Supply Chain Disruptions, Supplier Capital, and Financial Constraints by Liu et al. (Working)

Lishu Zhang

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Outline (1)

Impact of supply chain disruptions on U.S. firms

- build a detailed, high-frequency supply chain disruption index
- define supplier capital: *supplier base establish and supplier relationship building*
- document new facts
  (i) considerable heterogeneity in the levels and persistence of disruptions across U.S. public firms
  (ii) substantial increase in disruptions in the aggregate
  (iii) a pronounced widening in the distribution of disruptions
  (iv) highly dispersed supplier capital investment rates
  (v) associated with lower stock returns and revenues
  (vi) firms tend to increase their investment in supplier capital following disruptions (financial constraint $\Rightarrow$ increase by less)

Outline (2)

- a GE model with heterogeneous firms in line with the facts
  - firms combine different inputs to produce a homogeneous final output
  - can expand **intermediate inputs** by investments ⇒ supplier capital
  - introduce financial frictions as a working capital constraint
- use the model to study the impact of an aggregate increase in supply chain disruptions
  - firms experience a one-period increase in the severity of supply chain disruptions
  - model predicts:
    (i) requires 10 quarters to fully recover
    (ii) firms accumulating supplier capital = an important endogenous margin of adjustment
    (iii) limiting firms' ability to adjust supplier capital can significant delay the recovery

Data

- S&P Global Panjiva, bill of lading (BoL) database
  - shipment-level records for cross-border trade transactions obtained from U.S. Customs and border Protection (CBP) through the Freedom of Information Act of 1966 (FOIA)
  - including shipper (exporter) and consignee (importer) names and addresses, description of goods, transportation, ports, weight and container details
  - impute shipment volume and value based on container information and other shipment attributes
  - 2007 to present, only seaborne import
- exclude obs where top-100 logistics companies and freight forwarders are listed as consignees

Measuring supply chain disruptions (1)

measure supply chain disruptions as a fraction of established trade pairs that are temporarily inactive with three components:

(i) HS 2-digit supply chain disruptions: for each project category j at time t

$$\text{Disruption rate}_{jt}(X,p,v) = \frac{|\{\text{established}(X,p) \cap \text{inactive} \cap \text{active in future}(v)\}_{jt}|}{|\{\text{established}(X,p)\}_{jt}|}. \quad (3)$$

A trade pair is established at time t if the pair has actively traded for X months over a consecutive 12-month period before time t and if the pair has been active at least once between $t-p$ and $t-1$. The disruption rate is the fraction of established pairs that are inactive at time t but become active in the future between $t+1$ and $t+v$. The restriction on being active again in the future enables us to focus on temporary disruptions. The tuning parameters are $X \in \{3,6,9,12\}$, $p \in \{12,24,36\}$ and $v \in \{1,2,6,12\}$ that we discuss below.

X: strictness for being established; p: horizon for recent activeness; ν: how soon to recover for being temporary inactive

Measuring supply chain disruptions (2)

(ii) HS 2-digit product category index $\hat{index}_{jt}$ is the mean of Disruption rate$_{jt}(X, p, \nu)$ (deseasonalized and smoothed using a 3-month rolling window) taken over all combinations of parameters X, p, and ν

(iii) from aggregate to firm-level:

- for each product category j at time t, determine exposure: $W_{ijt} = \frac{\text{Tot. value}_{ijt}}{\sum_{j \in \mathcal{N}_{it}} \text{Tot.value}_{ijt}}$.
  import value in USD, deflated, annually (reduce SR demand fluctuations)
- weighted average over the product space:

$$\text{Index}_{it} = \sum_{j \in \mathcal{N}_{it}} W_{ijt} \times \widehat{\text{Index}}_{jt}, \qquad (1)$$

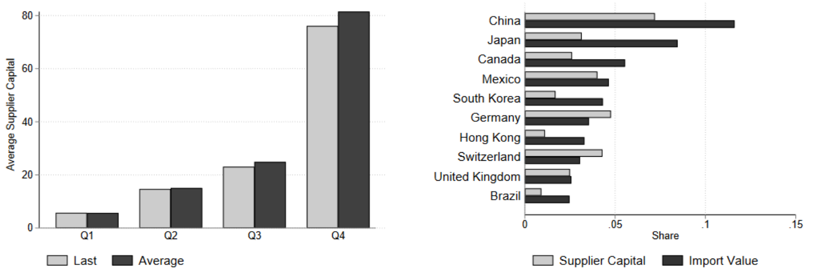
where $\widehat{\text{Index}}_{jt}$ is an index of supply chain disruptions within product category j at time t, $\mathcal{N}_{it}$ is the set of HS 2-digit product categories firm i imported at time t, and W_{ijt} is the share of the total import value of firm i accounted for by product category j at time t:

monthly frequency

Supplier capital

- firm's international supplier capital: total import value in USD accounted for by established trader partners with whom the firm recently traded, with $X = 3$ and $p = 24$

FIGURE 4: SUPPLIER CAPITAL: RELATIONSHIP WITH THE NUMBER OF ESTABLISHED TRADE PAIRS AND TOTAL TRADE VALUE



(A) Supplier capital by quantile of the number of established trade partners

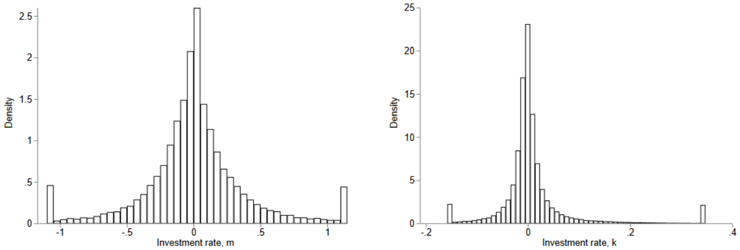
(B) Supplier capital and import value shares for largest exporters to the U.S.

Notes: Figure 4 consists of two panels. Panel (A) plots the average supplier capital by quantile of the

Empirical facts (1)

(i) The distribution of supplier capital investment rates, as measured by supplier capital growth rates, is highly dispersed. Moreover, there is little evidence of excess lumpiness in supplier capital investment.

FIGURE 5: DISTRIBUTIONS OF CAPITAL GROWTH RATES



(A) Supplier capital   (B) Physical capital

Notes: Figure 5 consists of two panels. Panel (A) plots distribution of supplier capital growth rates $\Delta \log m$; Panel (B) plots distribution of physical capital growth rates $\Delta \log k$. The data are winsorized at 1 and 99 percentiles.

Empirical facts (2)

(ii) Supply chain disruptions are associated with lower stock returns and revenue; the effect is more pronounced for financially constrained firms.

Table 2: Supply Chain Disruptions and Firms' Revenue and Returns

	Returns				Revenue			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔIndex	-0.16**	-0.15*	-0.15*	-0.16*	-0.28***	-0.14***	-0.14***	-0.24***
	(0.08)	(0.08)	(0.08)	(0.09)	(0.07)	(0.04)	(0.04)	(0.05)
Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	Y	Y	Y	N	Y	Y	N
Controls	N	N	N	Y	N	N	N	Y
R^2	0.20	0.24	0.24	0.25	0.01	0.84	0.84	0.90
N	229,668	229,663	229,663	163,737	86,456	86,382	86,382	50,650

Notes: Table 2 reports OLS estimates of the following equation:

$$y_{it} = \beta \Delta \text{Index}_{it} + \lambda \mathbf{X}_{it-1} + \varepsilon_{it},$$

Empirical facts (2)

(three common measures of financially constrained: the long-term debt ratio (LT), the Kaplan and Zingales (1997) measure (KZ), and the Whited and Wu (2006) measure (WW); also construct a composite measure (Comp) as the average of the standardized LT, KZ, and WW.)

TABLE 3: SUPPLY CHAIN DISRUPTIONS AND FIRMS' REVENUE AND RETURNS: ROLE OF FINANCIAL CONSTRAINTS

	Returns				Revenue			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ΔIndex $\times$ LT$_{t-1}$	-0.10**				-0.09***			
	(0.05)				(0.03)			
ΔIndex $\times$ KZ$_{t-1}$		-0.13***				-0.07**		
		(0.05)				(0.03)		
ΔIndex $\times$ WW$_{t-1}$			-0.16*				-0.17**	
			(0.09)				(0.07)	
ΔIndex $\times$ Comp$_{t-1}$				-0.13***				-0.05**
				(0.05)				(0.03)
Time FE	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.25	0.25	0.25	0.25	0.90	0.90	0.90	0.90
N	162,683	163,585	163,600	162,706	50,349	50,649	50,650	50,362

Notes: Table 3 reports OLS estimates of the following equation:

$$y_{it} = \beta_0 \Delta\text{Index}_{it} + \beta_1 \Delta\text{Index}_{it} \times FC_{it-1} + \lambda \mathbf{X}_{it-1} + \varepsilon_{it}.$$

Empirical facts (3)

(iii) Supply chain disruptions are associated with a positive future investment in supplier capital; the effect is less pronounced for more financially constrained firms.

TABLE 4: SUPPLY CHAIN DISRUPTIONS AND FIRM INVESTMENT IN SUPPLIER CAPITAL

	$\Delta_t^{t+1} \log m$			$\Delta_t^{t+2} \log m$			$\Delta_t^{t+4} \log m$		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Index	1.63**	1.40**	1.42**	2.15*	1.73	1.78	3.80**	3.23**	3.32**
	(0.65)	(0.65)	(0.65)	(1.10)	(1.08)	(1.08)	(1.65)	(1.64)	(1.63)
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	N	N	Y	N	N	Y	N	N	Y
R^2	0.07	0.07	0.08	0.12	0.12	0.13	0.21	0.22	0.22
N	21,497	21,497	21,497	21,410	21,410	21,410	20,692	20,692	20,692

Notes: Table 4 reports OLS estimates. The dependent variable is investment rate into supplier capital $\Delta_t^{t+k} \log m$ where $k \in \{1, 2, 4\}$. *Index* is a firm-level index of supply chain disruptions constructed in Section 2.3. All specifications control for lagged $\log m$. Columns (2), (3), (5), (6), (8), and (9) include lagged supplier concentration and lagged relationship strength as controls. Controls include lagged logarithm of supplier concentration, lagged relationship strength, firm size, lagged market-to-book ratio, lagged net price margin, lagged accrual, and lagged logarithm of physical capital. Standard errors are clustered at the firm level. All variables are winsorized at top and bottom 1 percent. *, **, *** denote statistical significance at 10, 5, and 1 percent levels, respectively.

Empirical facts (3)

Table 5: Supply Chain Disruptions and Firm Investment in Supplier Capital: Role of Financial Constraints

	$\Delta_t^{t+1} \log m$				$\Delta_t^{t+2} \log m$				$\Delta_t^{t+4} \log m$			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Index × LT_{t-1}	-0.40*				-1.08***				-1.32**			
	(0.22)				(0.37)				(0.66)			
Index × KZ_{t-1}		-0.37				-1.21***				-1.84***		
		(0.23)				(0.39)				(0.69)		
Index × WW_{t-1}			-0.32				-0.00				0.83	
			(0.45)				(0.63)				(0.90)	
Index × Comp_{t-1}				-0.47**				-1.05***				-1.58**
				(0.21)				(0.35)				(0.63)
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
R^2	0.08	0.08	0.08	0.04	0.04	0.04	0.07	0.07	0.07	0.07	0.07	0.07
N	21,454	21,456	21,496	21,472	21,367	21,409	20,651	20,691	20,668	20,601	20,602	20,603

Notes: Table 5 reports OLS estimates of the following equation:

$$\Delta_t^{t+k} \log m = \beta_0 \text{Index}_{it} + \beta_1 \text{Index}_{it} \times FC_{it-1} + \lambda \mathbf{X}_{it-1} + \varepsilon_{it}.$$

Conclusion

Reference I