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How Brazil, Chile, Colombia, Mexico and Peru have responded to terms of trade shocks during inflation targeting?

Alberto Ortiz Bolaños
CEMLA and EGADE

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Motivation

Should open-economy variables (such as exchange rates, global business cycle conditions, or global imbalances) be part of a central bank's monetary policy strategy?

No necessarily.

Clarida, Galí and Gertler (AER 2001) show that under complete exchange-rate-pass-through (producer currency pricing) and frictionless asset markets ensuring efficient risk-sharing the monetary policy design problem for the small open economy is isomorphic to the problem of the closed economy.

As far as relative prices are not distorted, the central bank should allow for free floating of the exchange rate despite the impact of the resulting exchange variability on inflation, focusing only on output gaps and inflation.

Likely yes.

Corsetti and Pesenti (JME 2005) show that when firms' markups are exposed to currency fluctuations, foreign prices increase vis-à-vis currency uncertainty reducing the purchasing power of domestic consumers. Therefore, optimal monetary rules should limit exchange rate variability.

Corsetti, Dedola and Leduc (Handbook of Monetary Economics V3 2011) show that incomplete asset markets create policy trade-offs where optimal policies include responding to external quantities and prices.

Motivation (cont.)

Are open-economy variables part of central banks' monetary policy strategy?

$$r_t = \rho_r r_{t-1} + (1-\rho_r)(\psi_1 \pi_t + \psi_2 y_t + \psi_3 \Delta e_t) + \varepsilon_t^r$$

Table 2.2 Monetary Policy Parameter Estimation Results

Country	Exchange Rate Regime[3]	Estimation Period		ψ_1	ψ_2	ψ_3	$1-\rho_R$
Australia[1]	Float	1983:Q1	2002:Q4	1.41	0.24	0.07	0.24
Canada[1]	Float/Managed Float	1983:Q1	2002:Q4	1.30	0.23	0.14	0.31
New Zealand[1]	Fix	1988:Q1	2002:Q4	1.69	0.25	0.04	0.37
South Africa[2]	Fix/Managed Float/Float	1983:Q1	2002:Q4	1.11	0.27	0.11	0.27
United Kingdom[1]	Float	1983:Q1	2002:Q4	1.30	0.20	0.13	0.26
Average				**1.36**	**0.24**	**0.1**	**0.29**
Argentina 94	Fix	1991:Q2	1994:Q4	0.17	0.68	4.35	0.59
Argentina 98	Fix	1991:Q2	1998:Q2	0.13	0.21	6.22	0.62
Brazil	Managed Float	1994:Q4	1997:Q4	0.71	0.19	0.25	0.50
Chile	Float	1988:Q3	1998:Q2	1.49	0.17	0.17	0.22
Colombia	Float	1994:Q2	1998:Q2	1.49	0.15	0.23	0.49
Croatia	Managed Float	1994:Q3	1997:Q4	0.67	0.4	01.51	0.57
Ecuador	Float/Managed Float	1990:Q2	1998:Q4	1.15	0.17	0.23	0.75
Indonesia	Managed Float	1994:Q2	1997:Q4	0.75	0.15	0.25	0.95
Korea	Managed Float	1987:Q4	1997:Q3	1.64	0.33	0.72	0.31
Malaysia	Managed Float	1989:Q1	1997:Q4	3.12	0.40	0.15	0.20
Mexico	Fix	1990:Q4	1994:Q4	0.51	0.66	0.34	0.11
Peru	Float	1995:Q1	1997:Q4	1.92	0.53	0.82	0.44
Philippines	Managed Float	1990:Q4	1997:Q4	1.38	0.29	0.11	0.59
Poland	Float	1995:Q2	1997:Q4	1.18	0.64	0.80	0.16
Russia	Fix	1995:Q2	1997:Q4	0.71	0.68	0.64	0.94
Thailand	Managed Float	1993:Q2	1996:Q3	2.00	0.17	1.04	0.75
Turkey 93	Float	1989:Q2	1993:Q4	1.19	0.17	0.29	0.56
Turkey 98	Float	1989:Q2	1998:Q1	1.77	0.20	0.50	0.87
Average				**1.22**	**0.34**	**1.04**	**0.54**

Source: [1] Lubik and Schorfheide (2007), [2] Ortiz and Sturzenegger (2007), and [3] Levy Yeyati and Sturzenegger (2005).

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Overview of the results

- We explore if the nominal exchange rate or the terms-of-trade are part of central banks' monetary policy strategy in Brazil, Chile, Colombia, Mexico and Peru since the adoption of the inflation-targeting framework.

- According to the numerical exercise, Peru is the only country where the interest rate policy responds to exchange rate fluctuations. There is slight evidence that Brazilian SELIC responds to terms of trade.

- An improvement in the terms of trade raises output, appreciates the currency and lowers inflation (except for Peru). These movements prompt the central banks to loosen policy.

- The analysis allows us to do an historical shock decomposition to uncover the effects of different shocks, including terms of trade, on the behavior of macroeconomic variables.

Overview of the results (cont.)

- Asymptotically, terms of trade shocks explain between 23% to 40% of nominal exchange rate fluctuations in Colombia, Mexico and Peru, but without price and asset market distortions present in the model they do not seem relevant in explaining other variables.

- Newer estimations of a framework that adds fiscal policy and considers incomplete asset markets and Law-of-One-Price gap gives quantitative evidence of a larger role for terms of trade shocks.

- For Colombia, asymptotically, terms of trade shocks explain 39% of output growth, 23% of interest rate movements, 66% of imported goods inflation, 6% of exchange rate movements, 15% of government expenditure, 13% of taxation, 15% of country's indebtedness and 10% of current account movements.

A Monetary Small Open Economy General Equilibrium Model

- Open-economy IS curve:

$$y_t = E_t\{y_{t+1}\} - \frac{1}{\sigma_\alpha}(r_t - E_t\pi_{t+1} - \rho_a a_t - \alpha E_t \Delta q_{t+1}) + \alpha(\varpi - 1)E_t \Delta y^*_{t+1}$$

- Open-economy Phillips curve:

$$\pi_t + \alpha\Delta q_t = \beta E_t\{\pi_{t+1} + \alpha\Delta q_{t+1}\} + \kappa\left[(\sigma_\alpha + \varphi)\left(y_t - \frac{1+\varphi}{\sigma_\alpha+\varphi}a_t + \frac{\sigma-\sigma_\alpha}{\sigma_\alpha+\varphi}y^*_t\right)\right]$$

- Interest rate rule:

$$r_t = \rho_r r_{t-1} + (1-\rho_r)\left(r_\pi \pi_t + r_y y_t + r_{\Delta e}\Delta e_t + r_{\Delta q}\Delta q_t\right) + \varepsilon^r_t$$

- Nominal exchange rate $\left(\frac{\#\text{ of } LCU}{1\ USD}\right)$ determination:

$$\pi_t = \Delta e_t + (1-\alpha)\Delta q_t + \pi^*_t$$

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Model: External Sector and Technology

- AR(1) process for the terms of trade $\left(\frac{P^{exports}}{Pimports}\right)$:

$$\Delta q_t = \rho_q \Delta q_{t-1} + \varepsilon_t^q$$

- Evolution of foreign output

$$y_t^* = \rho_{y^*} y_{t-1}^* + \varepsilon_t^{y^*}$$

- Evolution of foreign inflation

$$\pi_t^* = \rho_{\pi^*} \pi_{t-1}^* + \varepsilon_t^{\pi^*}$$

- Evolution of technology

$$a_t = \rho_a a_{t-1} + \varepsilon_t^a$$

Measurement equations

Observable	Measurement Equation	Shocks
Output growth	$y_t - y_{t-1} + a_t$	ε_t^a
Inflation	$4\pi_t$	$\varepsilon_t^{y^*}$
Nominal interest rate	$4r_t$	ε_t^r
Nominal exchange rate depreciation	Δe_t	$\varepsilon_t^{\pi^*}$
Changes in terms of trade	Δq_t	ε_t^q

Monetary policy rules

	$r_\pi \pi_t + r_y y_t$	$+\ r_{\Delta e} \Delta e_t$	$+\ r_{\Delta q} \Delta q_t$
Brazil	$\rho_r = \mathbf{0.73}$ (0.70, 0.80) $r_\pi = \mathbf{1.17}$ (1.00, 1.34) $r_y = \mathbf{0.34}$ (0.13, 0.54)	$\rho_r = \mathbf{0.75}$ (0.68, 0.82) $r_\pi = \mathbf{1.18}$ (0.97, 1.40) $r_y = \mathbf{0.40}$ (0.15, 0.65) $r_{\Delta e} = \mathbf{0.04}$ (0.01, 0.06)	$\rho_r = \mathbf{0.74}$ (0.68, 0.81) $r_\pi = \mathbf{1.19}$ (1.00, 1.39) $r_y = \mathbf{0.36}$ (0.13, 0.59) $r_{\Delta q} = \mathbf{0.11}$ (0.03, 0.19)
Canada	$\rho_r = \mathbf{0.69}$ (0.59, 0.79) $r_\pi = \mathbf{1.27}$ (1.00, 1.54) $r_y = \mathbf{0.38}$ (0.13, 0.62)	$\rho_r = \mathbf{0.69}$ (0.60, 0.78) $r_\pi = \mathbf{1.13}$ (0.91, 1.36) $r_y = \mathbf{0.37}$ (0.14, 0.60) $r_{\Delta e} = \mathbf{0.13}$ (0.06, 0.19)	$\rho_r = \mathbf{0.70}$ (0.61, 0.79) $r_\pi = \mathbf{1.26}$ (1.02, 1.48) $r_y = \mathbf{0.38}$ (0.15, 0.59) $r_{\Delta q} = \mathbf{0.08}$ (0.02, 0.14)
Chile	$\rho_r = \mathbf{0.66}$ (0.56, 0.75) $r_\pi = \mathbf{1.55}$ (0.99, 2.07) $r_y = \mathbf{0.37}$ (0.13, 0.61)	$\rho_r = \mathbf{0.71}$ (0.61, 0.81) $r_\pi = \mathbf{1.52}$ (0.95, 2.11) $r_y = \mathbf{0.40}$ (0.18, 0.63) $r_{\Delta e} = \mathbf{0.05}$ (0.01, 0.09)	$\rho_r = \mathbf{0.69}$ (0.58, 0.79) $r_\pi = \mathbf{1.89}$ (1.07, 2.65) $r_y = \mathbf{0.41}$ (0.17, 0.65) $r_{\Delta q} = \mathbf{0.03}$ (0.01,0.04)
Colombia	$\rho_r = \mathbf{0.81}$ (0.75, 0.86) $r_\pi = \mathbf{1.22}$ (1.00, 1.44) $r_y = \mathbf{0.34}$ (0.14, 0.54)	$\rho_r = \mathbf{0.82}$ (0.77, 0.88) $r_\pi = \mathbf{1.24}$ (0.96, 1.52) $r_y = \mathbf{0.40}$ (0.17, 0.62) $r_{\Delta e} = \mathbf{0.05}$ (0.02, 0.09)	$\rho_r = \mathbf{0.82}$ (0.77, 0.88) $r_\pi = \mathbf{1.30}$ (1.00, 1.58) $r_y = \mathbf{0.38}$ (0.16, 0.59) $r_{\Delta q} = \mathbf{0.05}$ (0.01, 0.08)
Mexico	$\rho_r = \mathbf{0.81}$ (0.75, 0.87) $r_\pi = \mathbf{1.21}$ (1.00, 1.46) $r_y = \mathbf{0.33}$ (0.12, 0.53)	$\rho_r = \mathbf{0.82}$ (0.76, 0.88) $r_\pi = \mathbf{1.16}$ (0.89, 1.44) $r_y = \mathbf{0.38}$ (0.13, 0.60) $r_{\Delta e} = \mathbf{0.09}$ (0.04, 0.14)	$\rho_r = \mathbf{0.82}$ (0.76, 0.88) $r_\pi = \mathbf{1.30}$ (1.00, 1.62) $r_y = \mathbf{0.35}$ (0.13, 0.56) $r_{\Delta q} = \mathbf{0.08}$ (0.02, 0.13)
Peru	$\rho_r = \mathbf{0.68}$ (0.59, 0.77) $r_\pi = \mathbf{1.21}$ (1.00, 1.44) $r_y = \mathbf{0.33}$ (0.13, 0.52)	$\rho_r = \mathbf{0.69}$ (0.61, 0.77) $r_\pi = \mathbf{1.07}$ (0.79, 1.36) $r_y = \mathbf{0.36}$ (0.14, 0.57) $r_{\Delta e} = \mathbf{0.19}$ (0.08, 0.29)	$\rho_r = \mathbf{0.70}$ (0.61, 0.79) $r_\pi = \mathbf{1.30}$ (1.00, 1.61) $r_y = \mathbf{0.38}$ (0.15, 0.61) $r_{\Delta q} = \mathbf{0.05}$ (0.01, 0.09)

Models' fit comparison

- The following table shows the Log Data Density of the model with three alternative monetary policy rules:

	$r_\pi \pi_t + r_y y_t$	$+ r_{\Delta e} \Delta e_t$	$+ r_{\Delta q} \Delta q_t$
Brazil	-934.43 89%	-939.55 1%	-936.52 10%
Canada	-718.42 20%	-717.00 80%	-722.59 0%
Chile	-824.02 99%	-830.677552 1%	-839.907867 0%
Colombia	-714.13 100%	-720.25 0%	-720.88 0%
Mexico	-817.55 76%	-818.83 21%	-820.73 3%
Peru	-814.24 30%	-813.41 70%	-819.89 0%

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Variance decomposition

Monetary	Output growth	Inflation	Interest rates	Exchange rate
Brazil	5.6	4.7	2.8	0.1
Canada	13.1	8.0	2.7	1.5
Chile	0.2	4.8	32	0.0
Colombia	5.6	16.4	1.3	0.7
Mexico	2.8	29.0	11.7	1.1
Peru	2.0	14.8	25.9	0.3

Terms of trade	Output growth	Inflation	Interest rates	Exchange rate
Brazil	0.2	1.9	0.4	7.2
Canada	0.1	0.4	0.1	16.1
Chile	0.0	15.6	7.3	37.5
Colombia	0.5	2.1	0.4	23.1
Mexico	0.1	6.2	1.5	37.9
Peru	0.1	5.9	2.6	39.0

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Monetary and Fiscal Policies in Latin America: Evidence from an Estimated DSGE Model

Maritsa Hernández Henao
CEMLA

Alberto Ortiz Bolaños
CEMLA and EGADE

The views expressed in this presentation are those of the authors, and not necessarily those of CEMLA.

Model: evolution of government debt and expenditure and taxation policies

- Evolution of real debt:

$$b_{t+1} = r_t + \frac{1}{\beta}\left[b_t - \pi_t + (1-\beta)(\tau_t - y_t) + \frac{C_{ss}}{B_{ss}}(g_t - \tau_t)\right] + \varepsilon_t^b$$

- Government expenditure reaction function:

$$g_t = \rho_g g_{t-1} + \left(1-\rho_g\right)\left(g_y(y_{t-1} - y_{t-1}^n) + g_b b_t\right) + \varepsilon_t^g$$

- Taxation reaction function:

$$\tau_t = \rho_\tau \tau_{t-1} + (1-\rho_\tau)\left(\tau_y(y_{t-1} - y_{t-1}^n) + \tau_b b_t\right) + \varepsilon_t^\tau$$

Models' fit comparison

- The following table shows the Log Data Density of the monetary and fiscal models, both estimated without fiscal data.

	Monetary Model	Monetary Model Augmented with Fiscal Factors
Argentina	-441.65	-392.54
Brazil	-662.04	-614.66
Chile	-597.55	-565.46
Colombia	-555.95	-491.17
Mexico	-551.61	-502.18
Peru	-434.43	-345.42
Venezuela	-857.42	-849.54

- This exercise shows the benefits of adding fiscal factors to fit the macro variables of the monetary model.

Policy functions from a standard monetary DSGE model with fiscal factors

$$g = \rho_g g_{-1} + (1-\rho_g)(g_y (y_{-1} - y^n_{-1}) + g_b b)$$

	Argentina	Brazil	Colombia	Mexico	Peru
	2003 Q2 - 2011 Q3	1999 Q1 - 2012 Q1	2000 Q2 - 2011 Q4	2000 Q2 - 2012 Q1	2003 Q3 - 2011 Q4
ρ_g	0.47	0.43	0.48	0.41	0.49
g_y	-0.01	-0.02	-0.03	-0.03	0.00
g_b	-0.03	-0.04	-0.02	-0.04	-0.04

- Low persistence of government expenditure.
- Negative elasticity of government expenditure to lagged output gap.
- Government expenditure reductions in response to higher indebtedness.

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Policy functions from a standard monetary DSGE model with fiscal factors

$$t = \rho_t t_{-1} + (1-\rho_t)(t_y (y_{-1} - y^n_{-1}) + t_b b)$$

	Argentina	Brazil	Colombia	Mexico	Peru
	2003 Q2 - 2011 Q3	1999 Q1 - 2012 Q1	2000 Q2 - 2011 Q4	2000 Q2 - 2012 Q1	2003 Q3 - 2011 Q4
ρ_τ	0.38	0.35	0.44	0.37	0.21
τ_y	0.04	0.10	-0.04	-0.05	-0.08
τ_b	0.02	0.03	0.04	0.04	0.04

- Even lower degree of tax smoothing.
- Taxation increases in response to output expansions in Argentina and Brazil, while it decreases in the other three countries.
- Taxation increases in response to higher indebtedness.

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Responses to one-standard deviation unexpected increase in terms-of-trade

Terms-of-trade	y	π	$-\Delta e$	r	g_{+1}	t	b
Argentina	↑	↑	↑	↓	↑	↓	↓
Brazil	↑	↓	↑	↓	↑	↓	↓
Colombia	↑	↓	↑	↓	↔	↓	↓
Mexico	↑	↓	↑	↓	↔	↓	↓
Peru	↑	↑	↑	↓	↑	↓	↓

- Is expansionary and appreciates the currency.
- In Brazil, Colombia and Mexico lowers prices, while in Argentina and Peru it is inflationary.
- Decreases debt and tax collection.
- Government expenditure raises in Argentina, Brazil and Peru, while it remains almost unchanged in Colombia and Mexico.
- Interest rates decrease.

Responses to one-standard deviation unexpected increase in interest rates

Monetary	y	π	$-\Delta e$	r	g_{+1}	t_{+1}	b
Argentina	↓	↓	↑	↑	↑	↓	↑
Brazil	↓	↓	↑	↑	↑	↓	↑
Colombia	↓	↓	↑	↑	↔	↑	↑
Mexico	↓	↓	↑	↑	↔	↑	↑
Peru	↓	↓	↑	↑	↑	↑	↑

- Lowers output and inflation.
- Appreciates the currency.
- Increases debt.
- Government expenditure increases slightly due to its contracyclical stance.
- Due to the generalized increase of indebtedness, taxation increases aggressively in Peru, and slightly in Colombia and Mexico. Meanwhile, in Argentina and Brazil, the contracyclical motive causes a tax reduction.
- **Tight monetary → loose / neutral government expenditure and loose / tight taxation.**

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Responses to one-standard deviation unexpected increase in government expenditure

Gov´t	y	π	$-\Delta e$	r	g	t_{+1}	b
Argentina	↑	↑	↓	↔	↑	↑	↑
Brazil	↑	↑	↓	↔	↑	↑	↑
Colombia	↑	↑	↓	↑	↑	↑	↑
Mexico	↑	↑	↓	↑	↑	↑	↑
Peru	↑	↑	↓	↔	↑	↑	↑

- Increases output and inflation.
- Depreciates the currency.
- Increases debt.
- Taxation rises slightly in response to the higher indebtedness.
- Interest rates remain almost unchanged in Argentina, Brazil and Peru, while they rise in Colombia and Mexico.
- **Loose expenditure → neutral / tight monetary and tight taxation**

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Newer estimation based on an extended model: Colombia

Estimates from a monetary model with fiscal factors, incomplete asset markets and Law-of-One Price gap.

	Prior			Posteriors		
Parameter	Distribution	Mean	Std. Dev.	Mode	5%	95%
ρ_r	Beta	0.50	0.20	0.80	0.66	0.94
r_π	Gamma	1.50	0.50	2.37	1.65	3.07
r_y	Gamma	0.25	0.13	0.04	0.01	0.07
$r_{\Delta y}$	Gamma	0.75	0.20	0.13	0.08	0.18
$r_{\Delta e}$	Gamma	0.25	0.13	0.02	0.01	0.03
ρ_g	Beta	0.50	0.20	0.37	0.03	0.73
g_y	Normal	0.00	0.10	0.02	-0.14	0.20
g_b	Normal	0.00	1.00	-0.20	-0.55	0.14
g_{ca}	Normal	0.00	0.10	0.05	-0.09	0.21
ρ_{τ^l}	Beta	0.50	0.20	0.82	0.64	0.99
τ_y^l	Normal	0.00	0.10	-0.01	-0.17	0.15
τ_b^l	Normal	0.00	0.10	-0.01	-0.18	0.16
ρ_{τ^c}	Beta	0.50	0.20	0.45	0.05	0.80
τ_y^c	Normal	0.00	0.10	0.01	-0.13	0.14
τ_b^c	Normal	0.00	0.10	-0.04	-0.19	0.12

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Newer estimation based on an extended monetary model with fiscal factors: Asymptotic Variance Decomposition for Colombia

	eps_z	eps_pif	eps_pih	eps_risk	eps_i_shock	eps_y_star	eps_i_star	eps_pi_star	eps_g	eps_b	eps_tauc	eps_taul	eps_nti	eps_me_q	eps_me_e	eps_tot
y	2.2	5.6	18.5	0.1	0.7	7.0	2.5	0.7	0.3	0.0	0.0	43.2	0.0	0.0	0.0	19.2
data_c_y	1.0	14.0	0.8	6.0	0.1	30.5	12.2	8.6	1.0	0.1	0.0	9.2	0.0	0.0	0.0	16.5
data_dlogy	1.8	11.0	8.4	0.2	1.5	16.9	13.1	3.3	0.8	0.1	0.0	4.0	0.0	0.0	0.0	38.9
data_dlogs	0.1	8.1	0.1	0.0	0.0	5.7	0.1	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	85.7
data_i	9.6	5.9	4.2	4.4	0.8	15.8	10.0	21.5	1.5	0.1	0.0	3.5	0.0	0.0	0.0	22.8
data_dloge	0.9	14.3	0.5	0.5	0.4	30.9	8.1	20.7	0.1	0.0	0.0	0.1	0.0	0.0	17.5	6.0
data_dlogq	1.6	20.0	0.9	0.7	0.4	44.9	10.9	9.8	0.2	0.0	0.0	0.2	0.0	1.5	0.0	9.0
data_pi	17.4	0.9	12.2	2.0	19.6	8.0	10.0	12.1	1.0	0.1	0.0	9.0	0.0	0.0	0.0	7.6
data_pif	0.1	20.1	0.1	0.1	0.1	12.8	0.2	0.5	0.0	0.0	0.0	0.2	0.0	0.0	0.0	65.9
data_premium	0.4	12.1	0.3	48.0	0.1	16.6	17.9	1.0	0.1	0.0	0.0	1.1	0.0	0.0	0.0	2.4
data_T_y	3.7	1.7	3.8	0.4	0.1	0.6	0.9	0.3	0.1	0.1	1.2	81.5	5.2	0.0	0.0	0.5
data_taulwn_y	2.2	2.4	8.8	0.0	0.3	2.9	1.0	0.3	0.1	0.0	0.0	73.7	0.0	0.0	0.0	8.1
data_taucc_y	0.9	12.2	1.5	5.1	0.1	25.5	10.4	7.3	1.2	0.4	14.4	7.7	0.0	0.0	0.0	13.4
data_g_y	1.8	4.3	12.0	0.1	0.5	5.6	2.2	0.9	14.7	1.2	0.1	41.8	0.1	0.0	0.0	14.7
data_b_y	3.7	5.8	31.4	0.6	2.0	5.9	3.0	3.1	5.0	12.7	0.1	10.8	0.8	0.0	0.0	15.0
data_ca_y	1.4	5.0	15.0	1.5	1.1	2.5	23.6	0.4	0.4	0.0	0.0	38.7	0.0	0.0	0.0	10.3

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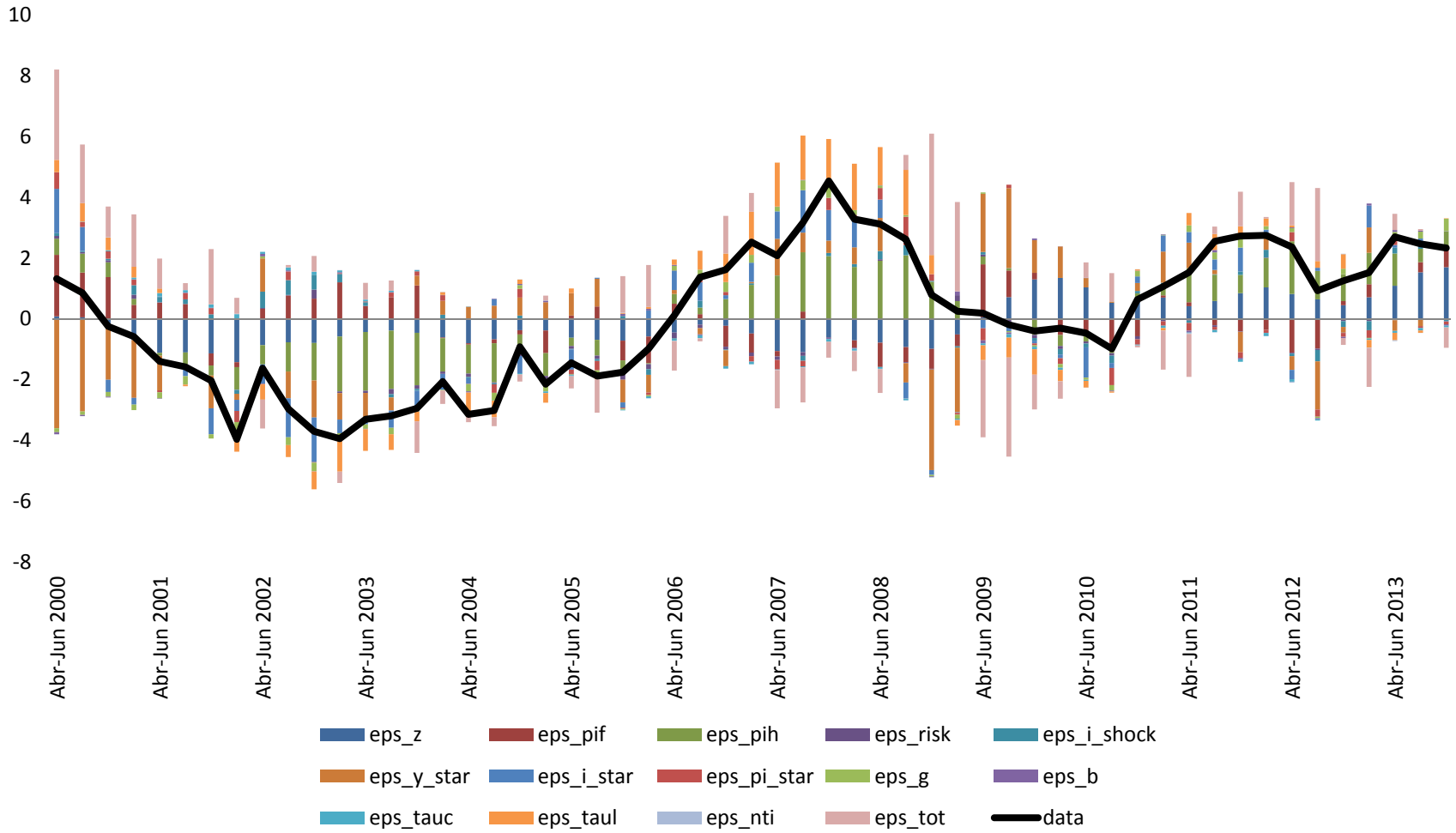
Historical decomposition of output: Colombia



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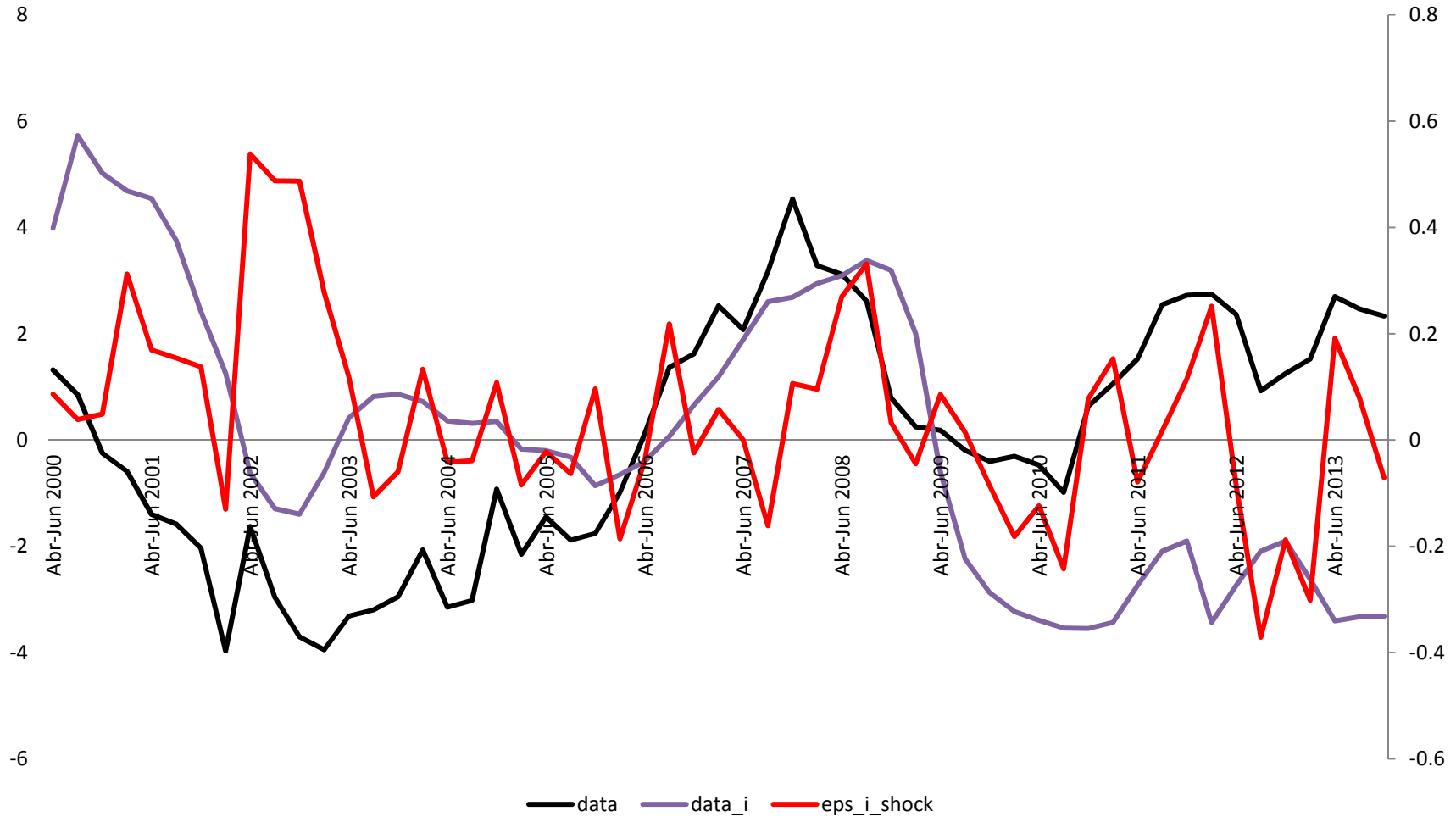
Historical decomposition of output: contribution of monetary policy



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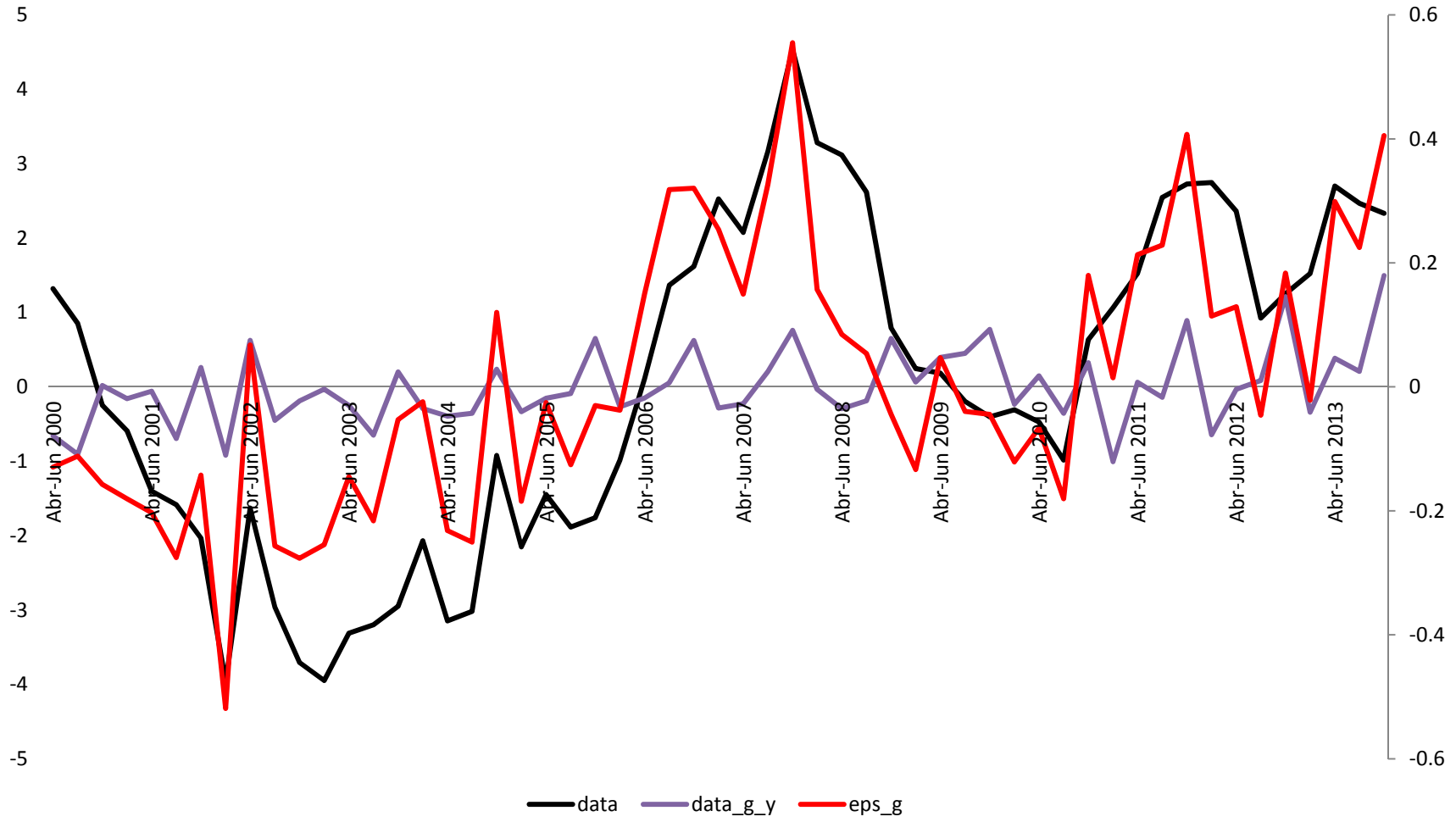
Historical decomposition of output: contribution of government expenditure policy



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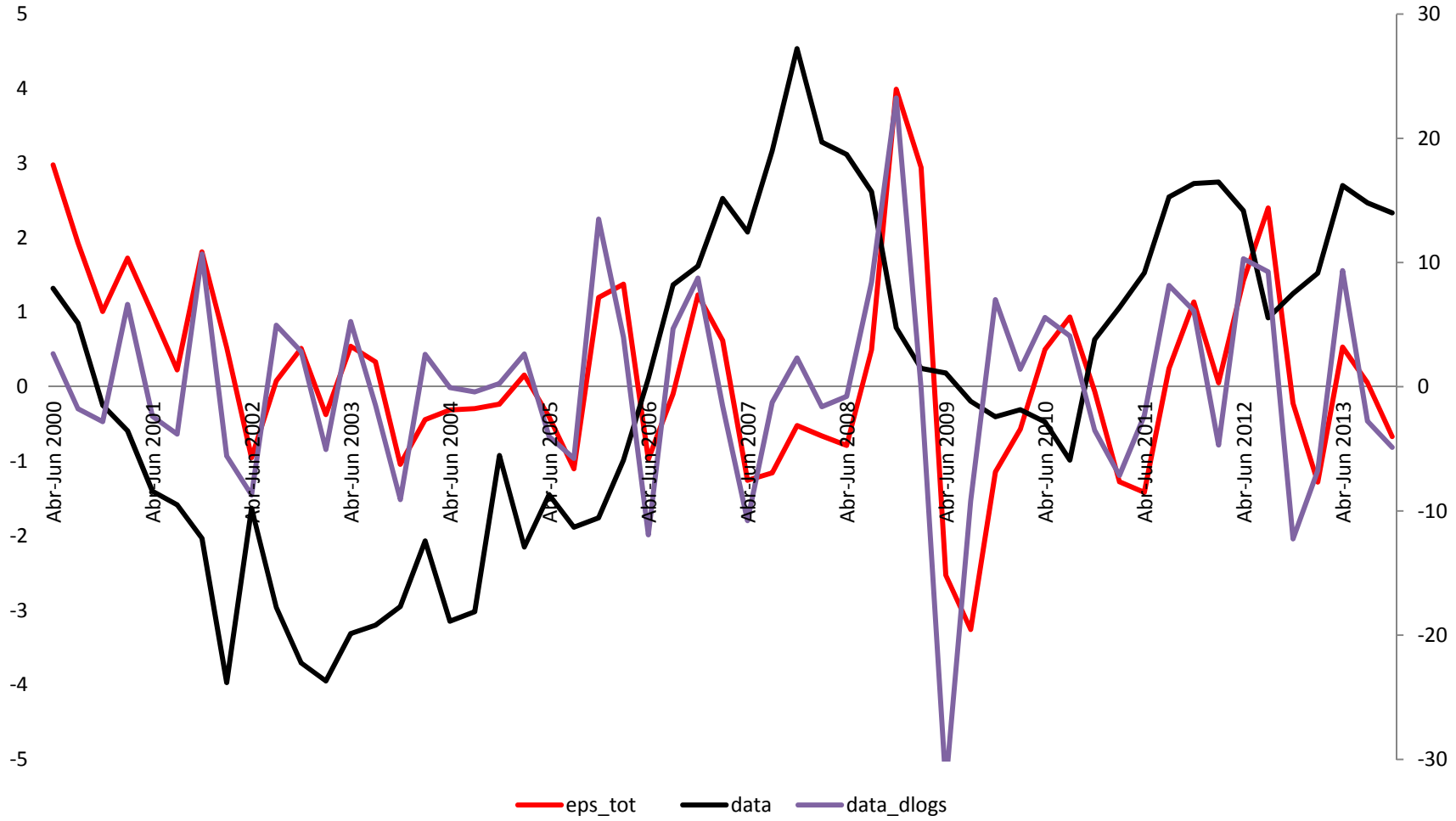
Historical decomposition of output: contribution of term of trade shocks



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Remarks

- This is work in progress and the goal is to have a country by country analysis of the cyclicality of their macroeconomic policies and the effect that different domestic and external shocks have in explaining their business cycle fluctuations.

- All comments or suggestions are greatly appreciated.

CEMLA
CENTRO DE ESTUDIOS MONETARIOS LATINOAMERICANOS

Monetary and Fiscal Policies in Latin America: Evidence from an Estimated DSGE Model

Maritsa Hernández Henao
CEMLA
jhernandez@cemla.org

Alberto Ortiz Bolaños
CEMLA and EGADE
ortiz@cemla.org

Thank you!