International Prices and Exchange Rates

Gita Gopinath

- Nominal and Real Exchange Rates
  - Exchange-rate pass-through and expenditure switching
- Currency Wars, Fear of Floating

Non-neutrality of Nominal Exchange Rates

International Spillovers

Nominal Rigidities

1. First generation ("Consensus View"): Fleming (1962), Mundell (1963), Dornbusch (1976), Svenson & van Wijnbergen (1989), Obstfeld & Rogoff (1995)

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   - Expenditure Switching: Improvement in trade balance.

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3. Handbook of Monetary Economics (2010, Friedman and Woodford), "Optimal Monetary Policy in Open Economies", Corsetti, Dedola, Leduc

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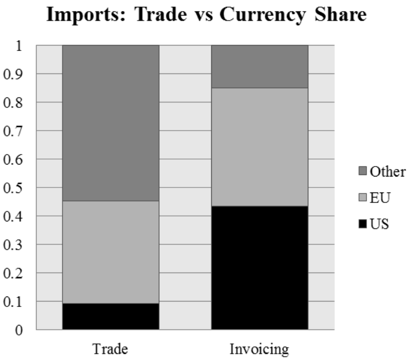
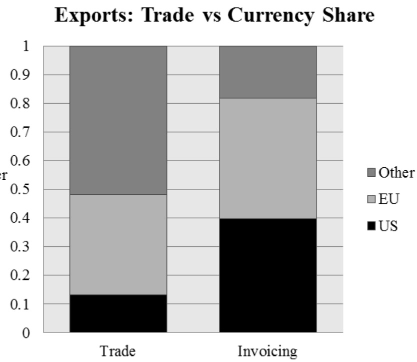
4. Dominant Currency Paradigm: 1+2+3

Road Map

- Dominant currencies
- Model
- Empirical Evidence

Dominance of dollar invoicing in world trade





- Covers 55% of imports, 57% of exports. Averages post 1999.
- Dollar invoicing share: 4.7 times its share in world imports, 3.1 times its share in world exports.
- Euro invoicing share: 1.2 times for imports and exports.
- Goldberg (2013), Goldberg and Tille (2009), Ito and Chinn (2013)

Limited own currency use in most countries

Country	Imports	Exports
United States	0.93	0.97
Italy*	0.58	0.61
Germany*	0.55	0.62
Spain*	0.54	0.58
France*	0.45	0.50
United Kingdom	0.32	0.51
Australia	0.31	0.20
Switzerland	0.31	0.35
Norway	0.30	0.03
Sweden	0.24	0.39
Japan	0.23	0.39

Country	Imports	Exports
Canada	0.20	0.23
Poland	0.06	0.04
Iceland	0.06	0.05
Thailand	0.04	0.07
Israel	0.03	0.00
Turkey	0.03	0.02
South Korea	0.02	0.01
Brazil	0.01	0.01
Indonesia	0.01	0.00
India	0.00	0.00

- EM share in world imports: 38%, exports: 33%

Model: New Keynesian small open economy

- Building Blocks
  - Sticky Prices and or Sticky Wages (Calvo)
  - Household and Firms
  - Asset markets
  - Monetary policy

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- Home H trades with U (dominant currency) and R

- All prices and quantities in U and R are exogenous (constant)

Households

- Utility:

$$U(C_t, N_t) = \frac{1}{1-\sigma_c} C_t^{1-\sigma_c} - \frac{\kappa}{1+\varphi} N_t^{1+\varphi}$$

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- Consumption Aggregator: Kimball

$$\sum_i \frac{1}{|\Omega_i|} \int_{\omega \in \Omega_i} \gamma_i \Upsilon \left(\frac{|\Omega_i| C_{iH}(\omega)}{\gamma_i C} \right) d\omega = 1.$$

- Strategic complementarities/Variable mark-ups (Dornbusch (1988), Krugman (1987))

- Demand for a variety

$$C_{iH,t}(\omega) = \gamma_i \left(1 - \epsilon \ln \frac{P_{iH}(\omega)}{P}\right)^{\sigma/\epsilon} \cdot C_t$$

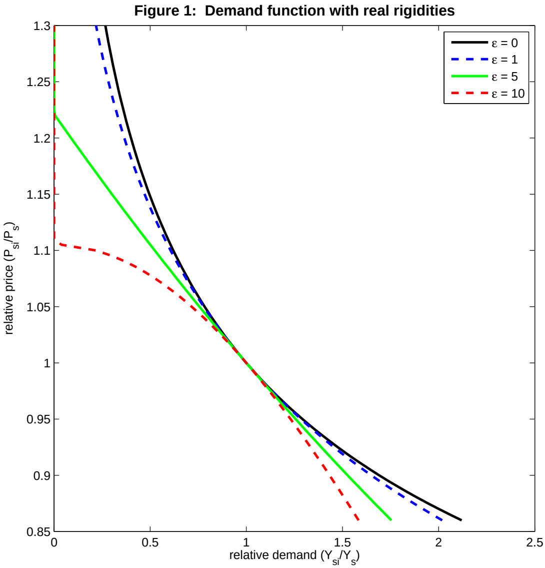
- Elasticity of demand

$$\sigma_{iH,t} = \frac{\sigma}{\left(1 - \epsilon \ln \frac{P_{iH}(\omega)}{P}\right)}$$

- Variability of the mark-up $\frac{\sigma_{iH,t}}{\sigma_{iH,t}-1}$

$$\Gamma_{iH,t} = \frac{\epsilon}{\left(\sigma - 1 + \epsilon \ln \frac{P_{iH}(\omega)}{P}\right)}$$

Kimball Demand



Households

- Households optimize

$$\max_{C_t, W_t, B_{U,t+1}, B_{t+1}(s')} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t U(C_t, N_t)$$

- Budget constraint

$$P_t C_t + \mathcal{E}_{U,t}(1+i_{U,t})B_{U,t} + B_t = W_t N_t + \Pi_t + \mathcal{E}_{U,t} B_{U,t+1} + \sum_{s' \in \mathcal{S}} Q_t(s') B_{t+1}(s') + \mathcal{E}_{U,t}\zeta_t$$

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- Consumption Demand

$$C_{iH,t}(\omega) = \gamma_i \psi \left(D_t \frac{P_{iH,t}(\omega)}{P_t} \right) C_t,$$

$$P_t C_t = \sum_i \int_{\Omega_i} P_{iH,t}(\omega) C_{iH,t}(\omega) d\omega$$

- Portfolio decisions

$$C_t^{-\sigma_c} = \beta(1 + i_{U,t})\mathbb{E}_t C_{t+1}^{-\sigma_c} \frac{P_t}{P_{t+1}} \frac{\mathcal{E}_{U,t+1}}{\mathcal{E}_{U,t}}$$

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Optimality Conditions

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- Wage setting (Calvo)

$$\mathbb{E}_t \sum_{s=t}^{\infty} \delta_w^{s-t} \Theta_{t,s} N_s W_s^{\vartheta(1+\varphi)} \left[\frac{\vartheta}{\vartheta - 1} \kappa P_s C_s^{\sigma} N_s^{\varphi} - \frac{\bar{W}_t(h)^{1+\vartheta\varphi}}{W_s^{\vartheta\varphi}} \right] = 0,$$

Producers

- Production Function

$$Y_t = e^{a_t} L_t^{1-\alpha} X_t^{\alpha}$$

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- Profits

$$\Pi_t(\omega) = \sum_{i,j} \mathcal{E}_{j,t} P^j_{Hi,t}(\omega) Y^j_{Hi,t}(\omega) - \mathcal{MC}_t \, Y_t(\omega)$$

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$$\mathcal{MC}_t = \frac{1}{\alpha^\alpha (1-\alpha)^{1-\alpha}} \cdot \frac{W_t^{1-\alpha} P_t^\alpha}{e^{a_t}}$$

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- Input demand

$$(1-\alpha)\frac{Y_t}{L_t} = \frac{W_t}{\mathcal{MC}_t}, \qquad L_t(h) = \left(\frac{W_t(h)}{W_t}\right)^{-\vartheta} L_t$$

$$\alpha \frac{Y_t}{X_t} = \frac{P_t}{\mathcal{MC}_t} \qquad X_{iH,t}(\omega) = \gamma_i \psi \left(D_t \frac{P_{iH,t}(\omega)}{P_t}\right) X_t$$

Producers

Pricing equations (Calvo)

- θ^{i}_{ij}: fraction prices in producer currency
- θ^{j}_{ij}: fraction prices in local/destination currency
- θ^{u}_{ij}: fraction prices in dominant currency
- Domestic prices and wages sticky in H currency

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- Reset Prices

$$\mathbb{E}_t \sum_{s=t}^{\infty} \delta_p^{s-t} \Theta_{t,s} Y^j_{Hi,s|t}(\omega)(\sigma_{Hi,s}(\omega)-1)\left(\mathcal{E}_{j,s}\bar{P}^j_{Hi,t}(\omega) - \frac{\sigma_{Hi,s}(\omega)}{\sigma_{Hi,s}(\omega)-1}\mathcal{MC}_s\right) = 0$$

Interest Rates

- Monetary Policy: Domestic interest rates

$$i_t - i^* = \rho_m(i_{t-1} - i^*) + (1 - \rho_m)\phi_M \pi_t + \epsilon_{M,t}$$

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- Exchange rate U-R

$$\ln \mathcal{E}_{R,t} - \ln P_t = \eta \left(\ln \mathcal{E}_{U,t} - \ln P_t\right) + \epsilon_{R,t}$$

Exchange Rate Pass-through

- Export price pass-through in H currency higher
    - Greater the variability of mark-ups
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  - Greater the reliance on imported inputs
- Import price pass-through in H currency lower
  - Greater the variability of mark-ups

Some Analytics

Exchange Rate Pass-through: Fully flexible prices

- Export Prices

$$p_{Hi,t} = \mu_{Hi,t} + mc_t$$

$$\mu_{Hi} = \mu_{Hi}(p_{Hi} - e_i - p_i^i)$$

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$$\Delta p_{Hi,t} = \frac{1}{1+\Gamma}\Delta mc_t + \frac{\Gamma}{1+\Gamma}\left(\Delta p_{i,t}^i + \Delta e_{i,t}\right)$$

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$$\Delta mc_t = \frac{1-\alpha}{1-\alpha\gamma_H}\Delta w_t + \frac{\alpha}{1-\alpha\gamma_H}\sum_{i\in U,R}\gamma_i\left(\Delta mc_{i,t}^i + \Delta e_{i,t}\right) - \frac{1}{1-\alpha\gamma_H}\Delta a_t$$

Some Analytics

Exchange Rate Pass-through: Fully flexible prices

- Export Prices

$$\begin{aligned}\Delta p_{Hi,t} &= \frac{1}{1+\Gamma}\left[\frac{\alpha\gamma_i}{1-\alpha\gamma_H}+\Gamma\right]\Delta e_{i,t} \\ &\quad +\frac{1}{1+\Gamma}\frac{\alpha\gamma_j}{1-\alpha\gamma_H}\Delta e_{j,t} \\ &\quad +\frac{1}{1+\Gamma}\frac{1-\alpha}{1-\alpha\gamma_H}\Delta w_t-\frac{1}{1+\Gamma}\frac{1}{1-\alpha\gamma_H}\Delta a_t\end{aligned}$$

where $j \neq i$, for $i, j \in \{U, R\}^2$. ■

- If $\Gamma = 0$, $\alpha = 0$ or $\gamma_H = 1$, 100% PT into destination currency

Some Analytics

Exchange Rate Pass-through: Fully flexible prices

- Import Prices

$$
\begin{aligned}
\Delta p_{iH,t} \quad = \quad & \frac{1}{1+\Gamma}\left[1+\Gamma\frac{\alpha\gamma_H\gamma_i}{1-\alpha\gamma_H}\right]\Delta e_{i,t} \\
& +\frac{\Gamma}{1+\Gamma}\frac{\alpha\gamma_H\gamma_j}{1-\alpha\gamma_H}\Delta e_{j,t} \\
& +\frac{\Gamma}{1+\Gamma}\gamma_H\frac{1-\alpha}{1-\alpha\gamma_H}\Delta w_t - \frac{\Gamma}{1+\Gamma}\gamma_H\Delta a_t
\end{aligned}
$$

where $j \neq i$, for $i, j \in \{U, R\}^2$. ■

Some Analytics

Exchange Rate Pass-through: Fully rigid prices

- PCP, $\theta^H_{HU} = 1$ and $\theta^H_{HR} = 1$

$$\begin{aligned} \Delta p_{Hi,t} &= 0 \cdot \Delta e_{i,t} + 0 \cdot \Delta e_{j\neq i,t}, \qquad \Delta p_{iH,t} = 1 \cdot \Delta e_{i,t} + 0 \cdot \Delta e_{j\neq i,t}, \qquad \forall i \\ tot_{Hi,t} &= \Delta p_{Hi,t} - \Delta p_{iH,t} = -1 \cdot \Delta e_{i,t} \qquad \forall i \end{aligned}$$

- LCP, $\theta^U_{HU} = 1$ and $\theta^R_{HR} = 1$

$$\begin{aligned} \Delta p_{Hi,t} &= 1 \cdot \Delta e_{i,t} + 0 \cdot \Delta e_{j\neq i,t} \qquad \Delta p_{iH,t} = 0 \cdot \Delta e_{i,t} + 0 \cdot \Delta e_{j\neq i,t} \qquad \forall i \\ tot_{Hi,t} &= \Delta p_{Hi,t} - \Delta p_{iH,t} = 1 \cdot \Delta e_{i,t} \qquad \forall i \end{aligned}$$

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where tot_{Hi} is the terms of trade between regions H and i ■

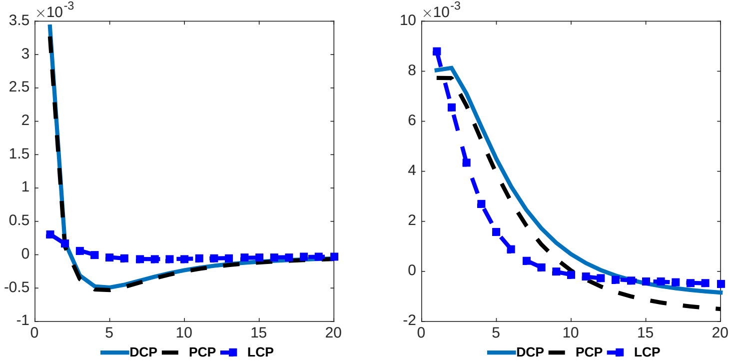
	Parameter	Value
Household Preferences		
Discount factor	β	0.99
Risk aversion	σ_c	2.00
Frisch elasticity of N	φ^{-1}	0.50
Disutility of labor	κ	1.00
Production		
Interm share	α	$2/3$
Demand		
Elasticity	σ	2.00
Super-elasticity	ϵ	1.00
Rigidities		
Wage	δ_w	0.85
Price	δ_p	0.75
Monetary Rule		
Inertia	ρ_m	0.50
Inflation sensitivity	ϕ_M	1.50
Shock persistence	ρ_{ε_i}	0.50

Note: other parameter values as reported in the text.

Table : Parameter Values

Impulse Response to Monetary Expansion

Log-linearization

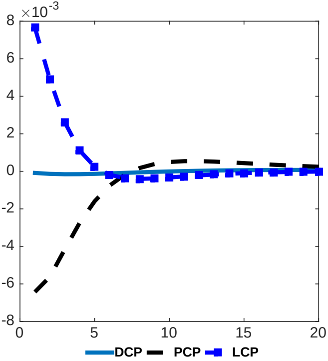


(a) Inflation

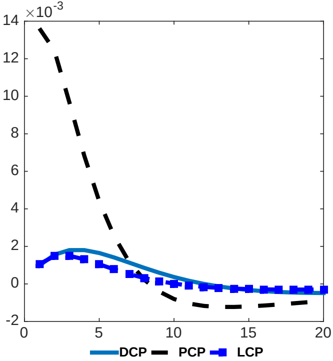
(b) Exchange Rates

Impulse Response to Monetary Expansion

Log-linearization



(c) Terms of Trade



(d) Export Quantity

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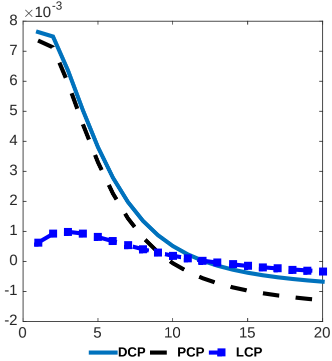
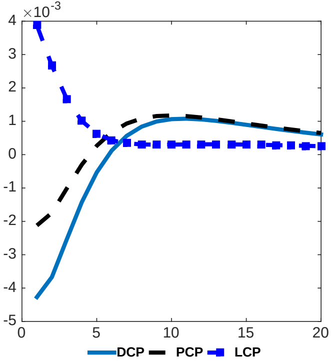


(e) Import Price



(f) Import Quantity

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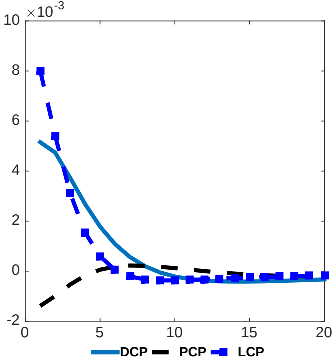
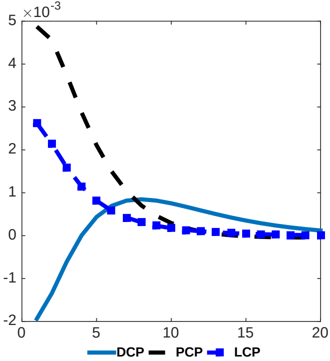


(g) Mark-up



(h) Trade

Colombia

- 2005-2014, Source: DIAN/DANE (customs), SIREM (agency supervising large private firms
- Commodity Currency, Free float since September 1999
- Share of mining output in exports is 58.4%, Manufacturing, 36.9%
- Currency composition of exports: USD: 98.4%
- Weighted (by income) average imported input share: 38% for manufacturers, 44% for manuf exporters
- Focus on manufacturing

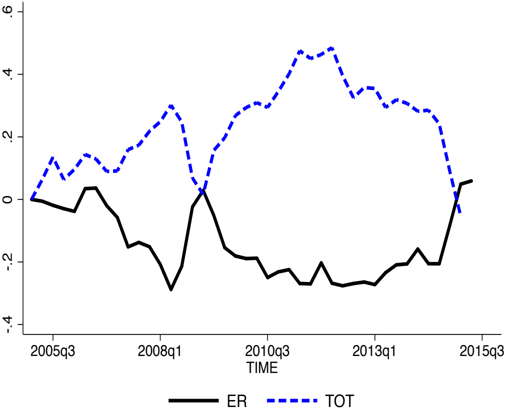
Colombia

Table : Currency Distribution

	All Exports	Manufactures
US Dollar	98.28%	98.39%
Euro	0.72%	0.70%
Colombian Peso	0.67%	0.52%
Venezuelan Bolívar	0.27%	0.33%
Sterling Pound	0.02%	0.01%
Mexican Peso	0.01%	0.01%
Other currencies	0.03%	0.03%

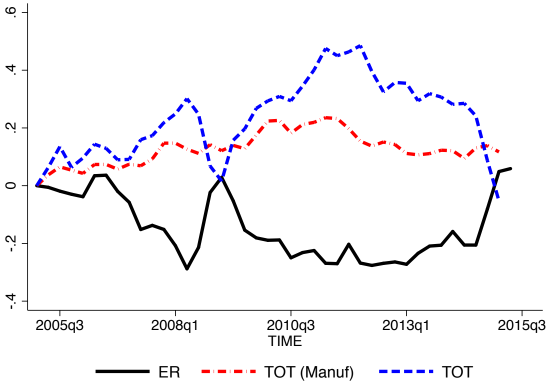
Colombia

Terms of Trade and Nominal Exchange Rate



- $\text{TOT} \equiv \frac{P_X}{P_M}$, $Corr(TOT, \mathcal{E}_{p/\$}) = -0.89$

Colombia: Stability of Terms of Trade



	Data
$\frac{Cov(ER, TOT)}{Var(ER)}$	-0.33

	Parameter	Value
Measured		
Domestic Input Share	γ_H	0.60
Export Invoicing Shares		
to U	θ_{HU}^{U}	1.00
to R	$\theta_{HR}^{U}, \theta_{HR}^{R}$	0.93,0.07
Shocks		
commodity prices	σ_ζ, ρ_ζ	0.13, 0.74
Strategic complementarities	ε	2
Elasticity of Demand	σ	2
Estimated		
Import Invoicing Shares		
from U	θ_{UH}^{U}	1
from R	$\theta_{RH}^{U}, \theta_{RH}^{R}$	0.86, 0.14
Oil share	ζ	1
Shocks		
productivity shocks	σ_a, ρ_a	0.01,0.9
e_R	η, σ_R	1.5, 0.019

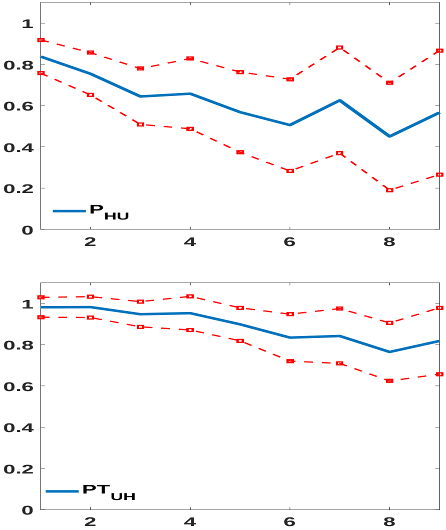
Note: other parameter values as reported in the text.

Table : Parameter Values

Pass-through, U

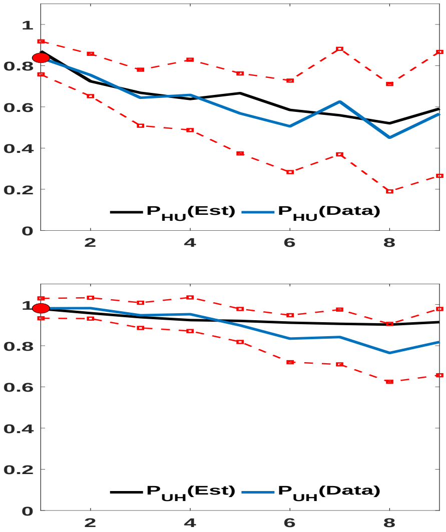
Data $\Delta p_t = \alpha + \sum_{k=0}^{8} \beta_k \Delta e_{t-k} + Z_t + \epsilon_t$

firm*industry*country FE, quarter*year clusters



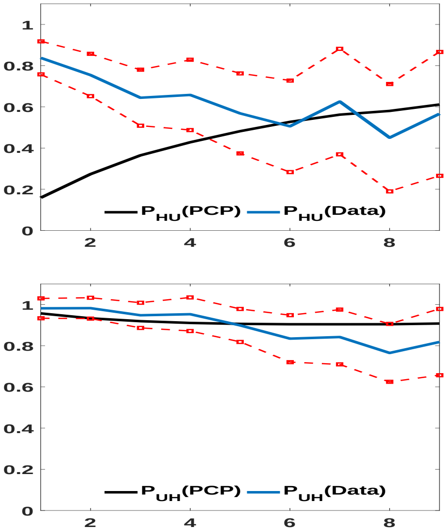
Pass-through, U

Data Vs. DCP



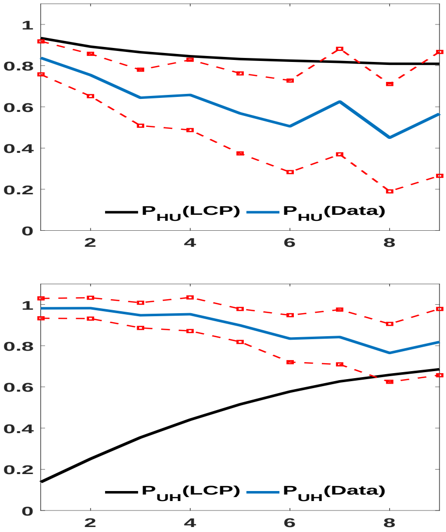
Pass-through, U

Data Vs. PCP



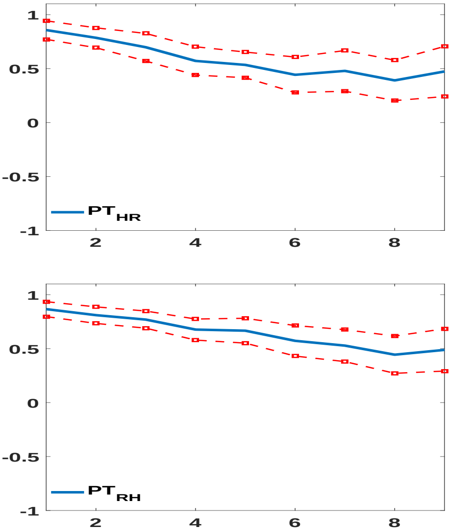
Pass-through, U

Data Vs. LCP

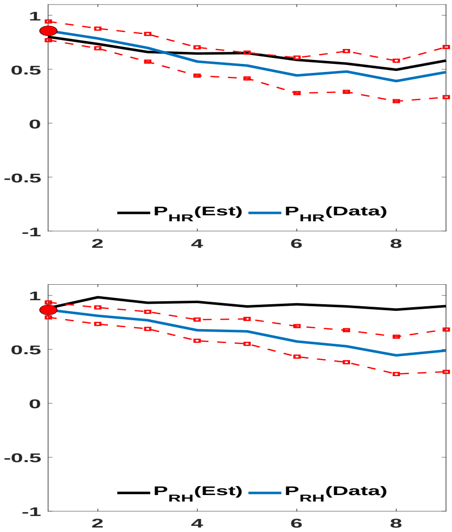


Pass-through, R

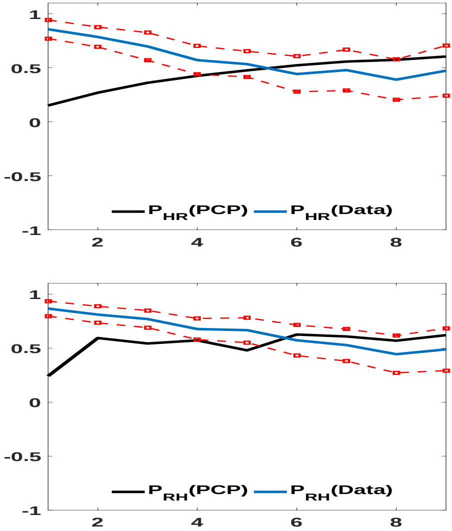
Data



DCP



PCP



LCP

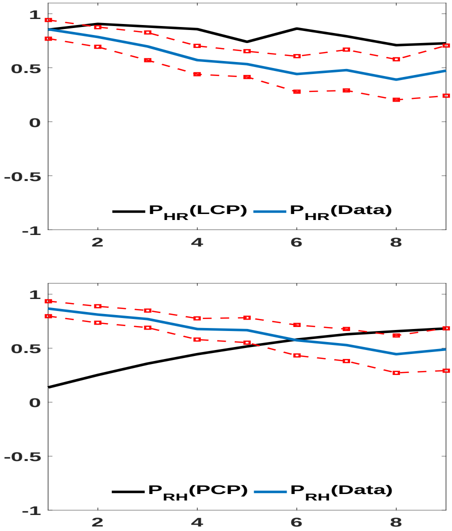


Table : ERPT (Non-Dollarized Economies)

	(1) Δp_{HR}	(2) Δp_{HR}	(3) Δp_{RH}	(4) Δp_{RH}
		Data		
Δe_R	0.697***	0.0896*	0.742***	0.301***
	(0.115)	(0.0464)	(0.126)	(0.0791)
Δe_U		0.660***		0.540***
		(0.0473)		(0.0662)
		DCP		
Δe_R	0.70	0.09	0.77	0.05
Δe_U		0.77		0.90
		PCP		
Δe_R	0.52	0.09	0.95	0.97
Δe_U		0.56		-0.03
		LCP		
Δe_R	0.71	1.00	0.78	0.03
Δe_U		-0.02		0.67

Conclusion

- Most trade is invoiced in very few currencies.
- Dominant currency paradigm
  - pricing in a dominant currency
  - pricing complementarities
  - imported input use in production
- Data rejects PCP/LCP in favor of DCP.
- Implications
  - MP has limited impact on exports and terms of trade.
  - TB adjusts mainly through exports not imports
  - Adverse shock in emerging markets reduces world trade
  - Inflation and imports sensitivity to DC exchange rates far exceeds the share of the dominant currency country in trade