BANK FOR INTERNATIONAL SETTLEMENTS

"Devaluations, output and the balance sheet effect"

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Motivation

Are currency devaluations expansionary or contractionary in terms of output?

- The standard macroeconomic literature (i.e. Mundell-Fleming) posits that currency devaluations are expansionary.

- However, there is a strong presumption among economists that devaluations of the nominal exchange rate are contractionary in terms of output. This is particularly true in the light of recent financial crises.

- In fact, referring to the Asian crises Krugman (1999) argued that the worsening of firms´ balance sheets following a devaluation could lead to a contraction of output. [Cespedes, Chang and Velasco (2004,2003); Gilchrist,Gertler and Natalucci (forthcoming), Cook (2004)].

- Given the disagreement at the theoretical level on the effects of devaluations on output, the empirical evidence plays a fundamental role in disentangling the effect of devaluations on output

Empirically, the relative importance of different transmission channels is open to debate

- Cross-country reduced form analysis provides no conclusive answers (Gupta et al, 2007; Magendzo, 2002; Tovar, 2004).

  During 1970-2000 "[...] about 60% of crises [currency depreciations] are contractionary, while the rest are expansionary". "[…] we did not find crises in the 1990s to be more severe than those in the 1980s or the 1970s" *Gupta et al (2007), JIE*

  "Without controlling for selection bias I find devaluations to be associated with a growth rate that is 2 percentage points lower than otherwise predicted. However, after controlling for selection bias, the contractionary effect of devaluations disappears. […] These results are robust: devaluations show no statistically significant effect on output growth."

  Magendzo, 2002, CBCh

- Is there really no impact? For sure, empirical studies addressing the effect of currency devaluations on output have limitations in identifying and isolating the relative importance of the different transmission channels involved.

This paper estimates a DSGE model to address the question

- Its main objective is:
  - To assess empirically the impact of currency devaluations on output in South Korea.
  - Disentangle the relative importance of key transmission channels. In particular, the expenditure-switching effect and the balance sheet effect.
  - And shed some light on whether one should blame policy-induced devaluations or sudden stops for sharp contractions of output.
  - In addition some results are compared with Latin American economies (Colombia, Chile and Mexico).

The model

Framework

- Céspedes, Chang and Velasco's (2004, 2003) model is extended:
- Key features are:
  - Fully dynamic model.
  - Endogenous nominal rigidities → Quadratic adjustment costs
  - Endogenous monetary policy → Interest rate rule
  - To avoid the stochastic singularity problems arising in the estimation of DSGE models:
    - 6 structural shocks are incorporated (preferences, technology, cost-push, international interest rates, export demand, and nominal exchange rate target).
    - 5 measurement errors are also included.

Framework

- There are two mechanisms through which devaluations affect output:
  - Expenditure-switching effect: a devaluation affects relative prices and, therefore, the demand for domestically produced goods.
  - Balance sheet effect: if debts are denominated in dollars while firms' revenues are denominated in domestic currency, unexpected changes in the exchange rate will affect firms' balance sheets. The deterioration of balance sheets has two implications:
    - It limits firms' capacity to borrow and invest.
    - Borrowing becomes more expensive endogenously as the risk premium increases.

Framework

Households

•Consume, borrow and supply labour in a monopolistically competitive manner (set wages)

•Face wage adjustment cost.

•Subject to a preference shock.

Firms

•Rent capital and hire labour.

•Produce in a monopolistically competitive market. Face price adjustment cost.

•Subject to a technology and cost-push shock.

Entrepreneurs

•Own firms and rent capital to them.

•Decide how much to invest. So they borrow in international capital markets by issuing foreign currency denominated debt contracts.

•Due to imperfections in international capital markets entrepreneurs face a risk premium over the international risk free interest rate.

Monetary authority

•Conducts monetary policy through an interest rate rule.

•There are three targets: expected inflation, output and the nominal exchange rate.

•There is a time-varying target: Nominal exchange rate.

Firms´ problem

$$\underset{L_{jt},K_{jt}}{Max}\ E_o \sum_{t=0}^{\infty} \Delta_t \left(P_{jt}Y_{jt} - \int_0^1 W_{ijt}L_{ijt}di - R_tK_{jt} - P_tAC_t^P \right) \tag{1}$$

$$Y_{jt} = A_tK_{jt}^{\alpha}L_{jt}^{1-\alpha}, \quad 0 < \alpha < 1 \tag{2}$$

$$P_{jt} = \left[\frac{Y_{jt}}{Y_t} \right]^{-\frac{1}{\theta_t}} P_t, \quad \theta_t > 1 \tag{3}$$

$$AC_t^P = \frac{\psi_p}{2} \left[\frac{P_{jt}}{P_{jt-1}} - \bar{f}^p \right]^2 Y_t \tag{4}$$

$$L_{jt} = \left[\int_0^1 L_{ijt}^{\frac{\sigma-1}{\sigma}} di \right]^{\frac{\sigma}{\sigma-1}}, \quad \sigma > 1 \tag{5}$$

Households´ problem

$$\underset{C_{it},L_{it},B_{it},B^*_{it}}{Max} E_o \sum_{t=0}^{\infty} \beta^t a_t \left(lnC_{it} - \left(\frac{\sigma - 1}{\sigma} \right) \frac{1}{\nu} L_{it}^{\nu} \right)$$

$$C_{it} = \kappa \left(C_{it}^H \right)^{\gamma} \left(C_{it}^F \right)^{1-\gamma}, \; 0 < \gamma < 1 \tag{6}$$

$$P_t C_{it}^H + S_t C_{it}^F = Q_t C_{it} \tag{7}$$

$$B_{it} - B_{it-1} + S_t \left(B^*_{it} - B^*_{it-1} \right) = i_{t-1} B_{it-1} + S_t i^*_{t-1} B^*_{t-1} + W_{it} L_{it} - AC_t^w - Q_t C_{it} \tag{8}$$

$$W_{it} = \left(\frac{L_{it}}{L_t} \right)^{-\frac{1}{\sigma}} W_t \tag{9}$$

$$AC_t^w = \frac{\psi_w}{2} \left[\frac{W_{it}}{W_{it-1}} - \bar{\Omega} \bar{\pi} \right]^2 W_t \tag{10}$$

Entrepreneurs' problem

- The entrepreneurs own firms and rent capital to them. Their main activity is to finance investment, which they do by issuing dollar denominated debt in international markets.

- Formally, entrepreneurs engage in an optimal debt contract with costly-state verification (à la Bernanke, Gertler and Gilchrist, 1999 and extended to open economies by Céspedes, Chang and Velasco, 2004).

- The full microeconomic problem is derived in Tovar (2005). In what follows, and for simplicity, I only report the optimality conditions derived from this debt problem with costly-state verification.

Entrepreneurs' problem

- Any investment in excess of net worth is financed in international markets:

$$Q_t K_{t+1} = P_t N_t + S_t D_{t+1} \tag{11}$$

- Due to costly-state verification, entrepreneurs borrow abroad at a risk premium above the world risk free interest rate. The risk premium is an increasing concave function of the ratio of investment to net worth:

$$1 + \eta_t = \left(\frac{Q_t K_{t+1}}{P_t N_t} \right)^{\mu} \tag{12}$$

Entrepreneurs' problem

- In equilibrium, the expected yield of capital in foreign currency must equal the cost of borrowing in international capital markets to finance capital investment:

$$\frac{E_t\left(R_{t+1}K_{t+1}/S_{t+1}\right)}{Q_tK_{t+1}/S_t} = \left(1+\rho_t\right)\left(1+\eta_t\right) \qquad (13)$$

- Net worth is defined as:

$$P_tN_t = R_tK_t + \Pi_t - S_tD_t \qquad (14)$$

Monetary policy

- Monetary policy follows an interest rate rule with partial adjustment. There are three targets: expected inflation, output and the nominal exchange rate.

$$\frac{1+\tilde{i}_t}{1+\bar{i}} = \left(\frac{E_t\pi_{t+1}}{\bar{\pi}}\right)^{\omega_\pi} \left(\frac{Y_t}{\bar{Y}}\right)^{\omega_y} \left(\frac{S_t}{\bar{S}_t}\right)^{\frac{\omega_s}{1-\omega_s}}$$

where $\omega_\pi, \omega_y, \omega_s$ and $\omega_i \in [0, 1]$.

$$\frac{1+i_t}{1+\bar{i}} = \left(\frac{1+i_{t-1}}{1+\bar{i}}\right)^{\omega_i} \left(\frac{1+\tilde{i}_t}{1+\bar{i}}\right)^{1-\omega_i} \qquad (16)$$

- KEY: A devaluation is defined as an increase in: $\bar{S}_t$

Market clearing

$$P_t Y_t = \gamma Q_t \left(K_{t+1} + C_t\right) + \frac{\psi_p}{2}\left(f_t^p - \bar{f}^p\right)^2 P_t Y_t + S_t X_t \qquad (18)$$

Estimation method

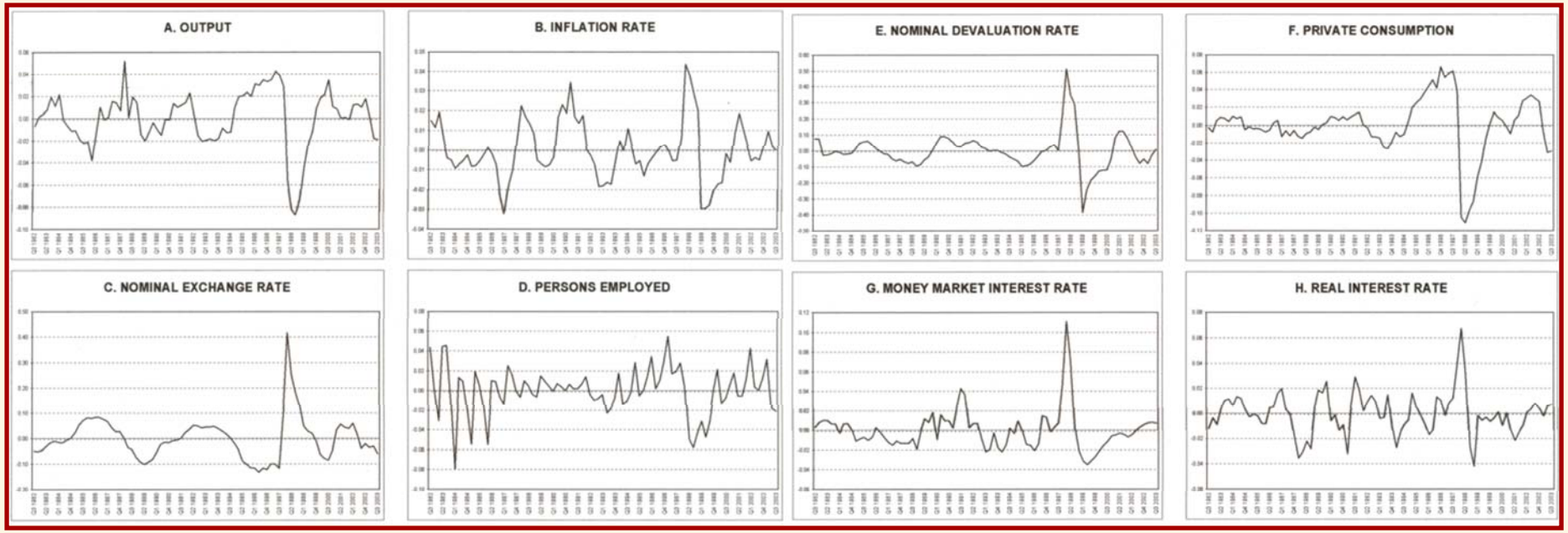
- The model is log-linearised around the non-stochastic symmetric steady-state and solved using the method of undetermined coefficients.

- Then, the model is written in state-space form (with and without measurement errors which are incorporated into the observation equations).

- The Kalman filter is used to construct the likelihood function, and the parameters are estimated maximising this function.

- Model is estimated for South Korea using quarterly data from 1982:3 through 2003:3.

South Korea



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Estimation results

Calibrated parameter values

Table 1: **Benchmark parameter values for estimation**

Preferences		Technology	
- Discount factor	$\beta = 0.99$		
- Elasticity of labor supply	$\nu = 2$	-Capital share	$\alpha = 0.4$
- Consumption share of home goods	$\gamma = 0.65$	-Elast. of labor demand	$\sigma = 2$
- Elast. of substitution b/w different varieties	$\theta = 6$		

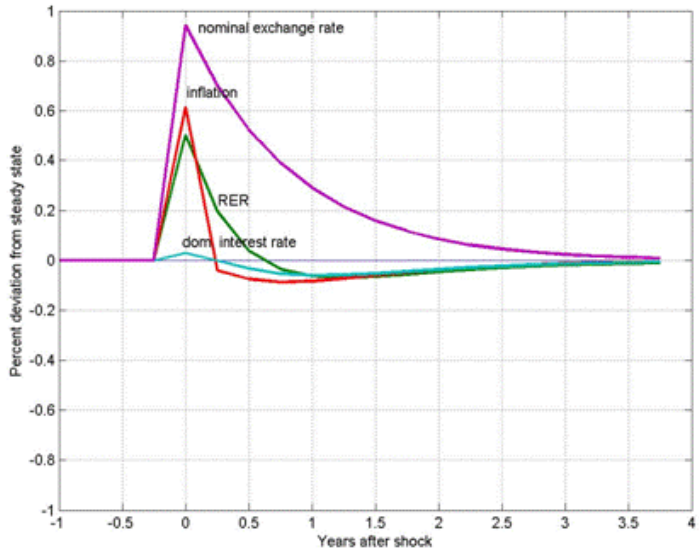
Estimated parameter values

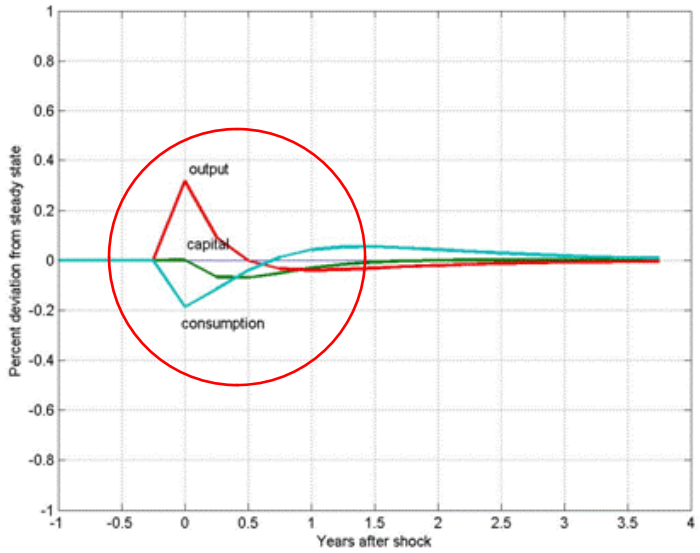
Parameters		Estimates	Standard Errors
- Degree of price rigidity	ψ_p	5.69540	0.69672
- Degree of wage rigidity	ψ_w	1.35920	0.32488
- International capital market imperfections	μ	0.40796	0.04356
Interest rate response to:			
- Lagged interest rate	ω_i	0.74992	0.03066
- Expected inflation	ω_p	2.60610	0.58025
- Output	ω_y	1.40660	0.96648
- Nominal exchange rate	ω_s	0.79997	0.05510

Estimated parameter values

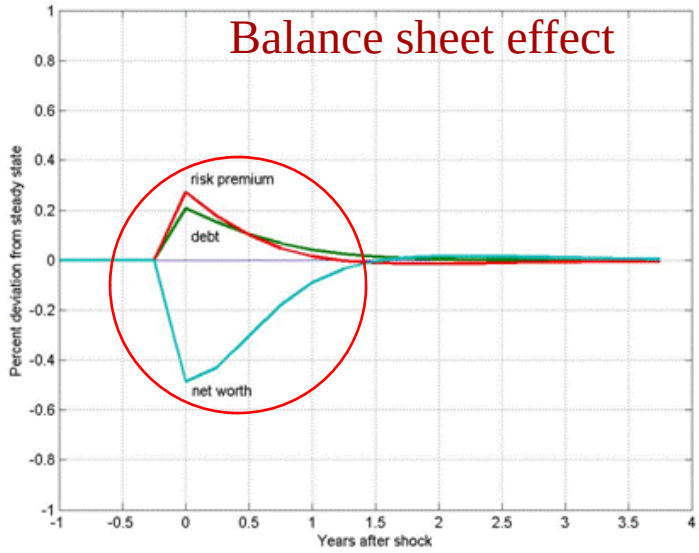
	Persistence	Estimates	Stand. Errors	Stand. Dev.	Estimates	Stand. Errors
- Technology	ζ_A	0.75731	0.21200	σ_A	0.18344	0.02143
- Mark-up	ζ_θ	0.95164	0.00058	σ_θ	0.28992	0.02289
- Preferences	ζ_a	0.19833	2.79140	σ_a	0.03564	0.36334
- Devaluationary policy	ζ_χ	0.70724	0.07222	σ_χ	0.22594	0.02642
- Intern. risk free interest rate	ζ_ρ	0.97727	0.01084	σ_ρ	0.19539	0.01996
- Exports	ζ_x	0.67179	0.09137	σ_x	0.11976	0.02018

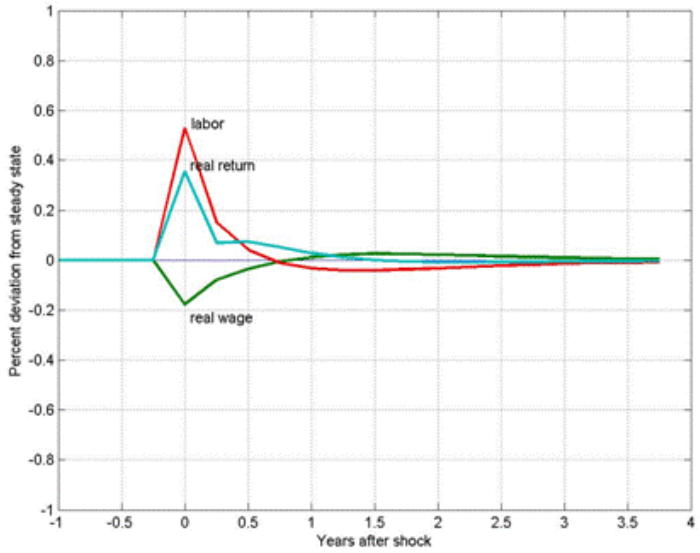
Impulse response to a devaluationary policy shock





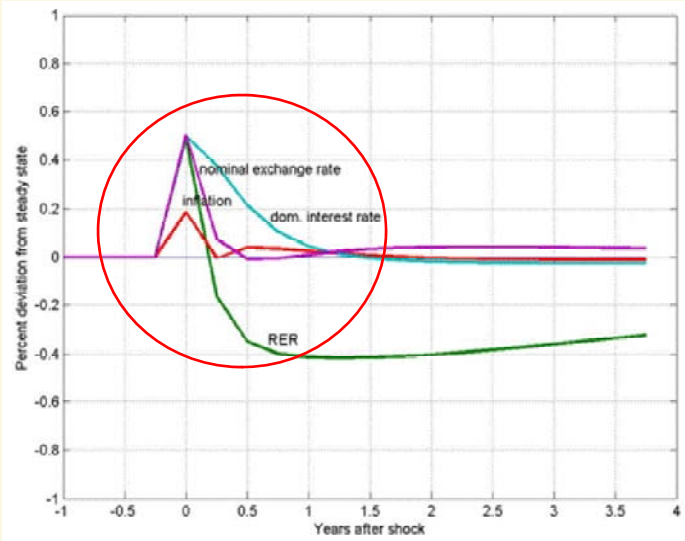
Balance sheet effect

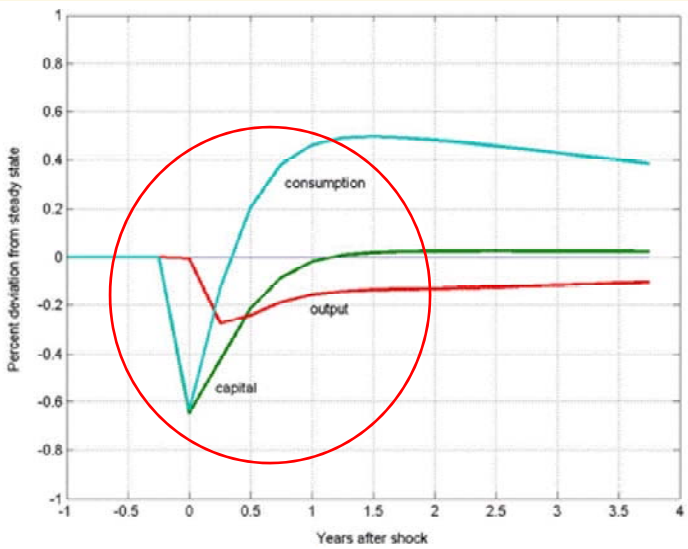


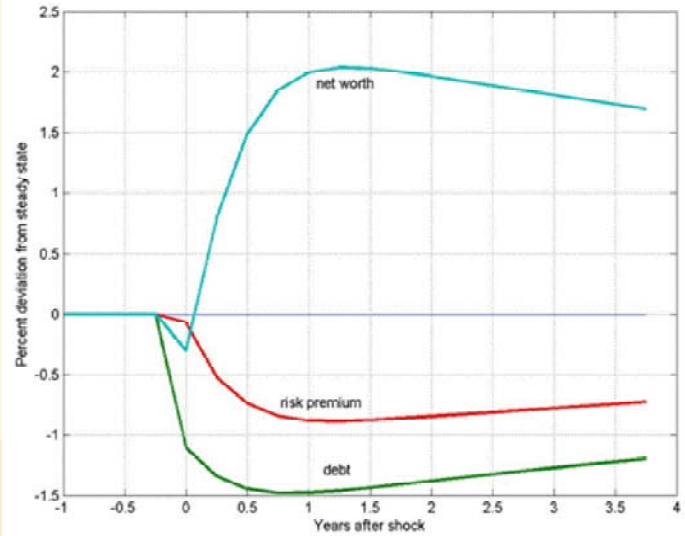


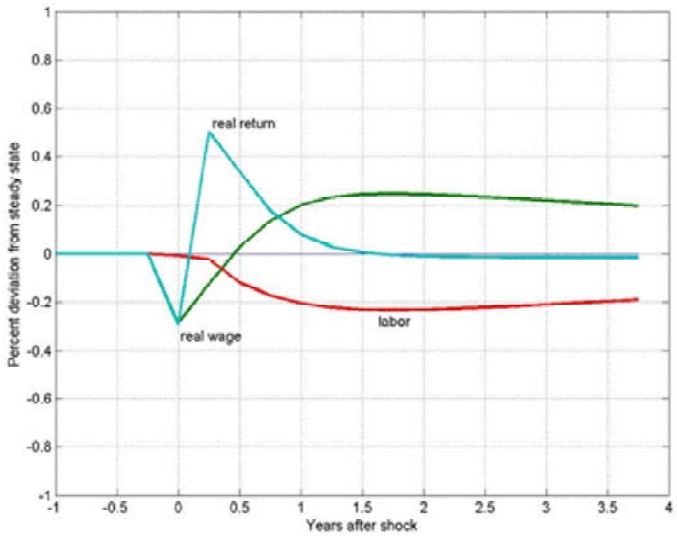
Is it then sudden stops rather than contractionary devaluations?

Impulse response to a shock on the international interest rate

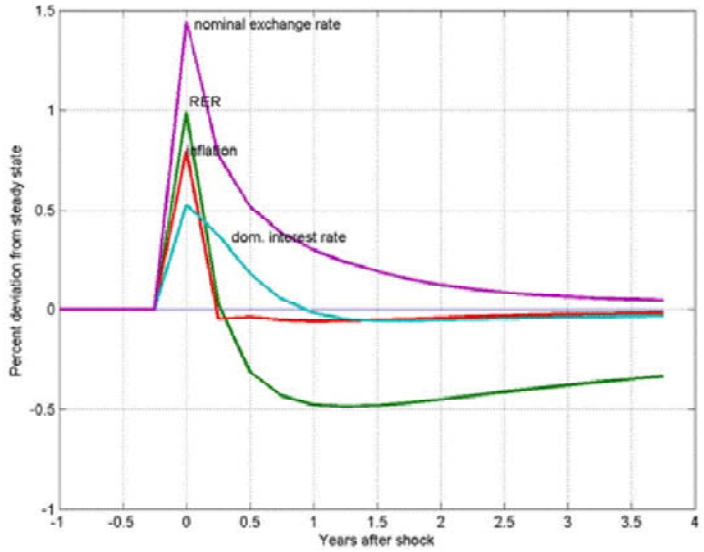


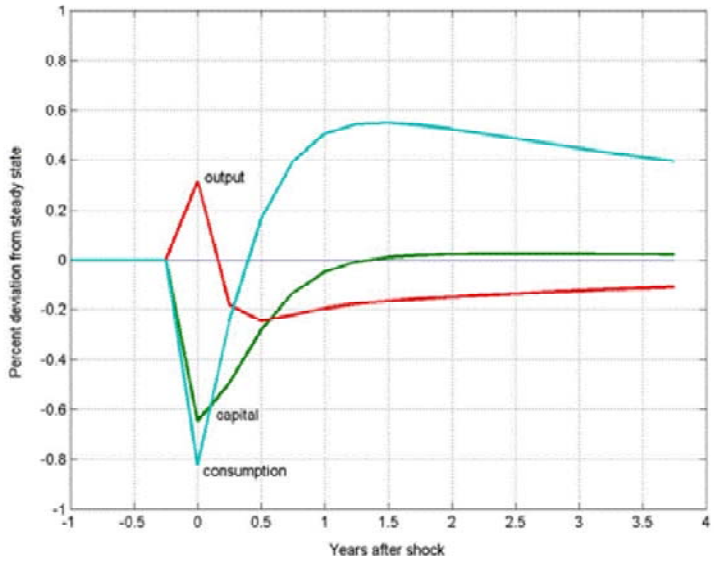


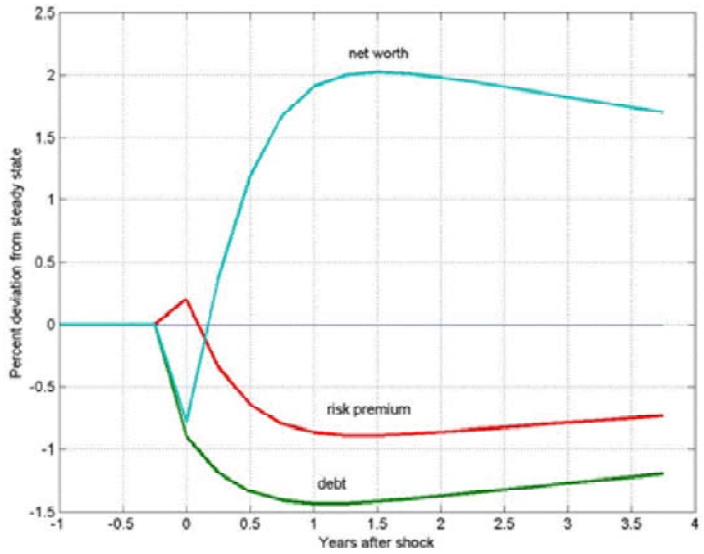


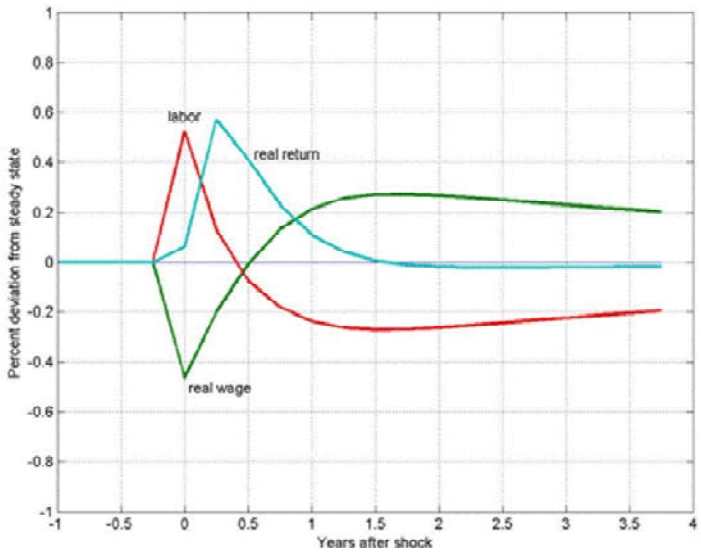


Impulse response to joint adverse shock







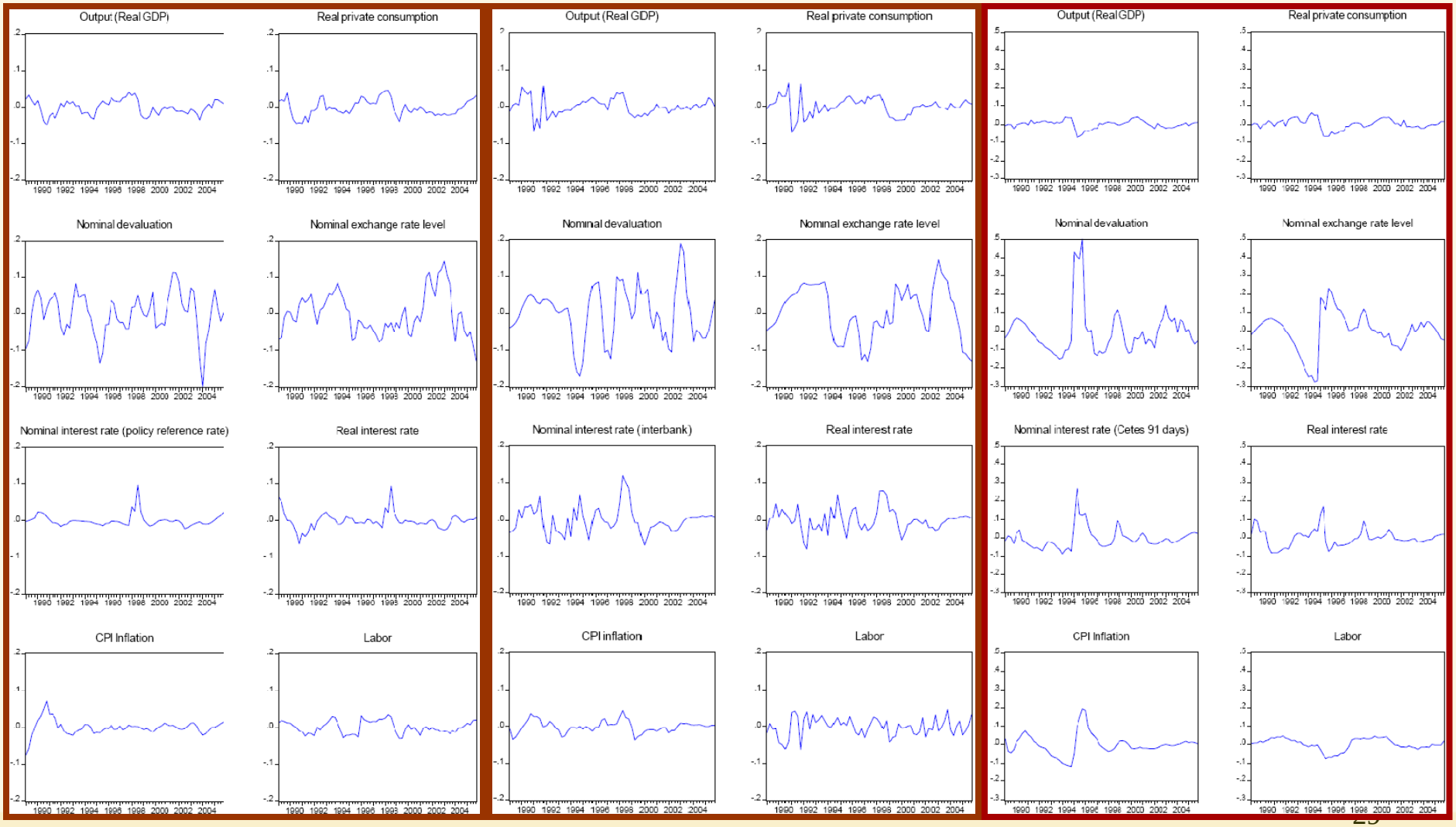


Forecast error variance decompositions

	Technology		Mark-up		Preference		Devaluation		Intl. Interest		Export		Meas. Error	
	coef.	s.e.	coef.	s.e	coef.	s.e	coef.	s.e.	coef.	s.e.	coef.	s.e	coef.	s.e
							Output							
1	8.03	1.510	37.45	7.418	0.05	0.057	3.40	0.636	0.00	0.009	0.15	0.017	50.93	6.597
4	3.80	1.086	17.80	4.370	0.01	0.008	0.36	0.078	0.27	0.065	0.02	0.003	77.75	3.844
8	0.02	0.006	0.13	0.032	0.00	0.000	0.00	0.000	0.00	0.000	0.00	0.000	99.85	0.026
							Nominal Exchange Rate							
1	19.06	0.497	3.31	1.464	0.00	0.002	75.10	6.025	2.11	1.314	0.42	0.085	0.00	0.000
4	17.00	0.203	5.76	1.518	0.01	0.007	68.30	2.461	8.70	1.298	0.24	0.067	0.00	0.000
8	13.84	1.078	19.67	4.811	0.00	0.006	51.53	3.193	14.80	1.840	0.15	0.043	0.00	0.000

Comparing the results with some Latin American economies. How robust are the results?

Chile | Colombia | Mexico



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Estimated parameter values

No measurement errors

Table 2: **Maximum likelihood estimates: main parameter values**

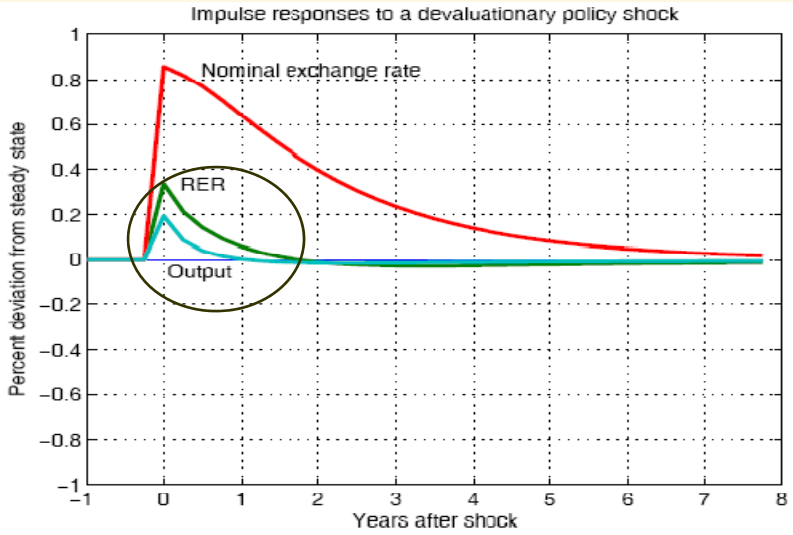
	Chile		Colombia		Mexico	
	Estimate	Std Error	Estimate	Std. Error	Estimate	Std. Error
Transmission channels of devaluations						
- Balance sheet, μ	0.31	0.0019	0.23	0.0021	0.14	0.0030
- Expenditure switching, γ	0.62	0.0012	0.68	0.0046	0.63	0.0034
Interest rate response to:						
- Lagged interest rate, ω_i	0.03	0.0014	0.53	0.0024	0.55	0.0029
- Expected inflation, ω_p	1.93	0.0013	1.98	0.0012	2.50	0.0024
- Output, ω_y	0.04	0.0011	0.16	0.0033	1.14	0.0049
- Nominal exchange rate, ω_s	0.66	0.0007	0.92	0.0028	0.58	0.0029
Nominal rigidities						
- Price rigidities, ψ_p	7.13	0.0050	6.38	0.0024	4.60	0.0024
- Wage rigidities, ψ_w	0.86	0.0010	1.53	0.0030	0.24	0.0043

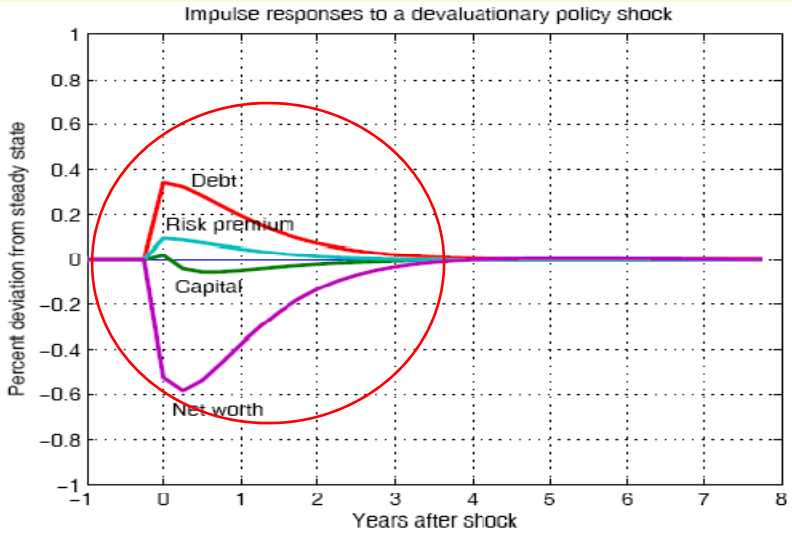
With measurement errors

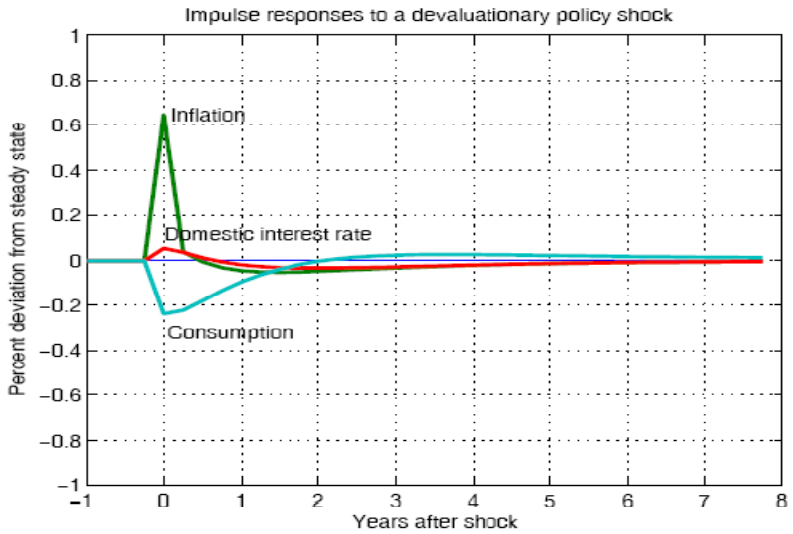
Table 15: **Maximum likelihood estimates with measurement erros: main parameter values**

	Chile		Colombia		Mexico	
	Estimate	Std Error	Estimate	Std. Error	Estimate	Std. Error
Transmission channels of devaluations						
- Balance sheet, μ	0.24	0.003	0.30	0.0151	0.18	0.002
- Expenditure switching, γ	0.59	0.018	0.68	0.013	0.63	0.002
Interest rate response to:						
- Lagged interest rate, ω_i	0.49	0.036	0.71	0.034	0.74	0.006
- Expected inflation, ω_p	1.60	0.012	2.15	0.084	1.50	0.070
- Output, ω_y	0.70	0.201	0.53	0.410	1.14	0.036
- Nominal exchange rate, ω_s	0.71	0.001	0.89	0.005	0.67	0.007
Nominal rigidities						
- Price rigidities, ψ_p	5.10	0.53	6.37	1.212	4.78	0.125
- Wage rigidities, ψ_w	1.60	0.012	1.74	0.436	1.14	0.036

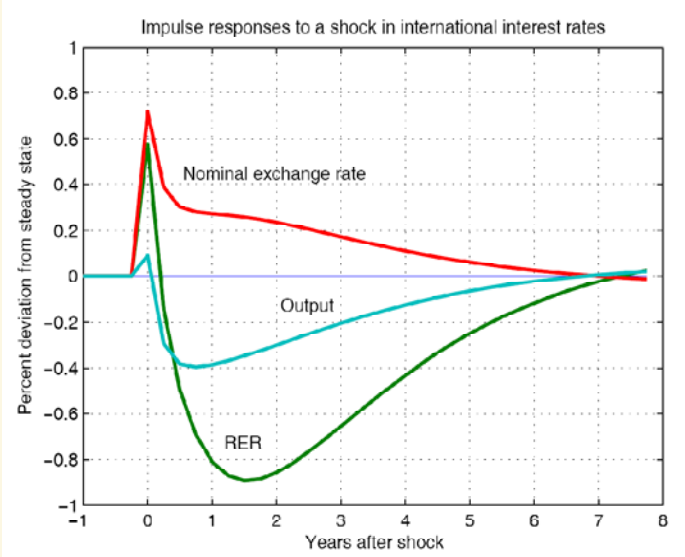
Impulse response to a devaluationary policy shock: Mexico

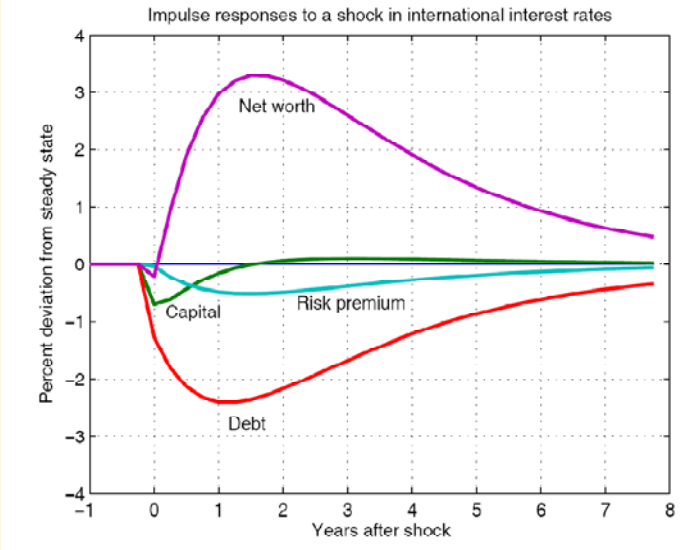


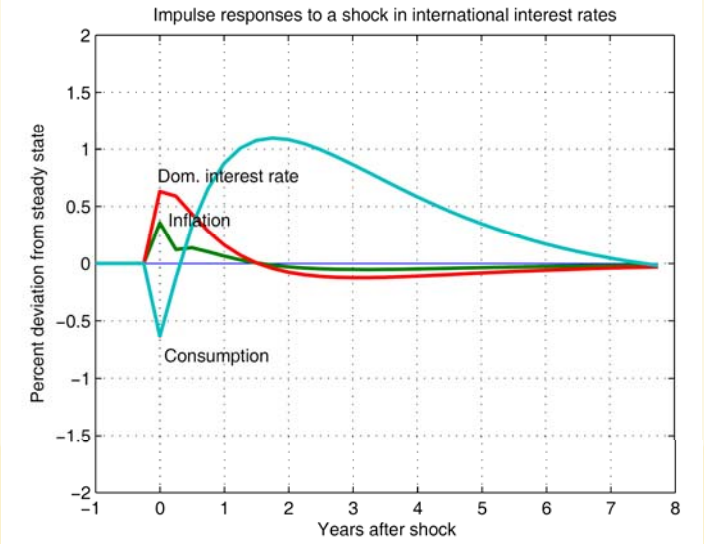




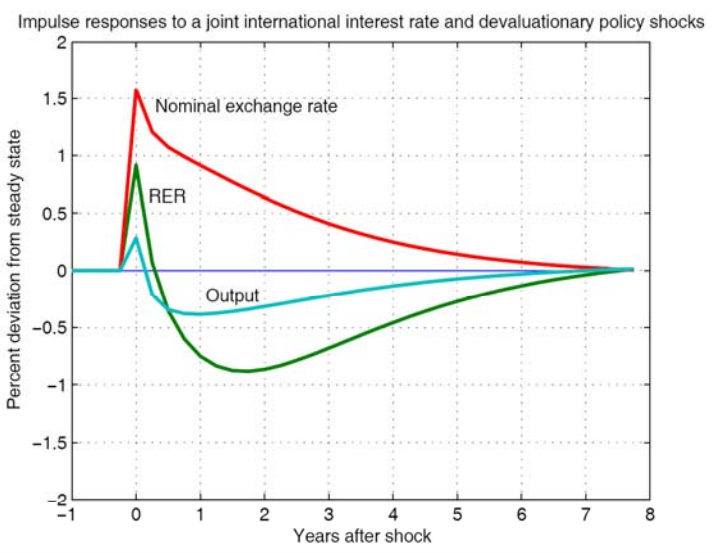
Impulse response to shock on inter. interest rates: Mexico

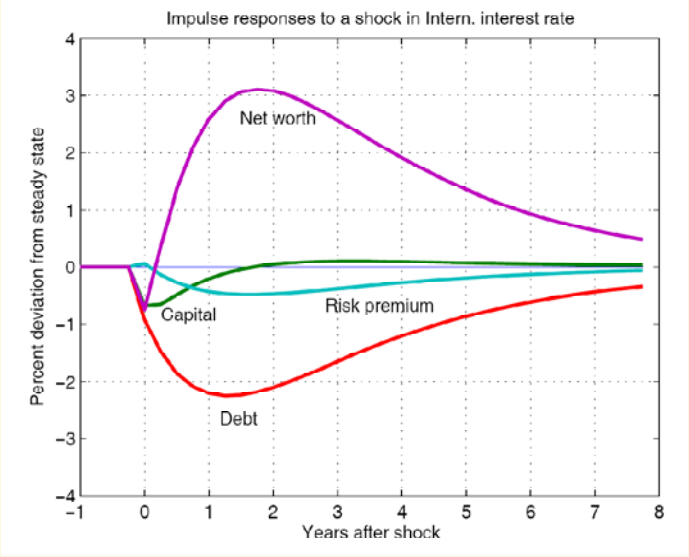


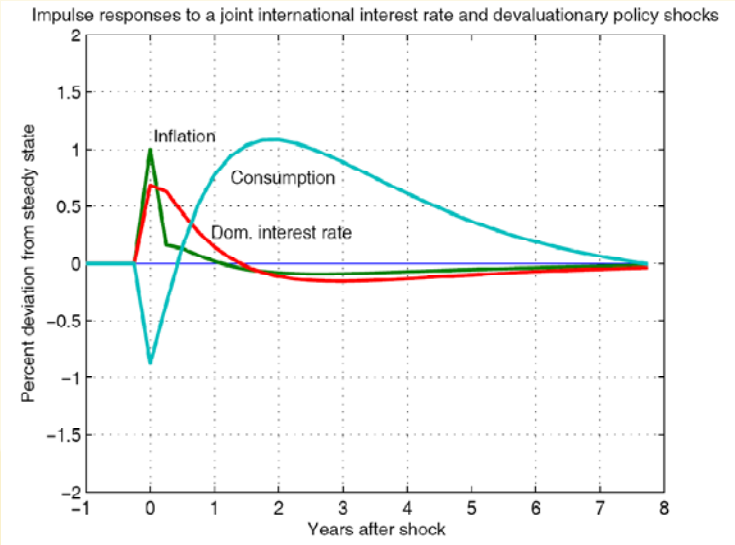




Impulse response to a joint adverse external shock and devaluationary policy







Concluding remarks

- A stylised structural DSGE model is used to answer two main questions:
  - Are currency devaluations expansionary or contractionary in terms of output?
  - What is the relative importance of the different mechanisms involved?
- Estimates show that explicit policy decisions are expansionary:
  - exogenous devaluationary policy shocks, ceteris paribus, have been on average expansionary.
  - the contractionary balance sheet transmission mechanism is dominated by the expenditure-switching effect.
  - Also that all else equal, balance sheet effects were more significant in South Korea than in Mexico, Chile or Colombia.

Concluding remarks

- The prevalence of negative correlations between exchange rate changes and output does not support the claim that devaluations are contractionary.
- The sign of the correlation between exchange rate changes and output depends on the nature of the shock that hits the economy. In other words, it is not contractionary devaluations but sudden stops that lead to sharp output contractions.
- An important implication is that isolating the exchange rate fluctuations associated with different shocks can be a difficult task to accomplish in reduced form models. Therefore, this explains the difficulties faced by the existing empirical literature in assessing the effects of devaluations on output. At the same time, it shows the advantages of employing a structural model, such as the one presented here.

Thank you!

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