Production networks, nominal rigidities, and the propagation of shocks

E. Pasten, R. Schoenle, and M. Weber

discussed by: James Costain, Banco de España

17 December 2015
Motivation

- A quantitative, empirical paper on the sources of shocks driving business cycles.

- **How do realistic forms of heterogeneity—related to multisectoral economy—alter the impact of shocks?**
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- A quantitative, empirical paper on the sources of shocks driving business cycles.

- **How do realistic forms of heterogeneity—related to multisectoral economy—alter the impact of shocks?**

  - Carvalho (2006) says **heterogeneity in price stickiness** increases real impact of money shocks
    - How is this affected by intermediate inputs in the production function?
    - How is this affected by *heterogeneity* in input/output structure?

  - Gabaix (2011) says **heterogeneity in sector size** may imply aggregate fluctuations from sector-specific shocks
    - How is this affected by price stickiness?
    - How is this affected by *heterogeneity* in price stickiness?
Model ingredients and data sources

- **Standard New Keynesian DSGE** framework, with some heterogeneity built in...

- **Calvo price stickiness** (but flexible wages)
  - Allow for *sectoral heterogeneity* in stickiness
  - Map to PPI data: *sectoral frequency of price adjustment*
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- Shocks to Taylor rule
- Sector-specific productivity shocks
Theoretical comparisons

**Table:** Theoretical results: impact of heterogeneity

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**Effects of monetary shocks**
- Prop. 1
- Prop. 4
- Prop. 6

**Effects of sector-specific technology shocks**
- Prop. 2
- Prop. 5
- Prop. 7

Prop. 3
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Effects of monetary shocks
- Prop. 1 (Basu, '95)
- Prop. 4 (Carvalho, '06?)
- Prop. 6

Effects of sector-specific technology shocks
- Prop. 2 (Gabaix, '11)
- Prop. 5
- Prop. 3 (Acemoglu et al, '12)
- Prop. 7
Suppose prices are equally sticky in all sectors. Then...

Money shocks:

- **Prop. 1.** Higher share of intermediate inputs in production implies greater monetary nonneutrality. (Basu '95)
  - But heterogeneity in input use is irrelevant for nonneutrality.
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Sectoral productivity shocks:

- **Prop. 2.** Suppose all sectors use inputs in same proportions. Then slowly-decaying power law in sector size implies LLN fails: sectoral shocks have aggregate effects. (Gabaix, ’11)
  - These aggregate effects are decreasing in price stickiness (???)
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- **Prop. 3.** Suppose sectoral importance in the I/O matrix obeys a slowly-decaying power law. Then LLN fails: sectoral shocks have aggregate effects. (Acemoglu, Akcigit, Kerr '13)
Suppose input weights equal consumption shares for all sectors. Then...

**Money shocks:**

- **Prop. 4.** Greater *heterogeneity of price stickiness* across sectors has an *ambiguous effect monetary nonneutrality*.
  - So the sign of the effect is left for the calibration exercise...
  - C. Carvalho ('06): heterogeneous stickiness strongly increases nonneutrality!
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**Sectoral productivity shocks:**

- Prop. 5. LLN is more likely to fail if larger sectors tend to have more **flexible** prices.
  - But the multiplier of sectoral shocks on aggregate output is **decreased by heterogeneity** of price stickiness (???)
Suppose heterogeneity in stickiness and in input weights. Then...

**Money shocks:**

- **Prop. 6.** Generalizes Props. 1 and 4.
  - Ambiguous effects in Prop. 4 are now said to be unambiguous???
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**Sectoral productivity shocks:**

- **Prop. 7.** Generalizes Prop. 5: **LLN is more likely to fail if more important sectors** tend to have **more flexible** prices.
QUANTITATIVE RESULTS
Output response to money shock

Main quantitative results:

- Heterogeneous stickiness amplifies nonneutrality (Case 2 → 3)
- Heterogeneity of input linkages has little effect on nonneutrality

This figure plots the impulse response function of consumption to a one-standard deviation monetary policy shock for a 58 sector model in the top panel and a 350 sector model in the bottom panel for different cases (see Table 2).
SOME COMMENTS
Disciplined exploration of complex quantitative modeling issues
Model structure closely matches data structure
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Model structure closely matches data structure

A concern about this class of models: missing frictions?

- Only prices are sticky.
- Wages, labor allocation across firms and sectors, demand allocation across firms and sectors are all flexible.
- Impulse responses and welfare analysis could be sensitive to frictions in those other adjustment margins too...
Text misinterprets Prop. 2, claiming that the effects of sectoral shocks decrease with price rigidity?

- Sectoral shocks multiplier $\Lambda_{ac} = 0$ if prices fully rigid
- Sectoral shocks multiplier $\Lambda_{ac} > 0$ if prices fully flexible
On the propositions

- **Text misinterprets Prop. 2**, claiming that the effects of sectoral shocks decrease with price rigidity?
  - Sectoral shocks multiplier $\Lambda_{ac} = 0$ if prices fully rigid
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  - But formula shows that effect is **nonmonotonic**!
  - Gradually increasing rigidity initially makes $\Lambda_{ac}$ explode to infinity, then it converges to zero from $-\infty$!
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Are Props. 6-7 really propositions at this point, or just rough observations? Why does 6 seem to contradict 4?
What else to do with a sectoral sticky-price model?

- Model has implications for response to changes in input prices (propagation of stickiness through I/O relations)
- This can’t be explored with data sources used in this paper
- Need matched data on prices of wholesalers/retailers or input suppliers/purchasers
Boivin/Giannoni/Mihov ’09, Mackowiak/Moench/Wiederholt ’09 claim that prices react more quickly to sectoral shocks than to aggregate shocks. However, they don’t observe sectoral shocks! What they actually show is that sectoral inflation residuals unexplained by aggregate shocks look like permanent shocks and explain more than 90% of sectoral inflation variance. Costain/Nakov ’11 show that a model of intermittent price changes without sectoral shocks reproduces the MMW09 evidence on sectoral inflation residuals almost perfectly, if the (finite) number of products per sector obeys a power law. Why? The sectoral inflation residual is just random variation which firms adjust when. We used a state-dependent pricing model, but the same argument should work in a Calvo model!
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THANKS FOR YOUR ATTENTION!