The Bullwhip: Time-to-Build and Sectoral Fluctuations

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Summary

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- Develop a theory of sectoral demand shocks + heterogeneous time-to-build production
  - Closed-form solutions for sectoral responses to demand shocks at diff. horizons across sectors
- Provide empirical evidence for the bullwhip effect across supply chains in the US
  - Sectoral value-added (IP data) + IO table (BEA) + back-log ratio (Census survey) for manufacturing
  - Extract downstream value-added innovations and estimate upstream IRFs
  - Classify downstream sectors by the relative importance of AR(2) shocks with PACF

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  - Extract downstream value-added innovations and estimate upstream IRFs
  - Classify downstream sectors by the relative importance of AR(2) shocks with PACF
- Quantify the importance of the bullwhip effect in accounting for supply chain volatility

Main Findings & Contribution

1. Bullwhip effect arises if current demand signals future expected demand strongly
   - hetero. lags in time-to-build + hump-shaped demand shocks amplifies upstream responses (unlike static model or uniform lags)
2. Even under incomplete info, hump-shaped response exists along the network, and this gets pronounced with more hump-shaped shocks
3. Empirically, downstream sectors exhibit AR(2) demand shocks and hump-shaped responses
4. The shocks also generate hump-shaped response along the supply chain, more amplified in upstream sectors, and more pronounced in sectors with more dominance of AR(2) shocks
5. Such bullwhip effect accounts for 47.6% of supply chain volatility in the US

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★ Tractable model giving a full analytic characterization of shock propagation

★ Nicely test and quantify the time-to-build dynamics in creating bullwhip effects

Comments

Overview

- Super interesting & a very well-written paper. I learned a lot!
- Some comments:
  1. Production Function Assumptions
  2. Identification of Demand Shocks: Demand vs. Supply?
  3. Alternative sources of dynamic responses

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Q: How would allowing input substitution and endogenous time-to-build choices affect the bullwhip?

Identification of Demand Shocks

Empirically, innovations in **downstream value added** (r_{it}) are treated as **demand shocks**:

$$\text{VA}_{it}^{down} = \sum_{s=1}^{p} \gamma_s VA_{it-s}^{down} + \mu_i + \mu_t + \mathbf{r}_{it}$$

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- However, value added is an equilibrium object from both supply/demand sides in the data
  - Downstream supply shocks can also propagate upstream through input demand, potentially confounding the demand-driven bullwhip effects using value-added data

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- Why demand shocks, necessarily? Can we distinguish supply vs demand shock and compare the amplification effect? (relaxing to non-unit elastic demand, e.g., CES)

Alternative Sources

In this paper:

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In contrast, bullwhip mechanisms can still be created by **alternative sources of dynamic responses:**

- Inventory smoothing and stock-adjustment
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Q: To what extent can time-to-build account for observed upstream volatility *relative to* other adjustment margins? How do these differ in welfare implications for the bullwhip?

Conclusion

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This paper:

- Provides a clean, closed-form theory of the bullwhip effect + data evidence
- Highlights the role of heterogeneous time-to-build in generating shock propagation

Review: promising and well-executed paper with insightful theoretical and empirical results!

Might still be useful to

- Clarify the role of production function assumptions
- Validate the identification and distinction of demand shocks
- Discuss alternative adjustment margins and clarify how this channel differs