Can Sticky Price Models Generate Volatile and Persistent Real Exchange Rates?

Chari, Kehoe, and McGrattan (REStud 2002)

Discussion by Fernando Leibovici

Real Exchange Rate

Definition

- $RER \equiv \frac{eP^*}{P}$
- Price of foreign output relative to domestic output in a common currency

US-Europe 1973Q1-1994Q4

	SD relative to GDP	Autocorrelation
RER	4.36	0.83
e	4.67	0.86
$\frac{P^*}{P}$	0.71	0.87

Sticky Prices and RER Fluctuations

Mechanism

- Under sticky prices, Δ money supply lead to
  - Δ R such that money market clears
  - Δ e such that all currencies offer same nominal expected rate of return
  - Stable $\frac{P^*}{P}$
  - Thus, $\Delta \frac{eP^*}{P}$

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This paper asks:

- Can this mechanism account for the volatility and persistence of RER?
  1. Standard frictionless model + sticky prices
  2. RER volatility
  3. RER persistence
  4. Quantitative evaluation

Setup

- 2 countries $\rightarrow$ H and F
- Agents in each country
  - Representative household
  - Representative producer of final consumption-capital good
  - Continuum $[0, 1]$ of intermediate good producers
  - Central bank
- Commodities
  - Continuum $[0, 1]$ of H and F intermediate goods $\rightarrow$ Traded internationally
  - H and F final consumption-capital goods
  - H and F money
  - Labor

Representative Final Good Producers in H

Problem

$$\max_{Y_{H,it}, Y_{F,it}} P_t Y_t - \int_0^1 P_{H,it} Y_{H,it} di - \int_0^1 P_{F,it} Y_{F,it} di$$

subject to

$$Y_t = \left[a_1 \left(\int_0^1 Y_{H,it}^{\theta} di \right)^{\frac{\rho}{\theta}} + a_2 \left(\int_0^1 Y_{F,it}^{\theta} di \right)^{\frac{\rho}{\theta}} \right]^{\frac{1}{\rho}}$$

Remark

- Home-bias $\rightarrow a_1 > a_2$

Intermediate Good Producers in H

Technology

$$Y_{H,it} + Y^*_{H,it} = K^{\alpha}_{it} L^{1-\alpha}_{it}$$

$$K_{i,t+1} = (1-\delta)K_{it} + X_{it} - \phi\left(\frac{X_{it}}{K_{it}}\right)K_{it}$$

Market structure

- Monopolistic competition
- International market segmentation $\rightarrow$ Pricing-to-market

Intermediate Good Producers in H: Pricing

Exogenous stickiness

- Prices are fixed for N periods

Endogenous stickiness: staggeredness

- Interval $[0, 1]$ of producers is divided into N sub-intervals
- Every period, producers from only 1 sub-interval adjust prices
- This introduces a backward-looking component to current optimal prices

Intermediate Good Producers in H: Pricing (cont.)

Without sticky prices

$$P_{H,it} = \frac{P_\tau mc_{it}}{\theta}$$

With sticky prices

$$P_{H,it} = \frac{\sum_{\tau=t}^{t+N-1} \sum_{S^\tau} Q_\tau \Lambda_{H,\tau} P_\tau mc_{i\tau}}{\theta \sum_{\tau=t}^{t+N-1} \sum_{S^\tau} Q_\tau \Lambda_{H,\tau}}$$

$$\Lambda_{H,\tau} = \theta_1 y_\tau P_\tau^{\theta_2} P_{H,\tau}^{\theta_3}$$

Representative Household

Problem

$$\max_{C_t, M_t, L_t, B_{t+1}} E_0 \sum_t \beta^t U(C_t, L_t, M_t/P_t)$$

subject to

$$P_t C_t + M_t + \sum_{S_{t+1}} Q(S^{t+1}, S^t) B(S^{t+1}) \leq P_t w_t L_t + M_{t-1} + B_t + \Pi_t + T_t$$

Remark

- Complete markets

Central Bank and Market Clearing

Central bank

$$M_t = \mu_t M_{t-1}$$
$$T_t = M_t - M_{t-1}$$

Market clearing conditions

$$Y_t = C_t + \int_0^1 X_{it} di$$
$$L_t = \int_0^1 L_{it} di$$
$$B(S^t) + B^*(S^t) = 0 \; \forall S^t$$

Utility specifications

- Separable utility
  - $U(C, L, M/P) = \frac{1}{1-\sigma}\left[\left(\omega C^{\frac{\eta-1}{\eta}} + (1-\omega)\left(\frac{M}{P}\right)^{\frac{\eta-1}{\eta}}\right)\right]^{1-\sigma} + \Psi\frac{(1-L)^{1-\gamma}}{1-\gamma}$
- Nonseparable utility
  - $U(C, L, M/P) = \frac{1}{1-\sigma}\left[\left(\omega C^{\frac{\eta-1}{\eta}} + (1-\omega)\left(\frac{M}{P}\right)^{\frac{\eta-1}{\eta}}\right)(1-L)^{\xi}\right]^{1-\sigma}$

Calibration: Key Parameters

- Sticky prices $\rightarrow N = 4$
- Risk aversion $\rightarrow \sigma = 5$
- Money growth process
  - AR(1) with persistence 0.68
  - Cross-country correlation $= 0.5$ (to match *GDP* cross-country correlation)
  - SD $= 2.3\%$ to match *GDP* volatility (vs. 1.15% in the data)
- Only disturbances are monetary shocks

Results: Real Exchange Rate

	SD relative to *GDP*	Autocorrelation	Half-life
Data	4.36	0.83	3.72
Model (separable *U*)	4.27	0.62	1.45
Model (nonseparable *U*)	0.05	0.77	2.65

→ Tension between getting volatility and persistence right

Real Exchange Rate Volatility

Perfect international risk sharing

$$q_t \equiv \frac{e_t P_t^*}{P_t} = \frac{U_{c,t}^*}{U_{c,t}}$$

Log-deviations around steady-state

- Separable utility

$$\hat{q}_t \approx \sigma \widehat{\left(\frac{c_t}{c_t^*}\right)}$$

- Nonseparable utility

$$\hat{q}_t \approx \sigma \widehat{\left(\frac{c_t}{c_t^*}\right)} - \Omega(\sigma) \widehat{\left(\frac{L_t}{L_t^*}\right)}, \quad \Omega, \Omega' > 0$$

→ Need high σ and separable utility

Real Exchange Rate Persistence

$$\hat{q}_t \approx \sigma \widehat{\left(\frac{c_t}{c_t^*}\right)}$$

1. Persistent $\hat{q}_t \rightarrow$ Persistent $\widehat{\frac{c_t}{c_t^*}}$
2. To get persistent $\widehat{\frac{c_t}{c_t^*}}$, need high price stickiness
   - Otherwise prices adjust fast, pushing the economy back to steady-state

$\rightarrow$ So, what determines the speed of price adjustment?

- Tension between stickiness and cost movements

Real Exchange Rate Persistence (cont.)

Consider $\uparrow C_t$ and $\uparrow q_t$ after a positive shock to the money supply

1. Labor supply with separable utility

$$\uparrow w_t L_t^{\sigma} = \frac{\Psi}{\downarrow U_{c,t}}$$

2. Marginal cost

$$\uparrow mc_t = \frac{\uparrow w_t L_t^{\alpha}}{(1-\alpha) K_t^{\alpha}}$$

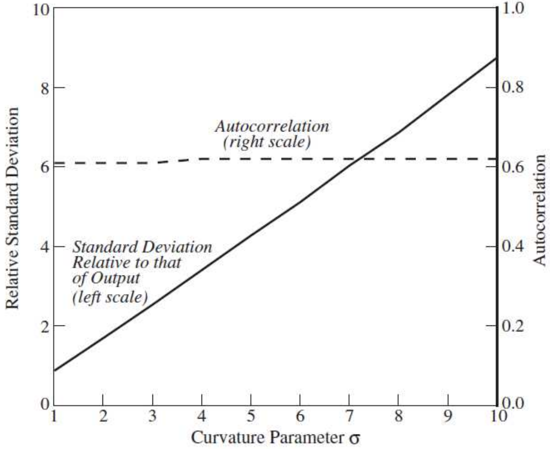
3. Optimal prices

$$\uparrow P_{H,it} = \frac{\sum_{\tau=t}^{t+N-1} \sum_{S^{\tau}} Q_{\tau} \Lambda_{H,\tau} P_{\tau} \uparrow mc_{i\tau}}{\theta \sum_{\tau=t}^{t+N-1} \sum_{S^{\tau}} Q_{\tau} \Lambda_{H,\tau}}$$

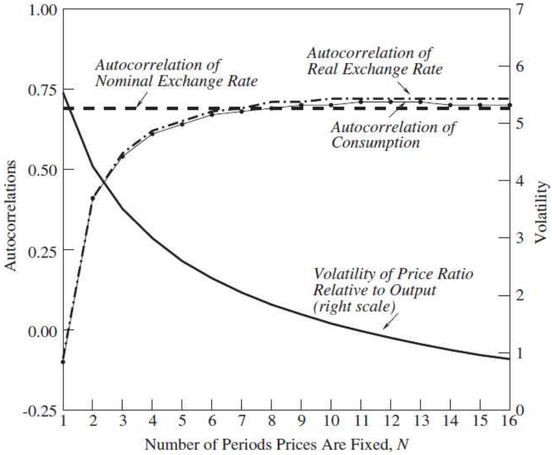
4. $\uparrow P_t$

5. $\downarrow C_t$ and $\downarrow q_t$

Results: Volatility



Results: Persistence



Sensitivity Analysis

- Sticky wages
- Incomplete markets
- Real shocks: productivity and government consumption
- Nonseparable utility
- High exports

Conclusion

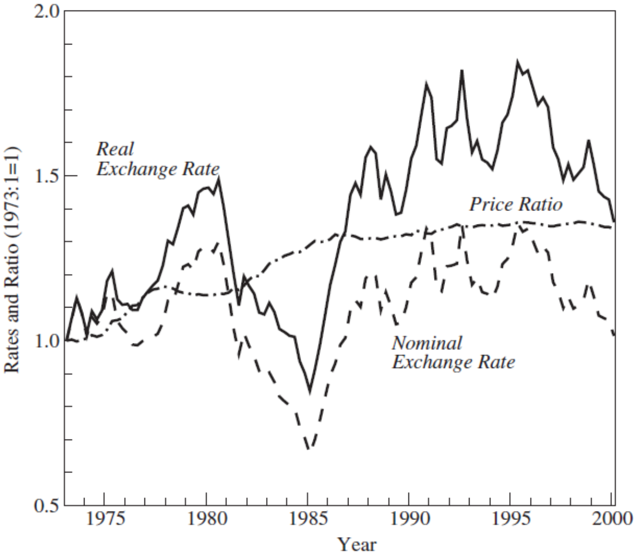
Can sticky prices generate volatile and persistent RER? “Some success”

- $\sigma = 5$ and separable utility $\rightarrow$ Volatility but can't get enough persistence
- Nonseparable utility $\rightarrow$ Persistence but can't get volatility

Remarks

- Staggered pricing are a weak source of endogenous stickiness (CKM 2000)
- Alternative sources of real pricing rigidities may deliver the puzzle?
- Correlation between C and RER is too high $\rightarrow$ Too much intl risk-sharing

Appendix: US-Europe RER



Appendix: Intermediate Good Producers in H

Problem

$$\max_{P_{H,it},P^*_{H,it},X_{it},L_{it}} \sum_{t=0}^{\infty} \sum_{S^t} Q(S^t) \underbrace{\left[P_{H,it} y_{H,it} + e_t P^*_{H,it} y^*_{H,it} - P_t w_t L_{it} - P_t X_{it}\right]}_{\equiv \Pi_t}$$

subject to

$y_{H,it}, y^*_{H,it}$ CES demand functions

$$y_{H,it} + y^*_{H,it} = F(K_{it}, L_{it})$$

$$K_{it} = (1-\delta)K_{i,t-1} + X_{it} - \phi\left(\frac{X_{it}}{K_{i,t-1}}\right) K_{i,t-1}$$

$$P_{H,i\tau} = ... = P_{H,i,\tau+N-1},\ \tau = t, t+N, ...$$

$$P^*_{H,i\tau} = ... = P^*_{H,i,\tau+N-1},\ \tau = t, t+N, ...$$