A Stochastic General Equilibrium Model with Partial Dollarization

Paul Castillo, Carlos Montoro and Vicente Tuesta
"Foreign Currency Related Risk Taking by Financial Institutions, Firms and Households"

Central Reserve Bank of Peru

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Motivation
Types of Partial Dollarization

**Definition:** Partial replacement of the domestic currency by a foreign currency (i.e. US dollars) in its basic functions

- Currency Substitution (CS): Dollars accepted as a medium of payment
- Price Dollarization (PD): Prices are indexed to changes in the exchange rate
- Financial Dollarization (FD): Dollars are used as a store of value
Motivation

Peru is one of the most highly dollarized economies + IT

Other LA countries: Bolivia, Nicaragua, Paraguay and Uruguay.
Motivation

Why dollarization is important for policy makers?

- Limitations of the Central Bank in stabilizing inflation and output
- Transmission mechanism of monetary policy: Demand and supply side effects of dollarization.
- Affects objectives of the central bank: Exchange rate smoothing versus interest rate smoothing.
- Regulatory and prudential issues: currency mismatches and balance-sheet effects.
Motivation

Goal of the Paper

- To develop a DSGE model with partial dollarization to understand the transmission mechanism.
- Use the model to account for the effects of partial dollarization.
- Estimate the model using Bayesian techniques.
- Policy evaluation (MEGA-D).
Motivation
What do we do?

- Add to a standard sticky price SOE model 3 forms of partial dollarization: CS, PD and FD
- Estimate the model using Bayesian Methods and Peruvian data
- Use the model for policy analysis (forecast)
The model
Main ingredients

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- Include three types of dollarisation (transactions, prices, financial).
- Exchange rate intervention.
Dollarisation: Some Related Literature

- **Transaction dollarisation:** Felices and Tuesta (2006), Castillo (2006a), Batini, Levine and Pearlman (2006): Transaction costs induce a relative demand for foreign currency. Mechanism works through the marginal utility of consumption (weakens the interest rate channel).

- **Price dollarisation:** Ize and Parrado (2004), Castillo and Montoro (2004), Castillo (2006b): Endogenously some firms decide to set prices in dollars (makes the exchange rate channel stronger).


- **Exchange rate intervention:** Boënger y Wollmershäuser (2003), Adolfson et al. (2007, Riskbank), Florian, Salas and Vega (2007): Intervention affects risk premium in the UIP.
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Extension 1: Currency substitution

\[ U \left( C_t \right) = \xi_t \log \left\{ \left[ b \left( C_t - hC_{t-1} \right)^{\frac{\omega-1}{\omega}} + (1 - b) Z_{t+i}^{j} \frac{\omega-1}{\omega} \right] \right\} \]

where \( Z_{t+i}^{j} \) is a money aggregate defined as

\[ Z_{t+i}^{j} = \left( \frac{M_{t+i}^{j}}{P_{t+i}} \right)^{1-\delta_{cs}} \left( \frac{D_{t+i}^{j} S_{t+i}}{P_{t+i}} \right)^{\delta_{cs}} \]
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In log linear form

\[ u_{ct}^{CS} = u_{ct} - \Lambda (\omega) \left[ (1 - \delta_{cs}) i_t + \delta_{cs} i^*_t \right] \]

MUC is affected by both domestic and foreign interest rate.
Extension 2: Price dollarisation

\[ \pi_{Ht} = \left(1 - \delta^{pd}\right) \pi_{s,t} + \delta^{pd} (\pi_{d,t} + ds_t) \]

\[ \pi_{s,t} - \lambda_{\pi_s} \pi_{s,t-1} = \beta (E_t \pi_{s,t+1} - \lambda_{\pi_s} \pi_{s,t}) + \kappa S mc_t^D \]

\[ \pi_{d,t} - \lambda_{\pi_d} \pi_{d,t-1} = \beta (E_t \pi_{d,t+1} - \lambda_{\pi_d} \pi_{d,t}) + \kappa_{PD} mc_t^S \]

- Increases the sensitivity of domestic inflation, \( \pi_{Ht} \) to the depreciation of the nominal exchange rate.
Extension 3:
Financial Dollarization

Entrepreneurs: expected real return of investing in capital

\[ E_t \left[ R_{t+1}^{KH} \right] = (1 + RP_t) E_t \left[ \left( \frac{1 + i^*_t}{\Pi_{t+1}} \right)^{\delta^{FD}} \left( \frac{1 + i_t}{\Pi_{t+1}} \right)^{1-\delta^{FD}} \right] \]
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\[ E_t \left[ R_{t+1}^{KH} \right] = (1 + RP_t) \ E_t \left[ \left( \left( 1 + i_t^* \right) \frac{DS_{t+1}}{\Pi_{t+1}} \right)^{\delta^{FD}} \left( \frac{1 + i_t}{\Pi_{t+1}} \right)^{1-\delta^{FD}} \right] \]

Risk premium depends on debt relative to net worth:

\[ RP_t = \left( \frac{D_t}{N_t} \right)^\chi \]

\[ N_t = \left( R_t^{KH} \right) Q_{t-1} K_{t-1} \]

\[ - (1 + RP_{t-1}) \left[ \left( \left( 1 + i_{t-1}^* \right) \frac{DS_t}{\Pi_t} \right)^{\delta^{FD}} \left( \frac{1 + i_{t-1}}{\Pi_t} \right)^{1-\delta^{FD}} \right] D_{t-1} \]
Extension 4:
Exchange rate intervention
Introduce a "backward looking" behavior in the exchange rate expectations:

\[ E_t^{\exp} s_{t+1} = (1 - \lambda_s) E_t s_{t+1} + \lambda_s s_{t-1} \]
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Iterate forward and solve for \( s_t \):

\[ s_t = s_{t-1} - \frac{1}{\lambda_s} \sum_{j=0}^{\infty} \left( \frac{1 - \lambda_s}{\lambda_s} \right)^j [i_{t+j} - i_{t+j}^* - \text{prem}_{t+j}] \]

when \( \lambda_s \to 1 \): \( s_t = s_{t-1} \)

\( \lambda_s \to 0 \): \( s_t = \sum_{j=0}^{\infty} [i_{t+j} - i_{t+j}^* - \text{prem}_{t+j}] \)
Data and Estimation

- Sample 1995:01..2007:04. 10 observable variables
  \[ x_t = \{ \triangle c_t, \triangle y_t, \triangle inv_t, rer_t, \triangle s_t, \triangle tot_t, i_t, i^*_t, \pi_t, \pi^m_t \} \]

- 11 Shocks: One permanent global tech shock and 10 AR(1) shocks: technology, domestic inflation mark-up, intermediate imported mark-up, monetary, preference, foreign monetary policy, investment, UIP,PPP, and foreign technology.

- Unit root shock in the model. Consistency between data and model

- Nominal interest rate and inflation have been detrended considering the structural break (inflation target).
Estimation

- Bayesian methods to estimate model’s parameters ($\Psi$)
  
  Priors $\Pi(\Psi)$ and Likelihood Function: $L(\{x_t\}_{t=1}^{T} \mid \Psi)$

- Random-Walk Metropolis-Hastings algorithm to obtain 250,000 draws from the posterior distribution. (acceptation rate 0.25-0.35).

- From which we also obtain posterior second moments and impulse response functions.

- Compute the marginal likelihood of each model using the modified harmonic mean estimator.
Result 1: Model Comparison

- Based on Bayes Factor: model with three types of dollarization dominates the rest of the models.
- Main ingredient: financial dollarization.
- CS and PD do not add that much relative to FD.

<table>
<thead>
<tr>
<th></th>
<th>Benchmark</th>
<th>CS</th>
<th>PD</th>
<th>FD</th>
<th>CS+PD+FD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log-Marginal</td>
<td>-950.98</td>
<td>-948.61</td>
<td>-947.86</td>
<td>-945.32</td>
<td>-944.88</td>
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</table>
Real frictions are important in all models

Prices are not that sticky. Firms change prices every 2 quarters.

Price indexation is present: $\lambda_P = 0.5$

Relative large standard deviations of shocks (compared to developed economies)

Elasticity of risk premium to Debt/Net worth ratio is similar to other studies ($\chi = 0.03$)

Taylor Rule: $\varphi_\pi = 2.29, \varphi_y = 0.26, \varphi_s = 0.80, \varphi_i = 0.06$

Dollarization $\delta^{cs} = 0.46, \delta^{pd} = 0.12, \delta^{fd} = 0.59$
Results: Transmission mechanism, contractive monetary policy shock.

Dollarisation counterfactual

![Core Inflation](chart1)

![Output Gap](chart2)

![Nominal Interest Rate](chart3)

![Nominal Exchange Rate](chart4)

BCRP (Central Reserve Bank of Peru)  
MEGA-D  
22/23-09-2008 17 / 20
Results: Transmission mechanism, increase in foreign interest rate.

Dollarisation counterfactual
Forecasting

Concluding remarks and extensions

- The estimation and model evaluation validate the three forms of partial dollarization. However FD is the more important.
- Exchange rate intervention can help to ameliorate the effects of partial dollarization.
- Extensions for further work:
  - Include non-tradables goods (Balassa-Samuelson effect should be important).
  - Financial versus nominal frictions in emerging markets economics.
  - Dollarisaton as a endogenous decision (but this is problematic).
  - Change in policy regime.
  - Evaluate forecast