"Shock Spillover and Financial Response in Supply Chain Networks: Evidence from Firm-Level Data"

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Related literature

Motivation: do firm-level shocks propagate in production networks?... in a way that lead to sizable fluctuations at the aggregate level?

- Theoretical: input-output linkages and aggregate volatility
  - Long and Plosser 1983, Acemoglu et al. 2012, Acemoglu et al. 2015...
  - Taking into account market power: Baqaee 2016, Grassi 2016.

- Empirical: shocks propagation
  - Sector-level evidence: Foerster et al. 2011, Atalay 2014, Caliendo et al. 2016...
  - Firm-level evidence: Barrot and Sauvagnat 2016, Boehm et al. 2016, Carvalho et al. 2016, this paper.

- Implications for corporate finance
  - Kale and Shahrur 2007, Banerjee et al. 2008, Ahern and Harford 2014...

The discussion

- Placing the paper in the (empirical) literature
- Discussing threats to the empirical strategy
- Interpreting the estimates

Propagation of shocks in firm-level production networks

Carvalho, Nirei, Saito and Tahbaz-Salehi (2016):

- Use Tohoku Earthquake as a source of shock
- (up to 24) customer-supplier links from a private credit reporting agency for around 1 million firms

Main results:

- Evidence of both upstream and downstream propagation
- Stronger downstream
- Goes beyond first link, but dies out as we move away from the source.

Propagation of shocks in firm-level production networks

Carvalho, Nirei, Saito and Tahbaz-Salehi (2016):
Firms' sales growth in disaster area drop by 2.9pp

Table 4. Downstream and Upstream Propagation

	Post-Earthquake Sales Growth Rate	
	(1)	(2)
Downstream Distance 1	−0.007***	−0.020***
	(0.002)	(0.003)
Downstream Distance 2		−0.013***
		(0.003)
Downstream Distance 3		−0.013***
		(0.003)
Downstream Distance 4		−0.011***
		(0.004)
Upstream Distance 1	−0.0003	−0.012***
	(0.0024)	(0.003)
Upstream Distance 2		−0.007***
		(0.003)
Upstream Distance 3		−0.007**
		(0.003)
Upstream Distance 4		0.001
		(0.004)
Constant	−0.029**	−0.021***
	(0.010)	(0.010)
Firm Controls	Yes	Yes
Prefecture FE	Yes	Yes
Industry FE	Yes	Yes
Observations	419,897	419,897
R^2	0.022	0.022

Propagation of shocks in firm-level production networks

Barrot and Sauvagnat (2016):

- Use natural disasters in the US over 1980-2012
- Supplier-customer links from regulation SFAS No. 131 (customer representing more than 10% of sales)

Main results:

- Substantial downstream and horizontal propagation
- Effects driven by specific inputs
  - Propagation only when supplier produces differentiated goods, does R&D expenses, or holds patents

Lots to like in the paper

Strengths of the dataset:

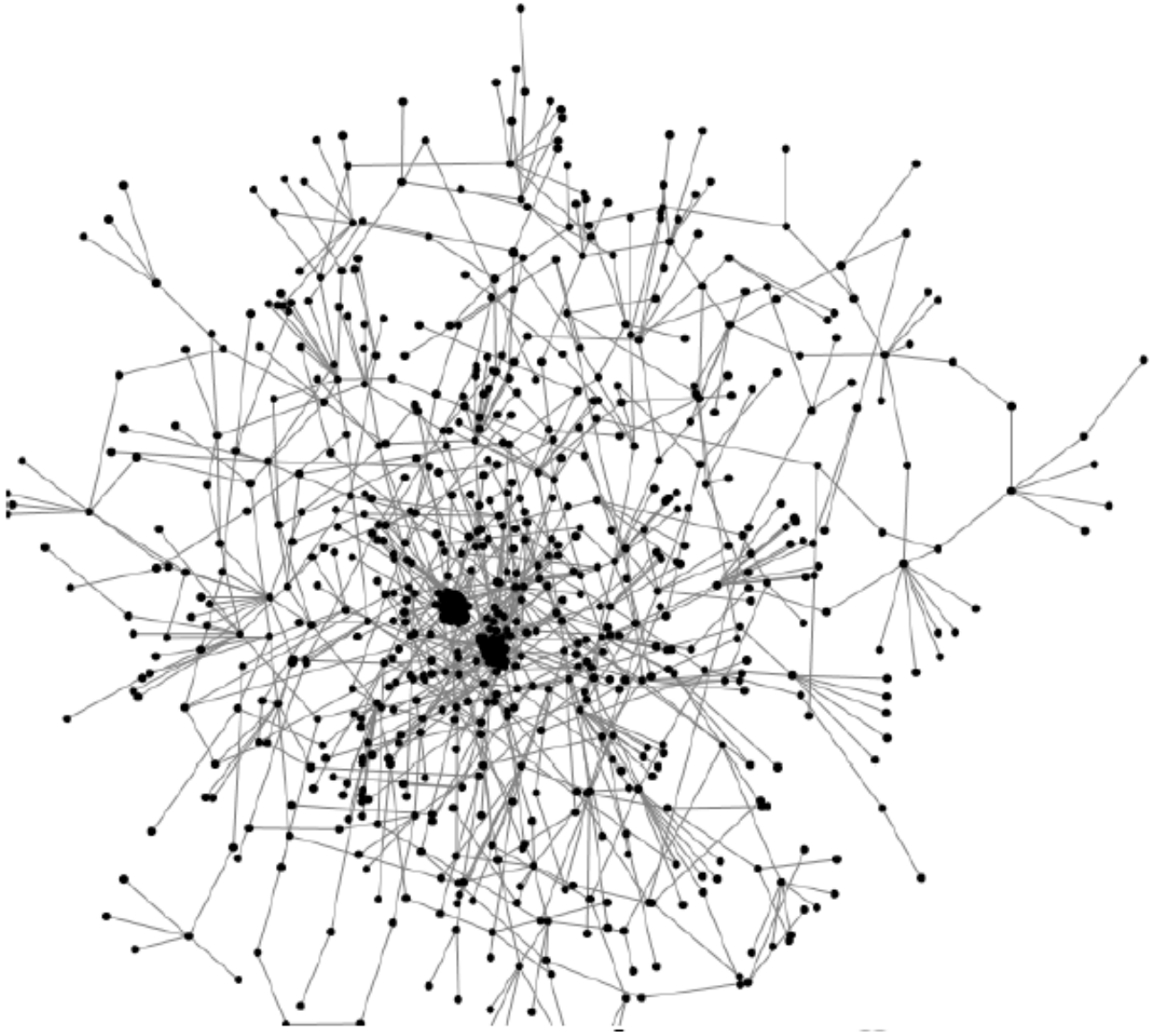
- A lot of links (more than in the previous two papers)
  - on average 92 links per firm
  - ... still not exhaustive
- Can isolate purely firm-specific shocks
  - Mitigates concerns for the validity of the exclusion restriction
  - (using e.g. natural disasters, concern e.g. that customers' HQ/plants locations simultaneously affected)
- Observe relationship terminations

Summary of the empirical findings

- Evidence that shocks propagate downstream through linkages
- (Main) new finding: do not seem to die out as we move away from the source of the shock
- Propagation is stronger when market power is low (or supplier market power is high)
- Market power decreases along the supply chain
- Affected firms hold more inventories and cash after experiencing "input disruptions"

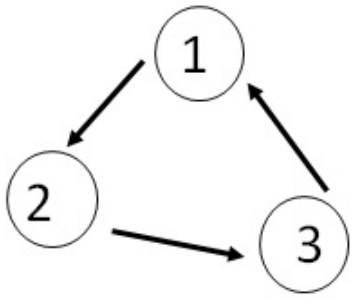
Measuring distance

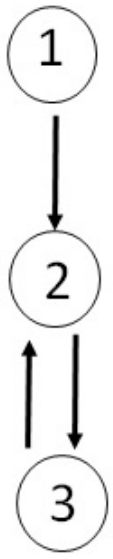
- Production networks are more complex than simple vertical chains

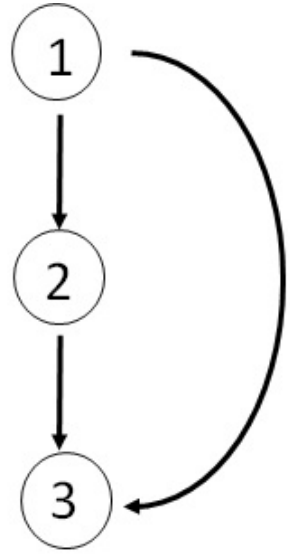


Measuring distance

- Production networks are more complex than simple vertical chains
- Make it difficult to compute "downstreamness" (distance from origin)







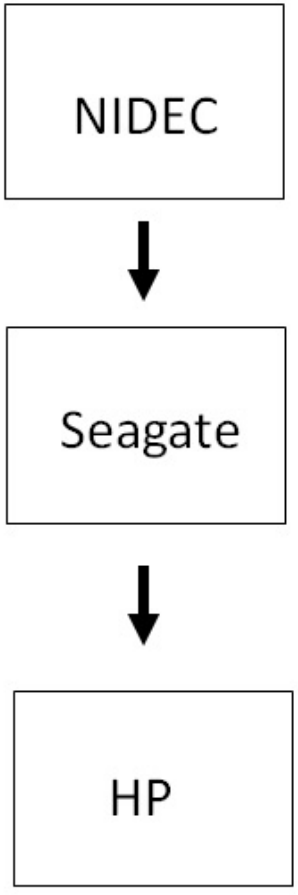
- Key for the paper to precisely measure the "distance" of each customer - that is, the **shortest** (directed) path to origin

Measuring distance

- In the sample, consider "distance" as the shortest path to origin?
- Still, because we do not observe all the links, there is a measurement issue:
  - True distance from origin $<$ observed distance from origin
- Result that estimates do not seem to fade out after the first link might simply reflect the fact that customers are in reality "closer" to the origin
- -> overestimate the "persistence" of propagation along the supply chain

Measuring distance

- The paper provides a "propagation" example along a "vertical chain" in which the source of the shock is the 2011 Floods in Thailand:



Measuring distance

- The paper provides a "propagation" example along a "vertical chain" in which the source of the shock is the 2011 Floods in Thailand:

HP Suppliers

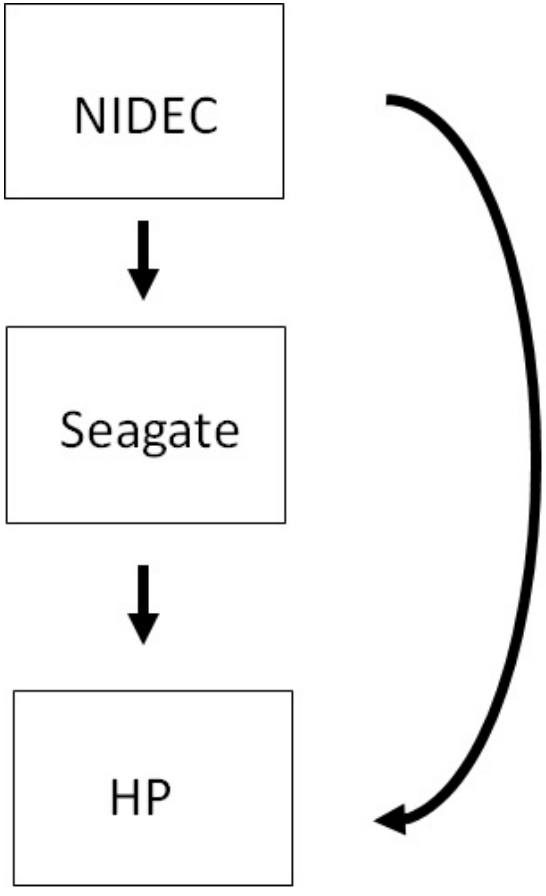
Below is an alphabetized listing of HP suppliers. These suppliers represent more than 95% of HP's procurement expenditures for materials, manufacturing and assembly of HP's products all over the world. This list includes contract manufacturers, electronic manufacturing services providers, original design manufacturers, and commodity suppliers. HP is sharing this list with the intent of promoting transparency and progress in raising social and environmental standards in the electronics industry supply chain.

ACCTON TECHNOLOGY
ADVANCED MICRO DEVICES
AMPHENOL
AMTEK
ATHEROS TECHNOLOGY
AU OPTRONICS CORP.
AVAGO TECHNOLOGIES LIMITED
AVOCENT
BESTEC POWER ELECTRONICS CO., LTD.
BROADCOM
BROCADE COMMUNICATIONS
CANON
CELESTICA
CELLEXPERT
CHI MEI OPTOELECTRONICS CORPORATION
CHICONY ELECTRONICS CO., LTD.
CISCO
COMPAL ELECTRONICS
COMPEQ
CREATIVE SENSOR INC.
CYPRESS SEMICONDUCTOR
DELTA ELECTRONICS
DOT HILL
DYNAPACK INTERNATIONAL TECHNOLOGY CORPORATION
EATON
ELPIDA MEMORY,INC.
EMERSON ELECTRIC
EMULEX CORPORATION
FAIRCHILD SEMICONDUCTOR
FCI

FLEXTRONICS
FONG KAI
FREESCALE
FUJITSU
GEMTEK
GOLD CIRCUIT ELECTRONICS
HITACHI
HON-HAI
HYNIX SEMICONDUCTOR INC.
INTEL
INVENTEC
JABIL
KEMET
KINPO
KYOCERA
LG
LITE-ON
LSI
MACRONIX EUROPE NV
MARVELL SEMICONDUCTOR
MAXIM INTEGRATED PRODUCTS INC
MICRON
MICROSOFT
MICRO-STAR INTERNATIONAL CO., LTD.
MITAC INTERNATIONAL CORP.
MITSUMI ELECTRIC CO., LTD.
MOLEX
MULTEK
MURATA MANUFACTURING COMPANY,LTD.
NANYA TECHNOLOGY
NATIONAL SEMICONDUCTOR CORPORATION
NEC ELECTRONICS AMERICA, INC.
NIDEC CORPORATION
NIPON MINATURE BEARING (NMB)
NVIDIA CORPORATION
NXP SEMICONDUCTORS
ON SEMICONDUCTOR LTD
OVERLAND STORAGE, INC.
PANASONIC
PEGATRON (ASUS)

Measuring distance

- The paper provides a "propagation" example along a "vertical chain" in which the source of the shock is the 2011 Floods in Thailand:

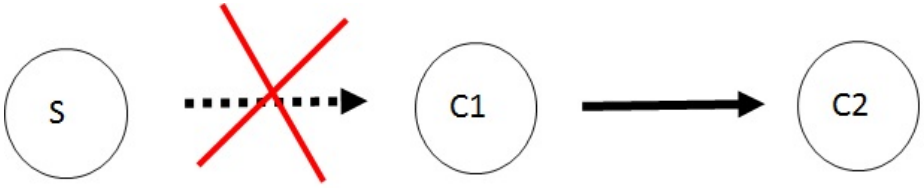


Measuring distance

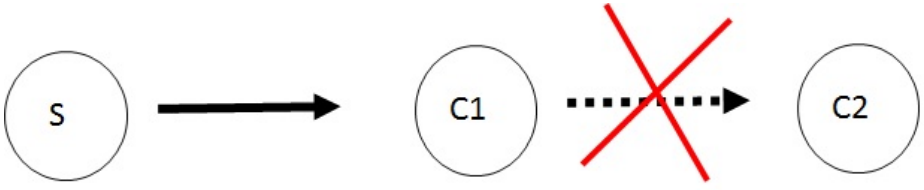
- An "isolated" example?
- Use supplier-customer links from regulation SFAS No. 131 to compute customers "distance"
- For each supplier in the sample:
  - 9% of all "distance 2" customers are also "distance 1" customers
  - 30% of all "distance 3" customers are either "distance 1" or "distance 2" customers
- Suggestions:
  - In sample, define distance as "shortest downstream path"
  - Still, concern with unobserved links
  - Run placebo tests using relationship terminations?

Terminations in placebo tests

- What happens if S-C1 link not active anymore and S is hit by a shock?



- If exclusion restriction satisfied, we should see no effect on C1 and C2
- But we would see an effect if:
  - S is a direct supplier of C2 (but we do not observe it in the data)
  - (C1 is linked to S through another channel than its input-output linkage)



- If exclusion restriction satisfied, we should see an effect on C1, but no effect on C2...

Heterogenous effects: measuring market power

- Not directly observable
  - Measured in the paper with market shares in Compustat
  - Ali, Klasa and Yeung (2009): concentration measures based on Compustat data have low correlations with concentration measures based on full samples of firms in each industry (e.g. using U.S. Census).
  - Use other proxies? (price-cost margins, "product-based" HHI from Hoberg and Phillips JPE 2016)

- In the context of the paper, might be proxying for other "relevant" characteristics:
  - Correlation between firm size and (better) management practices (Bloom and Van Reenen 2007)
  - Supplier market power correlated with supplier input share (called "supplier substitutability" in the paper)?
  - Observationally-equivalent to input specificity?

- Robustness of upstreamness-market power relationship?
  - Suggestion: use upstreamness measure from Antras et al. (2012) and industry-level market-power data using Census

Other comments on the empirics

- Corporate response to shocks: "behavioral" or "rational" responses?
  - Find that after being hit, firms adjust upward their inventory levels and cash holdings
  - Overreaction to salient risk? (Dessaint and Matray 2016)
  - or rational upward reassessment of supplier risk?
  - To disentangle between the two, look at whether supplier risk is stationary in the data
  - Might not be the case in your sample for some types of shocks for which proba(hit) might depend on (time-varying) firm characteristics

- "Temporary" vs "permanent" shocks
  - Do you observe firm exit (due to shocks)?
  - Baqaee (2016) finds combination of market power and exit can break "Hulten's theorem", i.e. theoretically possible to get that small industries have arbitrarily large effects on equilibrium output.

Do the results "reject" predictions of standard network model (with competitive firms)?

- Take a GE network model based on Long Plosser 1983 and Acemoglu 2012 with competitive firms
  - Model disruptions as destruction of a portion of output (or equivalently Hicksian-neutral productivity shock)
  - Can be used to derive first-order approximations of how a shock to one firm's output or sales affects other firms' output/sales in the network
- Carvalho et al. (2016) Proposition 1: Suppose that a firm in the simple production chain is hit with a negative shock. Then:
  - The outputs of all its downstream firms decrease.
  - The impact on a given firm is smaller, the further downstream it is from the shock's origin
  - The impact on all downstream firms intensifies as σ increases
- Simple calibration in Barrot and Sauvagnat (2016):
  - Estimates consistent with very low substitution between inputs ($\sigma = 0$)
  - When $\sigma = 0$, downstream (sales) pass-through ranges from 0.1 to 0.7 in sensitivity analysis

Do the results "reject" predictions of standard network model (with competitive firms)?

Four-Quarter Revenue Growth Rates

	Distance from Shock Origin (in # of Connections)				
	n=1	n=2	n=3	n=4	n=5
D	0.8271***	1.0313***	0.8762***	0.4036**	0.1209
	(3.16)	(3.98)	(3.55)	(2.62)	(1.54)

Using Carvalho et al. (2016) results:

	0.689	0.448	0.448	0.379

"Scale" the rate of decay along the supply chain with effect on "distance 1 customers":

	0.827	0.684	0.566	0.468