Macroeconomic and Asset Pricing Effects of Supply Chain Disasters

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What Is This Paper About?

Q: Impact of micro-disasters on macroeconomy and asset prices?

Empirically:

- Show that distribution of employment changes has heavy tails
- Large shocks are less persistent than small shocks

Theoretically:

- Develop a production economy which accounts for:
  - business cycle statistics & key asset pricing moments
- Assess the role of microeconomic disasters + their persistence

Application: Supply chain disruptions

- Use new data to document a big rise in SC disruptions
- SC disruptions are associated with large sales declines
- Use model to assess impact of SC disrupt. on asset prices

▸ Related literature

Outline

Employment Changes: Heavy Tails

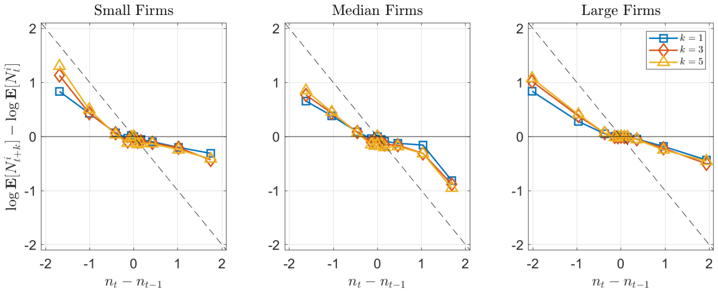
U.S. Census Longitudinal Business Database

- Universe of U.S. businesses with paid employees
- Covers time period since 1976
- Observe age, industry, employment, location, firm affiliation
- Roll-up data to firm level

	$P(\lvert\Delta \log n\rvert \in S)$				
$S:$	≤ 0.05	≤ 0.10	≤ 0.20	$\geq 2\sigma\ (\approx 0.8)$	$\geq 3\sigma\ (\approx 1.2)$
Data	0.444	0.492	0.604	0.059	0.021
$\mathcal{N}(0, 0.41)$	0.097	0.193	0.374	0.046	0.003
Ratio	4.577	2.549	1.615	1.283	**7.000**

Tails are much heavier than Gaussian density

Large Shocks Are More Transient than Small Shocks



Details

Outline

1. Empirical Evidence on Employment Changes
2. Model
3. Quantitative Implications
4. Application: Supply Chain Disruptions

Environment

Firms

- Operate a DRS technology $y = e^{X^Z} e^z k^\alpha n^\nu, \quad \alpha + \eta < 1$
- Quadratic and non-convex adj. costs
- Idiosyncratic stochastic process

$$z_i' = \rho_z z_i + \chi(X^Z) J_i + \varepsilon_i^z$$
$$\chi(X_t^Z) = -\rho_0 e^{-\rho_1 X_t^Z}$$
$$J_i \sim Poisson(\lambda)$$

Household

- Owns all firms, consumes C, supplies (inelastically) labor N
- Preferences with external habit formation

Household problem: Details

Recursive Formulation

Firm's profit

$$\pi(k,z;\mathbf{S}) = \max_{n\geq 0}[e^{X^Z} e^z k^\alpha n^\nu - W(\mathbf{S})n]$$

Value at start of t

$$v(k,z;\mathbf{S}) = \pi(k,z;\mathbf{S}) + \int \max\{v^{\text{adj}}(k,z;\mathbf{S}) - \eta W(\mathbf{S}), v^{\text{no adj}}(k,z;\mathbf{S})\} dF^\eta$$

Value of adjusting

$$\begin{aligned} v^{\text{adj}}(k,z;\mathbf{S}) &= \max_{k'\geq 0} -i - AC(k',k) + \mathbb{E}[M(\mathbf{S},\mathbf{S}')v(k',z';\mathbf{S}')] \\ k' &= i + (1-\delta)k \\ AC(k',k) &= \frac{\varphi}{2}\left(\frac{i}{k}\right)^2 k \end{aligned}$$

Value of not adjusting is the same as v^{adj} with $\left|\frac{i}{k}\right| \leq b$

Outline

Asset Pricing and Business Cycle Moments

Moment	Data	Model
$\mathbb{E}[r^f]$	0.89	0.79
$\mathbb{E}[r^e - r^f]$	6.36	6.56
$\sigma[r^f]$	1.82	2.46
$\sigma[r^e - r^f]$	16.52	18.50
$AC_1[r^f]$	0.84	0.99
$AC_1[r^e - r^f]$	0.08	0.00
$\sigma(Y)$	1.78	1.81
$\rho(C, Y)$	0.91	0.99
$\rho(I, Y)$	0.87	0.95
$\sigma(C)/\sigma(Y)$	0.82	0.52
$\sigma(I)/\sigma(Y)$	4.64	4.29

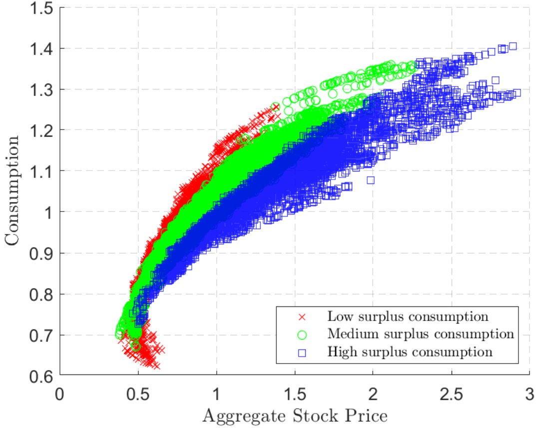
The model accounts for the equity premium puzzle

- Large and volatile equity premium arises in habit models
- Risk-free rate is smooth:

$$\underbrace{\text{low EIS}}_{\frac{\partial \mathbb{E}_t(\Delta c_{t+1})}{\partial r_{f,t+1}} = \frac{\bar{S}}{\sigma} = 0.05} + \underbrace{\text{high PS Motive}}_{\text{countercyclical } \sigma_t(\Delta c_{t+1})}$$

Distributional fit | Predictability regressions

Countercyclical Consumption Volatility: Illustration



Value Premium

Five B/M sorted portfolios

- Rebalance every 4 quarters
- Model analog of B/M is $\frac{k}{v(k,z;\mathbf{S})-d(k,z;\mathbf{S})}$

Portfolio	$\mathbb{E}[R_{port}]$ Data	$\lambda = 0$	$\lambda = 0.011$	$\sigma[R_{port}]$ Data	$\lambda = 0$	$\lambda = 0.011$
Low	7.4	4.8	4.7	18.7	17.5	16.2
2	7.8	4.8	4.7	16.1	17.0	15.5
3	8.7	5.2	5.3	15.5	17.0	15.5
4	9.4	5.8	6.3	17.9	17.0	15.8
High	11.6	6.5	8.6	20.2	17.1	16.5

Value premium in the data (5-1 B/M return) is 4.2%

- Value premium without jumps is 1.7%
- Microeconomic disasters generate a premium of 3.9%
- The change is mostly accounted for by *value stocks*

▸ Investment premium

Persistence of Small vs. Big Shocks

	B/M Sorted		Investment Sorted	
Portfolio	Small Shocks	Big Shocks	Small Shocks	Big Shocks
Low	–1.1	–1.8	+0.5	+2.7
2	–1.2	–0.6	+1.7	+3.2
3	–0.9	+1.0	+0.3	+2.7
4	–0.3	+3.6	–0.9	+0.1
High	+1.4	+9.2	–1.6	–0.5

Effect of increasing ρ_z from 0.88 to 0.92 on

- "small" shocks: $\underbrace{\{\lambda=0,\rho_z=0.92\}-\{\lambda=0,\rho_z=0.88\}}_{\text{jumps turned off}}$
- "big" shocks:

$$\underbrace{[\{\lambda=0.01,\rho_z=0.92\}-\{\lambda=0.01,\rho_z=0.88\}]}_{\text{impact on both small and big shocks}} - \underbrace{[\{\lambda=0,\rho_z=0.92\}-\{\lambda=0,\rho_z=0.88\}]}_{\text{impact on small shocks}}$$

Outline

What Do We Do?

Identify SC disruptions using import patterns of US firms

- Use real-time Bill of Lading data on the seaborne U.S. imports
- Data span 2007-present time
- Observe identities of importers and exporters
- 180mln obs for $\approx 490K$ consignees ($\approx 280K$ ultimate parent firms)

Outline of this section

- Data overview
- Measurement of SC disruptions using full sample
- Link between SC disruptions and firm performance (Compustat)

Panjiva: Overview of the Data

Observe the following information:

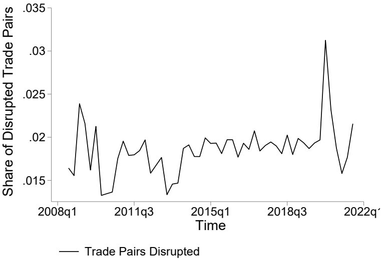
- day of arrival
- consignee and shipper IDs
- volume and weight of shipment
- ports of lading and unlading
- vessel IMO
- value of goods and 6-digit HS code

▸ Import activity of US firms ▸ Compustat Top-10: Volume ▸ Compustat Top-10: Num.of shippers
▸ Details on data construction ▸ Summary statistics

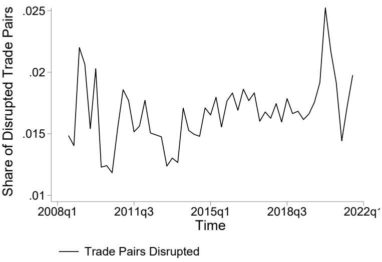
Shares of Disrupted Trade Pairs

Disruption b/w consignee i and shipper j at t according to **"4-0-1"** rule:

- pair is *established* if ever active for 4 quarters in a row,
- was inactive in t,
- was active in at least 1 quarter over the next year



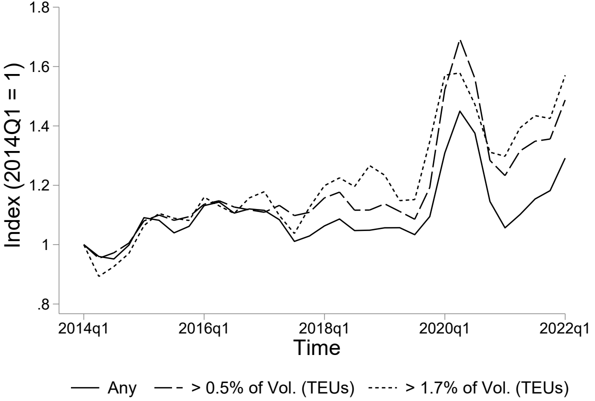
Full sample



Compustat

▸ Alternative definitions

Large vs. Small Disruptions



Sales Growth and Disruptions

$$\widetilde{\Delta}\text{Sales}^{t}_{i,t-1} = \beta \mathbf{1}_{\text{Disruption}_{i,t}} + \lambda \mathbf{X}_{i,t} + \varepsilon_{i,t}$$

	$\widetilde{\Delta}Sales^{t}_{i,t-1}$			$\widetilde{\Delta}Sales^{t-1}_{i,t-2}$	$\widetilde{\Delta}Sales^{t+1}_{i,t-1}$	$\widetilde{\Delta}Sales^{t+2}_{i,t-1}$	$\widetilde{\Delta}Sales^{t+3}_{i,t-1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0055**	-0.0076**		-0.0022	-0.0118***	-0.0096**	-0.0044
	(0.003)	(0.003)		(0.003)	(0.004)	(0.004)	(0.005)
Share disrupted$_{i,t}$			-0.3250**				
			(0.135)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.048	0.061	0.061	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

Impact of disruptions is large and persistent

- Disruption $\Longrightarrow$ 0.8pp slower growth
- 10pp $\uparrow$ in the share of disrupted import $\Longrightarrow$ 3pp $\downarrow$ growth
- Effect persists (on average) for 3 quarters

Sales Growth and Probability of Disruptions

$$\mathbf{1}_{\text{Disruption}_{i,t}>0} = \sum_{q=2}^{5} \beta_q \mathbf{1}_{\widetilde{\Delta}\text{Sales}_{i,t-1}^{t+1} \in Q_q} + \lambda \mathbf{X}_{i,t} + \varepsilon_{i,t}$$

	$\mathbf{1}_{\text{Disruption}_{i,t}>0.005}$	$\mathbf{1}_{\text{Disruption}_{i,t}>0.017}$
	(1)	(2)
Sales growth quintile 2	-0.0045	-0.0076
	(0.009)	(0.006)
Sales growth quintile 3	-0.0149*	-0.0125*
	(0.009)	(0.007)
Sales growth quintile 4	-0.0153*	-0.0116*
	(0.009)	(0.007)
Sales growth quintile 5	-0.0218***	-0.0121*
	(0.008)	(0.007)
Constant	0.1593***	0.0858***
	(0.007)	(0.005)
Year-Quarter FE	✓	✓
Industry FE	✓	✓
State FE	✓	✓
R^2	0.107	0.052
Observations	20493	20493

Capturing SC Disruptions in Model

Break down probability of jump $\lambda = 0.011$ into two components:

- Related to supply chains, λ_{SC}
- Not related to supply chains, λ_{other}

Assume λ_{other} stays the same:

$$\lambda' = \lambda_{other} + \Delta \times \lambda_{SC}$$

Need two parameters, Δ and λ_{SC}

- $\lambda_{SC} = 0.00095$, share of firms w/ very large disruptions ($\geq \mu + 3\sigma$)
  - Assumption: share of large disruptions in the left tail is also $\approx$ 9%
- Fraction of trade pairs being disrupted $\uparrow$ 80%, $\Delta = 1.8$

In the model, $P[\text{disasters}]$ increased by 6.9%, $\lambda' \approx 0.01176$

Asset Pricing Implications

A 6.9% increase in λ leads to:

- $\mathbb{E}[r^e - r^f] = 6.72\%$ $(\Delta = 0.16pp)$
- $\mathbb{E}[r^f] = 0.72\%$ $(\Delta = -0.07pp)$

	B/M sorted, $\mathbb{E}[R_{port}]$			Inv. sorted, $\mathbb{E}[R_{port}]$		
Portfolio	λ	λ'	Δ	λ	λ'	Δ
Low	4.7	4.7	0.0	8.9	9.2	0.3
2	4.7	4.7	0.0	8.5	8.8	0.3
3	5.3	5.3	0.0	6.5	6.7	0.2
4	6.3	6.4	0.1	4.9	5.0	0.1
High	8.6	9.1	0.5	3.8	3.7	-0.1

Effect is heterogeneous in the cross-section

- Raises value $(\Delta = 0.5\text{pp})$ and investment $(\Delta = 0.4\text{pp})$ premiums
- Accounted for by unproductive (value) firms

Conclusions

This paper makes several contributions:

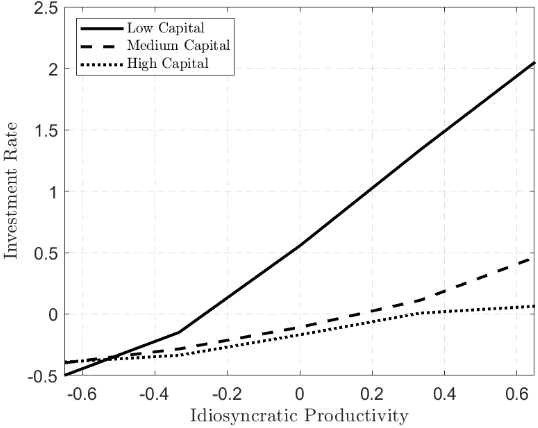
- Develops a GE model with microeconomic disasters
- Model accounts for macro, distributional and asset pricing moments
- Show empirically and highlight quant. role of mean-reversion
- Documented a rise in SC disruptions using novel data
- SC disruptions $\uparrow \Longrightarrow$ value and investment premiums $\uparrow$ by ≈ 0.5pp

Future work: endogenizing search for suppliers

- search for suppliers à la “shopping time” (i.e., Aguiar Hurst)
- introduce another factor of production (supplier capital)
- firms optimally invest into supplier capital

Appendix

Investment Rate and Productivity



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Excess Return and Dividend Growth Predictability

$$Y = \alpha + \beta(p_{m,t} - d_{m,t}) + \varepsilon_t$$

		Dependent Variable							
		$\sum_{j=1}^{L}(r_{m,t+j} - r_{f,t+j})$				$\sum_{j=1}^{L}\Delta d_{m,t+j}$			
			Model				Model		
	L(year)	Data	Mean	P5	P95	Data	Mean	P5	P95
	1	-0.12	-0.08	-0.18	-0.02	0.00	0.03	0.01	0.06
$\widehat{\beta}$	3	-0.27	-0.23	-0.45	-0.08	0.01	0.10	0.03	0.19
	5	-0.42	-0.35	-0.71	-0.12	0.04	0.17	0.06	0.33
	1	-2.63	-1.85	-3.35	-0.47	0.11	2.22	0.68	3.29
t-stat	3	-3.19	-3.42	-7.21	-0.92	0.19	4.40	2.15	6.27
	5	-3.37	-4.49	-9.57	-0.85	0.48	6.20	3.49	9.20
	1	0.09	0.07	0.00	0.16	0.00	0.08	0.01	0.15
R^2	3	0.19	0.18	0.01	0.47	0.00	0.25	0.07	0.40
	5	0.26	0.26	0.01	0.62	0.01	0.39	0.18	0.60

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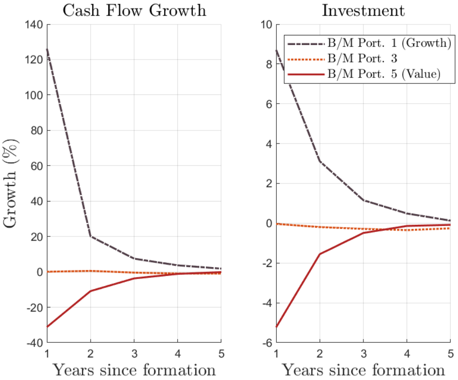
Investment and Cash Flow Growth after Portfolio Formation



Cash flows of value firms are more exposed to discount rate shocks

- After portfolio formation, growth firms start disinvesting
- While cash flows of value firms are in more distant future

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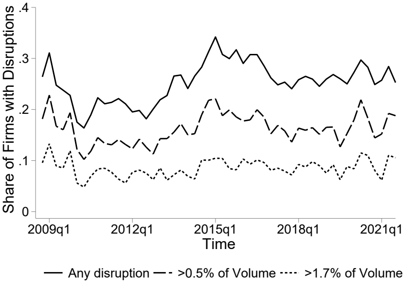
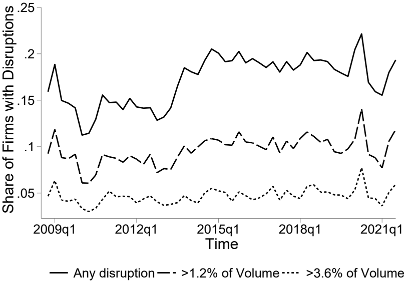
Share of Firms with Disruptions



Compustat sample



Full sample

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Investment Premium

Five investment sorted portfolios

- Sort on $\frac{k_{t-1}-k_{t-2}}{k_{t-2}}$ from the end of $t-2$ to the end of $t-1$
- Rebalance every 4 quarters

	$\mathbb{E}[R_{port}]$			$\sigma[R_{port}]$		
Portfolio	Data	$\lambda = 0$	$\lambda = 0.011$	Data	$\lambda = 0$	$\lambda = 0.011$
Low	10.5	7.3	8.9	18.8	18.6	18.1
2	8.6	6.7	8.5	14.9	17.9	17.3
3	8.0	5.8	6.5	15.8	17.2	16.0
4	8.0	4.9	4.9	17.0	16.7	15.3
High	7.2	3.9	3.8	22.0	16.2	14.7

Investment premium in the data (1-5 investment return) is 3.3%

- Investment premium without jumps is 3.4%
- Microeconomic disasters generate a premium of 5%
- The change is accounted for by low inv. stocks (quintile 1)
- Argument is similar: productive firms invest more Figure

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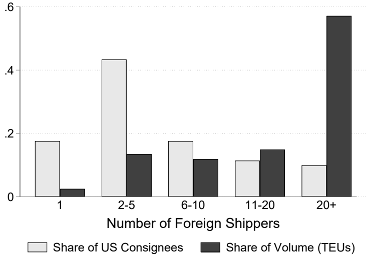
Importing Activity of US Firms



- companies with 20+ shippers account for 60% of import
- frequent trade pairs account for 80% of imports

Remark: Here restriction of 20 shippers on average not imposed

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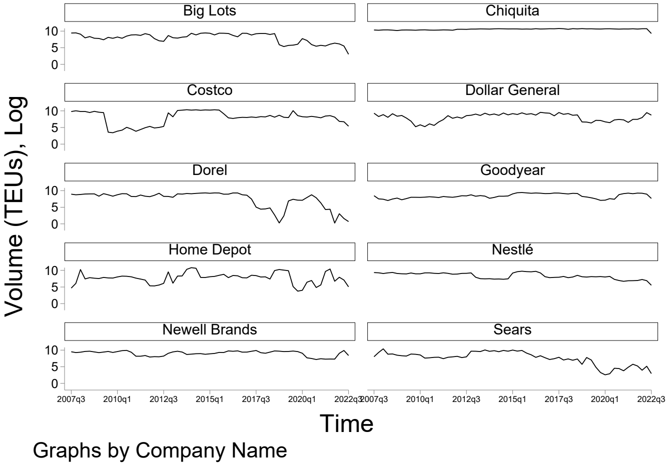
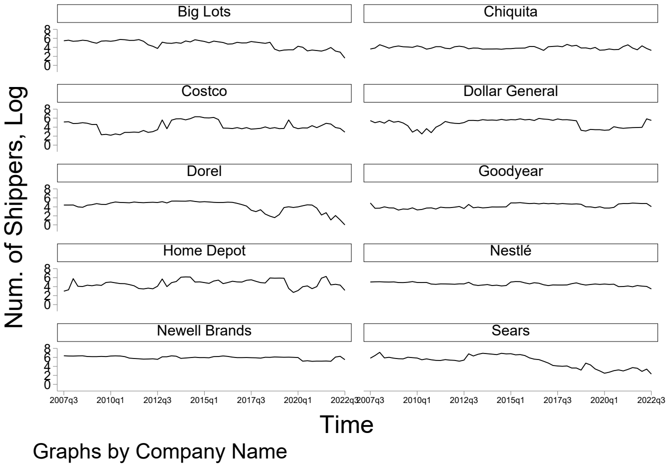
Top-10 Compustat Consignees, Total Volume



Top-10 Compustat Consignees, Number of Shippers



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Summary Statistics

Shipment Data (Panjiva)						
Variable	Number of Firms	Mean	Std. Dev.	P10	P50	P90
Shipments (1000s)	2919	0.684	2.464	0.015	0.275	1.414
Volume (1000s TEUs)	2919	1.533	6.757	0.016	0.359	3.256
Number of shippers	2919	63.0	84.8	6.0	46.0	120.0
Share redacted	2919	0.095	0.194	0.000	0.011	0.321
Number of disruptions	2919	0.565	0.899	0.000	0.250	1.500
Share of import disrupted	2482	0.019	0.049	0.000	0.006	0.046

Compustat						
Variable	Number of Firms	Mean	Std. Dev.	P10	P50	P90
Shipments (1000s)	420	1.298	2.091	0.069	0.594	3.046
Volume (1000s TEUs)	420	2.842	5.640	0.072	1.054	7.057
Number of shippers	420	102.6	123.8	19.0	67.0	216.5
Share redacted	420	0.115	0.198	0.000	0.027	0.359
Sales(bn)	424	16.44	37.51	0.49	4.36	37.72
Total assets(bn)	424	44.23	199.30	0.52	4.59	61.13
Quarterly sales growth	410	0.003	0.055	-0.034	0.007	0.040
Number of disruptions	424	0.582	1.101	0.000	0.000	1.750
Share of import disrupted	424	0.005	0.013	0.000	0.000	0.015

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Alternative Definitions

- 6-0-1 Figures Impact on Sales Growth
- 2-0-1 Figures Impact on Sales Growth
- 4-0-2 Figures Impact on Sales Growth
- 4-0-0 Figures Impact on Sales Growth
- 4-0-$\frac{3}{4}$ Figures Impact on Sales Growth

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Top-10 Compustat Consignees, Number of Shippers

Key steps:

1. roll up data to ultimate parent using Panjiva concordance file
2. drop firms which trade less than 50% of the time
3. drop if number of shippers ever exceeds $\mu \pm 3\sigma$ (redaction issue)
4. drop firms with < 20 shippers on average when studying disruptions
5. total number of firms $\approx 50K$, around $3K$ satisfy [1]-[4]

To construct Compustat sample:

1. use ultimate parent ID to GVKEY concordance file
2. about $2K$ Compustat firms can be merged
3. ... but we work with ≈ 500 (because of [4] above)
4. results for Compustat sample are similar to full sample

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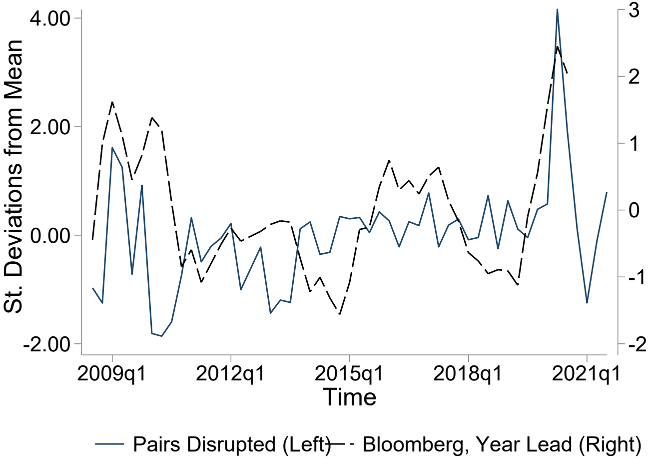
Bloomberg's Supply Constraints Index



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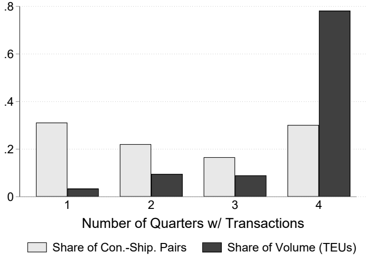
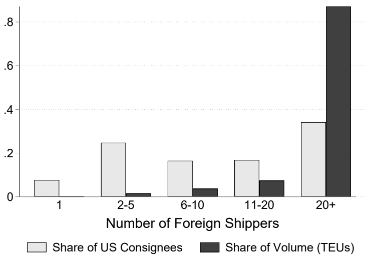
Importing Activity of Compustat Firms





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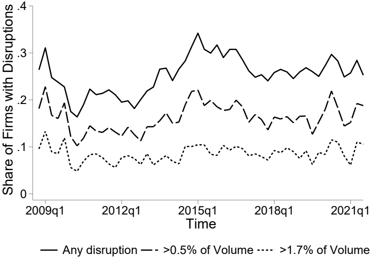
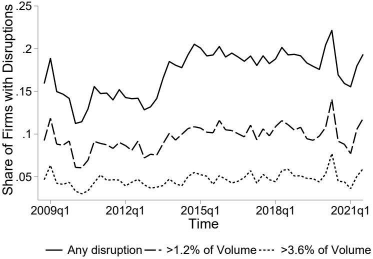
Fraction of Firms with Disruptions



(a) Compustat sample



(b) All firms

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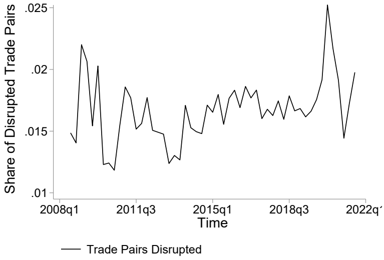
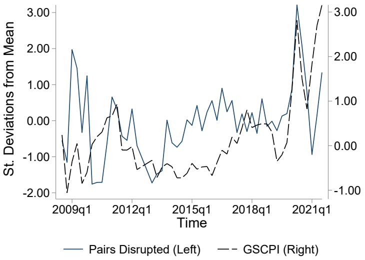
Shares of Disrupted Trade Pairs, Compustat





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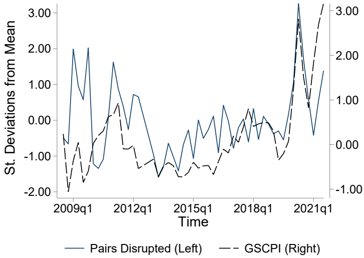
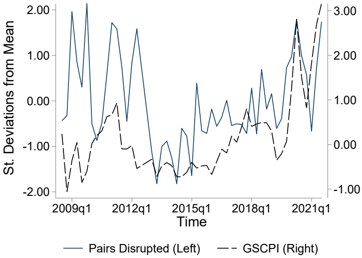
Shares of Disrupted Trade Pairs by Importance, Compustat



(a) $> 0.5\%$



(b) $> 1.5\%$

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Sales Growth and Disruptions, “6-0-1” Rule

	$\widetilde{\Delta}\text{Sales}^{t}_{i,t-1}$			$\widetilde{\Delta}\text{Sales}^{t-1}_{i,t-2}$	$\widetilde{\Delta}\text{Sales}^{t+1}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+2}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+3}_{i,t-1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0127***	-0.0154***		0.0053	-0.0240***	-0.0141**	-0.0026
	(0.003)	(0.004)		(0.004)	(0.005)	(0.006)	(0.005)
Share disrupted$_{i,t}$			-0.4525***				
			(0.143)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.049	0.062	0.062	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

▸ Back

Supply Chain Disruptions and Realized Returns in 2020 Rule

$$r_{i,2020q1} = \beta_0 + \beta_1 \mathbf{1}_{\text{Above P50}_{i,2019q4}} + \beta_2 \mathbf{1}_{\text{Disruption}_{i,2020q1}} + \\ + \beta_3 \mathbf{1}_{\text{Disruption}_{i,2020q1}} \mathbf{1}_{\text{Above P50}_{i,2019q4}} + \varepsilon_i$$

	$r_{i,2020q1}$	
	(1)	(2)
Disruption	0.0094	-0.0684***
	(0.015)	(0.018)
High B/M	-0.1691***	
	(0.014)	
High Inv		0.0673***
		(0.013)
High B/M x Disruption	-0.0557**	
	(0.027)	
High Inv x Disruption		0.1250***
		(0.026)
Constant	-0.1536***	-0.2316***
	(0.007)	(0.010)
R^2	0.22	0.10
Observations	857	857

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Sales Growth and Disruptions, “2-0-1” Rule

	$\widetilde{\Delta}\text{Sales}^{t}_{i,t-1}$			$\widetilde{\Delta}\text{Sales}^{t-1}_{i,t-2}$	$\widetilde{\Delta}\text{Sales}^{t+1}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+2}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+3}_{i,t-1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0022	-0.0036		-0.0024	-0.0053	-0.0019	0.0001
	(0.002)	(0.003)		(0.003)	(0.004)	(0.004)	(0.004)
Share disrupted$_{i,t}$			-0.0989				
			(0.065)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.048	0.061	0.061	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

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Sales Growth and Disruptions, "4-0-2" Rule

	$\widetilde{\Delta}\text{Sales}^{t}_{i,t-1}$			$\widetilde{\Delta}\text{Sales}^{t-1}_{i,t-2}$	$\widetilde{\Delta}\text{Sales}^{t+1}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+2}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+3}_{i,t-1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0090***	-0.0115***		0.0026	-0.0204***	-0.0183***	-0.0088*
	(0.003)	(0.004)		(0.004)	(0.005)	(0.005)	(0.005)
Share disrupted$_{i,t}$			-0.5245***				
			(0.175)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.048	0.061	0.062	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

▸ Back

Sales Growth and Disruptions, “4-0-0” Rule

	$\widetilde{\Delta}\text{Sales}_{i,t-1}^{t}$			$\widetilde{\Delta}\text{Sales}_{i,t-2}^{t-1}$	$\widetilde{\Delta}\text{Sales}_{i,t-1}^{t+1}$	$\widetilde{\Delta}\text{Sales}_{i,t-1}^{t+2}$	$\widetilde{\Delta}\text{Sales}_{i,t-1}^{t+3}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0031	-0.0038		0.0012	-0.0040	-0.0077	-0.0066
	(0.002)	(0.003)		(0.003)	(0.004)	(0.005)	(0.005)
Share disrupted$_{i,t}$			-0.0351				
			(0.025)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.048	0.061	0.061	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

▸ Back

Sales Growth and Disruptions, "4-0-3/4" Rule

	$\widetilde{\Delta}\text{Sales}^{t}_{i,t-1}$			$\widetilde{\Delta}\text{Sales}^{t-1}_{i,t-2}$	$\widetilde{\Delta}\text{Sales}^{t+1}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+2}_{i,t-1}$	$\widetilde{\Delta}\text{Sales}^{t+3}_{i,t-1}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbf{1}_{\text{Disruption}_{i,t}}$	-0.0052	-0.0071*		0.0046	-0.0140***	-0.0101*	0.0048
	(0.003)	(0.004)		(0.004)	(0.005)	(0.005)	(0.005)
Share disrupted$_{i,t}$			-0.3248**				
			(0.151)				
Year-Quarter FE	✓	✓	✓	✓	✓	✓	✓
Firm FE	—	✓	✓	✓	✓	✓	✓
R^2	0.048	0.061	0.061	0.060	0.071	0.102	0.161
N	20595	20593	20593	20240	20181	19773	19356

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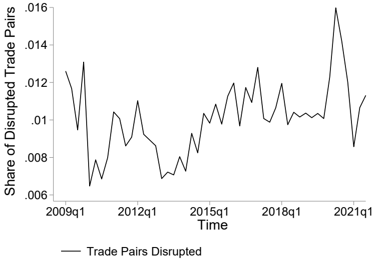
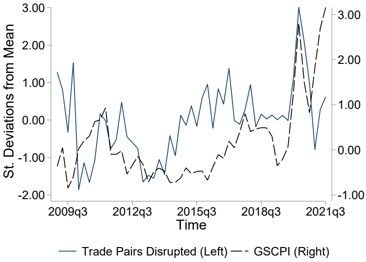
Shares of Disrupted Trade Pairs, “6-0-1” Rule





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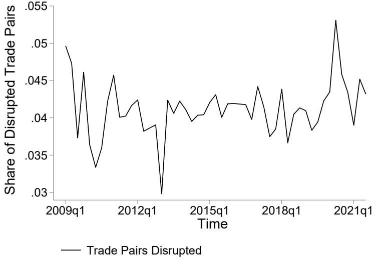
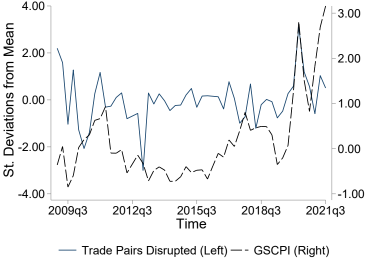
Shares of Disrupted Trade Pairs, “2-0-1” Rule





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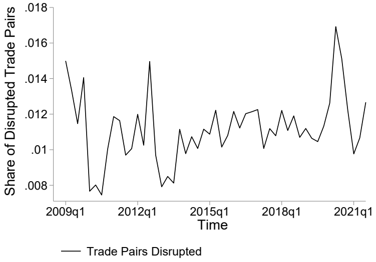
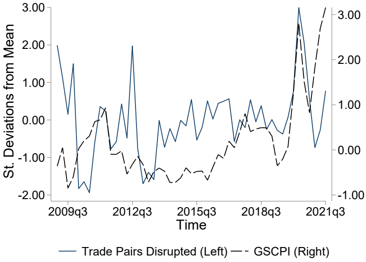
Shares of Disrupted Trade Pairs, “4-0-2” Rule





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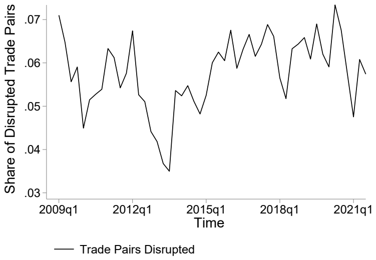
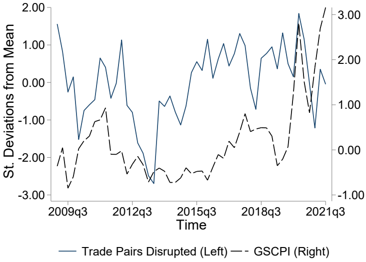
Shares of Disrupted Trade Pairs, “4-0-0” Rule





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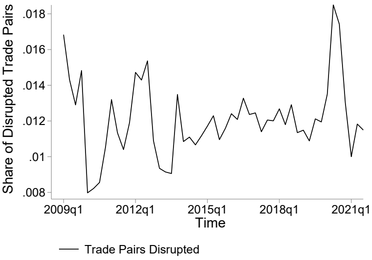
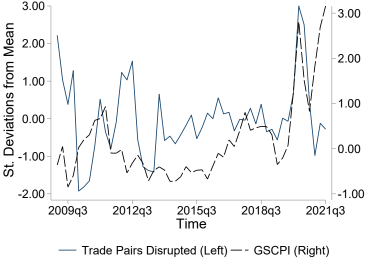
Shares of Disrupted Trade Pairs, “4-0-3/4” Rule





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Mean-Reversion of Employment Changes

Non-parametrically:

- Group firms by employment growth between $t-1$ and t & size
- Follow employment over the next 5 years

Implementation Details:

- Employment growth is log difference $n_t^i - n_{t-1}^i$
- Log employment n_t^i is net of age, industry and year FE
- Size of firm i at time t is average over 5 years $RS_t^i = \frac{1}{5}\sum_{p=1}^{5} \widetilde{N}_{t-p}^i$
- Sort firms into 20 RS percentiles: 1-5, . . . , 96-100
- Within each percentile, sort wrt growth between $t-1$ and t
  - ensures that firms within group have similar sizes up to $t-1$
  - ... and experience a similar change in employment from $t-1$ to t
- $\forall$ group compute log change of average employment from t to $t+k$

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Household's Problem

Household:

- consumes c
- inelastically supplies labor $\overline{N} = 1$
- invests into firms' shares $\xi'(k, z)$
- utility function $U = \frac{[C-H]^{1-\sigma}}{1-\sigma} = \frac{[CS]^{1-\sigma}}{1-\sigma}$
  - surplus consumption $S := \frac{C-H}{C}$
- law of motion for surplus consumption $S_{t+1} = \bar{S}^{1-\rho_H} S_t^{\rho_H} \left(\frac{C_{t+1}}{C_t}\right)^{\lambda_H}$

Recursive formulation:

$$H(\mathbf{S}) = \max_{c,\xi'} \left[U(c) + \beta \mathbb{E} H(\mathbf{S}')\right]$$

$$\text{s.t. } c + \int \rho_1(k', z'; \mathbf{S}) d\xi' \leq W(\mathbf{S})\overline{N} + \int \rho_0(k, z; \mathbf{S}) d\mu$$

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Parameterization

Parameter	Description	Value	Target/Source	Data	Model
β	Discount factor	0.989	90-day Treasury-bill return	0.24	0.20
α	Capital share	0.210			
ν	Labor share	0.640			
σ	Utility curvature	2	Campbell Cochrane'99		
δ	Depreciation rate	0.025	$\mathbb{E}\left[\frac{i}{k}\right]$	0.10	0.10
ρ_z	Persistence of idiosyncratic AR(1)	0.880	Mean-reversion of emp. changes		
σ_ε	Std of idiosyncratic AR(1)	0.038	$\mathbb{E}[P9010_t(\Delta \log E)]$	0.56	0.62
b	Adj. region	0	–		
$\bar{\eta}$	Upper bound non-convex	0.010	$P\left[\left\|\frac{i}{k}\right\| > 0.2\right]$	0.14	0.17
φ	Quadratic adj. cost	0.450	$\sigma\left[\frac{i}{k}\right]$	0.16	0.12
$\bar{S}$	Steady state surplus consumption	0.100	Mean Sharpe ratio	0.44	0.37
ρ_H	Habit persistence	0.980	Persistence of P/D	0.87	0.87
λ_H	Habit sensitivity	$\frac{1}{\bar{S}} - 1$			
ρ_Z	Persistence of aggregate TFP	0.980	Persistence of Solow res.	0.92	0.93
σ_Z	Std of aggregate TFP	0.014	$\sigma(Y)$	1.78	1.82
ρ_0	Size of jump	0.300	$\mathbb{E}[P5010_t(\Delta \log E)]$	0.26	0.31
ρ_1	Sensitivity of jump	4.050	$\sigma[P5010_t(\Delta \log E)]$	0.03	0.03
λ	Jump intensity	0.011	$P[\Delta \log E \leq -3\sigma]$	0.01	0.01

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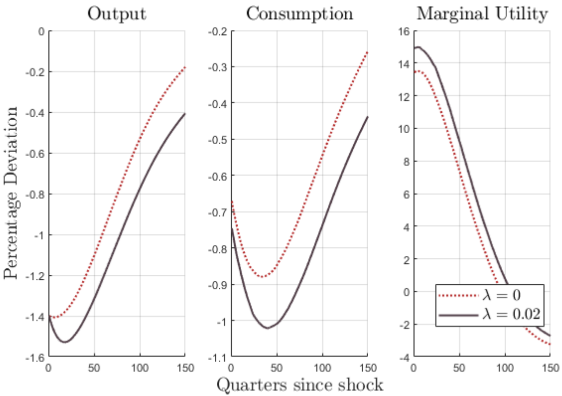
Impulse Response Functions



Rare negative jumps increase countercyclicality of marginal utility

- Production capacity of the economy is reduced (starting from $t+1$)
- This leads to a bigger decline in consumption

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Related Literature

Heogeneous firms with aggregate uncertainty

- *Thomas (2002), Khan Thomas (2008), Bloom et al. (2018), Winberry (2021)*
- This paper adds microeconomic disasters + studies asset pricing implications

Production-based asset pricing models

- *Jermann (1998), Zhang (2005), Chen (2018), Bai et al. (2019)*
- Capture lumpy investment, procyclical skewness of employment changes + put discipline using administrative data

Application: Increase in one type of disasters — Supply chains

- *Carvalho et al. (2021), Pierce et al. (2021), Alessandria et al. (2023)*
- Leverage novel data on universe ($\approx$ 180mln transactions) of seaborne US import to measure increasing SC disruptions

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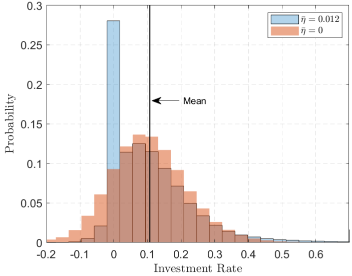
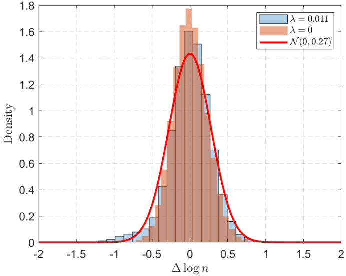
Distributional Fit in Steady State



Distribution of investment rates



Distribution of employment changes

▸ Parameterization ▸ IRFs

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