An Estimated Stochastic General Equilibrium Model with Partial Dollarization: A Bayesian Approach

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1 Motivation: Types of Partial Dollarization

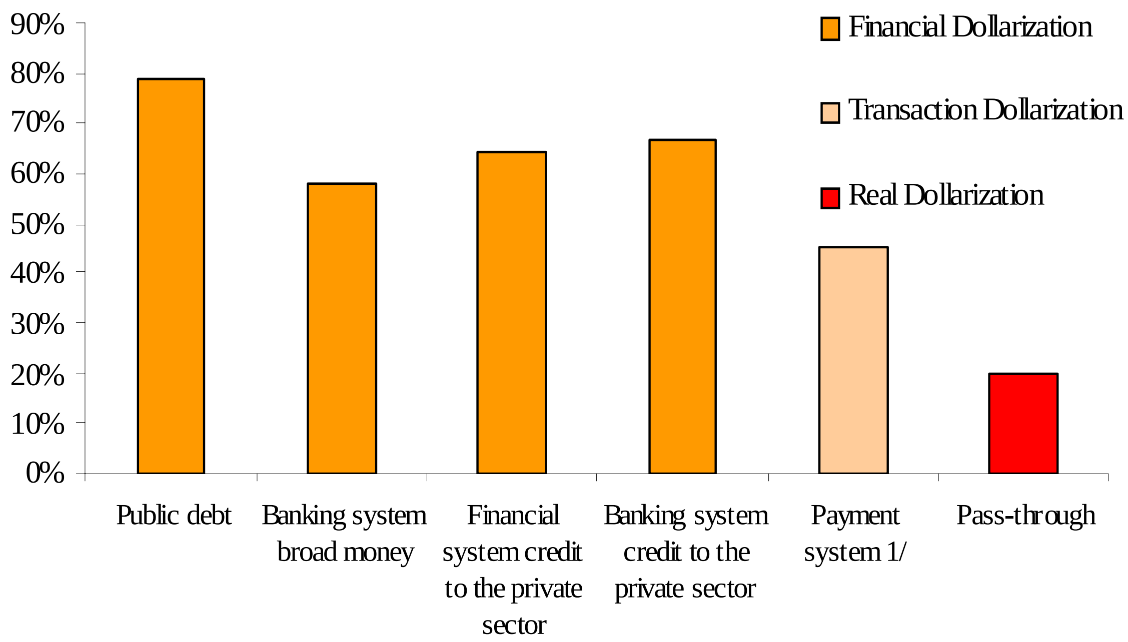
Definition: Partial replacement of the domestic currency by a foreign currency (i.e. US dollars) in its basic functions

- 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

2 Motivation: Peru is one of the most highly dollarized economies + IT



3 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.

4 Goal of the Paper

- To develop and to estimate a DSGE model with partial dollarization using Bayesian techniques

- Used the model to account for the effects of partial dollarization

- Policy evaluation (MEGA-D)

5 What do we do?

- Add to a standard sticky price SOE model two forms of partial dollarization: CS and PD

- Estimate the model using Bayesian Methods and Peruvian data

6 The Model

- SOE (limiting case of a two-country model)

- Baseline version includes

  Two tradable goods (home produced and imported consumption goods)

  External habit formation in consumption

  Slow adjustment in real wages

  Capital accumulation plus investment adjustment cost

  Incomplete Markets and incomplete pass-through

7 Some Related Literature

- CS: 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)

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

- FD: Céspedes Chang and Velasco (2005), Gertler, Gilchrist and Natalucci (2006), Tovar (2006): Open economy financial accelerator. FD1=Working capital dollarization

8 Extension 1: CS

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

where Z_{t+i}^j is a money aggregate defined as $Z_{t+i}^j = \left(\frac{M_{t+i}^j}{P_{t+i}}\right)^{1-\delta^{cs}}\left(\frac{D_{t+i}^j S_{t+i}}{P_{t+i}}\right)^{\delta^{cs}}$

in log linear form

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

- MUC is affected by both domestic and foreign interest rate.

9 Extension 2: PD

$$
\begin{aligned}
\pi_{Ht} &= \left(1-\delta^{pd}\right)\pi_{s,t} + \delta^{pd}\left(\pi_{d,t} + ds_t\right) \\
\pi_{s,t} - \lambda_{\pi_s}\pi_{s,t-1} &= \beta\left(E_t\pi_{s,t+1} - \lambda_{\pi_s}\pi_{s,t}\right) + \kappa_S mc_t + \kappa_S \delta^{pd} rpd_t \\
\pi_{d,t} - \lambda_{\pi_d}\pi_{d,t-1} &= \beta\left(E_t\pi_{d,t+1} - \lambda_{\pi_d}\pi_{d,t}\right) + \kappa_{PD} mc_t - \kappa_{PD}\left(1-\delta^{pd}\right) rpd_t \\
\Delta rpd_t &= ds_t + \pi_{d,t} - \pi_{s,t}, \qquad\qquad P_t^s \neq S_t P_t^d,
\end{aligned}
$$

- increase the sensitivity of domestic inflation, π_{Ht} to the depreciation of the nominal exchange rate.

10 Extension 3: CS + PD

11 Data and Estimation

- Sample 1992:02 2006:01. 8 observable variables

$$x_t = \left\{\triangle c_t, \triangle y_t, \triangle inv_t, \triangle wp_t \triangle rer_t, \triangle tot_t, i_t, \pi_t\right\}'$$

- 8 Shocks: One permanent technology Shock and 7 AR(1) shocks: technology, domestic inflation mark-up, intermediate imported mark-up, monetary, preference, foreign monetary policy and UIP

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

- Nominal interest rate and inflation have been detrended considering the structural break.

12 Estimation

- Bayesian methods to estimate model´s parameters (Ψ)

  Priors $\Pi(\Psi)$

  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.

13 Estimation

- Model Comparison. Marginal likelihood for each model

$$L(\{x_t\}_{t=1}^T \mid m) = \int_{\psi \in \Psi} L(\{x_t\}_{t=1}^T \mid \Psi, m)\Pi(\Psi, m) d\psi$$

- Posterior odds ratio=Bayes Factor

$$\frac{P(A \mid \{x_t\}_{t=1}^T)}{P(B \mid \{x_t\}_{t=1}^T)} = \frac{\Pr(A) L(\{x_t\}_{t=1}^T \mid \text{model} = A)}{\Pr(B) L(\{x_t\}_{t=1}^T \mid \text{model} = B)}.$$

- Compute the marginal likelihood of each model using the modified harmonic mean estimator.

14 Result 1: Parameter Estimates

- Real frictions are important in all models
- Price are not that sticky. Firms change prices every 2 quarters.
- Low price indexation $\lambda_P = 0.4$
- Relative large standard deviations of shocks (compared to developed economies)
- Taylor Rule: $\varphi_\pi = 1.94, \varphi_y = 0.09, \varphi_s = 0.84, \varphi_i = 0.03$
- Dollarization $\delta^{cs} = [0.33 - 0.66]$ and $\delta^{pd} = [0.35 - 0.66]$ Priors!!!

15 Result 2: Model Comparison

- Based on Bayes Factor: CS + PD model dominates the rest of the models

- Model with CS performs better than the benchmark

- PD dollarization itself does not add that much.

	Benchmark	CS	PD	CS+PD
Log-Marginal	**-940.30**	**-933.61**	**-936.11**	**-931.00**

16 Result 3: Why the "preferred" model rank first?

Standard deviation (in percent)							
Model	Δy	Δc	Δinv	i	π	Δrer	Δtot
Data	0.81	**0.85**	**2.26**	2.14	**0.62**	**1.21**	**1.46**
Benchmark	2.12	**1.66**	**6.88**	2.95	**1.04**	**2.68**	**2.89**
CS and PD	2.27	**1.56**	**6.55**	3.01	**0.98**	**2.05**	**2.41**
Autocorrelations							
Model	y	c	inv	i	π	rer	tot
Data	0.73	**0.71**	**0.84**	**0.50**	0.33	**0.71**	0.62
Benchmark	0.70	**0.82**	**0.38**	**-0.02**	0.36	**0.57**	0.79
CS and PD	0.70	**0.80**	**0.47**	**0.09**	0.23	**0.65**	0.81
Cross-correlation with output							
Model	y	c	inv	i	π	rer	tot
Data	1.00	0.78	0.81	0.15	-0.14	**-0.25**	**0.61**
Benchmark	1.00	0.65	0.45	-0.24	-0.06	**0.44**	**-0.68**
CS and PD	1.00	0.70	0.46	-0.27	-0.17	**0.46**	**-0.71**

17 Result 4: Variance Decomposition (CS + PD)

- Unexpected fluctuations of output are mainly driven by domestic supply shocks (mark-up, permanent and transitory technology shocks). Yet, foreign interest rate has had some importance (33%). In contrast with Justiniano and Preston (2006).

- Inflation is mainly explained by monetary and UIP shocks (39,8% and 25% respectively)

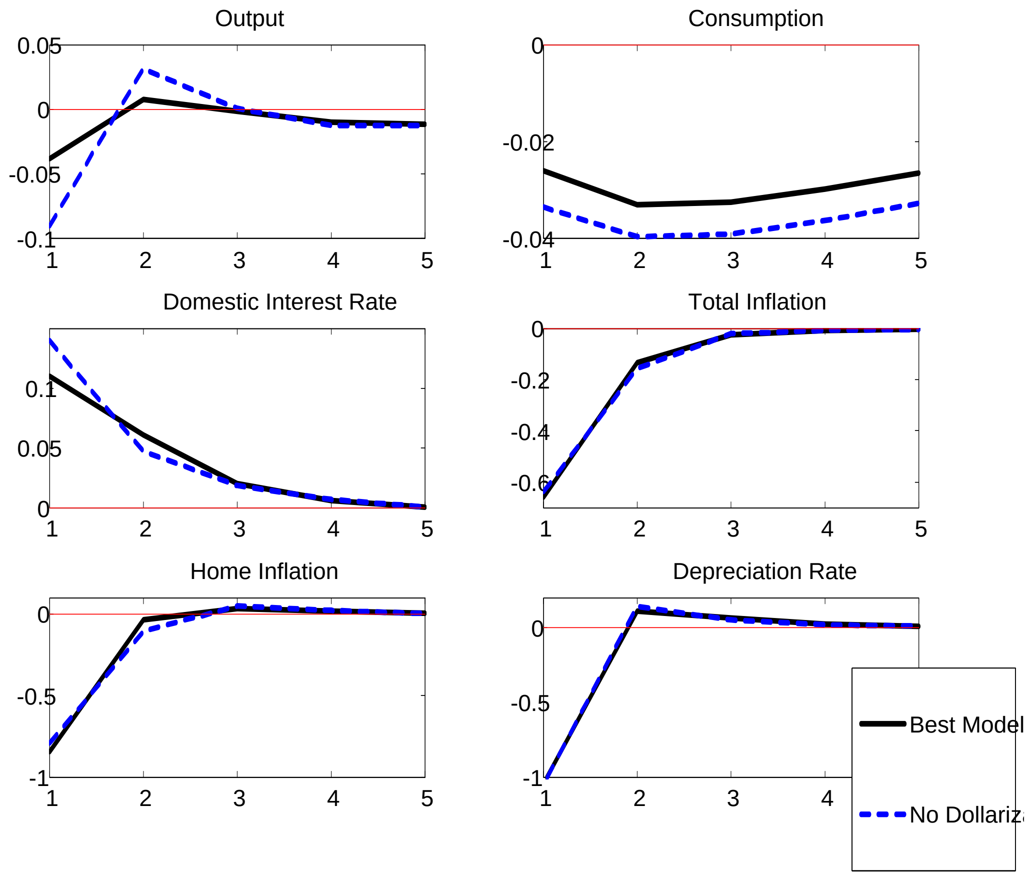
- What about the interest rate channel of monetary policy transmission? Exchange rate channel?. Domestic nominal interest rate mainly driven by UIP and foreign interest rate shocks (98%)

18 Result 4: Variance Decomposition (CS + PD)

Table 7: Contributions of the shocks to the variance (Model with currency substitution and price dollarisation)

SHOCK	Δy	Δc	Δinv	i	π	Δrer	Δtot
DEMAND SHOCKS:							
Preferences	0.13	57.12	0.09	0.19	0.20	0.07	0.22
Domestic interest rate	0.43	0.15	1.08	0.55	**38.90**	6.38	1.69
SUPPLY SHOCKS:							
Domestic productivity	**6.70**	1.60	0.63	0.29	2.35	4.38	9.90
Mark-up	**9.71**	0.24	4.38	0.32	3.68	4.69	8.49
Imported sector mark-up	0.03	0.45	0.63	0.30	4.39	14.70	8.90
Unit root	**47.98**	2.24	7.17	0.74	3.60	15.18	**35.10**
EXTERNAL SHOCKS:							
UIP	2.20	22.40	30.55	**19.78**	**25.08**	8.95	19.33
Foreign interest rate	**32.83**	15.82	55.48	**77.82**	**21.81**	**45.65**	16.37

19 Result 5: Counterfactual Impulse Response



Partial dollarization reduces output response to a monetary policy shock in 50%

20 Shortcomings

- Excessive volatility of real variables

- Lack of slow adjustment in the policy rule

- Cross correlation output-tot (positive in the data where as negative in all models), output-RER (negative in the data, where as positive in all models)

21 Robustness: PPP shocks

$$rer_t = -\gamma_H tot_t + lop_t + ppp_t$$

- Likelihood improves.

- $\varphi_i = 0.22$.Slow adjustment of the nominal interest rate

- The model fits better the data.: Volatility of both real and nominal variables gets closer to the data.

- Real exchange rate is mainly explained by PPP shocks.

22 Concluding Remarks and Extensions

- The estimation and model evaluation validate the two forms of partial dollarization.

- Extensions for further work:

  Historical decomposition of the endongenous variables.

  Financial Dollarization.

  NT goods in the line of Cristadoro, Gerali, Neri and Pisani (2006).

  Financial versus nominal frictions in emerging markets economies

- Stochastic Volatility. Justiniano and Primaceri (2006).,Non-Linear Estimation (Small Scale Models)

- Del Negro and Schorfheide (2006): Form priors based on beliefs of moments of endogenous variables