Department of Economics- FEA/USP

Overcoming the Original Sin: Gains from Local Currency External Debt

RICARDO SABBADINI

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Ricardo Sabbadini (ricardo.sabbadini@usp.br)

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RICARDO SABBADINI*

*Central Bank of Brazil and IPE-USP***

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** Economist at the Central Bank of Brazil (on leave) and PhD candidate at the Department of Economics, University of São Paulo. E-mail: ricardo.sabbadini@bcb.gov.br.

1. INTRODUCTION

In the last decade emerging markets abandoned negative net external positions in foreign currency (Bénétrix, Lane and Shambaugh, 2015) and overcame their inability to borrow from foreigners in their own currencies (Burger, Warnock and Warnock, 2010, Alfaro and Kanczuk, 2015, Du and Schreger 2016b), what Einchengreen and Hausmann (1999) had dubbed the "original sin". This happened mostly through an increasing participation of non-resident lenders in local government debt markets. Arslanalp and Tsuda (2014) showed that the share of foreign ownership of government debt denominated in local currency increased from 2.7% in the last quarter of 2004 to 17.7% in the second quarter of 2016 for the median of a sample of 22 emerging countries. The adherence of these countries to inflation target regimes (Hammond, 2012) helped them to reduce inflation and its volatility (Vega and Winkelried, 2005, Gonçalves and Salles, 2008, Lin and Ye, 2009) and, therefore, to attract foreign investors to local currency bonds (Burger, Warnock and Warnock, 2010, and Hale, Jones and Spiegel, 2016). But even sovereign debt denominated in local currency is not free from de jure defaults, as extensively pointed out by the recent historical and empirical literature (Kohlscheen 2010, Rogoff and Reinhart 2011, Du and Schreger 2016a, and Alexandre and Souissi, 2016).

The change in the denomination of external net positions can be observed in table 1 that lists 12 emerging countries whose gross external debt (excluding intercompany lending operations, classified as direct investment) exceeds US$ 50 billion in 2015 and for which its currency composition is available[1]. Countries are ordered by the size of their Gross External Debt in US dollars (column 1), whose sum is US$ 2.7 trillion. For the median country, the Gross External Debt to GDP ratio is 34.3% and 22.9% of this total is denominated in local currency (columns 2 and 3 respectively). While column 4 shows the sum of international reserves and other debt assets held by residents[2], column 5 presents the net position for foreign currency debt instruments (gross external debt in foreign currency minus assets in column 4)[3]. Nine of twelve countries are creditors in this criterion, in line with Bénétrix, Lane

[1] Data obtained in the Quarterly External Debt Statistics Database (QEDS) from the World Bank and IMF collaboration for countries that subscribe to the IMF's Special Data Dissemination Standard. Currency composition comes from Table 2 in "Country Tables" and Table C5 in "Cross Country Tables". These data were compared with those in table C2 in "Cross Country Tables" to check for which countries the gross external debt statistics contained intercompany lending, which I classify as Direct Investment instead of Debt. Furthermore, some large emerging economies, as Mexico and India, do not report this statistic. I also compared the data to the sovereign investor base estimates by Arslanalp and Tsuda (2014), and read the Metadata by country, to exclude countries whose statistics available at QEDS do not include non-residents participation in domestic bond markets.

[2] Both were obtained from the IMF Balance of Payments and International Investment Position Statistics (BOP/IIP).

[3] In order to construct net external debt measures by currency, it is necessary to subtract assets denominated in each currency. Here I suppose that all external debt assets owned by emerging markets residents are denominated in foreign currency. For Brazil, using data from the Central Bank, I find that in 2015 only 0.2% of debt assets and reserves were denominated in Brazilian Real. See the monthly Foreign Sector Press Release tables 4 and 33 at http://www.bcb.gov.br/pt-br/#!/n/press. Since the totality of international reserves is denominated in foreign currency, I obtain the estimate in the text using this information and the debt assets by currency denomination (excluding intercompany lending) from table 33.

and Shambaugh (2015). The last column of table 1 presents the net position of external debt in local currency, and almost all countries have relevant debtor positions.

Table 1 – Net external debt and currency composition

Country	Gross External Debt			Reserves plus Other Debt Assets	Net Assets in Foreign Currency	Net External Debt in Local Currency
	US$ bi	% GDP	% in Local Currency	US$ bi	% GDP	% GDP
	1	2	3	4	5	6
India	479.3	23.1	28.7	390.9	2.4	6.6
Brazil	459.4	25.9	22.9	442.4	5.0	5.9
Mexico	417.6	36.5	29.5	409.3	10.1	10.8
Russia	378.6	28.5	16.4	786.1	35.4	4.7
Poland	249.7	52.6	35.4	138.5	-4.8	18.6
Argentina	141.8	22.5	3.9	234.7	15.6	0.9
Thailand	114.6	29.0	24.8	245.2	40.2	7.2
Ukraine	110.2	121.7	0.8	114.8	6.2	1.0
Chile	103.2	43.0	3.7	99.4	0.0	1.6
South Africa	100.7	32.0	42.6	90.4	10.4	13.6
Hungary	89.3	74.0	23.0	60.1	-7.2	17.0
Romania	74.4	41.8	11.2	56.2	-5.6	4.7
Median	**128.2**	**34.3**	**22.9**	**186.6**	**5.6**	**6.3**

Given these facts, I investigate the consequences of changing the denomination of external debt from foreign currency (FC) to local currency (LC). I use a dynamic and stochastic model of a small open economy with endogenous default, as pioneered by the quantitative works of Alfaro and Kanczuk (2005), Aguiar and Gopinath (2006) and Arellano (2008), but with two sectors (traded and non-traded goods), as in Gumus (2013), Alfaro and Kanczuk (2015), Asonuma (2016), and Na et al (2016). In this framework, a benevolent, but discretionary, sovereign chooses consumption and borrowing from foreign lenders. Repayment, however, is not certain, but a strategic choice made every period. I focus on the contingency in the repayment value of LC debt provided by variations in the real exchange rate. This is obtained if during surprisingly bad times (low GDP) the real exchange rate increases (depreciation of the domestic currency) and the value of debt, measured in foreign currency, declines, loosening the resource constraint of the domestic economy and allowing a less severe contraction in consumption.

I calibrate the model with data from Brazil, a large emerging country with a long history of defaults and one of the first non-advanced economies to adopt an inflation target regime, whose (net) external debt denomination is shifting from FC to LC. Figure 1 shows that Brazilian net external debt (considering instruments issued abroad, almost exclusively in foreign currency) decreased from an average of 23.4% between 1971 and 2006 to -2.9% from 2007 to 2016, particularly due to the accumulation of international reserves by the public sector. Meanwhile, the participation of foreigners in the domestic market for government debt, entirely denominated in local currency, increased from less than 1% to more than 8% of GDP, as displayed in figure 2. Besides, Brazil has values close to the median for all variables of interest in table 1.

Figure 1: Brazil net external debt (% GDP)

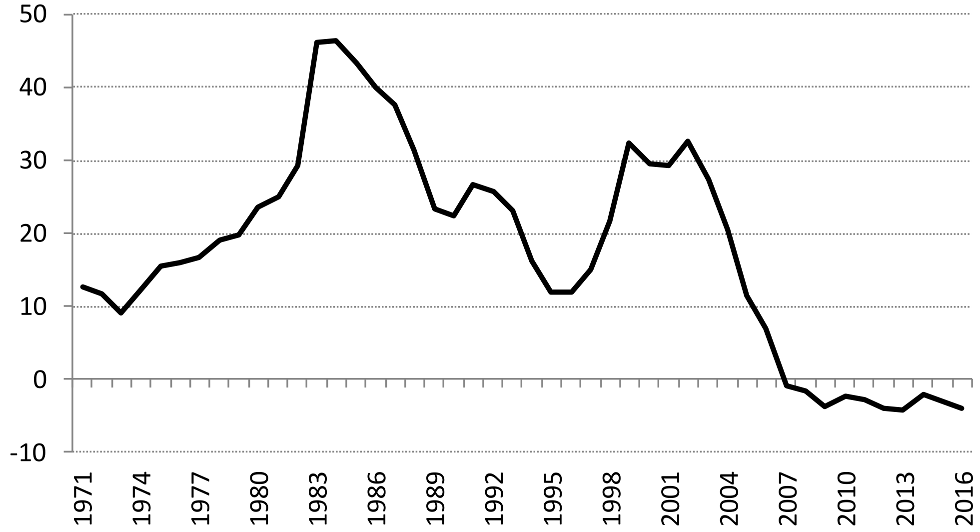
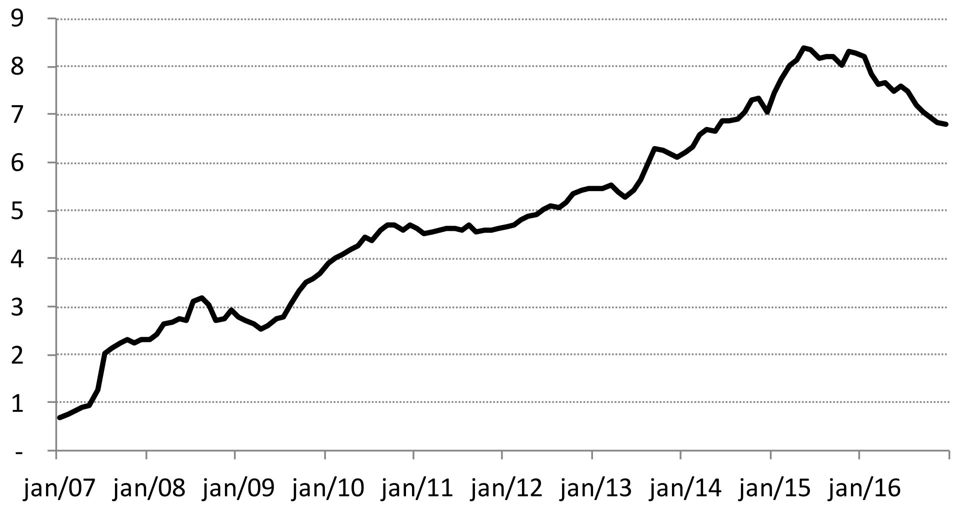


Figure 2: Foreign holdings of domestic public debt (% GDP)



With simulated data I find that the model with FC debt is able to replicate the average debt level and the default frequency of the Brazilian economy in the period 1971-2006. It also exhibits counter-cyclical risk premium, trade balance, and exchange rate, and consumption is more volatile than output.

All of these are typical features of emerging economies. As in the works of Asonuma (2016) and Na et al (2016), defaults are accompanied by real exchange rate depreciations, the Twin Ds phenomenon.

When external debt is issued in local currency, the average indebtedness increases from 7.2% to 8.3% of GDP and the default frequency declines from 2.9% to 1.2%, results in the same direction of those observed by Gumus (2013) in a similar model, but with exogenous exchange rates. Nevertheless, I also identify a 20% reduction in the volatility of the exchange rate, another feature present in the Brazilian economy and discussed in Alfaro and Kanczuk (2015). In line with this decline, the model suggests that the economy smoothes more its consumption under LC debt denomination. Due to the channels mentioned above, I estimate welfare gains from issuing debt in local currency equivalent to an increase of 0.43% of the flow certainty equivalent consumption, larger than suggested by the previous literature (Gumus, 2013).

However, the ability to issue external debt in local currency does not eliminate all difficulties of external borrowing. In this setup, the economy still faces counter-cyclical interest rate spread, albeit smaller, in line with the results from Gumus (2013). A novel result is that even in this situation the optimal policy still consists of real exchange rate depreciations around default episodes, although of smaller magnitude.

2. RELATED LITERATURE

I contribute to the literature on quantitative models of external debt and endogenous strategic default with incomplete markets that follows Eaton and Gersovitz (1981), Arellano (2008) and Aguiar and Gopinath (2006)[4]. Recent surveys of this approach are Stahler (2013), Aguiar and Amador (2014), and Aguiar, Chatterjee, Cole and Stangebye (2016)[5]. I study a two-sector small open economy model under two distinct scenarios of debt denomination: foreign or local currency. The works more closely related to mine, due to the same modeling framework, are those by Gumus (2013), Asonuma (2016), Na et al (2016), and Alfaro and Kanczuk (2015)[6].

Gumus (2013) studies a model in which the government uses foreign borrowing to smooth only public consumption and the real exchange rate is exogenous. She finds that with local currency debt the economy sustains higher levels of external debt and defaults less frequently, but the increase in welfare is modest. In the other three papers mentioned the real exchange rate is endogenously determined and might be influenced by the debt policy. Asonuma (2016) uses a model in which only 1% of liabilities is denominated in local currency – in order to match a stylized fact from the

[4] A similar but alternative structure for quantitative models of default was proposed by Alfaro and Kanczuk (2005) using the idea of excusable defaults of Grossman and Van Huyck (1988).

[5] For a more introductory presentation, see chapter 13 of Uribe and Schimitt-Grohé (2017).

[6] A parallel growing literature investigates the simultaneous determination of discretionary debt and monetary policies in models with endogenously determined defaults and inflation rates. Some of the recent papers are Du and Schreger (2016b), Nuño and Thomas (2016), Onder and Sunel (2016), and Sunder-Plassman (2016).

Argentinean economy from 1996 to 2006 that does not reflect the current situation in several emerging markets – and Na et al (2016) focus in economies with nominal wage rigidities that issue only debt denominated in foreign currency. The results from their models replicate the observed depreciation of the real exchange rate around defaults episodes. I extend these two papers in this direction by comparing scenarios with debt denominated in local and foreign currencies and calculating welfare differences between such situations. I find that gains from local currency debt derive not only from less defaults and more debt, but also from less volatile consumption and exchange rates, an ingredient absent from the work of Gumus (2013), but explored by Alfaro and Kanczuk (2015) in a model with simultaneous accumulation of debt and international reserves.

3. MODEL

I model a dynamic small open economy with two sectors that receives a stochastic endowment of traded goods and a fixed amount of non-traded goods every period. The central planner borrows from risk neutral foreign lenders using only debt (a non-contingent instrument). I compare the cases of debt denominated in foreign and local currency. Since the sovereign cannot commit to repay, every period it chooses whether or not to default in the stock of debt. If default is chosen, the country is excluded from international markets by a random number of periods. If the government decides to continue participating in markets, it must repay its debt and then is able to borrow today due to the next period, when a choice between default and repayment is made again[7].

Household preferences over traded and non-traded goods are given by equation (1), and follow the same specification used by as Alfaro and Kanczuk (2015) and Ottonello and Perez (2016), who study endogenous real exchange rate and local currency debt.

$$U = E\sum_{t=0}^{\infty}\beta^t \frac{\left[\left(c_t^T\right)^{\omega}\left(c_t^N\right)^{1-\omega}\right]^{1-\sigma}}{1-\sigma} \tag{1}$$

In the expression above, E is the expectation operator and c_t^T and c_t^N are the household consumptions of traded and non-traded goods in period t, respectively. The three parameters express the subjective discount rate,β, the constant relative risk aversion, σ, and the share of tradable goods in the utility function, ω.

I set the price of non-tradable goods as numéraire, $p_t^N = 1$, and consider an international economy with a stable price of traded goods, $p^* = 1$. Using the law of one price, I find that $p_t^T = p^* e_t = e_t$, in

[7] In order to focus on the contingency in the repayment value of the local currency debt provided by the variations in the real exchange rate, I suppose the domestic monetary authority is committed to a credible monetary regime, inspired by the evidence mentioned above, avoiding concerns about the erosion of debt with inflation. See the previous footnote for models that deal with this issue.

which e_t is the real exchange rate. An increase in the interest rate means a depreciation of the local currency.

If the sovereign chooses to repay its debt and keep its access to international markets, the resource constraint of the economy is given by (2) or (3) if debt is denominated in FC or LC respectively. In the expression below $\mathrm{y_t^T}$ and $\mathrm{y_t^N}$ are traded and non-traded endowments, respectively, while $\mathrm{d_t^*}$ and $\mathrm{d_t}$ denote FC and LC debt and $\mathrm{q_t}$ and $\mathrm{q_t^*}$ are their respective prices.

$$c_t^T + \frac{c_t^N}{e_t} = y_t^T + \frac{y_t^N}{e_t} + q_t^* d_{t+1}^* - d_t^* \tag{2}$$

$$c_t^T + \frac{c_t^N}{e_t} = y_t^T + \frac{y_t^N}{e_t} + q_t \frac{d_{t+1}}{e_t} - \frac{d_t}{e_t} \tag{3}$$

If the sovereign defaults, the resource constraint is reduced to equation (4) regardless of the currency in which debt is denominated. As usual in this literature, the economy faces a direct output cost when it defaults, because being excluded from markets is not a punishment harsh enough to sustain positive debt levels. I model this loss using the same specification as Arellano (2008), but restricting this ad hoc cost to the tradable sector of the economy since it is the only stochastic component, equation (5). It means that up to a certain threshold (ψ) there are no direct costs of default, but for higher output levels the marginal cost is 100%. This asymmetric output cost is essential to replicate observed debt levels and default frequencies in this type of model according to Aguiar, Chatterjee, Cole and Stangebye (2016). I normalize the fixed amount of non-traded goods to one, so that in equilibrium $c_t^N = y_t^N = 1$.

$$c_t^T = y_t^{T,a}. \tag{4}$$

$$y_t^{T,a} = \begin{cases} y_t^T \text{ , } if \ y_t^T \leq \psi \\ \psi . \ if \ y_t^T > \psi \end{cases} \tag{5}$$

Debt is priced by risk neutral foreign lenders, who have access to a risk free asset with return r^*, and reflects the sovereign's actions. Equation (6), in which $f_t = 1$ means the government defaults and $f_t = 0$ means it repays, shows that the price of FC debt depends on the state variable y_t and on the choice variable f_{t+1}. This happens because the relevant information for the lender is the state of the economy in the next period, when the sovereign will decide to repay or default. The current endowment value appears in the expression only because it brings information about its next realization, and is the reason why I use the conditional expectations operator E_y.

$$q_t^* = q^*\left(y^T, d^{*\prime}\right) = E_y\left[\frac{(1-f_{t+1})}{(1+r^*)}\right] \tag{6}$$

In the case of LC debt, its price is given by equation (7), in which the role of the real exchange rate is clear, because foreign investors are interested in the return in FC. Since the current real exchange rate, determined by the domestic private sector according to equation (8), appears in the right hand side of the equation (7), the price of this type of debt depends on the current level of debt too. In order to solve numerically this problem it is useful to define the auxiliary variable $\tilde{q}$, present in (9), that depends only on the current endowment and on the next period debt.

$$q_t = q_t(y^T, d, d') = E_y[\frac{(1-f_{t+1})e_t}{(1+r^*)e_{t+1}}] \quad (7)$$

$$e_t = \frac{\omega}{1-\omega}\frac{c_t^N}{c_t^T} \quad (8)$$

$$\tilde{q}_t = \tilde{q}_t(y^T, d') = \frac{q_t}{e_t} = E_y[\frac{(1-f_{t+1})}{(1+r^*)e_{t+1}}] \quad (9)$$

Equations (10), (11) and (12) present the problem in recursive form. As usual in the literature, variables with apostrophe represent values at $t+1$. For the value functions and restrictions defined below, we obtain policy functions for default (f), consumption of traded goods (c^T), real exchange rate (e), and next period debt (d^* or d depending on the currency of denomination). For the sovereign, the value of repaying is expressed by (10) subject to restriction (8) plus the resource constraint: equation (2) in case of FC debt or equation (3) in case of LC debt. The value of defaulting, (11), depends only on the current endowment. The parameter θ measures the exogenous probability of regaining access to the international markets with zero debt after default. Equation (12) depicts the discretionary government deciding at every period whether to repay and or to default.

$$v^R(y^T, d) = \max_{c^T, e, d'}\{u(c^T, y^N) + \beta E_y[v(y^{T\prime}, d')]\} \quad (10)$$

$$v^D(y^T) = u(y^{T,a}, y^N) + \beta E_y[\theta v^R(y^{T\prime}, 0) + (1-\theta)v^D(y^{T,a\prime})] \quad (11)$$

$$v(y, d) = \max_{f\in\{0,1\}}\{(1-f)v^R(y^T, d) + f v^D(y^T)\} \quad (12)$$

The model is a stochastic dynamic game played by a discretionary sovereign who cannot commit to a planned policy path against a continuum of small identical foreign lenders. Given the lack of commitment I focus on Markov Perfect Equilibrium.

Definition. Let $s = \{y, d^*\}$ for FC debt and $s = \{y, d\}$ for LC debt. A Markov perfect equilibrium is defined by:

i. A set of value functions $v(s), v^R(s), v^D(s)$ defined above.
ii. Policy functions for default, $f(s)$, consumption of traded goods, $c^T(s)$, real exchange rate, $e(s)$, and borrowing, $d^{*\prime}(s)$ for FC debt and $d'(s)$ for LC debt.

iii. A bond price function: q^* for FC debt and q for LC debt.

such that

I. Given a bond price function, the policy functions solve the Bellman equations (10)-(12).
II. Given the policy functions, the bond price function satisfies equation (6) for FC debt or (7) for LC debt.

In an economy with FC debt the spread between the interest rate and the risk-free international rate reflects the default risk premium, but in the LC economy the interest rate spread also contains a market (price) risk, because the payoff to be paid in the next period is not constant in terms of traded goods. In order to isolate the default risk premium I first define the pricing of an artificial bond denominated in local currency but without default risk in equation (13). Then, I compute the default risk premium for an economy with LC debt, expression (14), a concept related to the local currency credit risk spread calculated by Du and Schreger (2016a).

$$\tilde{q}_{free} = E_y[\frac{1}{(1+r^*)e_{t+1}}] \tag{13}$$

$$r^{LC} - r^{free} = \left(\frac{\tilde{q}_{free}}{\tilde{q}_t} - 1\right)(1 + r^*) \tag{14}$$

4. CALIBRATION

A period in the model refers to one year, thus I use $r^* = 0.04$, a standard choice of parameter value in this literature, and set the probability of redemption after default, θ, at 50%, what implies an average stay in autarky for two years, in line with estimates by Gelos, Sahay and Sandleris (2011). For the risk aversion coefficient, I use $\sigma = 2$, the standard value in business cycle studies and commonly used in the default literature.

For the remaining country-dependent parameters I use Brazil as a benchmark. Together with Mexico and Argentina (and more recently Greece and Spain), this large emerging market economy, and serial defaulter (Reinhart, Rogoff and Savastano, 2003), is one of the common references in the related literature.

For the endowment process, I suppose its logarithm follows an AR(1), as in equation (15), in which ε_t follows a standard normal distribution. The parameters ρ and η are, then, obtained from a regression using the cyclical component of the Brazilian GDP from 1948 to 2014 in yearly frequency[8]. Thus a Markov transition matrix for the endowment is obtained from these estimates, present in table 2, by

[8] The cyclical component is obtained using the HP filter, and I do not use GDP data for 2015 and 2016 because they are computed from quarterly estimates and still subject to potentially large revisions.

the simulation method proposed by Schimitt-Grohé and Uribe (2009). These estimates are close to the ones used by Ottonello and Perez (2016) for the tradable GDP of a panel of countries and by Bianchi, Hatchondo and Martinez (2016) for Mexico's total GDP. The traded sector share of the economy, measured by ω, is calibrated using the average share of agriculture and manufacturing in the Brazilian GDP in the last decades.

$$\ln(y_t) = \rho \ln(y_{t-1}) + \eta\varepsilon_t \tag{15}$$

I choose the values of the two remaining parameters, $\beta = 0.544$ and $\psi = 0.849$, to match observed average debt and default frequency. The targeted default frequency of 2.8% is obtained from one default from 1970 to 2006, and is a value similar to the one used by Aguiar et al (2016) for Mexico. The period starts when international debt markets reopened to emerging countries and lasts while the Brazilian economy borrowed mostly in foreign currency. In this period the Brazilian net external debt averaged 23.4% of GDP, but the total amount should not be considered unsecured. Since in the model the economy re-enters markets without debt, the calibration intends only to replicate the amount of debt not paid in case of default. According to Cruces and Trebesch (2013), the average haircut (excluding heavily indebted poor countries) is 29.7%, so the debt to GDP ratio of interest is 7% (23.4×29.7%)[9].

The model is solved numerically using value function iteration in a discrete state space. As suggested by Hatchondo, Martinez and Sapriza (2010), I find the equilibrium by solving the limit of the equivalent finite-horizon version of this model.

Table 2 – Parameter values

Parameter	Description	Value
σ	Risk Aversion	2
r*	Risk free rate	0.04
ω	Share of traded output	0.23
θ	Probability of re-entry after de1	0.5
ρ	GDP persistence	0.7
η	Std. Deviation of innovation to	0.026
β	Domestic discount factor	0.544
ψ	Direct default output cost	0.849

[9] Chatterjee and Eyigungor (2012) use this same calibration approach in a seminal paper of the related literature.

5. QUANTITATIVE RESULTS

In the first part of this section, I present the policy functions obtained in the FC and LC cases. In the second segment, I compare simulated statistics with those observed in the Brazilian economy. The last subsection shows the dynamics of the economy around default episodes.

5.1. POLICY FUNCTIONS

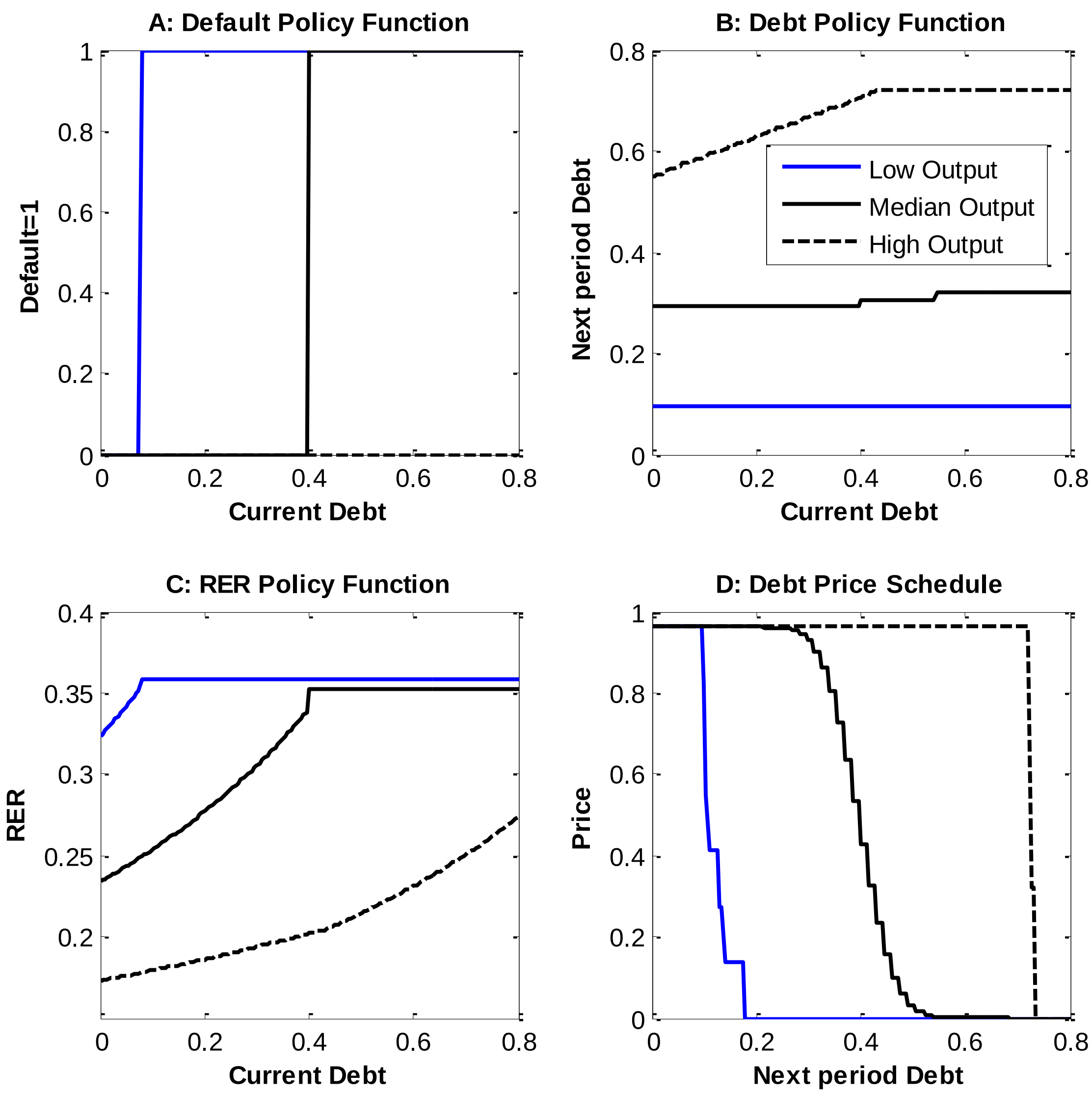
Figures 3 and 4 present the policy functions for FC and LC cases respectively. Since they display the level of debt (d^*or d) in the horizontal axis, it is convenient to remember that in steady state the real exchange rate is $e_t = \frac{\omega}{1-\omega} = 0.3$ and that debt to GDP ratios are given by equations (16) and (17) in each case. For this reason, the graphs in the mentioned figures show a different range of values in the horizontal axis.

$$FC: \ \frac{DEBT}{GPD} = \frac{e_t d_t^*}{e_t y_t^T + y_t^N} \tag{16}$$

$$LC: \ \frac{DEBT}{GPD} = \frac{d_t}{e_t y_t^T + y_t^N} \tag{17}$$

For each panel in figure 3 the lines represent the policy function for different realizations of the endowment. Defaults, shown in panel A, are more likely to happen in bad times (low realizations of the output process) and when debt level is elevated. In panels B and D we can see that more debt is accumulated in good times, when interest rates are lower (debt prices are higher). Furthermore, interest rate charged increases with debt levels because default is more probable when debt is high. Notice that in panel D the horizontal axis represents the new borrowing and not the current debt. Panel C plots the real exchange rate and we can see that it depends both on the debt level and the output shock realization. The exchange rate is lower (appreciated local currency) when output is above its mean, as commonly observed in emerging markets (see table 3 and the discussion in the next subsection), and when debt is low. As in the model, the correlation between debt and exchange rate is positive in the Brazilian economy in the period from 1971 to 2016. This result differs from those of Gumus (2013), because in her model the exchange rate choice does not depend on current or future debt, and from those of Asonuma (2016), which show a more appreciated local currency when debt is high. Notice that the real exchange rate policy function turns into a plateau at the debt level from which default is the optimal choice. This shape derives directly from the chosen functional form for the direct output cost of default, equation (5).

Figure 3: Policy functions for an economy with FC debt



With LC external debt, available in figure 4, the main characteristics of the policy functions remain. Default is still more likely in when debt is high and output is low, and more borrowing takes place during good times. The real exchange rate still is positively associated with current debt level and negatively with traded goods output. Although interest rates are still lower when output is above its mean and when debt is lower, the main difference is seen in panel D, that plots the price of LC debt in terms of traded goods, $\tilde{q}_t$. Even in a region of the state space in which default is not a concern, the price of LC debt declines. This happens because, for a given output level, if the sovereign chooses to borrow more, in the next period it starts with high debt and will choose a more depreciated currency (panel C), decreasing the return (in terms of traded goods) for the foreign lender. The contingency provided by this type of debt arises from the fact that the contract establishes a repayment value that depends on the future exchange rate and that if there is a negative surprise in the realization of the endowment of traded goods, then the effective exchange rate increases above the expectation formed in the previous period (panel C), diminishing the debt burden.

Figure 5 plots $\tilde{q}_t$ and $\tilde{q}_{free}$, its equivalent without the risk of default, for the median realization of the endowment of the traded goods, to elucidate the pricing of default and market risks, the latter associated with the future exchange rate in case of repayment.

Figure 4: Policy functions for an economy with LC debt

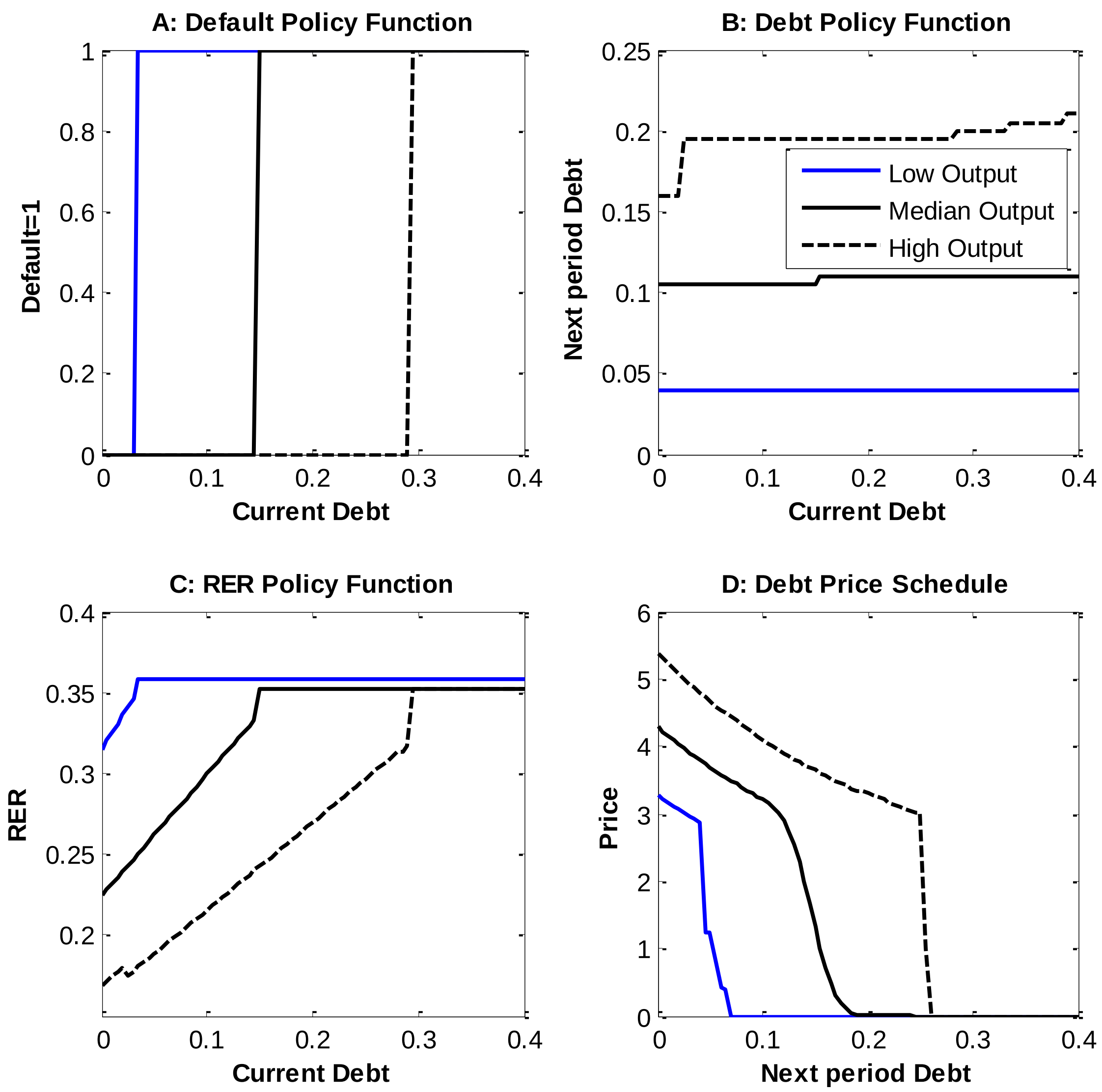
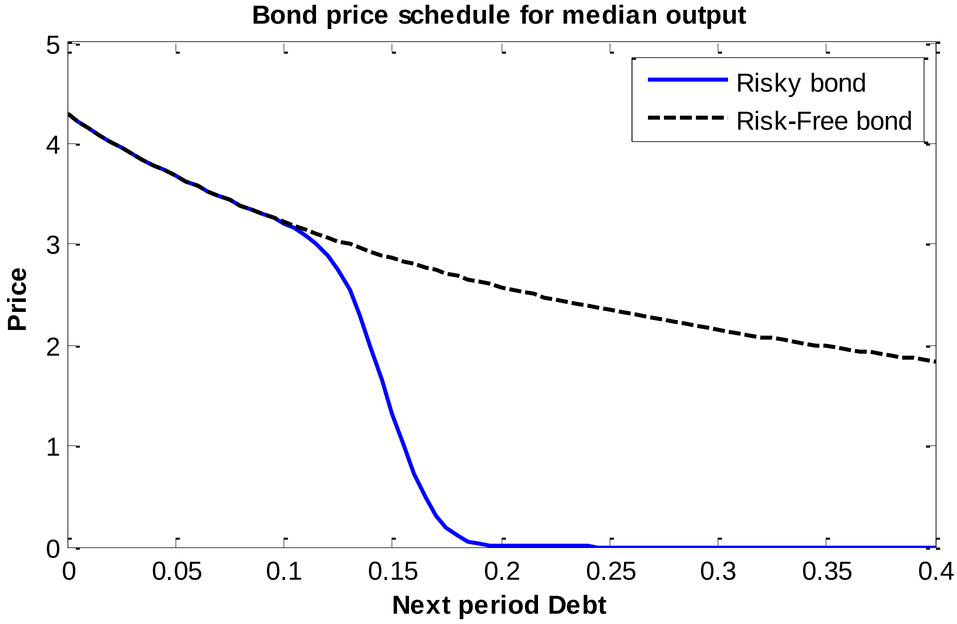


Figure 5: Price of LC debt with and without default risk



5.2. SIMULATION AND WELFARE

Before turning to the simulated moments, I discuss the Brazilian benchmark data present in the two first columns of table 3. The default frequency observed in the period 1970-2006 is 2.8%, but zero since then. For the first period, to be compared to the model with only FC debt, the average unsecured net external debt to GDP ratio is 7%, as explained in the previous section. In column 2, for 2007-2016, since the net external debt (instruments issued abroad mostly in foreign currency) is negative, the debt to GDP ratio shown for the second period, 1.5%, is the average of the participation of foreign lenders in the domestic central government bond market[10] in from 2007 to 2016 (5.2%) multiplied by the previously mentioned haircut rate (29.7%). This value is close to the median of the net external debt position in local currency for the 12 countries in table 1. The risk premium, for both periods, is the EMBI+ index, which measures the default risk for FC debt issued abroad and is available since 1994. Even for the period 2007-2016 I choose to use this variable, since it is a direct measure of credit risk exclusively. Beyond that, the local currency credit spread computed by Du and Schreger (2016a), using yields from US and domestic bonds and exchange rate forward contracts, for 10 emerging countries is 1.45% on average for the period 2005-2014, while the credit spread for foreign currency is only slightly higher, 2.01%. Brazil is the only country for which the risk in LC debt is greater than on FC debt (3.39% and 1.67%) and the authors suggest this might be related to the adoption of capital control measures instead of actual default risk[11]. Since I calibrate the model using the cyclical component of aggregate GDP, I also use data on consumption of both traded and non-traded goods.

[10] This is the main market for debt denominated in local currency for non-residents and data is available for the entire period of interest. Also, Durbin and Ng (2005) point to the high correlation between sovereign and corporate debt spreads.

[11] For more details on the capital control measures adopted in Brazil see Chamon and Garcia (2016) and Alfaro, Chari and Kanczuk (2016).

The exchange rate used is the effective (trade-weighted) real exchange rate obtained from the Central Bank of Brazil and the sample starts in 1988.

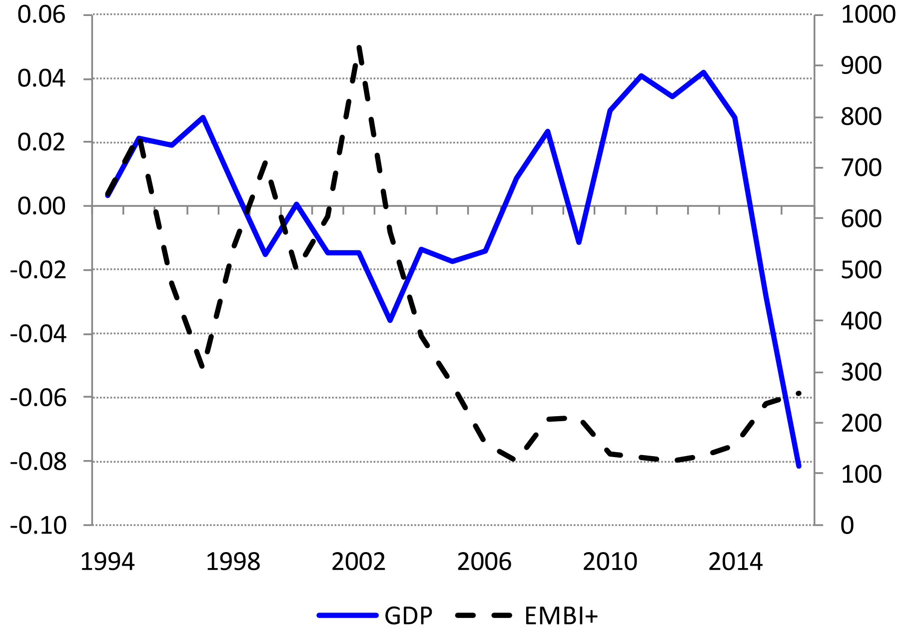
Table 3 - Basic statistics: Data and Model

Variables	Data		Model	
	1971-2006	2007-2016	FC debt	LC debt
	1	2	3	4
	Average			
Default frequency	2.8	-	2.9	1.2
Debt/GDP	7.0	1.5	7.2	8.3
Trade balance	1.5	1.1	1.5	1.3
Default Risk Premium	5.3	1.7	3.4	1.2
	Standard deviation			
Consumption	1.1	1.1	1.6	1.3
Trade balance	2.7	0.9	2.5	1.9
RER	6.7	3.3	1.7	1.4
Default Risk Premium	2.1	0.5	1.1	0.6
	Correlation with Output			
Consumption	0.86	0.96	0.83	0.84
Trade balance	-0.50	-0.61	-0.33	-0.10
RER	-0.41	-0.78	-0.82	-0.84
Default Risk Premium	-0.03	-0.85	-0.59	-0.10
	Welfare change			
Flow equivalent consumption	-	-	-	0.43

Note: Standard deviation for consumption is reported relative to that of output. For the last panel, displaying correlation with output, I use GDP for Brazilian data and endowment of traded goods for simulated data.

I simulate each model economy for 210 thousand periods and remove the first 10 thousand to calculate the statistics. In the economy with FC debt, the simulated average debt and default frequency match their targeted counterparties, and the mean trade balance also fits well the data, but, since the default risk premium is directly linked to the default frequency, the model underestimates the average observed spread. In Brazil, as in most emerging countries, consumption volatility is higher than that of GDP, and the artificial data also exhibits this feature, as usual for this class of model. Correlation with GDP (traded output) is positive for consumption and negative for both the exchange rate and trade balance, as in data. This counter cyclical trade balance reflects that the sovereign issues more debt in good times, when spreads are lower, increasing even more its consumption and generating negative trade balances. Surprisingly, in Brazilian data, the correlation between the default premium and GDP is close to zero between 1994 and 2006. As figure 6 reveals, however, this fact is heavily influenced by an abrupt fall (and possible structural break) in the EMBI+ spread in years 2005 and 2006. If we exclude these two years, the correlation changes from -0.03 to -0.30, a value much closer to what is observed in the full sample (-0.27) and to the stylized fact for emerging markets as a whole. Thus, in general, the model performs well in explaining the Brazilian experience in the era of US dollar denominated external debt.

Figure 6: GDP (LHS) and Credit Default Risk (EMBI+, RHS)



The model with debt denominated in local currency also replicates interesting features of the data. First of all, it suggests decreases in the default frequency, in the mean and standard deviation of both risk premium and trade balance, all in line with the observed in the period. It also generates less volatile exchange rates, as seen in data. The decrease in consumption variance, nonetheless, is not noticed in the decade studied, but might derive from the largest recession faced by Brazil since the Great Depression in the last two years of the sample. Correlation with GDP remains in the appropriate direction for all variables and decreases in absolute terms for risk premium and trade balance, in l in line with the findings of Gumus (2013), but still not observed in the Brazilian economy.

Although the model points to an increase in the average debt level, we observe in Brazil a lower indebtedness. I call attention to three possible explanations for this difference. As already exposed by Alfaro and Kanczuk (2015), Brazil seems to be transitioning between these two regimes, what is supported by increasing share of non-residents in the domestic central government debt market up to the current crisis in Brazil. The second reason is that monetary policy credibility might be partial, and in frameworks with discretionary monetary policy as well as default option (Nuño and Thomas, 2016, Onder and Sunel, 2016), the sustainable level of debt diminishes. The last motive is that, in the current decade, the parameter β, that measures the domestic impatience, might have increased. In the literature of quantitative models of sovereign default this parameter typically is calibrated with values much lower than those used in the business cycles studies, and the customary interpretation is that this might reflect political myopia. Bianchi, Hatchondo and Martinez (2016) use this decrease in political myopia in a model of debt and default as an explanation for the current increase in the accumulation of international reserves in emerging markets. Here this may also serve as a cause of lower debt levels.

To assess welfare gains from changing the denomination of debt, I calculate the flow certainty equivalent consumption for models in columns 3 and 4 using the same procedure as Chatterjee and Eyingungor (2012). I find the value of c that solves equation (18) below, in which $\Pi(y)$ is the invariant distribution of the Markov chain for y. Due to: i) higher debt, in an environment with a local economy less patient than the rest of the world, ii) less frequent costly defaults, and iii) less volatile exchange rates and consumption, I estimate welfare gains from issuing debt in local currency equivalent to an increase of 0.43% of the flow certainty equivalent consumption, larger than suggested Gumus (2013), the only other study attempting to answer this question. Her results point to an increase of only 0.08% in equivalent consumption[12]. My evaluation point to relevant gains, particularly when compared to welfare assessments made in the business cycle literature. Models with discretionary debt and monetary policies present mixed results regarding welfare gains, notably depending on the volatility of the income process (Onder and Sunel, 2016).

$$\frac{c^{1-\sigma}}{(1-\beta)(1-\sigma)} = \sum_y v(y,0)\Pi(y) \qquad (18)$$

5.3. TYPICAL DEFAULT EPISODE

In each panel of figure 7, I plot the median of a variable in a window of seven years centered on all default episodes in the simulated data. As already expected by the inspection of the policy functions, defaults happen in bad times. A novel result is that defaults in the LC case happen only when worse shocks hit the economy, what explains the lower occurrence of evaded payments. Common to both settings is the surprise of the output shock at the default date. For the median case, a sequence of bad shocks is not observed before default, but instead a precipitous negative realization of the endowment occurs.

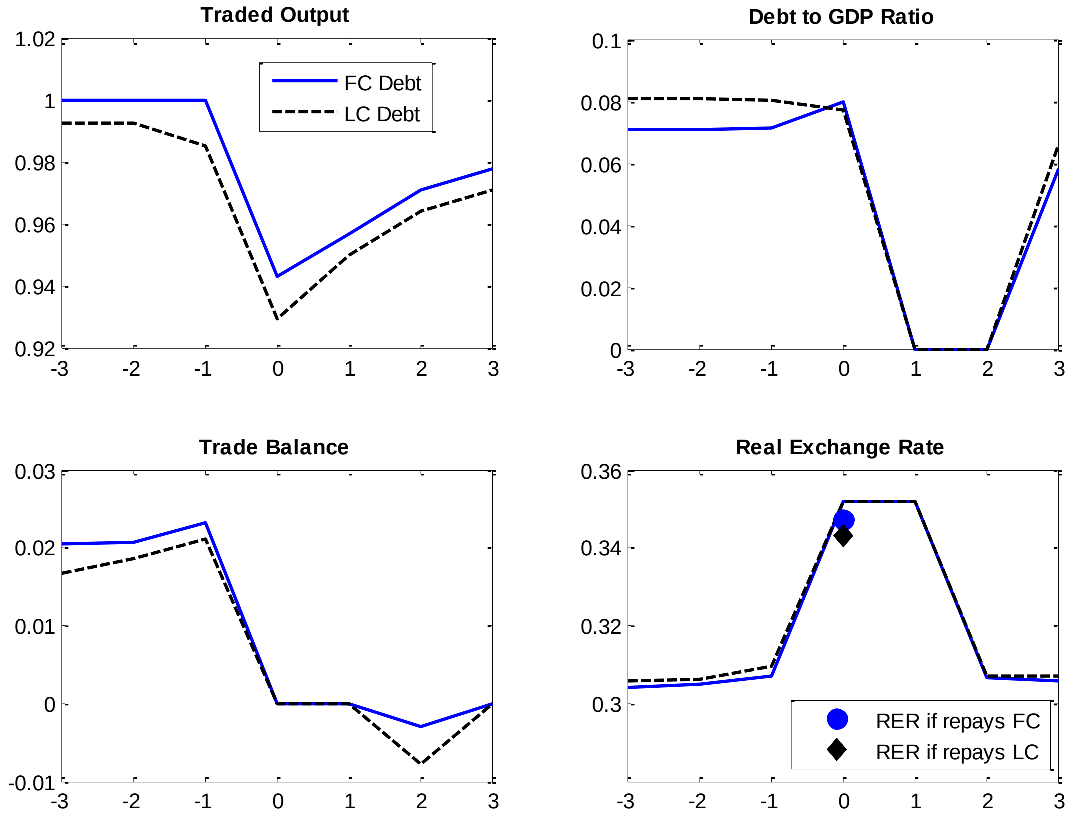
From this second panel it is clear that the country defaults at the moment 0 and remains excluded from markets in the next period, because the starting stock of liabilities is zero at $t = 1$ and $t = 2$. Since output is close to its mean up to one year before default, the debt ratio is remarkably stable in both scenarios. Only in the FC case at the moment of default, the debt to GDP rate increases few points due to the exchange rate increase and its valuation effect, equation (16).

The depreciation of the local currency in both scenarios appears in the last panel of figure 7. Even though defaults happen in the face of worst situations in the LC economy, both cases present

[12] Her original finding is 0.02%, but in a quarterly frequency.

depreciations of similar intensity. While the economy is excluded from markets, the exchange rate remains constant, a direct consequence of the functional form for the direct output cost of default, equation (5). Another specification, as the one use by Na et al (2016) with one extra parameter, could deliver a variable exchange rate even during exclusion periods, when this variable would depend only on the output realization. Considering that the gains from such specification are more relevant in models with long term debt, in which it helps to achieve higher volatilities of the risk premium, I prefer the more parsimonious configuration.

Figure 7 –Default episodes, three years before and after



For the moment of payment delinquency, I also plot the exchange rate that would be chosen if the sovereign had decided to repay. This original result shows that depreciation would occur even if the credit contract had been respected. Note that equation (5) implies that in the median situation the economy consumes $c_t^T = y_t^{T,a} = 0.85$ if in default, but if repayment were chosen, no direct cost of output would be imposed and then $y_t^T = 0.93$. But the debt burden would force a decrease in consumption on traded goods that would be associated with depreciation almost as large as the one accompanying default. Comparing this counterfactual depreciation in the two debt denomination settings, the blue circle and the black diamond, one can infer that a larger increase would occur under the FC case, despite the worst endowment realization in the LC economy.

6. CONCLUSION

Results from the quantitative model of external debt and sovereign default suggest that emerging countries with credible monetary regimes should embrace the opportunity to issue debt denominated in in local currency instead of borrowing in US dollars or Euros. Overcoming the "original sin" allows them to borrow essentially the same amounts and turns costly defaults into tools to be used even more rarely, because debt denominated in local currency already becomes less costly exactly when needed most, during times of unexpected output shocks. Although this new regime also brings less volatile consumption and real exchange rates, the interest rate spread is still counter-cyclical. The Twin D's phenomenon, concomitant default and depreciation of the local currency, also persist under the new circumstances, albeit attenuated.

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