

Discussion of  
“Weathering the Storm: Supply Chains and Climate Risk”  
Castro-Vincenzi, Khanna, Morales, and Pandalai-Nayar (2024)

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Firm Dynamics and the Macroeconomy  
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## Risk and Resilience in Supply Chains

- A large (theoretical and empirical) literature on how shocks/disruptions to supply chains propagate from suppliers to customers.
  - ▶ More recent and smaller literature: endogenous production networks
- However, aside from a handful of exceptions, the operating framework assume **perfect foresight**: firms face no uncertainty when deciding on their (1) set of suppliers and customers and (2) quantities

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- Benchmark models are fundamentally not useful for thinking about **risk**, **uncertainty**, and **resilience**.
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  - ▶ no **risk incentives** to form a diversified supply chain
- Clearly abstracting from an important mechanism!

# This Paper

- A theoretical and empirical investigation of formation of supply chains in the the presence of supply chain risk (in this case, climate shocks)
  
- **Empirical findings:**
  - ▶ **diversification:** firms mitigate risks by sourcing from multiple suppliers
  - ▶ **sourcing:** firms purchase from distant, dryer locations at higher prices
  - ▶ **price:** suppliers in higher-risk areas tend to charge lower prices
  
- **Impact of climate shocks:** event study
  - ▶ **temporary drops:** supplier sales drop temporarily following floods, with recovery within months
  - ▶ **limited substitution:** affected firms generally do not switch to new suppliers

# Model

- **Spatial general equilibrium model:** firms decide on input sourcing under climate risk, accounting for trade-offs between costs, risk, and productivity.
  - ▶ **main mechanism:** primary reason for trade here is risk diversification
  - ▶ **wage implications:** wages correlate inversely with climate risk exposure; safer regions experience wage increases.
  - ▶ **diversification trade-offs:** supply chain diversification reduces wage volatility but may increase costs.
  
- **Quantitative exercise:** census of manufacturing firms across India
  - ▶ **real wages:** higher (3.1%) and more volatile (9.25%) under autarky than with trade
  - ▶ **distributional effects:** climate risk exacerbates wage disparities across regions.

## Simplified Model 1

- General equilibrium spatial model of firm input sourcing under climate risk
- Unit mass of firms in each region, potentially sourcing from suppliers in all regions.
  - ▶ final good producers: **monopolistically competitive**
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- **Main assumption:** information friction in quantity choice  
**intermediate input** choices are made at  $t = 0$  **before** the realization of shocks;  
**pricing and labor** input decisions are made at  $t = 1$  **after** the realization of shocks

## Simplified Model 2

- Representative household in each country with log preferences over a CES bundle of domestically produced varieties:

$$W_i = \log C_i = \log \left[ \int_0^1 q_i(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right]^{\frac{\sigma}{\sigma-1}}$$

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- Model in the paper more general:
  - ▶ trade costs; nontrivial (but ex ante known) productivity shocks;

## Results

1. **Diversification:** firms have concave profit functions, which implies that they diversify their ex ante sourcing decisions  $M_{ij}$  to hedge against climate shocks  $\chi_j$
2. **wage-risk relationship:** “safer” regions see higher real wages in general equilibrium.

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- **Concave profit function:** the motive for diversification is simply due to the **price elasticity of demand** in the downstream market  $\rightarrow$  **general force independent of all other details of the model.**
- Also robust to the elasticity of substitution between different inputs.

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- The relationships between real wage and “disruption” is not due to the frictions per se. Rather, a consequence of **constant monopolistic markups**.
- Uncertainty's main roles seem to be to induce multisourcing.

## Supply Chain “Risks”?

- The notion of risk is used more colloquially (“bad things will happen”) rather than capturing uncertainty.
- Imagine a region with  $\chi < 1$  but there is **no uncertainty**. Then, disruptions are functionally no different from iceberg costs.
  - ▶ **paper’s interpretation**: high risk region
  - ▶ **my interpretation**: no uncertainty, hence no risk
- Beyond cosmetics/terminology:
  - ▶ the paper does not really explore how more or less uncertainty impacts firms’ sourcing decisions and macro outcomes
  - ▶ put differently, the role of the variance-covariance matrix of  $\chi$  is unexplored.

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  - ▶ Conditional on forming multiple suppliers, I worry none of the effects explored in the paper depend on the actual friction at hand.



## Result 3: Cost Minimization-Resilience Tradeoff

- Wages are inversely correlated with sourcing risk (as already discussed).
- But can this be an artifact of the assumption that a disruption only impacts shipped goods, but not labor supply?
- Floods and other climate/natural disasters also negatively impact labor supply, due to, say, displacements, casualties, etc.
  - ▶ if so, relative wages are no longer deterministic.
  - ▶ can the real wage go up after the disaster and hence on average?
  - ▶ implications for where to source from?

## Welfare Implications

- The paper presents quantification results for the welfare impact of trade costs: welfare is lower with autarky compared to the costly trade.
- This should be more than just a quantification exercise. This should be a result: my conjecture is that the planner chooses the same quantities as the firms.
  - ▶ Pellet and Tahbaz-Salehi (2023): constraint efficiency in a **closed-economy**.
- If so, solving the planner's problem can be a simpler alternative to solving the model (especially in the quantitative exercise)

## Conclusion

- Important questions: both empirically and theoretically
- Nice simple environment to think about supply chain diversification: risk-return tradeoff
  
- Since the paper is fundamentally about risk considerations on firms' decisions and their macro impact:
  - (1) what is the role of the risk exactly? theoretically and quantitatively?
  - (2) what macro outcomes depend on the risk/uncertainty that are not also present in the economy without uncertainty?