The Bullwhip: time to build and sectoral fluctuations

Discussion

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Summary

Question

What is the impact of demand shocks on output and volatility of upstream sectors?

Method

- Develop a model of production networks with demand shocks and heterogeneous time to build technology.
- Evaluate the bullwhip effect on long time series of US production.

Results

- Characterize the impact of (i) demand shocks, (ii) network structure of production, (iii) time-to-build heterogeneity on equilibrium output of all sectors.
- Bullwhip effects are sizable for the US economy.

Excellent paper!

Key results

Result 1: Equilibrium sector output $p_{it} y_{it} \equiv \gamma_{it}$ is given by

$$\gamma_t = \theta_\mathbf{t} + \sum_{\mathbf{s}=\mathbf{1}}^{\infty} \beta^\mathbf{s} \underbrace{\sum_{\phi \in \mathbf{\Phi}_t} \prod_{\phi_j \in \phi} \Omega_{\phi j}}_{\text{delay+network}} \underbrace{\mathbb{E}\left[\theta_{t+s}\right]}_{\text{future demand}} \quad \text{with } \Omega_d \equiv \left[\omega_{ij} \mathbf{1}_{d_{ij}=d}\right]'$$

I.e.: demand shocks θ_t affect sector output directly; future demand θ_{t+s} indirectly through all sectors j to which i supplies (Ω_d).

Result 2: If demand follows an $AR(\infty)$ process with AR coefficients δ_s, transitory demand shocks affect output as:

$$\frac{\partial \gamma_t}{\partial e_t} = I + \sum_{s=1}^{\infty} \beta^s \left(\sum_{\phi \in \mathbf{\Phi}_t} \prod_{\phi_j \in \phi} \delta_{\phi_j} \Omega_{\phi j} \right)$$

Key results

Result 3: Further parameterize the $AR(\infty)$ process as $AR(2)$ with $\rho > 0.5$

$$\tilde{\gamma}_t = \underbrace{G^{\epsilon}_{\infty}\left(\tilde{\theta}_t - \tilde{x}_t\right)}_{\textbf{transitory}} + \underbrace{G^{x}_{\infty}\tilde{x}_t}_{\textbf{persistent}}$$

- Output has transitory component (monotonic decay), and persistent component (hump shaped).
- Impact of a shock to j on output of upstream i can be written as a bilateral upstreamness measure (c.f Alfaro et al., 2019), accounting for time to build.

Result 4: Not only mean output increases, also the variance (the true bullwhip)

Empirics

Fact 1: Upstream sectors are more volatile than downstream sectors.
Fact 2: Demand shocks are indeed hump shaped.
Fact 3: Persistent demand shocks account for large share of sectoral fluctuations.

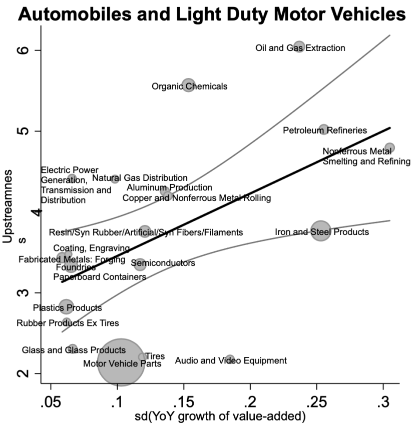
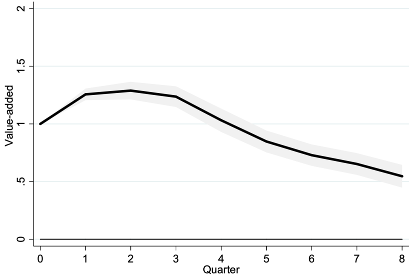


Figure 6. Cumulative impulse response



Some thoughts

Question 1: Can you characterize input substitutability?

- Network structure is surely not fixed over the long time period 1972-2023.
- Say input shares adjust in response to shocks, does this dampen or amplify the bullwhip effect?

Question 2: Are there potential induced effects?

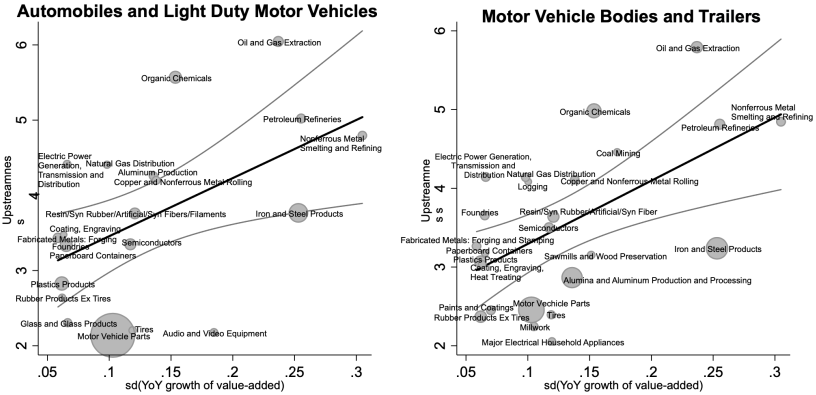
- Positive demand increases output $\theta_{it} = p_{it} c_{it}$ and value added $\alpha_i p_{it} y_{it}$.
- This additional value added (labor income) will be consumed again.
- Cf. Type I vs Type II multipliers in the older IO literature (induced effect).
- This is not just a scalar, but a heterogeneous feedback loop into the model.

Question 3: Are sector upstreamness/distance and d_{ij} correlated?

- Both are exogenous and time invariant, but are they correlated?
- Is it because sectors are upstream or because they take longer to build that they are more volatile?

Some thoughts

Question 4: Is it sector-specific demand shocks, common, or convoluted shocks?



- Say there is 1 macro shock –> what happens?

Minor remarks

- Fig 1 & 5: do not control for other supply shocks, or demand shocks to other sectors.
- Perform analysis on period 1972-2019 (avoid unexpected supply chain bottlenecks of Covid).
- Weird important upstream sectors to car/trailers including "AV equipment" and "electrical household appliances"?
- Figure 7 is inconclusive:
  - no significant difference between IRFs, non-monotonic implications between groups 1-4.
  - Is it too noisy? Too little data? Other mechanisms at play?