Aggregation and the PPP Puzzle in a Sticky Price Model

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• Very interesting paper
  – Contribution to PPP puzzle and macro models of open economies
  – Contribution to aggregation debate
  – Nicely ties into recent micro estimates of price stickiness

• Discussion
  – Give account of way model works
  – Some comments on empirical implications
Simple version of model

- 2 countries, LCP in both countries
- K sectors, Calvo coeff $\lambda_k$ each sector/country
- Complete markets

$$\rho c + p = \rho c^* + s + p^*$$

- Linear disutility of leisure

$$w = \rho c + p$$
Simple version of model

• Money market equilibrium

\[ m = \rho c + p \]

• Random walk money shocks

\[ m = m_{-1} + u \]
Simple version of model

• Equilibrium pricing equation in each sector

\[ p = (1 - \lambda_k) m + \lambda_k p_{-1} \]

• Exchange rate

\[ s = m - m^* \]
Simple version of model

- Sector real exchange rate \( q_k = p_k^* + s - p_k \)

\[ q_k = \lambda_k u + \lambda_k q_{k-1} \]

- Aggregate real exchange rate

\[ q = \sum f_k q_k \]
Sum of \( K \) AR(1) = ARMA(\( K, K-1 \))

- Leads to sector real exchange rate

\[
\prod_{1}^{K} (1 - \lambda_k L) q
\]

\[
= \sum_{1}^{K} \prod_{i \neq k}^{K} (1 - \lambda_i L) f_k \lambda_k u
\]
• Take an example with 2 sectors

\[ q = (\lambda_1 + \lambda_2)q_{-1} - \lambda_1 \lambda_2 q_{-2} \]

\[ + \frac{\lambda_1 + \lambda_2}{2} u - \lambda_1 \lambda_2 u_{-1} \]
Compare to averaged RER

• Leads to sector real exchange rate

\[ q^a = \frac{(\lambda_1 + \lambda_2)}{2} q_{-1} + \frac{(\lambda_1 + \lambda_2)}{2} u \]

• Result: persistence is greater for \( q \) than for \( q^a \)
Take unit shock to $u$

- Impulse response $q$

\[ q_t = \frac{\lambda_1}{2} + \frac{\lambda_2}{2} \]

- Impulse response $q^a$

\[ q_t^a = \left( \frac{\lambda_1 + \lambda_2}{2} \right)^t \]
Impulse response is a convex function of roots

- Therefore

\[ q_t > q_t^a \]
In this example, roots are:

\[ \lambda_1 = 0.55, \quad \lambda_2 = 0.95, \quad \frac{\lambda_1 + \lambda_2}{2} = 0.75 \]
Most persistent sector dominates

\[ q(\lambda_2) \]

\[ q(\lambda_1) \]
Decomposition

• Aggregation effect

\[ P(q_t) - \sum_k f_k P(q_k) \]

• Mis-specification effect

\[ \sum_k f_k P(q_k) - P(q^a) \]
Note, in IRF, there is only mis-specification, since:

\[ q = \sum_k f_k q_k \]
Heterogeneity effects

• Increases persistence \((u = 0.3u(-1))\)

\[
q = (0.95)q_{-1} + u
\]

\[
q^a = (0.86)q^a_{-1} + u
\]

• Increases volatility

\[
\sigma_q = 1.67\sigma_{q^a}
\]
Contribution

• PPP puzzle
  – Why RER so volatile and persistent?
  – Chari et. al. (2002): Sticky price models cannot easily explain this
  – This paper gets much closer
  – But number of other mechanisms
    • Lahiri and Johri
    • Steinsson
    • Kollman
Contribution

• Motivation of paper
  – Make more attempt to quantify macro moments – how does it do on other macro aggregates?
  – Need fully specified model as in CKM

• Deeper puzzle
  – Disconnect – not solved by this model
  – RER change equals relative consumption growth
Sectoral issues

• Model implies substantial differences across sectors in persistence and variability of RER
• Kehoe and Midrigan: this is not in data
Data don’t seem to support that? US-Germany
Related issue

• Are monetary non-neutralities very different across sectors?
  – By product of sticky price model
Role of highly persistent sectors

• Evidence that long run real exchange rate movement is dominated by small number of sectors?
Contribution of small persistent sector first minimal, but afterwards dominant.
Sectoral vs. aggregate

• Dynamic behavior of sectoral RER very different from aggregates?
• Sectoral AR(2)
• Aggregate ARMA(K+1,K-1)
  – Evidence of this?
Aggregation vs. Misspecification

• Depends on statistic used
• If aggregation biased measured by AR(1) coefficient, then most heterogeneity if due to aggregation
Conclusion

• Promising paper
• Needs to provide more support for importance of mechanism at sector level