Inflation-linked Public Debt in Emerging Economies ☆

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Abstract

This paper reports a set of stylized facts about inflation-linked public debt in emerging economies. On average, emerging economies issue 20% of their local currency public debt linked to inflation. Inflation-linked debt issuance is countercyclical, substitutes foreign currency debt, increases in periods of real and nominal effective exchange rate depreciations, and, for the most part, is cheaper than foreign currency debt issuance. A small-open economy model of public debt composition with exogenous tradable endowment can deliver the stylized facts. Finally, the paper considers episodes of recent real exchange rate depreciations and presents counterfactual increases in public debt burden, had countries issued more of their public debt linked to inflation.

Keywords: Public debt, Inflation-linked debt, Foreign currency debt

JEL: F34, F41, H63

☆This project benefited from the support of Fordham University's Faculty Research Grant. I thank Johanna Francis and Diego Perez for thoughtful comments and discussions. I would also like to thank Nicholas Rizzo for excellent research assistance and Luis Molina in the Banco de España for assistance with interest rate data collection.

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1. Introduction

Emerging economies issue a sizeable share of their public debt linked to inflation. Since 2004, in the study's sample, emerging economies have issued, on average, 13% of their public debt linked to inflation. This represents 20% of their local currency (LC) public debt issuance.

Furthermore, this asset's relevance in total emerging economies' public debt has increased. The share of public debt issued linked to inflation is, on average, six percentage points higher now than in 2004.

Inflation-linked (IL) debt can insulate emerging economies' public debt burden from sudden exchange rate depreciations. The gains from this insulation can be large for large exchange rate depreciations, like the 2002 Argentina depreciation, and for highly indebted countries enduring an exchange rate depreciation, like Russia in 1998.

Despite the importance of IL debt in emerging economies' public debt issuance, relatively little is known about their experience with this type of asset. This paper aims to fill this gap.

The paper reports that IL debt issuance is countercyclical and increases in periods of real and nominal effective exchange rate depreciations. Importantly, IL debt issuance substitutes foreign currency (FC) debt in emerging economies' public debt issuance. Finally, interest rates on IL debt are, for the most part, lower than interest rates on FC debt.

Previous work has studied IL debt vis-a-vis nominal debt (Bohn (1988), Bohn (1990), Calvo and Guidotti (1990), Diaz-Gimenez et al. (2008), Alfaro and Kanczuk (2010), Sunder-Plassmann (2017)). This paper complements this literature by examining IL debt vis-a-vis FC debt, which has been a

relevant substitution in emerging economies' public debt composition.

To do this, the paper presents a small-open economy model of public debt composition, where a government raises taxes and issues IL and FC debt to finance an exogenous level of government spending. Public debt markets are segmented: domestic consumers invest in IL debt and foreign consumers invest in FC debt. The government commits to repay both types of securities.

The key result of the model is that in bad times, when the economy endures real and nominal exchange rate depreciations, the government moves away from FC debt and increases its IL debt issuance. Hence, the model can deliver the key stylized facts about IL debt issuance in emerging economies.

The segmented public debt markets implies no debt price dynamics because, from the perspective of their respective investors, both assets are safe. Allowing for IL debt price dynamics does not change any of the qualitative results and the model is still able to deliver the key stylized facts about IL debt issuance in emerging economies.

The rest of the paper is structured as follows. Section 2 presents the stylized facts about IL debt issuance for a sample of emerging economies. Section 3 lays out the model and the key result on substitution of FC debt for IL debt. Section 4 introduces IL debt price dynamics. Section 5 considers episodes of recent exchange rate depreciations and presents counterfactual increases in public debt burden, had countries issued more of their debt linked to inflation. Lastly, section 6 concludes.

1.1. Literature Review

This paper is related to several strands of the literature. First, it is related to the literature on IL public debt and the references cited in the previous

subsection. These studies all examine IL public debt vis-a-vis nominal debt in an environment where the government lacks commitment. In that environment, the benefit of IL debt is that it acts as a commitment device for the government, lowering cost of borrowing. The drawback of IL debt is the government's inability to introduce state-contingency through inflation. This paper complements the study of IL debt vis-a-vis FC debt in an environment with commitment and an exogenous price level.

Second, it is related to the vast literature on FC debt. The 'original sin', or emerging economies' inability to borrow abroad in LC, got a lot of attention (Eichengreen et al. (2005) and Eichengreen et al. (2007)). More recently, Du and Schreger (2016) and Du et al. (2016) find that this situation has improved. This paper's focus is not external debt but rather all public debt, held domestically and abroad. From a normative perspective, Engel and Park (2017) and Ottonello and Perez (2016) examine the optimal composition of LC and FC debt in an environment with strategic default and strategic debasement through inflation. In an environment with commitment, Korinek (2009) studies borrowing in LC and holding reserves in FC as a way for small-open economies to insure against shocks. In contrast to them, this paper is positive (instead of normative), features commitment (no strategic default or strategic debasement), and does not allow for positive positions in any currency (no reserves in FC).

Finally, from the modeling standpoint, the paper uses a standard tradable-non-tradables (TNT) model. Chapter 8 in Schmitt-Grohe and Uribe (2017) is a recent reference and labels the model as TNT model. This model is closest to the one featured in Ottonello and Perez (2016). The main differ-

ences between this paper and theirs are as follow. First, this paper features a government and taxation. Second, this paper features domestic ownership of one of the public securities (IL debt). Third, public debt is issued to finance government spending and not exclusively for risk-sharing reasons.

2. Stylized Facts

This section compiles a set of stylized facts about IL debt issuance for a sample of emerging economies. Appendix A lists the countries in the sample and the data sources.

Fact 1: Emerging economies have issued, on average, 13% of their public debt linked to inflation between 2004 and 2016. This represents 20% of their LC debt.

Table 1 shows the share of IL debt over total debt (column 2) and the share of IL debt over LC debt (column 3) between 2004 and 2016. The last row shows the average IL debt issuance for the countries in the sample: 12.9% of total public debt and 20.4% of LC debt.

The table shows substantial heterogeneity across countries in IL debt over debt. Some countries (e.g. Hungary, India, Peru, Poland and Russia) issue less than 3% of their total debt linked to inflation, while others (e.g. Argentina, Brazil, Chile and Israel) issue 18% or more.

The table also shows substantial heterogeneity in IL debt over LC debt. Some countries (e.g. Hungary, India, Poland and Russia) issue less than 4% of their LC debt linked to inflation, while others issue more than half (Argentina) or more than 80% (Chile).

IL debt in emerging economies, 2004-2016			
Country	IL debt/debt	IL debt/LC debt	Δ(IL debt/debt)
Argentina	20.5%	52.2%	-12.6%
Brazil	18.0%	28.7%	12.6%
Chile	48.1%	82.3%	37.5 %
Colombia	15.8%	25.5%	2.0%
Hungary	0.9%	1.6%	4.0%
India	0.02%	0.03%	-0.02%
Israel	21.4%	-	4.3%
Mexico	12.5%	14.5%	10.6%
Peru	2.2%	11.0%	2.1%
Poland	1.6%	2.5%	-0.3%
Russia	0.6%	1.7%	0.9%
South Africa	14.5%	20.1%	12.0%
Turkey	10.9%	16.0%	1.8%
Average	12.9%	20.4%	5.8%

Table 1: Average Inflation-Linked Government Debt (as % Total Government Debt and as % of Local Currency Government Debt) between 2004-2016. Averages are conditional on the country issuing this type of bond. Sources: See Appendix A.

The last column in table 1 presents the change in IL debt over debt between 2004 and 2016. All the countries in the sample except three (Argentina, India, and Poland) have considerably increased the share of debt linked to inflation. Figures A.4 and A.5 in Appendix A plot the entire time-series of IL debt over total government for all economies in the sample.

As the last column in the table and the plots in Appendix A show, IL debt exhibits a trend. To detrend this and the other macroaggregates used in the analysis, the stylized facts that follow use the first differences of log variables. The only exception is the monetary policy rate.

Stylized facts 2-4 that follow refer to table 2, which reports the time-series correlation between IL debt issuance and several macroaggregates by country.

Fact 2: In emerging economies IL debt issuance is countercylical.

The average correlation between IL debt over total government debt and real GDP is almost -20%. Only three countries (Argentina, Israel and Poland) deviate from this pattern, exhibiting procyclicality of IL debt issuance. See column labeled (I) in table 2.

Fact 3: IL debt issuance is higher when public debt over GDP is higher and substitutes FC debt issuance.

The average correlation between IL debt over total debt and public debt over GDP is 12.7%. Only three countries (Colombia, India and Israel) deviate from this pattern. See column labeled (VIII) in table 2.

The average correlation between IL debt over total debt and FC debt over total debt for emerging economies is -37%. Ony two countries (Colombia

and Russia) deviate from this pattern. Indeed, countries issue more of their government debt linked to inflation in periods when they decrease the share of government debt in FC. Column labeled (II) in table 2 shows this.

Figure A.6 in Appendix A shows the shares of IL debt and FC debt (over total government debt) between 2004 and 2016 for Argentina, Chile, Mexico and Turkey. Argentina and Chile in the first row are particular good examples of this substitution.

Fact 4: Emerging economies issue more of their government linked to inflation in periods of real and nominal effective exchange rate depreciations.

The average correlation between IL debt over total debt and the real effective exchange rate (REER) for emerging economies is -12%. An increase in the REER measure used in the analysis indicates an appreciation of the home currency against its trading partners.

There are some exceptions to this pattern (Brazil, Chile, Israel, Poland and South Africa) which can explain the relatively low average correlation. See column labeled (IV) in table 2.

Similarly, the average correlation between IL debt over total debt and the nominal effective exchange rate (NEER) is -15%. As before, an increase in the NEER measure used indicates a nominal appreciation of the home currency against its trading partners.

Also for the NEER, there are some exceptions to this pattern (Argentina, Brazil, Chile, Israel and South Africa). See column labeled (V) in table 2.

To sum up, on average, emerging economies issue on average more of their debt linked to inflation not only in periods of real depreciations, but also in periods of effective nominal depreciations.

Time series correlation (IL debt/debt, x)								
	(I)	(II)	(III)	(IV)	(V)	(VI)	(VII)	(VIII)
Country	x=Real GDP	x=FC debt	x=ER (LCU/$)	x=REER	x=NEER	x=GDP Deflator	x=CPI	x=Debt
Argentina	49.4%	-67.3%	-27.7%	-4.4%	13.9%	-37.5%	-	-
Brazil	-16.0%	-50.8%	-10.9%	16.3%	17.0%	-70.9%	52.6%	13.04%
Chile	-1.1%	-48.5%	-31.4%	22.4%	24.5%	21.2%	-	-
Colombia	-50.1%	12.4%	44.3 %	-44.2%	-41.8%	-1.9%	33.8%	-2.3%
Hungary	-91.3%	-42.0%	39.8%	-5.5%	-72.2%	43.9%	9.7%	51.3%
India	-29.0%	-	-67.0%	-95.5%	-87.3%	90.3%	-70.6%	-67.8%
Israel	23.8%	-	-62.9%	24.7%	43.2%	7.3%	-27.3%	-71.0%
Mexico	-19.5%	-38.3 %	7.0 %	-2.4%	-8.1%	-1.6%	18.3%	-
Peru	-23.6%	-52.2 %	19.4%	-48.5%	-33.0%	8.4%	-25.7%	43.9%
Poland	17.0%	-44.6 %	-2.4%	7.1%	-3.2%	46.2%	-46.3%	57.7%
Russia	-29.4%	1.7%	65.5%	-51.8%	-60.1%	-23.6%	7.9%	6.8%
South Africa	-52.0%	-26.2 %	-6.4%	27.7%	15.1%	29.1%	-39.8%	-
Turkey	-37.6%	-53.7 %	12.9%	-4.5%	-4.2%	-76.7%	-11.8%	83.8%
Average	-19.9%	-37.2%	-1.7%	-12.2%	-14.6%	2.6%	-9.0%	12.7%

Table 2: Time-series correlations between IL debt over debt and selected macroaggregates (2000-2016). Sources: See Appendix A.

Average Rate differential, FC - IL, 2002-2016			
Country	Rate Differential	Country	Rate Differential
Argentina	5.7%	Mexico	1.1%
Brazil	-0.8%	Peru	-1.8%
Chile	2.0%	Poland	1.9%
Colombia	1.0%	Russia	1.2%
Hungary	-	South Africa	2.9%
India	-1.5%	Turkey	2.5%
Israel	3.3%		
Average	1.7%		

Table 3: Average Rate Differentials between FC debt and IL debt (2002-2016). Sources: See Appendix A.

However, the correlation between IL debt over total debt and the nominal exchange rate defined as units of local currency needed to purchase one US dollar is small and negative (smaller than 2% in absolute value). See column labeled (III) in table 2.

Fact 5: The interest rate on IL debt is below the interest rate on FC debt.

For most of the economies in the sample and for most of the time period considered IL rates are below FC rates. See figures A.8 and A.7 in Appendix A.

There are some exceptions, but a majority of countries during most of the period considered exhibit a positive diffential between the FC and the IL rate. Table 3 shows this information by country and reports the average rate differential for all countries in the sample: 1.7%.

Moreover, figure A.9 in Appendix A shows the cross-country average by time and shows that for most of the sample the FC-IL rate differential was positive. The only exceptions are 2012Q3 and 2012Q4.

3. Model of Public Debt Composition

This section presents a small-open economy model of public debt composition, where a government raises taxes and issues IL and FC debt to finance an exogenous level of government spending.

3.1. Model Set-up

There are infinite periods and two goods: tradables and non-tradables. The domestic economy is populated by risk-neutral consumers, domestic firms producing non-tradables, and a government. Abroad, foreign consumers are also risk-neutral and demand the government's FC debt.

The economy is populated by a large number of identical households who maximize their utility. Let C_t denote consumption and h_t labor. Household preferences are given by:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[C_t - \frac{h_t^{1+\zeta}}{1+\zeta} \right] \tag{1}$$

where β is the domestic discount factor, which lies between 0 and 1 and C_t is a composite of tradable consumption goods.

Let $c_{T,t}$ be consumption of tradable goods and $c_{N,t}$ the consumption of non-tradable goods. The CES consumption index is defined by:

$$C_t = \left[(\gamma)^{\frac{1}{\rho}} (c_{T,t})^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}} (c_{N,t})^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{2}$$

and P_t is the idealized price index which equals:

$$P_t = \left[(\gamma)\left(p_{T,t}\right)^{1-\rho} + (1-\gamma)\left(p_{N,t}\right)^{1-\rho}\right]^{\frac{1}{1-\rho}}$$

Households get tradable endowment $y_{T,t}$ and work in the non-tradable sector. The tradable endowment is stochastic and follows an autorregressive process of order 1. By working in the non-tradable sector households obtain an after-tax nominal wage of $(1-\tau_t)W_t$.

To smooth consumption across time households have access to an inflation-linked (IL) government security, denoted by d_t with price q_t. Using the previous information, households' budget constraint in nominal terms is given by:

$$P_t C_t + q_t P_t d_{t+1} = p_{T,t} y_{T,t} + (1-\tau_t) W_t h_t + P_t d_t \tag{3}$$

where IL securities are pre-multiplied by the price level because they are effectively real securities.

Consumers' maximization of (1) subject to (3) gives rise to the following optimality conditions:

$$\frac{c_{T,t}}{c_{N,t}} = \frac{\gamma}{1-\gamma}\left(\frac{p_{T,t}}{p_{N,t}}\right)^{-\rho} \tag{4}$$

$$h_t^{\zeta} = \frac{(1-\tau_t)W_t}{P_t} \tag{5}$$

$$q_t = \beta \tag{6}$$

The first condition is the intratemporal allocation between tradable and non-tradable consumption, which depends on the relative price between both goods. The second condition is the intertemporal allocation between consumption and hours worked, consumers' labor supply. The third condition is

the intertemporal condition, which pins down the price of IL securities. Because these securities promise a real return and consumers are risk-neutral in consumption, their price is just the real discount factor

The non-tradable production sector features perfectly competitive firms. Their production function is:

$$y_{N,t} = h_t^{\alpha}$$

Profits in the non-tradable sector are: $\pi_{N,t} = p_{N,t} y_{N,t} - W_t h_t$, implying that the nominal wage rate equals:

$$W_t = p_{N,t} \alpha h_t^{\alpha - 1} \tag{7}$$

The government needs to finance the purchase of non-tradable goods for government spending g_t. To do this, it raises tax revenues on labor income and issues a fixed quantity of public debt $\bar{d}$. Within its public debt issuance, the government can issue IL bonds (d_t) to domestic consumers or FC bonds ($d_t^{\star}$) to foreign consumers. The bond prices are, respectively, q_t and $q_t^{\star}$.

Thus, the government's budget constraint in local currency is as follows:

$$p_{N,t} g_t + P_t d_t + e_t d_t^{\star} = \tau_t W_t h_t + e_t q_t^{\star} d_{t+1}^{\star} + q_t P_t d_{t+1} \tag{8}$$

where expenses are on the left-hand side and revenues on the right-hand side. The nominal exchange rate, e_t, is defined as the amount of local currency needed to purchase one unit of FC. Thus, a depreciation is an increase in e_t.

Finally, foreign consumers are risk-neutral and buy FC bonds. Foreign consumers' discount factor $\beta^{\star}$ also lies between 0 and 1, but could be different to the domestic discount factor β.

The price of FC government bonds ($q_t^\star$) equals:

$$q_t^\star = \beta^\star \tag{9}$$

Indeed, absent default risk, the FC government bond is safe from the foreign consumers' perspective.

3.2. Equilibrium

In equilibrium the law of one price for the tradable good holds which implies that:

$$p_{T,t} = e_t \tag{10}$$

where the price of tradables in the foreign currency is normalized to one.

Using the previous equality and the idealized price index we have that:

$$e_t = \frac{P_t}{\left\{\gamma\left[1+\left(\frac{\gamma}{1-\gamma}\right)^{\frac{1}{\rho}}\left(\frac{c_{T,t}}{c_{N,t}}\right)^{\frac{1-\rho}{\rho}}\right]\right\}^{\frac{1}{1-\rho}}} \tag{11}$$

This equation exhibits two key relationships. First, the one between the nominal exchange rate and the inflation rate. If P_t increases, for a given P_{t-1}, inflation increases. From (11) it is clear that when inflation increases, the nominal exchange rate increases (depreciates).

Second, the one between the nominal exchange rate and the real exchange rate. The real exchange rate (RER), defined as the price of non-tradable in terms of tradables, is increasing in $\frac{c_{T,t}}{c_{N,t}}$. Equation (4) shows that this is the case. From (11) it is clear that when the RER depreciates, the nominal exchange rate increases (depreciates).

Market clearing, respectively, in the public debt market and the non-tradable production sector imply that:

$$d_t + d_t^\star = \bar{d} \tag{12}$$

$$c_{N,t} + g_t = y_{N,t} \tag{13}$$

Finally, the economy's resource constraint results from adding the government's and domestic consumers' budget constraints and it is equal to:

$$p_{T,t}c_{T,t} + p_{N,t}c_{N,t} + p_{N,t}g_t + e_t d_t^\star = p_{T,t}y_{T,t} + p_{N,t}y_{N,t} + e_t q_t^\star d_{t+1}^\star \tag{14}$$

which simplifies to:

$$c_{T,t} + d_t^\star = y_{T,t} + q_t^\star d_{t+1}^\star \tag{15}$$

using equations (10) and (13) and dividing through by e_t.

The equilibrium is given by a set $\{C_t, c_{T,t}, c_{N,t}, h_t, W_t, p_{N,t}, e_t, d_t, d_t^\star, q_t, q_t^\star\}$ for given exogenous processes $\{g_t, \tau_t, P_t, y_{T,t}\}$. The equilibrium must satisfy households' optimality conditions (4) to (6), the consumption index definition (2), firms' profit maximization condition (7), the government's budget constraint (8), foreign consumers' optimality condition (9), the exchange rate expression (11), and markets clearing conditions (12), (13) and (15).

3.3. Key result on FC and IL debt substitution

This subsection presents the model's response to a negative tradable endowment shock, $y_{T,t}$. Table 4 reports the parameter values used.

Table 5 compares some key ratios and the interest rate differential between FC and IL debt between the data and the ones delivered by the model in steady-state. The model replicates the share of debt that is inflation-linked

Parameter and symbol	Value	Reference
Parameter controlling labor elasticity (ζ)	2	Standard value
Labor share in non-tradable production (α)	0.7	Na (2015)
Tradable weight in consumption index (γ)	0.5	Stockman and Tesar (1995)
Parameter controlling elasticity of substitution between c_T and c_N (ρ)	0.74	Mendoza (1995)
Domestic discount factor (β)	0.95	Standard value
Foreign discount factor ($\beta^\star$)	0.935	Standard value
All autoregressive coefficients ($\rho_g, \rho_y, \rho_\tau$)	0.8	Standard value

Table 4: Parameter values

and the government spending over GDP better than debt and tax revenues over GDP.

The model succeeds in matching the FC-IL rate differential, which is exclusively pinned down by the domestic and the foreign discount factors. Indeed, the model abstracts away from default risk and features segmented markets, implying that domestic consumers buy IL debt and foreign consumers buy FC debt. From the perspective of each consumer, the debt security they purchase is safe. This is clear from pricing equations (6) and (9). The next section studies the implications of relaxing this assumption.

Figure 1 shows the impulse response functions of the model to a negative shock to the tradable endowment with respect to the steady state, turning off all other shocks.

It shows that after a negative tradable endowment shock of 10% the economy endures real and nominal exchange rate depreciations of about 15% with respect to steady state.

This happens because when $y_{T,t}$ drops, tradable consumption $c_{T,t}$ also

Variable	Data	Model
Debt over GDP	50.8%	16.5 %
IL debt over Debt	12.9%	14.6%
Government spending over GDP	16.2%	13.7%
Tax revenues over GDP	16.4%	32.1%
FC debt - IL debt rate differential	1.7%	1.7%

Table 5: Comparison between the model ratios and interest rate differential and the data for the average emerging economy in the study's sample.

decreases. By equation (4), a drop in tradable consumption depreciates the RER, depreciating, in turn, the nominal exchange rate (see equation (11)).

The RER drop decreases the value of the marginal product of labor, decreasing the demand for hours in the non-tradable sector and ultimately the number of hours worked in equilibrium. This decreases the wage rate in equilibrium too. The two previous effects combined, for a given tax rate, result in a decrease in tax revenues.

Because the nominal exchange rate depreciation renders FC debt burdensome for a government raising taxes in local currency, the government moves away from FC debt and increases IL debt issuance.

IL debt issuance increases by 6% and FC debt issuance decreases by 6%. For the average emerging economy the model is calibrated to, this implies a one percentage point increase in IL debt issuance and 5 percentage points decrease in FC debt issuance.

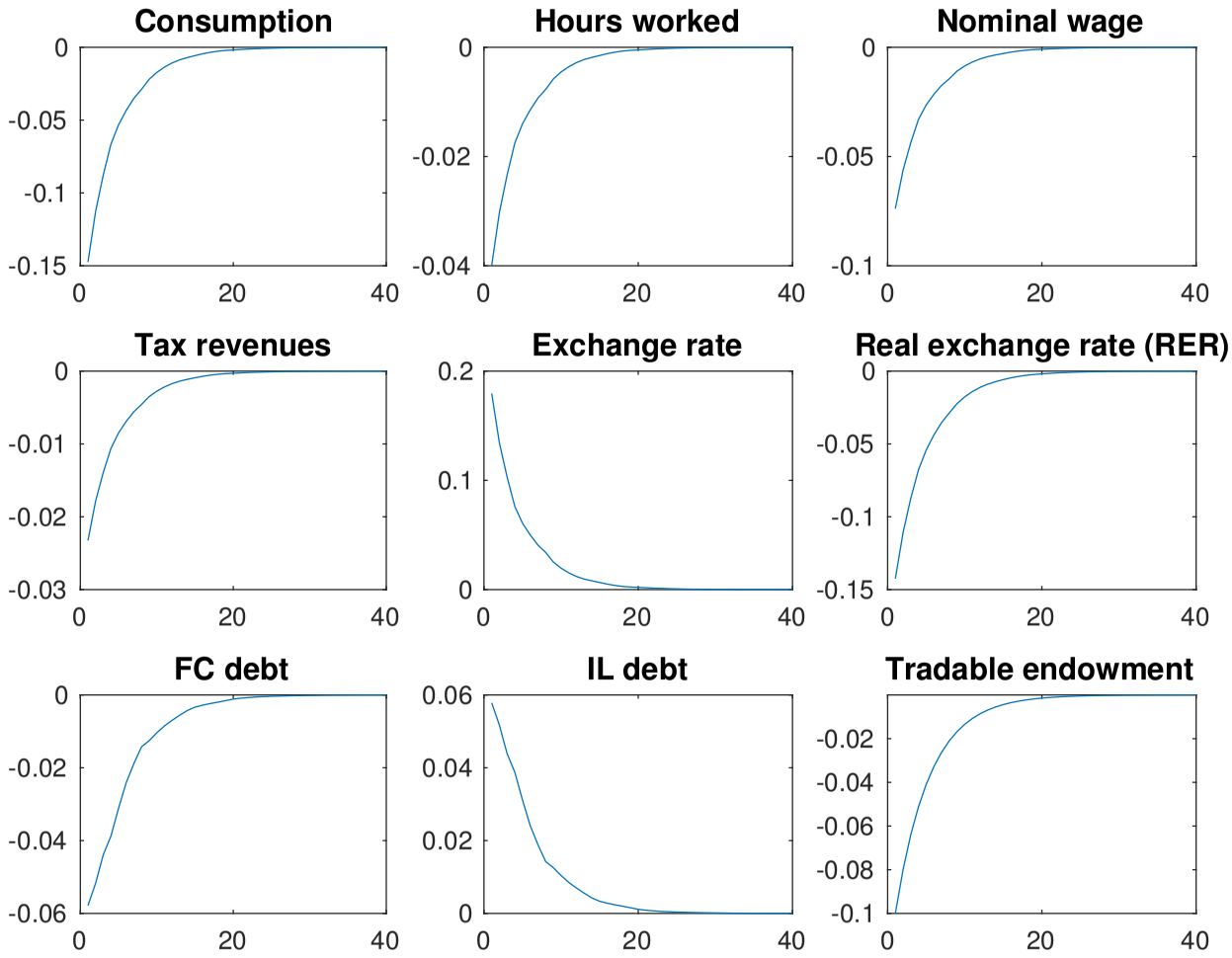

Figure 1: Model's response to a negative shock to the tradable endowment.

Embedding fact 5 in section 2 as an assumption, the model is able to capture the countercyclicality of IL debt issuance (fact 2 in section 2), the substitution of FC debt for IL debt (fact 3 in section 2), and the increase in IL debt issuance in periods of real and nominal effective depreciations (fact 4 in section 2).

3.4. Inflation

This subsection explores the role of inflation in the model. A shock to the price level does not impact real variables in the model. Figure B.10 in Appendix B shows the model's reponse to a 10% positive shock to the price level.

All the price increase translates into an exchange rate depreciation of the same magnitude, leaving the RER unchanged. This, in turn, leaves the public debt composition unchanged. Indeed, dividing the government's budget constraint, equation (8), through by P_t it becomes apparent that the relevant variable for public debt composition is the RER:

$$\frac{p_{N,t}}{P_t}g_t + d_t + \frac{1}{\Gamma(\frac{p_{N,t}}{e_t})}d_t^\star = \tau_t\frac{W_t}{P_t}h_t + \frac{1}{\Gamma(\frac{p_{N,t}}{e_t})}\beta^\star d_{t+1}^\star + \beta d_{t+1} \tag{16}$$

where debt prices are substituted by expressions (6) and (9) and $\Gamma(\frac{p_{N,t}}{e_t})) = \left\{\gamma\left[1+\left(\frac{\gamma}{1-\gamma}\right)^{\frac{2-\rho}{\rho}}\left(\frac{p_{N,t}}{e_t}\right)^{1-\rho}\right]\right\}^{\frac{1}{1-\rho}}$, obtained plugging equation 4 into equation (11).

Hours worked remain unchanged as well because the real nominal wage remains unchanged. Because hours worked and government expenditure remain unchanged, non-tradable consumption also stays the same. Finally, consumption remains unchanged because both types of consumption remain unchanged.

Inflation has the potential to generate effects in public debt composition if the model includes debt price dynamics. The next section explores this possibility.

4. Debt Price Dynamics

This section explores debt price dynamics. To do this, I assume all government debt (FC and IL debt) is held abroad. Before exploring the implications of this new assumption for the model and the results, the section starts presenting some empirical evidence to justify this assumption.

4.1. Empirical evidence on debt ownership

The empirical evidence on public debt ownership at the bond level is incomplete. Sunder-Plassmann (2017) uses Arslanalp and Tsuda (2014) data and concludes that virtually all FC debt is held by foreign investors.

For IL debt, the evidence is scattered. For example, the Russian Ministry of Finance reported the investor base composition for their 2015 IL debt issuance: 25% was bought by foreign investors [2]. The Brazilian Treasury reports that most of its IL debt is held by domestic investors, although there is a small foreign participation[3].

[2]See report titled "A debut Issue of Sovereign Inflation-Indexed Bonds by the Russian Federation" at `http://old.minfin.ru/common/upload/library/2015/09/main/OFZ-IN_case_study_ENG.pdf` for information from the Russian Ministry of Finance.

[3]For data until 2009, see "Non Resident Investors in Brazilian Public Debt" presentation given in October 2010 in Washington DC which reports that in 2009 3% of IL debt was held by foreign investors (`http://treasury.worldbank.org/web/Day_1_WS_2_Andre_Proite_Brazil_PolicyandPracticalIssue.pdf`). More recent

Because there is some foreign participation in IL debt but virtually no domestic participation in FC debt, all debt being held abroad is more acceptable than the opposite: all debt held domestically.

4.2. Changes in the model

Debt prices when all debt is held by foreign consumers are given by:

$$q^\star = \beta^\star \tag{17}$$

$$q = \beta^\star E_t \left[\frac{P_{t+1}}{P_t} \frac{e_t}{e_{t+1}} \right] \tag{18}$$

From the second equation it is clear that inflation affects the price of IL debt and that it can have effects in public debt composition.

Table 6 reports the key ratios and interest rate differential in the model with all debt held abroad. This model performs better in matching all key ratios, especially debt over GDP and tax revenues over GDP. However, it dramatically overestimates the FC - IL debt rate differential.

4.3. IL debt price dynamics

Figures 2 and 3 show the nominal exchange rate, the RER, and the IL debt price for, respectively, a negative tradable endowment shock and a positive price level shock.

Figure 2 shows that a negative tradable endowment shock depreciates the nominal and the real exchange rate. The nominal exchange rate depreciation increases the IL debt price vis-a-vis FC debt. FC debt's price is pinned down

data in the 2016 Annual Debt Report shows that only 9% of debt held abroad is inflation-linked (`http://www.tesouro.fazenda.gov.br/documents/10180/269444/RAD_2016_ingles_EN.pdf/c3ae2138-7077-4c29-a383-3f3940f67311`).

Variable	Data	Model
Debt over GDP	50.8%	51.7 %
IL debt over Debt	12.9%	10.8%
Government spending over GDP	16.2%	9.7%
Tax revenues over GDP	16.4%	22.6%
FC debt - IL debt rate differential	1.7%	31.9%

Table 6: Comparison between the model ratios and interest rate differential and the data for the average emerging economy in the study's sample.

by the foreign discount factor. An increase in the price of IL debt implies that the interest rate on IL debt decreases, making borrowing in IL debt cheaper from the government's perspective.

Figure 3 shows that a positive price level shock does not have any real effects as the response of the RER shows. However, it does have an effect on IL debt price. An increase in the price level depreciates the nominal exchange rate. Taken together, both effects increase the IL debt price, making borrowing in IL debt cheaper than in the FC debt counterpart.

In sum, including debt price dynamics for IL debt does not change the key qualitative results of the model. In periods of RER and nominal depreciations, the government will move towards IL debt because it becomes cheaper to borrow in this manner than in FC. Furthermore, by including debt price dynamics the model allows us to think about the effects of inflation in public debt composition. Inflation makes borrowing in IL debt cheaper than in FC.

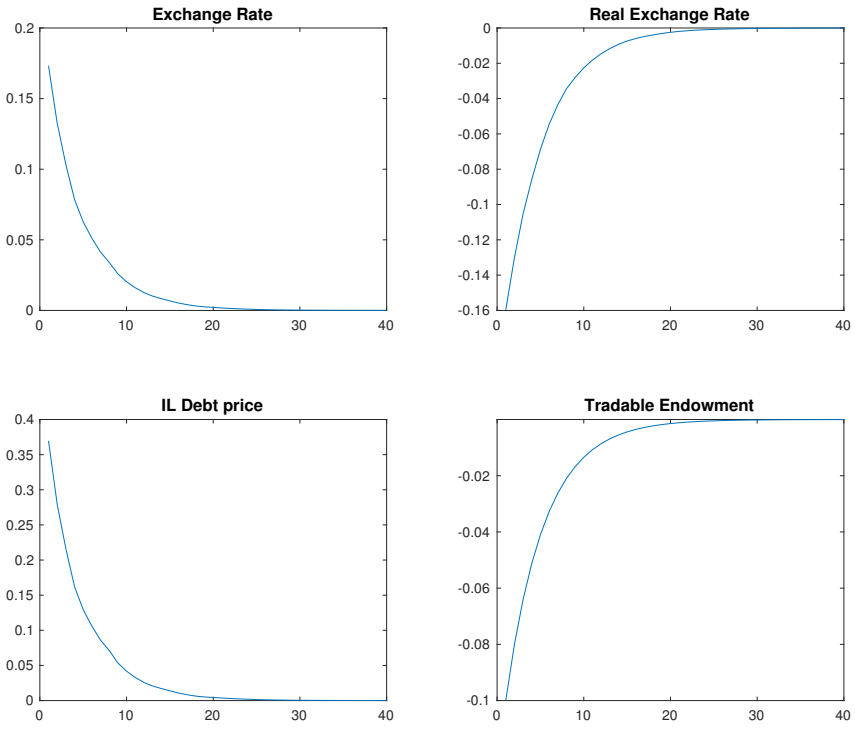

Figure 2: Model's responses to a negative shock to the tradable endowment.

5. Public debt burden around RER depreciations

This section considers recent episodes of RER depreciations in a selection of the emerging economies in the study's sample.

For each episode, this section presents the increase in public debt burden the country had to endure. All countries, at the time of these depreciations, issued no IL debt but differed in the share of debt issued in FC. Then, for each episode, this section reports the counterfactual increase in public debt burden, had countries moved away from FC debt and increased their public

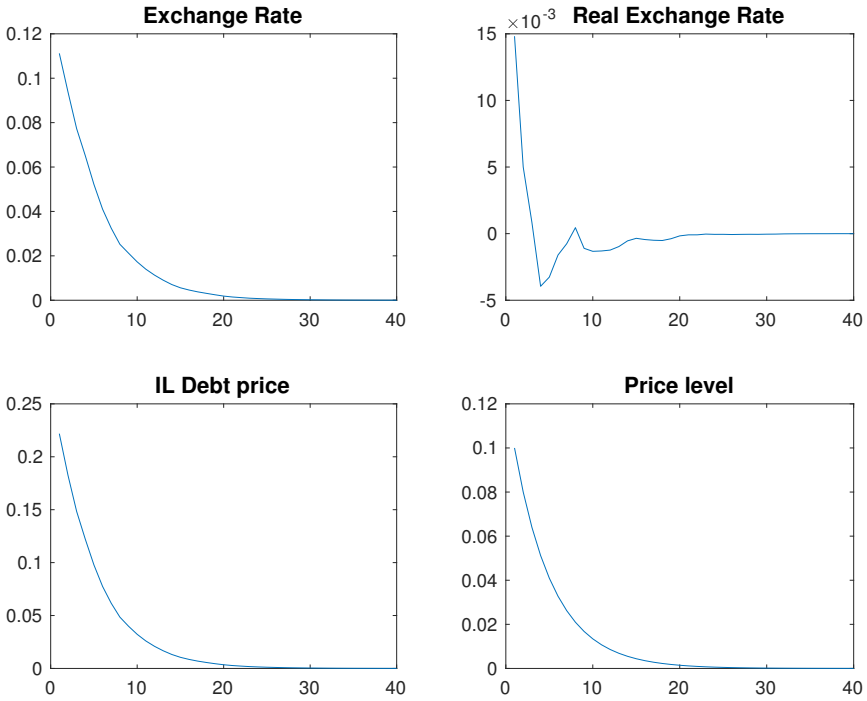

Figure 3: Model's responses to a positive shock to the price level

debt linked to inflation.

To calculate the public debt burden, I use the following expression:

$$d_t + \frac{1}{\left\{\gamma\left[1+\left(\frac{\gamma}{1-\gamma}\right)^{\frac{2-\rho}{\rho}}\left(\frac{p_{N,t}}{e_t}\right)^{1-\rho}\right]\right\}^{\frac{1}{1-\rho}}} d_t^{\star} \tag{19}$$

which comes from the modified government's budget constraint, equation (16).

Because countries issued no IL debt around these RER depreciations, the

increase in debt burden is given by:

$$\left[\frac{1}{\Gamma(\frac{p_{N,t}}{e_t})} - \frac{1}{\Gamma(\frac{p_{N,t-1}}{e_{t-1}})}\right](FCshare)\frac{\bar{d}}{GDP} \tag{20}$$

where $\Gamma(\frac{p_{N,t}}{e_t})) = \left\{\gamma\left[1+\left(\frac{\gamma}{1-\gamma}\right)^{\frac{2-\rho}{\rho}}\left(\frac{p_{N,t}}{e_t}\right)^{1-\rho}\right]\right\}^{\frac{1}{1-\rho}}$, t denotes the period after the depreciation, t-1 the period before, FC share is the share of debt that is issued in FC, and $\frac{\bar{d}}{GDP}$ the share of total debt over GDP.

Table 7 shows the results using the parameters in table 4. The first column labels the episode and the second column quantifies the RER depreciation in percentage terms. The next two columns report the level of debt as a percentage of GDP and the share of FC debt at the time of the episode. The fifth column uses equation (20) to calculate the increase in public debt burden due to the RER depreciation. The last column reports a counterfactual increase in debt burden had the country halved its FC debt issuance and moved towards IL debt.

Episode	RER depreciation	Debt/GDP	FC share	Actual Δ in Debt burden	Counterfactual Δ in debt burden
Argentina, 01-02	58.2%	50⋆%	1	1.3%	0.7%
Brazil, 98-99	33.3%	50⋆%	0.5	0.42%	0.21%
Russia, 98-99	23.2%	143%	1	2.2%	1.1%
Poland, 08-09	15.6%	50.3%	0.3	0.10%	0.05%
Colombia, 14-15	23.6%	80.3%	0.3	0.27%	0.14%

Table 7: Increases in debt burden under a counterfactual scenario where FC share halves. Starred debt-to-GDP ratios for Argentina and Brazil indicate that the sample average was used because of lack of data. Brazil's FC debt in 1998 is from Ferreira and Bonomo (2006)

Clearly when the share of FC halves and is substituted by IL debt, the counterfactual increase in debt burden also halves. More interestingly, table

7 shows that the drop in public debt burden is quantitatively relevant in two cases: one, for big RER depreciations like the one Argentina endured between 2001 and 2002 and, two, for cases where the debt burden itself is quantitatively relevant, like the Russian RER depreciation between 1998 and 1999.

If countries chose to issue all their debt linked to inflation, the increase in debt burden would dissappear. The model in section 3 and the empirical evidence in subsection 4.1 sheds some light on the drawback of issuing IL debt only. It would entail either only tapping domestic public debt markets or issuing only a limited amount of IL debt in foreign public debt markets, because of a limited foreign demand for IL debt.

Exploring further the reasons behind the limited foreign demand for IL debt and the trade-off between IL debt and FC debt is left for future research.

6. Conclusions

The paper reports a set of stylized facts about recent emerging economies' IL public debt issuance. On average, emerging economies issue 13% of their public debt linked to inflation. This represents 20% of their LC public debt. IL debt issuance is countercyclical, substitutes foreign currency (FC) debt, and increases in periods of real and nominal effective exchange rate depreciations. Data on IL and FC rates show some variability across countries. However, on average, for emerging economies issuing IL debt has been almost 2 percentage points cheaper than FC debt.

The paper then presents a small-open economy model of public debt composition with exogenous tradable endowment. It features a government

that issues IL and FC debt to finance an exogenous level of government spending and segmented public debt markets.

Embedding the FC-IL debt interest rate differential as an assumption, the model can deliver the previous stylized facts. Relaxing the segmented public debt markets assumption does not change the qualitative results of the model. Furthermore, it allows inflation to have a role in public debt composition.

Finally, the paper considers episodes of recent RER depreciations and presents counterfactual increases in public debt burden, had the countries issued half of their public debt linked to inflation. Due to the linearity in the expression for public debt burden, the increase in public debt burden halves. The drop in public debt burden is quantitatively relevant when debt burden or the magnitude of the RER depreciation are large.

Exploring the determinants of the optimal mix between IL debt and FC debt is left for future research.

Appendix A. Appendix to the Empirical Evidence

Appendix A.1. Sample, sources, and coverage of key variables

1. **IL debt issuance:** Bank of International Settlements. Table C2. Link: `https://www.bis.org/statistics/secstats.htm`. Available at yearly frequency only.
2. **Total government debt and local currency government debt:** for all economies except Israel, Arslanalp and Tsuda (2014). Data covers 2004-2016. For Israel OECD Statistics for public debt over GDP data (2001-2015). No data on LC government debt for Israel.
3. **REER and NEER:** Darvas (2012). Used 2000-2016.
4. **All other macroaggregates:** World Development Indicators (WDI). Used 2000-2016 coverage.
5. **FC bond rate**: JP Morgan EMBI+. Used 2000Q1-2017Q3 coverage.
6. **IL bond rate**: see table in next page.

Appendix A.2. Graphs

IL bond rate: coverage and sources			
Country	Source	Bloomberg Ticker or Link	Coverage
Argentina	Barclays	BEMA8y Index	2003Q4-2017Q3
Brazil	Bloomberg	TRBRI15	2006Q1-2017Q3
Chile	Banco de Chile	http://si3.bcentral.cl/Boletin/secure/boletin.aspx?idCanasta=1MRMW2951	2002Q3-2017Q3
Colombia	Banco de Colombia	http://www.banrep.gov.co/es/tes	2003Q1-2017Q3
Hungary	-	-	-
India	S&P Index	https://us.spindices.com/indices/fixed-income/sp-india-sovereign-inflation-linked-bond-index	2013Q3-2017Q3
Israel	Bloomberg	TRILI10	2008Q4-2017Q3
Mexico	Barclays	BEMM8y Index	2006Q1-2017Q3
Peru	S&P Index	https://us.spindices.com/indices/fixed-income/sp-peru-sovereign-inflation-linked-bond-index	2008Q2-2017Q3
Poland	Barclays	BEMv0y Index	2003Q3-2017Q3
Russia	Barclays	Brulcy Index	2015Q3-2017Q3
South Africa	Bloomberg	MLGSail	2004Q1-2017Q3
Turkey	Bloomberg	TRTKI5y	2013Q2-2017Q3

Table A.8: Sources and coverage for IL rates for all countries in sample.

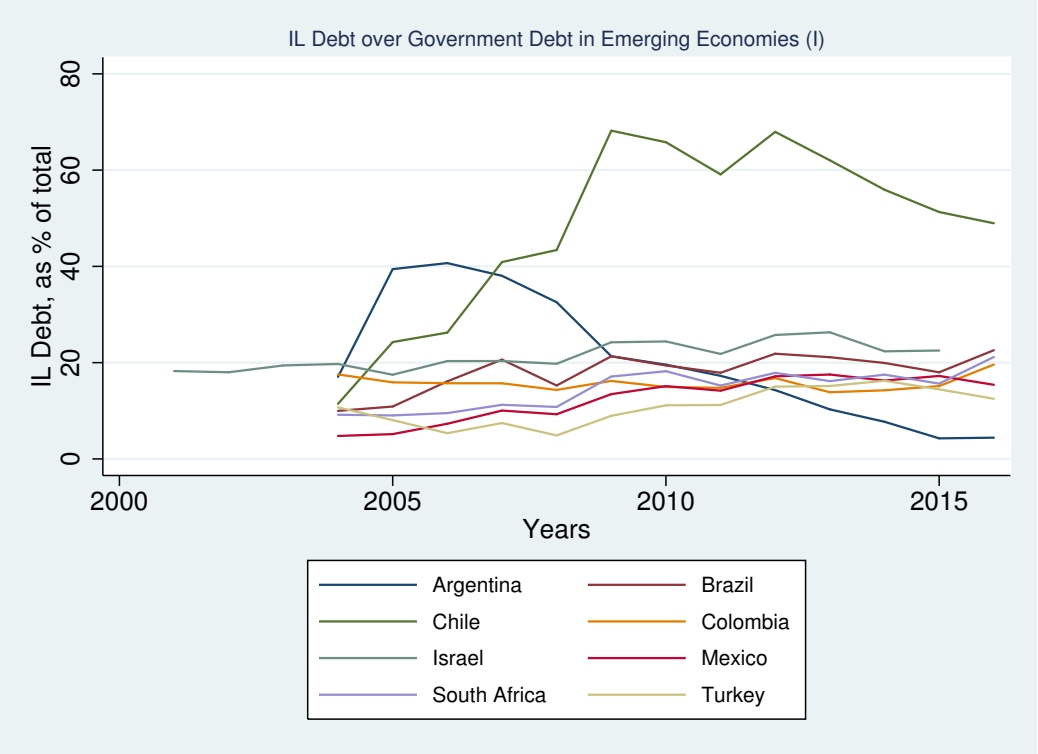

Figure A.4: Share of IL debt (as % of Total Government Debt) for Emerging Economies (I), by country. Data sources: see above.

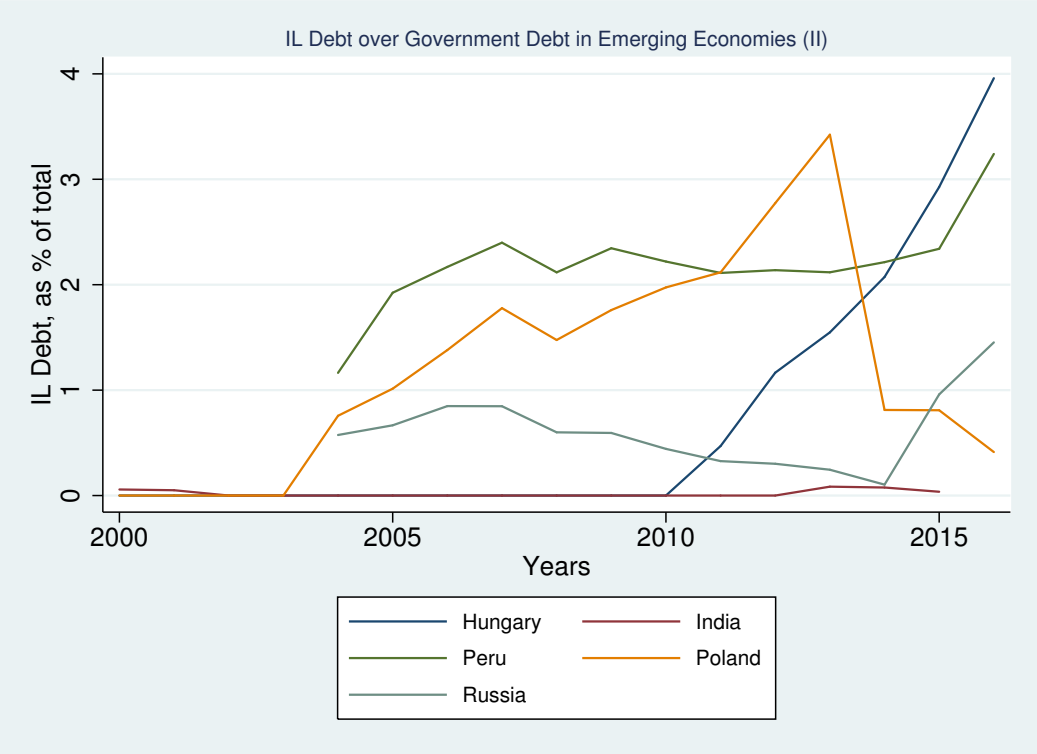

Figure A.5: Share of IL debt (as % of Total Government Debt) for Emerging Economies (II), by country. Data sources: see above.

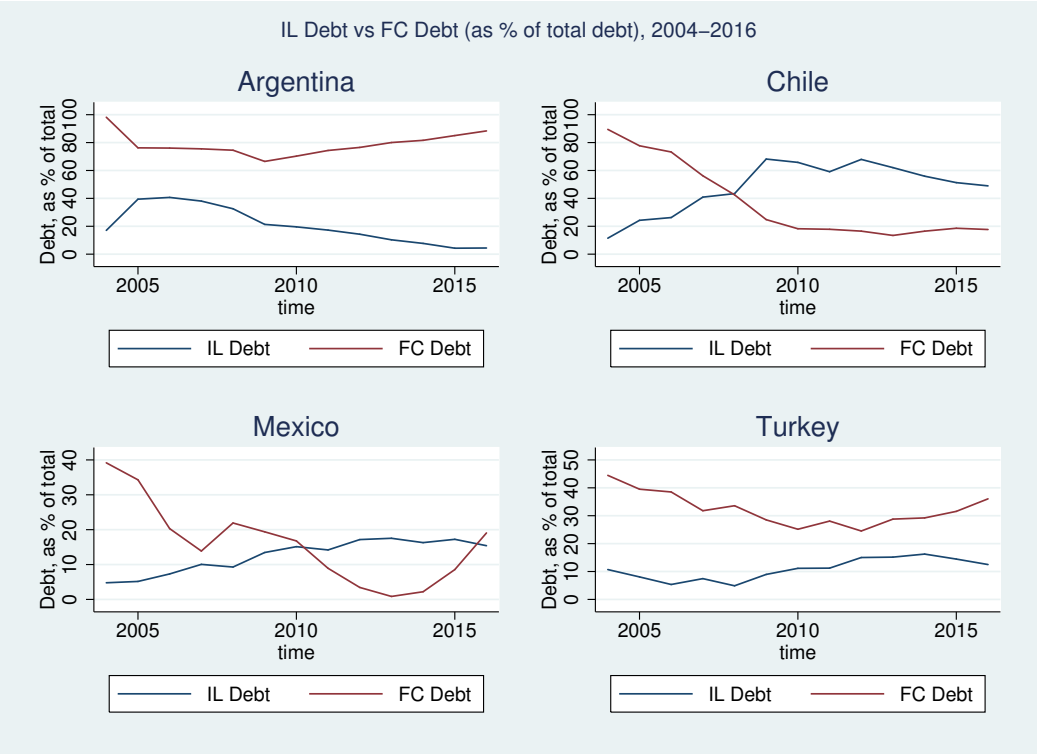

Figure A.6: Share of IL debt and FC debt (as % of Total Government Debt) for a selection of emerging economies. Data sources: see above.

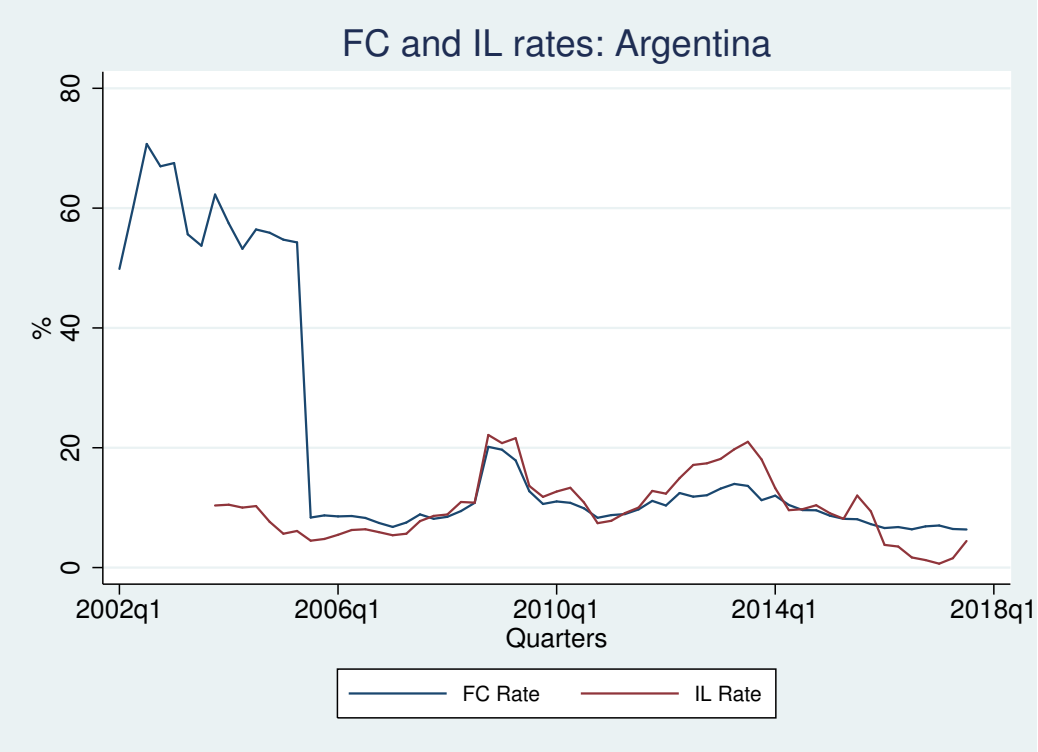

Figure A.7: Foreign currency (FC) and inflation-linked (IL) bond rates between 2002-2017 for Argentina. Data sources: see above.

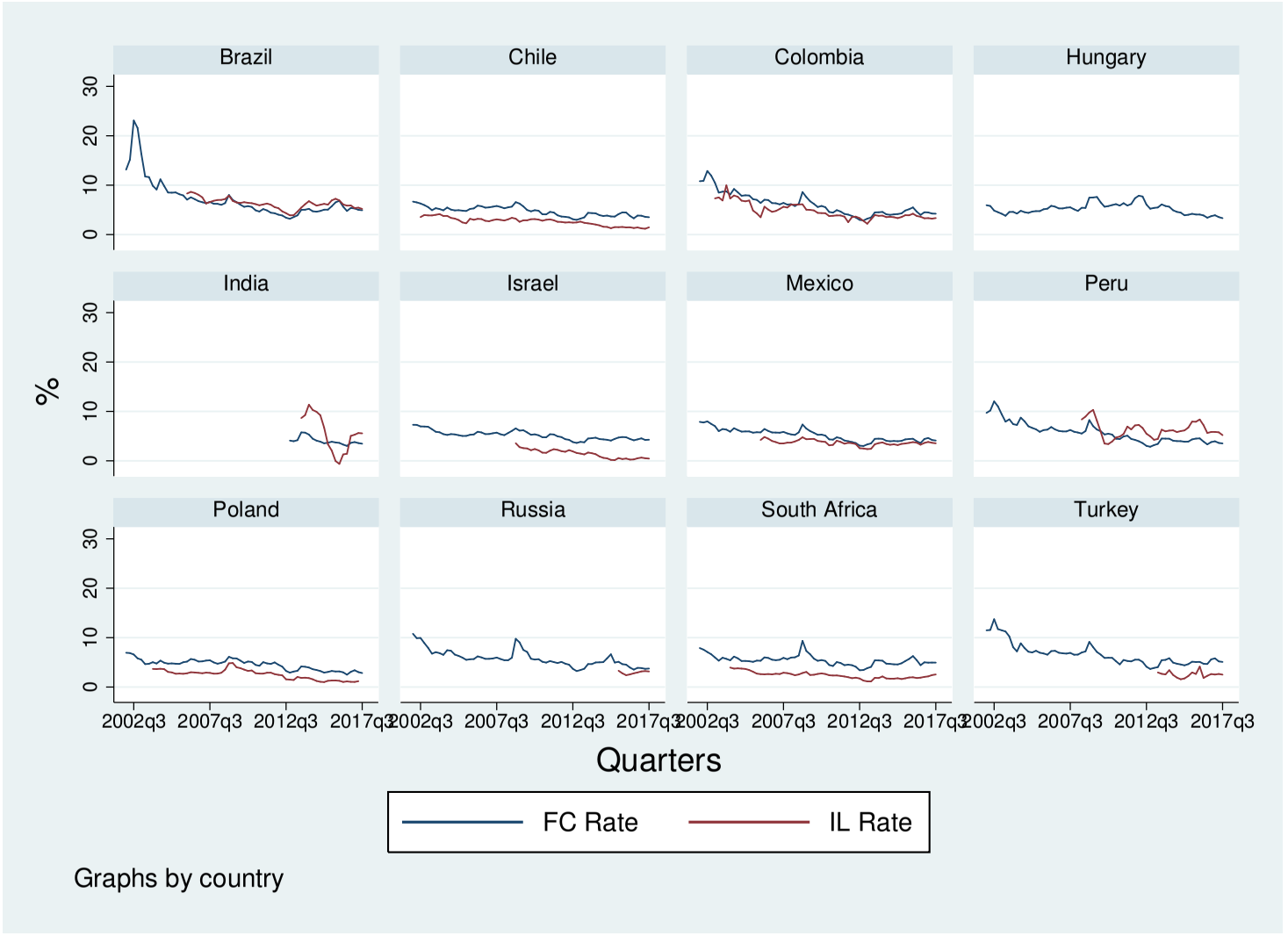

Figure A.8: Foreign currency (FC) and inflation-linked (IL) bond rates between 2002-2017. Sources: see above.

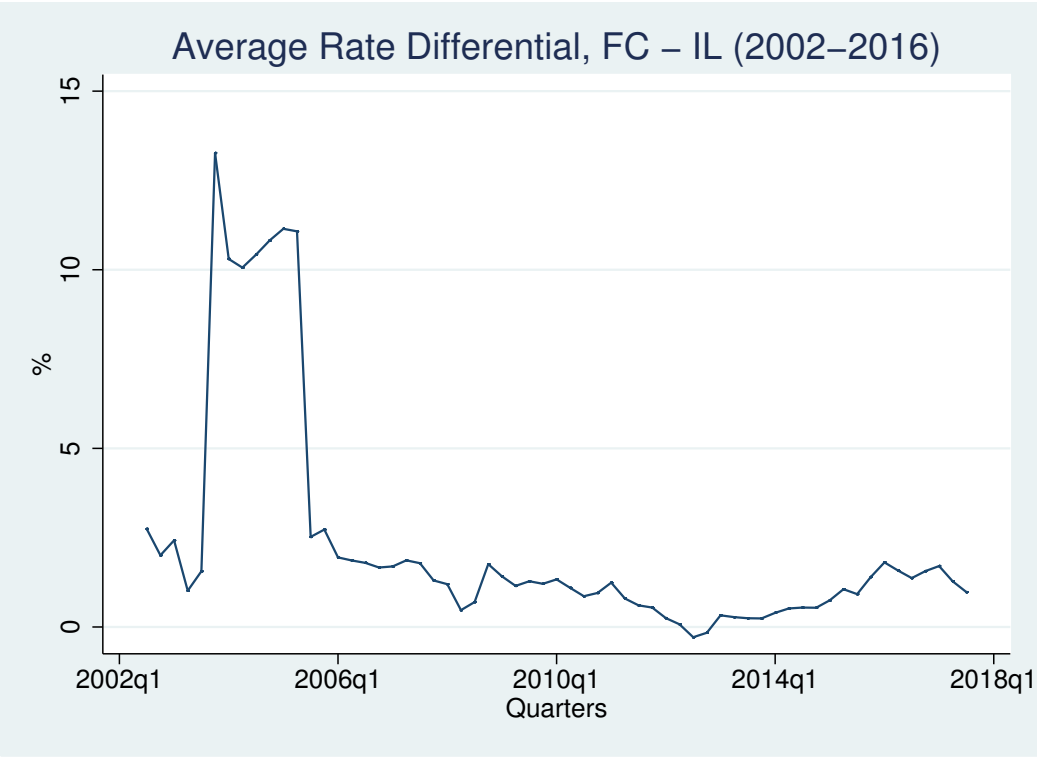

Figure A.9: Average Rate Differential, FC - IL (2002-2016). Sources: see above.

Appendix B. Appendix to the Model

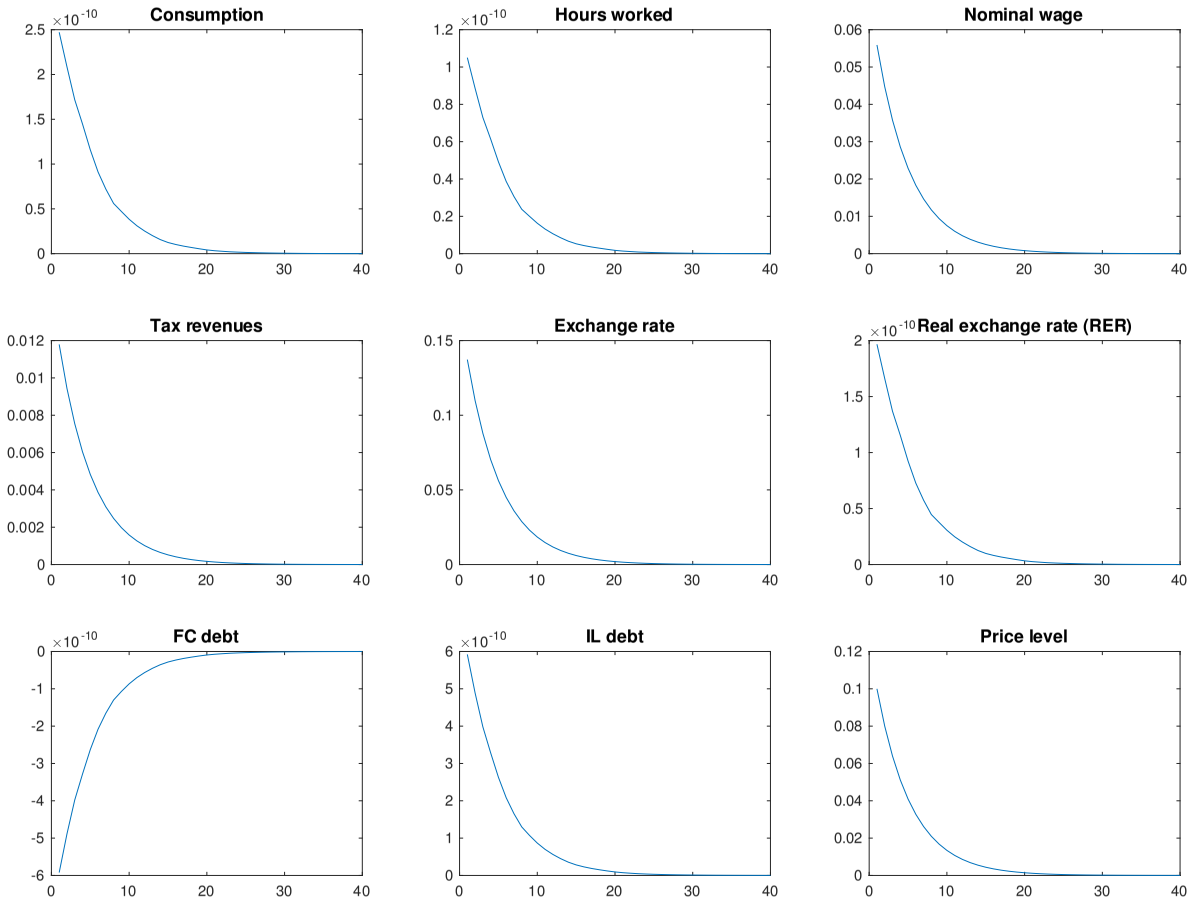

Figure B.10: Model's response to a positive price shock

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