's non-specific supplier (t-4,t-1)		-0.008 (0.015)	-0.003 (0.014)	-0.008 (0.015)
Firm FE	Yes	Yes	Yes	Yes
Year Quarter FE	Yes	Yes	Yes	Yes
Size, Age, Roa \times Year Quarter FE	Yes	Yes	Yes	Yes
Observations	139976	139976	139976	139976
R ²	0.192	0.192	0.192	0.192

Insurance

Wall-Mart 10K 2013:

"In light of the substantial premiums payable for insurance coverage for losses caused by certain natural disasters, such as hurricanes, cyclones, typhoons, tropical storms, earthquakes, floods and tsunamis in the current insurance market, as well as the limitations on available coverage for such losses, we have chosen to be primarily self-insured with respect to such losses."

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