Production Networks and Firm-level Elasticities of Substitution

Brian Cevallos Fujiy [1] Devaki Ghose [2] Gaurav Khanna [3]

[1]University of Michigan

[2]World Bank, DECRG

[3]UCSD

This Paper

- Being able to substitute across suppliers after shocks
  - Key for resilience of supply chains

This Paper

- Being able to substitute across suppliers after shocks
  - Key for resilience of supply chains
- **Provide one of the first causal estimates of firm-level elasticities of substitution across suppliers of the same product**
- Quantify importance of these elasticities in the propagation of shocks through firm networks

Paper in one slide

Data

- Real-time firm-to-firm transaction data for a large Indian state

Identification Strategy

- Supply shock: India's sudden lockdown policy due to Covid that made inputs costly to produce and transport for some producers

Paper in one slide

Data

- Real-time firm-to-firm transaction data for a large Indian state

Identification Strategy

- Supply shock: India's sudden lockdown policy due to Covid that made inputs costly to produce and transport for some producers

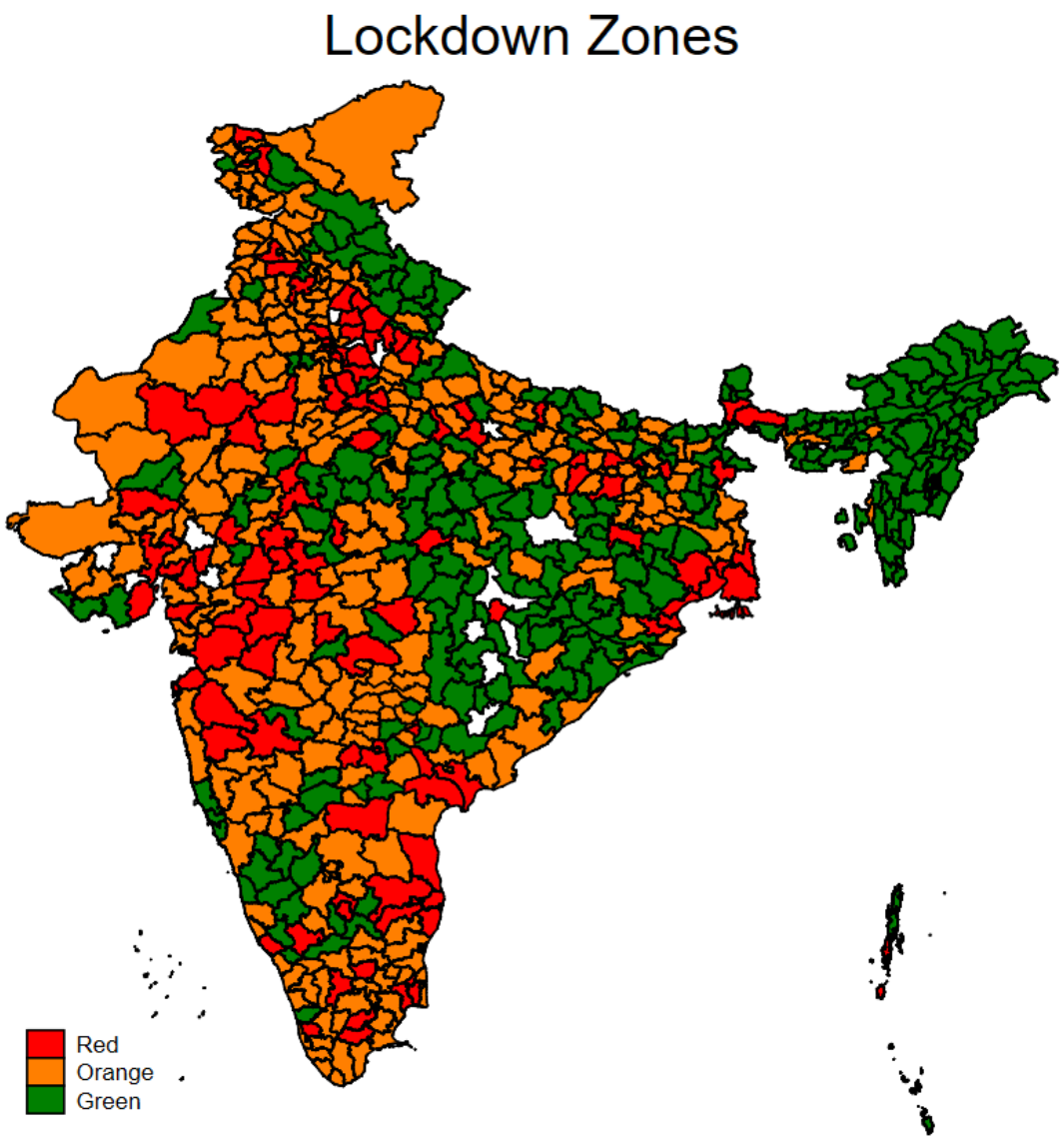
Empirical results

- Elasticities ≈ 0.52
- High levels of complementarity across suppliers

Model

- Extended production network model *a la* Baqaee and Farhi (2019)

Lockdown in India



Estimation of elasticity of substitution

- Estimating equation we take to the data:

$$\log\left(\frac{\widehat{PM}_{si,bj,t}}{\widehat{PM}_{i,bj,t}}\right) = (1-\epsilon)\log\left(\frac{\widehat{p}_{si,bj,t}}{\widehat{\widetilde{p}}_{i,bj,t}}\right) + \underbrace{\omega_{d_{(b)},t}}_{\text{buyer destination shocks}} + \omega_{o_{(s)}} + X\beta + \epsilon_{si,bj,t}$$

where $\widehat{x}_t = \frac{x_t}{x_{t-1}}$

Identification strategy

- Sources of variation:

$$\log\left(p_{si,bj,t}\right) = \log \underbrace{\left(p_{si,t}\right)}_{\text{seller's MC}} + \log \underbrace{\left(\tau_{sb,t}\right)}_{\text{transport cost}}$$

Identification strategy

- Sources of variation:

$$\log\left(p_{si,bj,t}\right) = \log \underbrace{\left(p_{si,t}\right)}_{\text{seller's MC}} + \log \underbrace{\left(\tau_{sb,t}\right)}_{\text{transport cost}}$$

- Variation in $p_{si,t}$ (Seller-level instrument):

$$log(\widehat{p}_{si,bj,t}) = \beta^{R} Red_{o_{(s)}} Lock_{t} + \beta^{O} Orange_{o_{(s)}} Lock_{t} + \omega_{d_{(b)},t} + \omega_{o_{(s)}} + X\beta + \epsilon^{\nu}_{si,bj,t}$$

Identification strategy

- Sources of variation:

$$\log\left(p_{si,bj,t}\right) = \log \underbrace{\left(p_{si,t}\right)}_{\text{seller's MC}} + \log \underbrace{\left(\tau_{sb,t}\right)}_{\text{transport cost}}$$

- Variation in $p_{si,t}$ (Seller-level instrument):

$$log(\widehat{p}_{si,bj,t}) = \beta^{R} Red_{o_{(s)}} Lock_{t} + \beta^{O} Orange_{o_{(s)}} Lock_{t} + \omega_{d_{(b)},t} + \omega_{o_{(s)}} + X\beta + \epsilon^{\nu}_{si,bj,t}$$

- Variation in $\tau_{sb,t}$ (Seller/buyer level instrument):

$$log(\widehat{p}_{si,bj,t}) = \beta^{R} Red_{o_{(s)}d_{(b)}} Lock_{t} + \beta^{O} Orange_{o_{(s)}d_{(b)}} Lock_{t} + \omega_{d_{(b)},t} + \omega_{o_{(s)}} + X\beta + \epsilon^{\nu}_{si,bj,t}$$

Estimated elasticity of substitution across suppliers

	(1)	(2)	(3)
$\log\left(\frac{\hat{p}}{\hat{\tilde{p}}}\right)$	0.48	0.65	.17
	(0.22)	(0.15)	(.01)
Obs	2426885	2426885	3611466
K-PF	20.31	12.58	-
J-stat	4.62	2.12	-
ϵ	0.52	0.35	.83
Seller/Buyer IV	Y		
Seller IV	Y	Y	
OLS			Y

Why does complementarity matter?

- When inputs are highly **complementary**: negative shocks to even a subset of firms can have large negative effects on the aggregate economy
- Lack of substitutability across suppliers can partially explain the fall in GDP in India during the Covid crisis

Conclusion

- We leverage **variation in input prices** following the Covid-19 lockdown
- Provide one of the first estimates of **elasticities of substitution across suppliers** within the same industry
- Embed these elasticities in extended production network model to quantify the role of complementarities

Thank You