Local debt expansion and vulnerability reduction: an assessment for six crisis-prone countries[1]

Paloma Acevedo, Enrique Alberola and Carmen Broto[2]

1. Introduction

The ratios of public and external debt to GDP constitute crucial indicators in assessing the financial and fiscal vulnerability of a country. On the one hand, high ratios of public debt jeopardise its sustainability and its solvency position. On the other hand, a high proportion of exchange rate exposure in debt composition may abruptly worsen its sustainability in times of financial stress, characterised by problems of access to external markets or by sharp exchange rate movements.

In some emerging markets, external and domestic debt denominated in foreign currency (both henceforth referred to as foreign exchange, or *forex*, debt) have played an important role in the structure of public sector debt because these markets could not issue debt locally or in local currency. This constraint is a phenomenon sometimes referred to in the literature as "the original sin" (Eichengreen and Hausman (1999)). The decreasing trend of public debt over GDP in recent years has been accompanied simultaneously and more intensely in many countries by a decrease in the corresponding share of forex debt and has coincided with a period of widespread appreciation of exchange rates.[3] These countries have therefore seen this evolution as signalling a breakthrough: their financial prospects are improved because their financial vulnerability is reduced.

Our goal in this paper is to assess quantitatively this vulnerability reduction and its reversibility under financial turbulence. We focus on six countries that provide an adequate sample of emerging regions: Brazil, Colombia, Indonesia, Russian Federation, Turkey and Uruguay.

We selected these countries among those undergoing crises in the last decade primarily because of data availability. In addition, they exemplify the generalisation of the downward trend of public and forex debt. We chose quasi-gross public debt as the type of debt to include in our analysis so that we could obtain a homogeneous sample of data across the countries and detect in the data the effect of the accumulation of reserves – which is also a central consideration.[4]

---

[1] The opinions expressed in this document are solely the authors' and do not represent the views of the Banco de España. We would like to thank Jose Montero, Iikka Korhonen and participants in the "CGFS Workshop on Balance Sheet Effects and Emerging Markets Bond Spreads" at the Bank of England (London), the emerging market workshop at the Austrian Central Bank, the BIS-FRB Atlanta Joint Meeting on "Recent Financing Trends in Latin America: a bumpy road towards stability" at Mexico City and the Banco de España for the helpful comments received. The usual disclaimers apply.

[2] Contact authors: paloma.acevedo@bde.es, alberola@bde.es, carmen.broto@bde.es.

[3] See, for instance, Inter-American Development Bank (IADB) (2007) for a recent general view concerning public debt in emerging countries.

[4] The choice among gross debt, net debt and any alternative type of measure of debt is not trivial. As stated in IADB (2007), although many countries provide measures of net debt, netting strategies differ across countries, so net debt does not constitute a homogeneous measure. Furthermore, gross debt does not capture the effect of international reserves. See Cowan et al (2006) or IMF (2003) for alternative debt definitions that are different from quasi-gross public debt.

Because no homogeneous database exists that perfectly suits the period of time and disaggregation required by this research, in all but two cases we collected data directly from the specific debt data releases of official institutions. For Russia and Indonesia we used International Monetary Fund (IMF) data. We decomposed quasi-gross debt into foreign debt (issued in international debt markets) versus local debt (issued in domestic debt markets). We then made a further distinction between local debt linked to the exchange rate and local debt linked to local currency when that distinction was available. Table 1 shows the sources and respective links used to create the database.

Table 1

Database construction

Country	Debt crisis year	Availability of data	Description	Source	Web link
Brazil	2002	1999	General government gross debt[1]	Central Bank of Brazil	www.bcb.gov.br
			Public sector domestic debt[2]	Ministry of Finance	www.stn.fazenda.gov.br/ estatistica/est_divida.asp
Colombia	2003	2001	Public sector debt[1]	Bank of the Republic	www.banrep.gov.co/economia/ deuda/BoletinDePu18.pdf
			National government domestic debt[2]	Ministry of Finance and Public Credit	www.minhacienda.gov.co
Indonesia	2001	2001	Central government gross debt	Art. IV (IMF)	
Russia	1999	1998	Central government gross debt	Art. IV (IMF)	
Turkey	2001	1998	Public sector debt[1]	Turkish Treasury	www.treasury.gov.tr
Uruguay	2003	1999	Public sector debt[1]	Central Bank of Uruguay	www.bcu.gub.uy/autoriza/ pepmaf/deudapublica/dbspg2.xls

[1] Domestic and external debt. [2] Used to calculate the breakdown of domestic public debt.

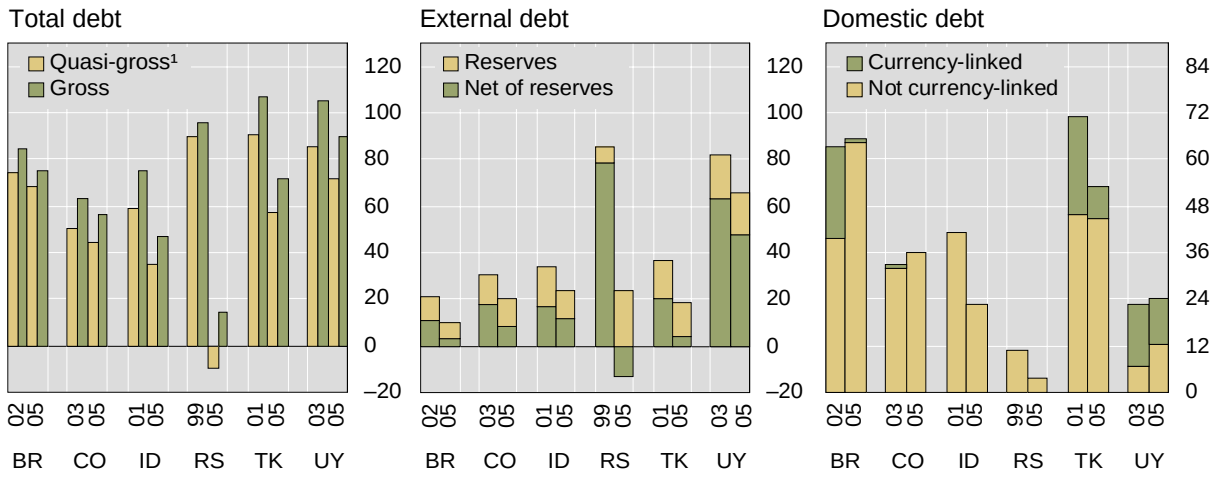
Source: Authors' elaboration.

Figure 1 displays the ratio of public sector debt to GDP for these countries in 2005 and in the year of the highest outstanding debt during the past decade, which in most cases coincides with episodes of financial turmoil (see Manasse and Roubini (2005) or de Bolle et al (2006) for a dating of financial crises). The graph shows both the gross debt holdings and debt net of international reserves (quasi-gross public debt).

Figure 1

Gross and quasi-gross public sector debt, selected countries

As a percentage of GDP



BR = Brazil; CO = Colombia; ID = Indonesia; RS = Russia; TK = Turkey; UY = Uruguay

[1] Domestic debt plus external debt net of international reserves.

Source: See Table 1 for variable definitions and sources.

As Figure 1 shows, Russia had the most significant debt reduction. Quasi-gross public debt within the sample shrank about 99 percentage points (pp) of GDP between 1999 and 2005 to become negative, due to the country's large reserve accumulation.[5] In Turkey and Indonesia, the reduction was 34 pp and 24 pp of GDP, respectively, from 2001 to 2005.[6] Brazil also exemplifies these dynamics: in 2002 its quasi-gross public sector debt was 74% of GDP, whereas in 2005 it decreased to around 68% of GDP. The quasi-gross public sector debt in Uruguay and Colombia fell around 13% and 6%, respectively, from 2003 to 2005. It is remarkable that the reduction in debt has been accompanied by an overall reduction in the share of forex debt (external debt, domestic debt in foreign currency or debt linked to the exchange rate).

Figure 2 clearly shows the reduction of the proportion of forex debt. This figure represents the evolution of the debt composition in terms of external debt, exchange rate-linked domestic debt and domestic debt in local currency for the same periods. The decline in the forex debt share is more dramatic in Brazil, Turkey and Colombia (40%, 28% and 18%, respectively). Also notable is the reduction in exchange rate-linked domestic debt in the two Latin American countries,[7] to the point that exchange rate-linked domestic debt was suppressed in Brazil by 2006. Only in Indonesia did the proportion of external debt increase in the later years.

---

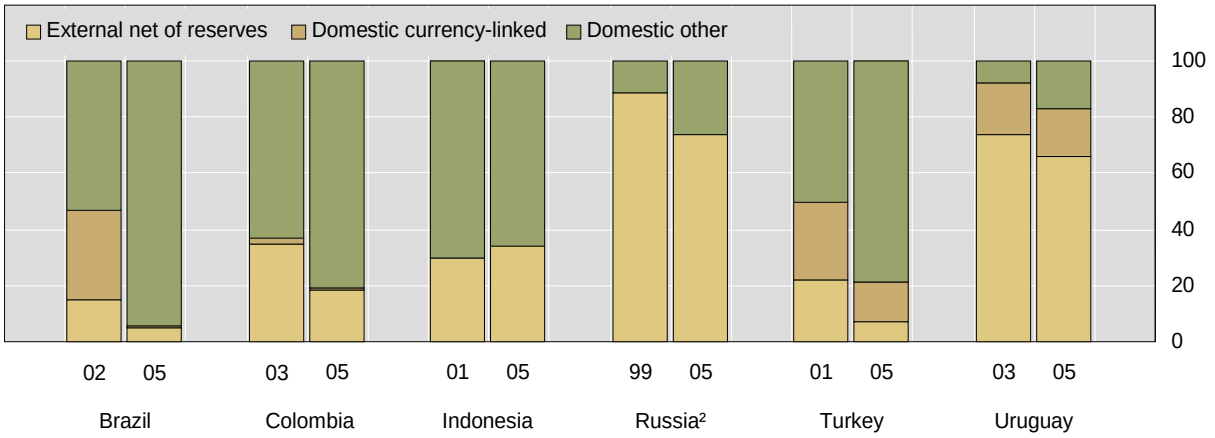
[5] Henceforth, for Russia only, we develop our analysis of public debt in terms of gross public debt rather than quasi-gross public debt. Otherwise, since quasi-gross debt is currently negative, the corresponding results for the rest of the analysis would be misleading.

[6] For Indonesia, the year 2001 is considered to be the previous peak of public debt, mainly because of data availability, although according to other papers (ie de Bolle et al (2006)), the most recent turmoil is traceable back to 1998.

[7] See Jeanneau and Tovar (2006) for a recent discussion of the evolution of domestic markets in Latin America and Tovar (2005) for a detailed analysis of debt denominated in local currency in the three Latin American countries of the sample (Uruguay, Colombia and Brazil).

Figure 2

Quasi-gross public sector debt composition, selected countries[1]



[1] In per cent. [2] Gross public debt used for calculations.

Source: See Table 1 for variable definitions and sources.

There are two categories of explanations for this development of both the public and the forex debt. Figure 3, which shows the evolution of the nominal exchange rate and the sovereign spreads, illustrates the first category: an international context of very favourable financial conditions have influenced public debt considerably. As we shall see, the second category is closely related to the first, i.e. the creation of proactive policies to manage public debt has also been significant.

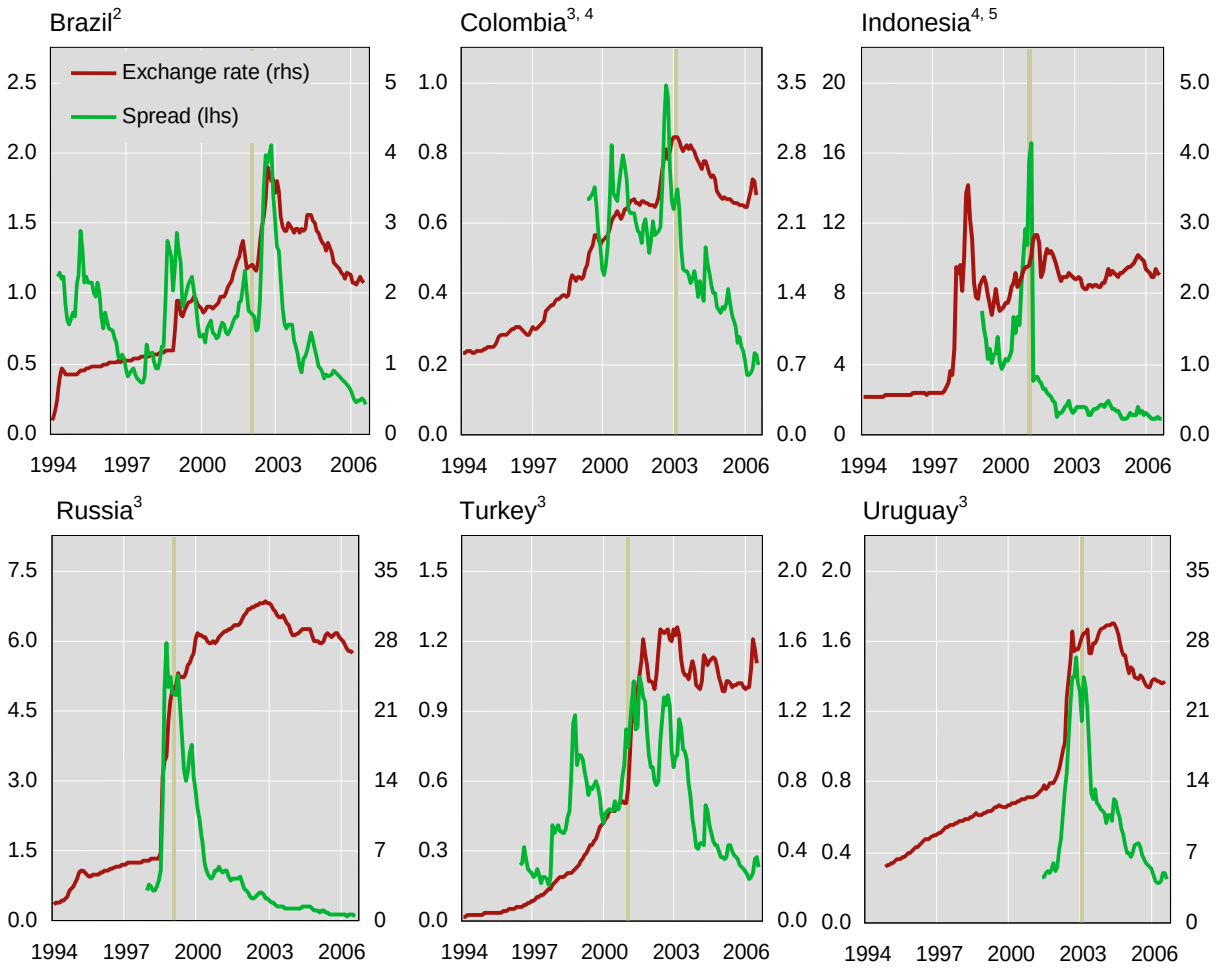
Regarding the favourable international financial context, some aspects are worth qualifying. For instance, just as exchange rate crises make debt explosive in countries with a large share of forex debt, real exchange rate appreciations can dramatically decrease debt ratios and have an impact on the structure of debt. This is precisely what happened after the crises. The exchange rate recoveries were generalised, as shown in the real exchange rate evolutions in Figure 4. The appreciation of the Russian rouble (a 64% real appreciation between 1999 and 2005), the Turkish lira (a 44% real appreciation between 2001 and 2005) and the Brazilian real (26% between 2002 and 2005) were the most significant. The Indonesian rupee is the only currency of the sample that depreciated from 2003 to 2005 (6%) – precisely the only country where the share of forex debt increased. The positive period for emerging financial markets is also confirmed by the dynamics of sovereign spreads that have narrowed in a context of increasing capital flows. In this sense, the EMBI Global Composite decreased around 900 basis points from January 1999 to October 2006, and this reduction of sovereign spreads was especially severe in emerging Europe, where in the same period it narrowed around 2000 basis points.

Another factor contributing to this benign financial framework is the favourable behaviour of the GDP growth rates in all emerging regions in the context of propitious world growth. For instance, the annual percent change of growth in 2005 for such emerging regions as developing Asia, Central and Eastern Europe and Latin America was 9.0%, 5.4% and 4.3% – well above the 2.6% rate of growth for advanced economies in 2005 and higher or similar to world growth (4.9%) (see IMF (2006)).

As for the proactive debt management factor, the evolution of public and forex debt is closely related to the development of local debt markets in local currency. Fiscal authorities began to attach increasing importance to reducing in a sustainable manner the vulnerability of public finances, and began to create more proactive debt policies to manage public debt in this direction. They had learned their lesson from past experience, when excessive exchange rate exposure gave rise to balance sheet mismatches.

Figure 3

Sovereign spreads and exchange rates in crisis episodes, selected countries[1]



Note: Dates of crisis episodes considered: Brazil (2002); Colombia and Uruguay (2003); Indonesia and Turkey (2001); and Russian Federation (1999).

[1] National currency per US dollar and spreads in thousands of basis points. [2] EMBI + index. [3] MBI Global Index. [4] Exchange rate in thousands of units per US dollar. [5] ABI index.

Source: Datastream.

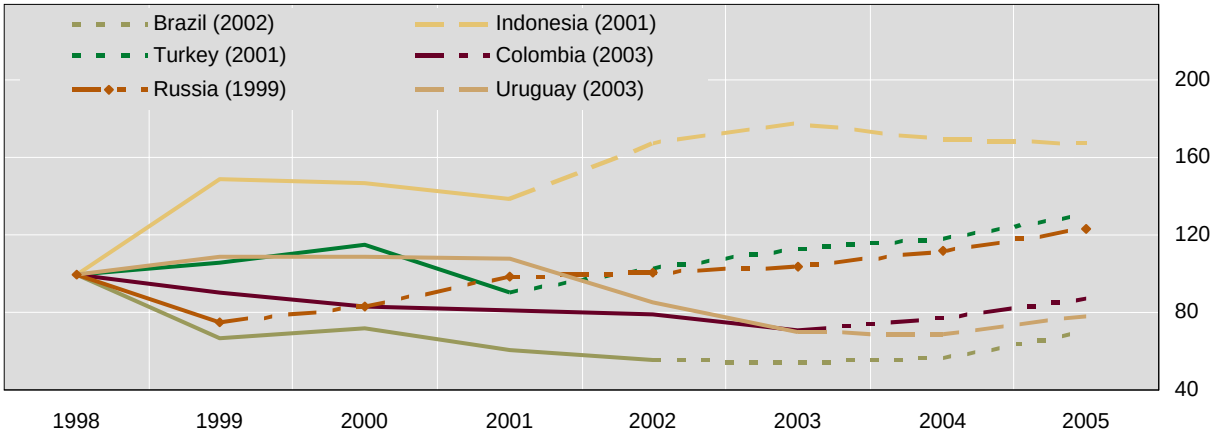
The link between benign conditions and proactive policies derives from another factor. The favourable financial conditions and the expected behaviour of the exchange rate, which increased the relative demand for local debt and the ability of the authorities to place it on the market, also encouraged authorities to make discretionary changes to the debt composition.

Interestingly, the conjunction of these two factors has created a paradox worth mentioning. In an environment of currency appreciation, authorities trying to maximise debt reduction in the short term have an incentive to maintain or increase the share of forex debt, as this would decrease public debt as a percentage of GDP, leading to some sort of "virtuous circle". Conversely, a reduction of forex debt as a result of active debt management tends to mitigate debt reduction driven by exchange rate appreciation. Contingent on financial turbulence, however, this "paradox of the local debt bias" can be solved. In such a case, the exchange

rate should sharply depreciate and, if there has previously been a reduction in the proportion of forex debt in total debt, then the country is better able to absorb the impact of the negative scenario. The comparison between the short-term costs of debt reduction and the long-term (contingent) benefits is one of the by-products of our analysis.[8]

Figure 4

Real exchange rates, selected countries[1]



Note: Year of major outstanding debt in brackets; dotted line thereafter.

[1] 1998 = 100.

Source: Economist Intelligence Unit.

For our analysis, we develop a quantitative approach to assess the effective vulnerability reduction in the debt composition and the precise contribution of proactive debt management. First, in the next section, we disentangle the contribution of the exchange rate to the shifts in debt structure from other autonomous or genuine composition effects in the structure of debt. Following that, we develop a theoretical framework of debt dynamics analysis, and then perform a counterfactual exercise based on calculating public debt dynamics under the previous debt structure. In this way we can assess the change in vulnerability based on the difference in percentage points of GDP between the actual debt and the debt resulting from this counterfactual exercise. Then, we replicate the previous crisis scenario of economic and financial turbulence for the period 2006–08 and perform a stress test analysis of debt sustainability. We also use alternative criteria to design the stress as a test of robustness. Finally, we summarise our findings.

2. Public debt composition: disentangling price and composition effects

This section focuses on setting a framework for analysis of the effects of the shifts in forex debt (the sum of external and domestic exchange rate-indexed debt) on total public debt. The share of forex debt, α_t is defined as

[8] In this paper, we focus on the sustainability-vulnerability assessment concerning the exchange rate-linked debt. We do not address other topics on debt composition – such as long-term versus short-term debt or nominal versus indexed debt – even though there is intense debate on these issues. See, for instance, Alfaro and Kanczuk (2006).

$$\alpha_t = \frac{e_t D_t^*}{(D_t + e_t D_t^*)} \quad (1)$$

where e_t is the nominal exchange rate in the period *t*, D_t^* is the amount of outstanding forex debt, either external debt or exchange rate-linked domestic debt, denominated in dollars in *t*, and D_t is the outstanding domestic debt denominated in local currency in period *t*.[9]

Within this framework, it is rather straightforward to evaluate the importance of the effect of the exchange rate and the effect due to the composition of debt on the total variation in composition. The total variation of the ratios of forex debt to total debt between the final (t = 1) and the initial (t = 0) periods of reference, that is, ($\alpha_1 - \alpha_0$), can be decomposed in these two effects, as follows:

$$\alpha_1 - \alpha_0 = EE + CE + \varepsilon \quad (2)$$

where the first part of the right-hand side of (2) (EE) is the exchange rate effect and CE is the composition effect. The residual term ε in the expression will be allocated between both effects, as we explain below.

EE is the variation in the proportion of external debt. It is indexed to a foreign currency domestic debt resulting from variations in the exchange rate obtained by keeping the amount of debt unaltered. Analytically:

$$EE = \frac{e_1 D_0^*}{D_0 + e_1 D_0^*} - \alpha_0 \quad (3)$$

where the first element in the right-hand side of EE will be denoted as α_1^E.

CE is the variation of α due to the changes in the relative volumes of the different types of debt, had the exchange rate not changed:

$$CE = \frac{e_0 D_1^*}{D_1 + e_0 D_1^*} - \alpha_0 \quad (4)$$

where, analogously to (3), the first element in the right-hand side of (4) will be denoted as α_1^C.

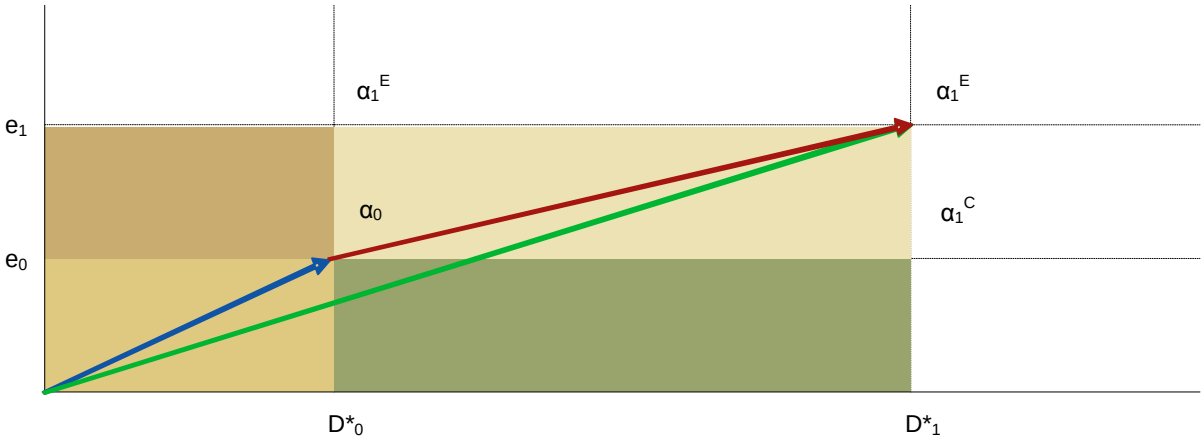
In this last type of effect, the effect of proactive management policies arises, although other factors, such as the relative demand and supply of debt instruments, may also be prominent.

The allocation of the residual change to each factor is made according to the scheme in Figure 5. Notice that the whole variation in the forex debt share (that is, $\alpha_1 - \alpha_0$) is the area defined by coordinates $e_1 D_1^*$ minus $e_0 D_0^*$ (the area shadowed with vertical lines). EE as stated in the previous notation would be the area comprising $\alpha_1^E - \alpha_0$ and CE would be $\alpha_1^C - \alpha_0$ (the yellow and green shaded areas, respectively). The remaining area should be equally distributed between EE and CE in order to accurately represent the difference between the vectors α_1 and α_0.

[9] See Calvo et al (2002) for a pioneering analysis of fiscal sustainability incorporating the currency composition of debt.

Figure 5

Public debt decomposition

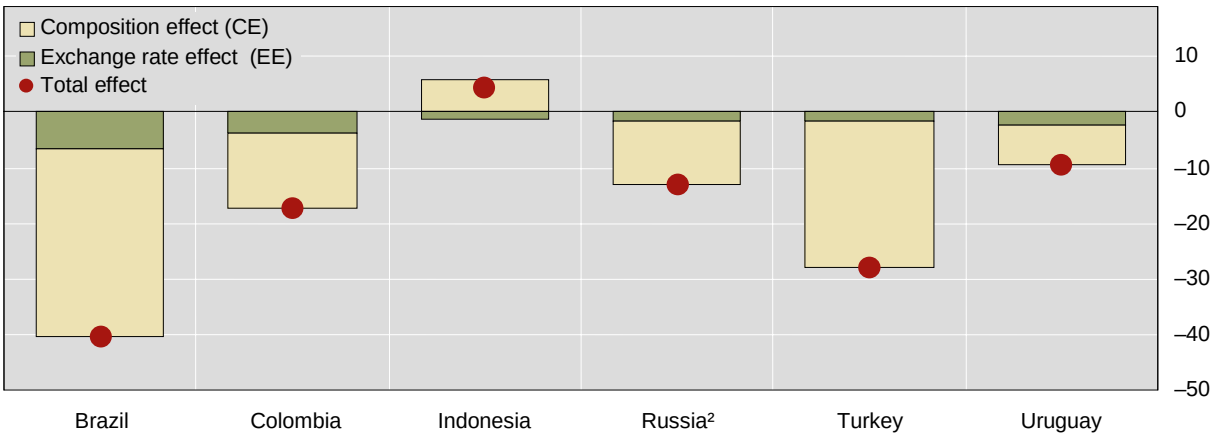


Source: Authors' elaboration.

The factorial decomposition of EE and CE is represented in Figure 6 for the six countries in terms of the percentage points that each factor has contributed to the reduction in the share of foreign currency debt, considering that t = 1 is 2005 and t = 0 is the year of the corresponding debt crisis for each country. We use as reference for this exercise the public debt net of reserves (quasi-gross public debt), except for Russia, where such magnitude is negative.

Figure 6

Exchange rate effect and composition effect, selected countries[1]



[1] Variation of the ratios of forex debt to total quasi-gross public debt between the crisis episode and the year 2005, in per cent. [2] Gross public debt used for calculations.

Source: Authors' calculations based on national data.

Despite the strong exchange rate appreciation, CE dominates in all countries but Indonesia, where it contributes to the increase in the share of forex debt. In absolute terms, CE is largest in Brazil: 34% of the 40% reduction in the forex debt share is due to CE. However, in relative terms, it is even more significant in Turkey: 26% of the 28% reduction is CE – in other words, more than 90% of the reduction is due to CE. For the average of the five countries where the share of foreign currency debt is reduced, 85% of the reduction can be attributed to the pure composition effect.

3. The framework of analysis: debt dynamics

Public debt sustainability analysis (DSA) is an increasingly widespread tool used to assess the vulnerability position of public finances. In recent years, more attention has been paid to this approach in policy analysis, most notably in IMF country assessments. A growing number of papers also employ DSA – sometimes from a stochastic approach (eg see Celasun et al (2006), Hostland and Karan (2005) or Garcia and Rigobon (2004)). Apart from its simplicity, the main advantage of this methodology for our objectives is that it can provide an explicit measure of vulnerability that can be traced over time and is well-suited to the stress test analysis.

DSA focuses on the debt dynamics equations that are determined, in a simplified framework, by a rather limited number of variables. Furthermore, forecasts for most of these variables are readily available on the market. These forecasts allow us to establish a baseline scenario for the future evolution of debt. The framework is also useful for visualizing how debt would respond to a situation of stress by changing the forecasts using estimates of the variables under negative shocks. These stress tests compound alternative scenarios; this gives an idea of the resilience of debt and therefore of the vulnerability of the public finance position.

The starting point is the debt dynamics equation expressed as:

$$D_t = -PB_t + \frac{(1+r_t)}{(1+g_t)}(1-\alpha_t)D_{t-1} + \frac{(1+r_t^*)(1+\Delta e_t)}{(1+g_t)}\alpha_t D_{t-1}, \quad (5)$$

where PB_t is the primary balance and D_t is the stock of public debt at the end of time t, both expressed as a ratio of GDP. The share of debt denominated in foreign exchange is α_t, as we already know, while $(1–\alpha_t)$ is the share of local currency debt; r^*_t and r_t are their corresponding real interest rates. Foreign-denominated external debt can be in foreign currency (mostly external debt) or indexed to the exchange rate (mostly domestic debt). Finally, Δe_t is the variation in the nominal exchange rate, where a positive Δe_t means an exchange rate depreciation and g_t is the real rate of growth.

After some algebra, the dynamics of public debt can be expressed as

$$\Delta D_t = -PB_t + \frac{(r_t - g_t)}{(1+g_t)}(1-\alpha_t)D_{t-1} + \frac{(r_t^* + \Delta e_t + r_t^*\Delta e_t)}{(1+g_t)}\alpha_t D_{t-1}, \quad (6)$$

where, for simplicity, we have dropped the contingent liabilities. This equation is the basis for the sustainability exercises performed in the DSA. Given the current level and composition of debt, for given forecasts of the primary balance, the growth rate, the nominal exchange rate and the real interest rates (domestic and foreign), it is possible to project debt trajectories. Increases in the ratio of debt to GDP derived from these exercises provide a measure of vulnerability, and a decrease in the ratio suggests a reduction in vulnerability.

Expression (6) can be transformed in a more convenient way by separating the effect of the exchange rate from the rest:

$$\Delta D_t = -PB_t + \frac{((1-\alpha_t)r_t + \alpha_t r_t^*)}{(1+g_t)}D_{t-1} - \frac{g_t}{(1+g_t)}(1-\alpha_t)D_{t-1} + \frac{\Delta e_t + r_t^*\Delta e_t}{(1+g_t)}\alpha_t D_{t-1}. \quad (7)$$

For practical purposes, it is important to note that the real interest rates by instrument or currency are not usually available, so that we have to find a way to measure the approximate real cost of local and forex debt. Data exist on interest payments on public debt: IP_t, which can be defined as

$$IP_t = ((1-\alpha_t)r_t + \alpha_t(1+\Delta e_t)r_t^*)D_{t-1} = \rho_t D_{t-1}, \quad (8)$$

where, for convenience, ρ_t denotes the average cost of debt at time t. ρ_t can be calculated in every country through the data of IP_t expressed as:

$$\rho_t = \frac{IP_t}{D_{t-1}} \tag{9}$$

For completeness and further convenience, also note that the implicit local debt real rate can be solved from the definition of r_t:

$$r_t = \frac{\rho_t - \alpha_t(1+\Delta e_t)r_t^*}{(1-\alpha_t)}. \tag{10}$$

so that if we are able to proxy for the real foreign cost of debt – through the spread, as it turns out – we derive an approximation of the respective real interest rate by country.

Substituting ρ_t in (7) yields the basic equation for the empirical approach:

$$\Delta D_t = -PB_t + [\rho_t - (1-\alpha_t)g_t + \Delta e_t \alpha_t]\frac{D_{t-1}}{(1+g_t)}. \tag{11}$$

4. Empirics: debt evolution, debt structure and vulnerability reductions

These expressions provide us with an adequate framework to analyse what has been going on in the countries under consideration here. It is convenient to start with an illustrative example of how the different factors impinge on the evolution of debt and then move to a more detailed analysis of the impact of the shifts in debt structure on vulnerability.

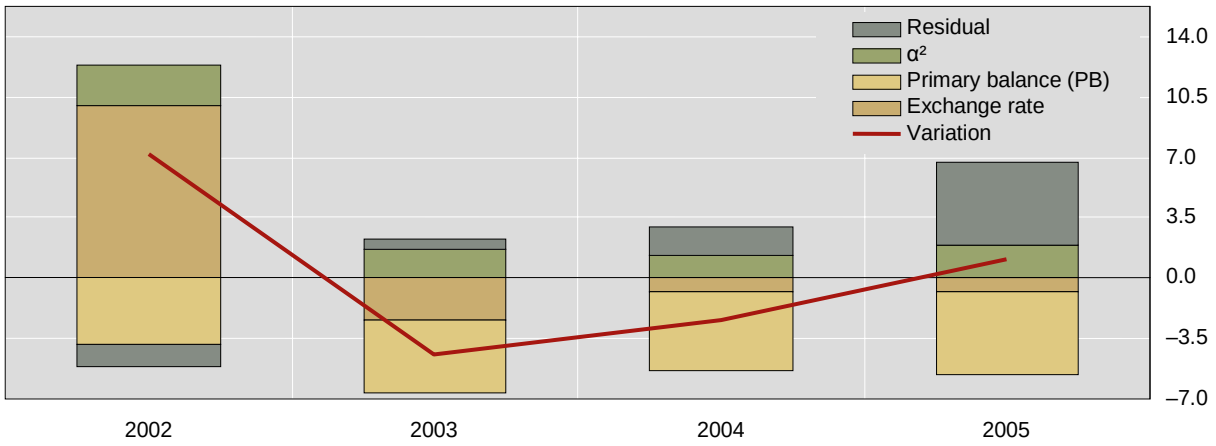
4.1 Contributions to debt reduction

Computing the partial derivatives in expression (5) allows us to determine the contribution of each factor to the variation of D_t (ΔD_t) on an annual basis. To focus on the issues we are more interested in, we consider the decomposition of the annual variation of D_t in terms of PB_t (in this case, there is a one-to-one relationship), and the annual variation of the share of forex debt in total public debt (α_t), the exchange rate (e_t) and, for the sake of simplicity, the remaining contributions (interest rates and rates of growth) are aggregated in a residual.

Figure 7 illustrates the case of Brazil. The substantial magnitude of the primary balance is a powerful debt reduction driver throughout the period. However, the more interesting results are the interaction between the exchange rate and the share of forex debt α_t. From 2001 to 2002, the currency depreciated, and there was an important positive contribution to debt of 9 pp of GDP. Thereafter, the appreciation of the exchange rate induced a negative contribution to public debt in GDP. The cumulative decrease in GDP from 2002 to 2005 was 4%. In parallel, α_t increased in the first, turbulent period. Owing to the contemporaneous exchange rate depreciation, this variable added 3 pp to the debt-to-GDP ratio (the green area in Figure 7). Both factors together (α_t and exchange rate) amounted to a 12 pp increase in debt in 2002. However, in the following years, the interaction of currency appreciation and reduction in forex debt had a different result: the contribution of the dwindling share of forex debt is positive because it mitigates the effect of the exchange rate appreciation on debt reduction. Finally, the residual picks up the combined contribution of interest rates, growth plus other adjustments.

Figure 7

Annual variation of public debt in GDP by term contributions in Brazil[1]



[1] As a percentage of GDP. [2] Share of forex debt in total debt, in per cent.

Source: Authors' calculations based on national data.

4.2 A counterfactual exercise: debt reductions without proactive management policies

The Brazilian example highlights the fact that the interaction between exchange rate appreciations and reductions in the forex share can work against debt reduction. This is the "paradox of the local debt bias" that we pointed out in the introduction. But we also noted later that the changes in debt structure (see Figure 6) are in part mechanically driven by the evolution of the exchange rate. In fact, we showed that a substantial part of the reduction in forex debt was not due to the exchange rate evolutions but rather to pure composition effects, in which the proactive debt management policies of the authorities have had a central role.

Now, within the debt dynamics framework, we can give a quantitative assessment of the (negative) impact of proactive debt management on debt reduction. The question is straightforward: what would the level of debt be today, netting out the composition effect – that is, looking at it without proactive debt management?

Obtaining the computations of α_1^E as stated in (3) on a yearly basis, we can determine counterfactual debt paths for the public debt ratio. Figure 8 shows the results of this exercise as carried out for all six countries. The blue line represents the actual public debt trajectory. Netting out the pure composition effect delivers the path represented by the green line. The graph is completed with the opposite exercise, shown by the red line. In this case, we consider the pure composition effect but assume that the impact brought about by the exchange rate evolutions disappears – that is, we assume this to be the current debt level, had the real exchange rate been kept constant.

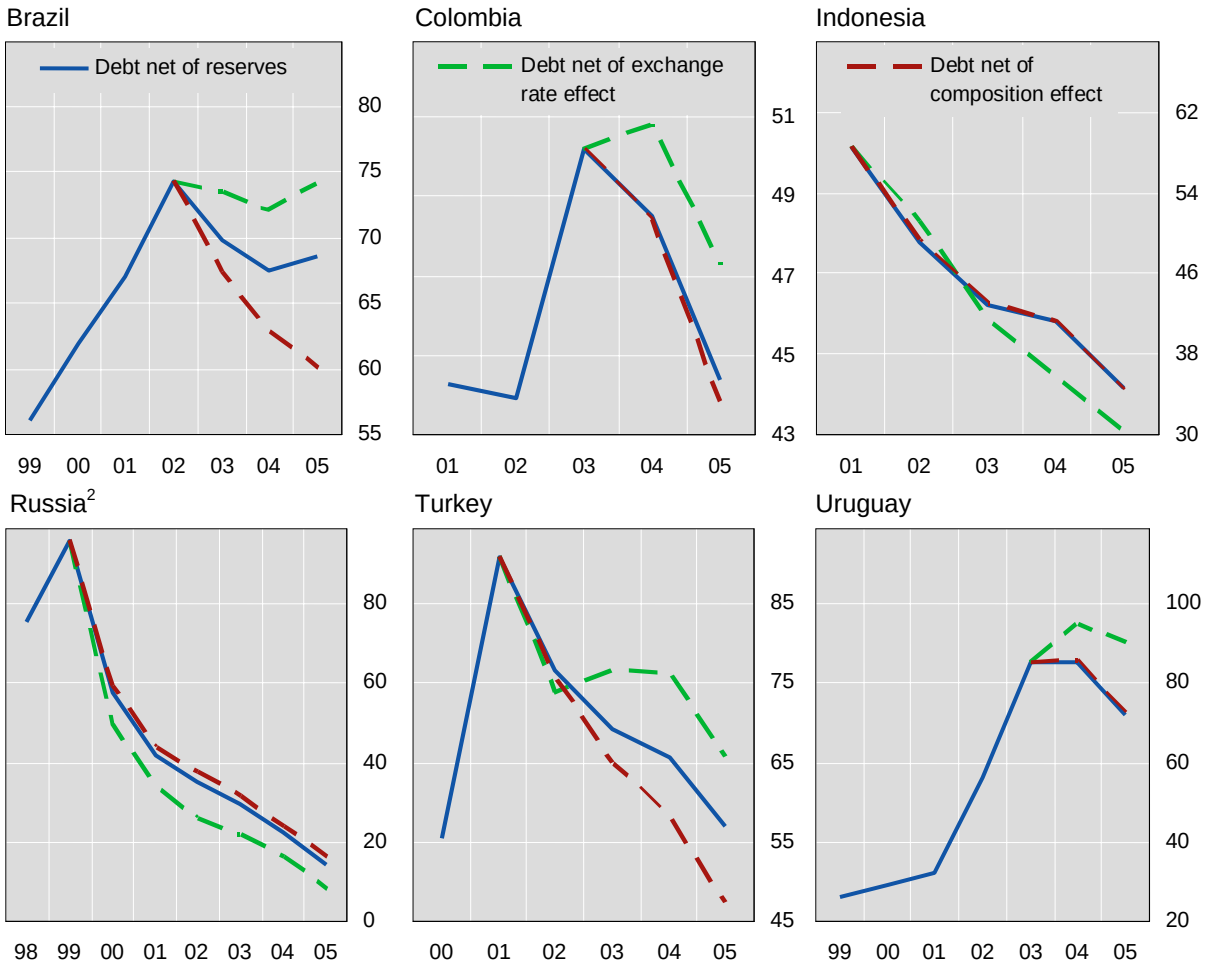
Table 2 summarises the outcomes of the counterfactual exercise for the six countries. In the case of Brazil, the actual path displays debt falling from 74% to 68% of GDP. However, this decrease is actually much greater, around 60% in 2005, when we net out the pure composition effect. The reason for this difference is that the dwindling forex debt does not fully capitalise the impact of the real exchange rate appreciation. To sum up for Brazil, the implicit loss, in terms of percentage points of debt to GDP, derived from proactive debt management would mean that the level of debt would now be a sizeable 8 pp of GDP. This can be taken as a measure of the opportunity costs of substituting local debt in local currency

for forex debt. On the contrary, if the nominal exchange rate had remained at the 2002 levels, the quasi-gross public debt in 2005 would have been around 79% of GDP.

Figure 8

Actual vs counterfactual debt evolution, selected countries[1]

As a percentage of GDP



[1] Public debt net of reserves (quasi-gross debt). [2] Gross public debt used for calculations.

Source: Authors' calculations based on national data.

In Turkey, these proactive policies have also been quite pronounced. There, netting the change in composition due to the government's debt management means that the public debt in 2005 would be 10 pp of GDP less. In the rest of the countries where the reduction in the share of forex debt in total public debt has been relatively small or has not taken place (ie Colombia, Indonesia, Russian Federation and Uruguay), the difference between the actual path of public debt and the public debt under constant composition of the year of crisis is also small (this difference represents less than 1 pp of the GDP of each country).

Brazil and Turkey are clear examples of where the "opportunity costs" of diminishing the share of forex debt in total public debt are more evident, due to both the intense exchange rate appreciations and the efforts by the fiscal authorities to recompose debt in favour of local and local currency-denominated debt.

Table 2

Counterfactual exercise results for 2005

Counterfactual (2005)	Brazil	Colombia	Indonesia	Russia	Turkey	Uruguay
Public debt net of reserves/GDP	68.5%	44.4%	34.6%	14.5%	57.1%	71.9%
Debt/GDP net of exchange rate effect	74.0%	47.3%	30.4%	54.6%	65.7%	90.3%
Debt/GDP net of composition effect	60.0%	43.8%	34.4%	14.7%	47.3%	72.3%
Points of debt/GDP due to composition effect	5.5	2.9	–4.2	40.1	8.6	18.4
Points of debt/GDP due to exchange rate effect	–8.5	–0.5	–0.2	0.2	–9.7	0.5

Source: Authors' calculations.

Some important caveats, however, give a more nuanced view of the opportunity costs of moving out of forex debt. Most important is that this is a partial exercise. We are assuming that nothing else changes, but this is quite an assumption. As mentioned above, fiscal authorities could not have developed the local debt markets as swiftly under more stringent financial conditions. More importantly, the very same evolution of the exchange rate is not far from the evolution of debt composition; the reduction in external debt, a process deepened by very active policies in Brazil, shapes the expectation of agents and has probably contributed to a greater pressure on the exchange rate and fostered a higher accumulation of reserves (and thus a bigger reduction of quasi-gross debt).

From the second type of exercise, where the exchange rate is kept unaltered, some interesting conclusions also follow. As expected, the numbers show that debt dynamics would have been much less favourable under the exchange rates of the year of crises for the six countries – except for Indonesia and Russia, where the nominal exchange rate has appreciated with respect to their years of crises. The more damaged country in terms of maintaining the same nominal exchange rate would have been Uruguay, which would have increased its debt 18 pp of GDP.

All in all, under the perspective taken in this section, it might seem that proactive policies to reduce the share of forex debt in total GDP have entailed costs in terms of limited debt reduction. Nevertheless, this short-term cost must be balanced with the prospective benefits derived from a less forex-dependent debt structure in cases of financial turbulence.

4.3 Stress test: resilience in debt vulnerability

The standard DSA framework based on stress testing consists of designing a situation of turbulence (or stress) comparable to the most recent crises to determine whether vulnerability has effectively been reduced and then contrasting it with a baseline scenario.

The first step, then, is to define the baseline scenario. With forecasts from the IMF's Article IV reports for the countries under study (2003–2006) and *LatinFocus Consensus Forecast* (2006) over a three-year horizon (2006, 2007 and 2008), we obtained the raw data to project the debt paths.

This methodology is useful for improving the homogeneity of the analysis and for comparing the different outcomes with those provided by the IMF. Next, we designed the stress

scenario to replicate the most recent financial turmoil experienced by these countries – coinciding, as we showed above, with the previous peak in debt. Table 3 displays the data underlying the baseline and the stress scenarios. The changes therein are applied to all variables in debt dynamics equation (5).[10]

Table 3

Baseline scenario and stress scenario for the simulation of debt dynamics

In per cent

	Baseline scenario				Stress scenario			
	2005	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Brazil								
Exchange rate[1]	–12.2	–4.3	3.6	0.0	–12.2	50.3	7.9	18.5
Real GDP growth	2.3	3.5	4.0	3.5	2.3	–0.8	–0.3	3.3
GDP deflator	7.2	4.0	4.2	4.4	7.2	7.5	7.7	7.9
Interest rate (i)[2]	13.5	14.3	12.9	12.4	13.5	14.9	15.5	12.3
Interest rate (i*)[3]	7.5	7.5	7.5	7.5	7.5	11.6	11.6	11.6
Primary balance[4]	4.8	4.3	4.3	4.2	4.8	0.0	3.2	3.5
Implicit liabilities[4, 5]	–0.5	3.0	3.0	0.0	–0.5	3.0	3.0	0.0
Colombia								
Exchange rate[1]	–5.4	6.5	3.4	0.0	–5.4	24.0	–2.6	–13.3
Real GDP growth	5.2	5.2	4.5	4.0	5.2	2.3	–2.4	4.7
GDP deflator	5.5	4.7	4.1	3.5	5.5	5.3	7.4	6.4
Interest rate (i)[2]	8.6	12.2	11.6	10.2	8.6	13.1	12.7	11.2
Interest rate (i*)[3]	6.8	6.8	6.8	6.8	6.8	8.8	8.8	8.8
Primary balance[4]	3.5	3.1	2.4	2.2	3.5	0.9	0.9	–0.3
Implicit liabilities[4, 5]	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Indonesia								
Exchange rate[1]	6.0	0.0	0.0	0.0	6.0	15.6	–3.1	2.2
Real GDP growth	5.6	5.2	6.0	6.5	5.6	4.5	4.9	5.7
GDP deflator	13.7	13.2	6.5	6.5	13.7	16.7	6.0	4.4
Interest rate (i)[2]	6.1	5.7	5.5	5.7	6.1	–3.1	3.4	5.6
Interest rate (i*)[3]	7.4	7.4	7.4	7.4	7.4	25.8	16.6	7.4
Primary balance[4]	2.2	1.2	1.3	1.1	2.2	0.4	0.5	0.3
Implicit liabilities[4, 5]	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0

For footnotes, see the end of the table.

[10] In those isolated cases with no data available for the period of crisis, we obtained the negative shock by adding to the data in the baseline scenario one standard deviation of the available data.

Table 3 (cont)

Baseline scenario and stress scenario for the simulation of debt dynamics

In per cent

	Baseline scenario				Stress scenario			
	2005	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Russia								
Exchange rate[1]	–1.8	0.0	0.0	0.0	–1.8	153.3	14.4	3.7
Real GDP growth	6.4	6.5	6.5	6.1	6.4	–0.3	11.4	15.0
GDP deflator	19.6	15.6	8.9	6.2	19.6	32.5	27.8	25.1
Interest rate (i)[2]	7.7	10.8	9.2	17.4	7.7	38.8	19.9	22.8
Interest rate (i*)[3]	5.6	5.6	5.6	5.6	5.6	23.5	13.9	7.6
Primary balance[4]	9.2	10.0	8.7	7.8	9.2	–3.6	2.9	7.5
Implicit liabilities[4, 5]	–0.5	3.0	3.0	0.0	0.0	0.0	0.0	0.0
Turkey								
Exchange rate[1]	0.7	0.0	0.0	0.0	0.7	116.4	13.1	–14.6
Real GDP growth	7.4	5.0	5.0	5.0	7.4	–7.4	8.0	5.9
GDP deflator	5.4	7.0	5.0	5.0	5.4	26.8	42.2	56.8
Interest rate (i)[2]	24.6	22.9	22.2	22.4	24.6	90.1	112.4	122.9
Interest rate (i*)[3]	6.6	6.6	6.6	6.6	6.6	9.5	9.5	9.5
Primary balance[4]	6.5	6.5	6.5	6.5	6.5	5.5	5.5	5.5
Implicit liabilities[4, 5]	–0.5	3.0	3.0	0.0	–0.5	3.0	3.0	0.0
Uruguay								
Exchange rate[1]	–10.2	2.7	2.8	0.0	–10.2	84.2	7.8	–9.9
Real GDP growth	6.6	4.6	4.2	2.8	6.6	–1.1	0.2	1.2
GDP deflator	1.7	5.1	3.8	4.0	1.7	15.0	14.8	3.8
Interest rate (i)[2]	–6.9	6.5	6.3	8.6	–6.9	9.9	9.5	19.8
Interest rate (i*)[3]	7.4	7.4	7.4	7.4	7.4	15.0	15.0	15.0
Primary balance[4]	3.9	3.7	4.0	4.0	3.9	0.1	2.7	3.8
Implicit liabilities[4, 5]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

[1] Variation of national currency per US dollar. [2] Nominal domestic interest rate. [3] Nominal external interest rate. [4] As a percentage of GDP. [5] Recognition of implicit or contingent liabilities.

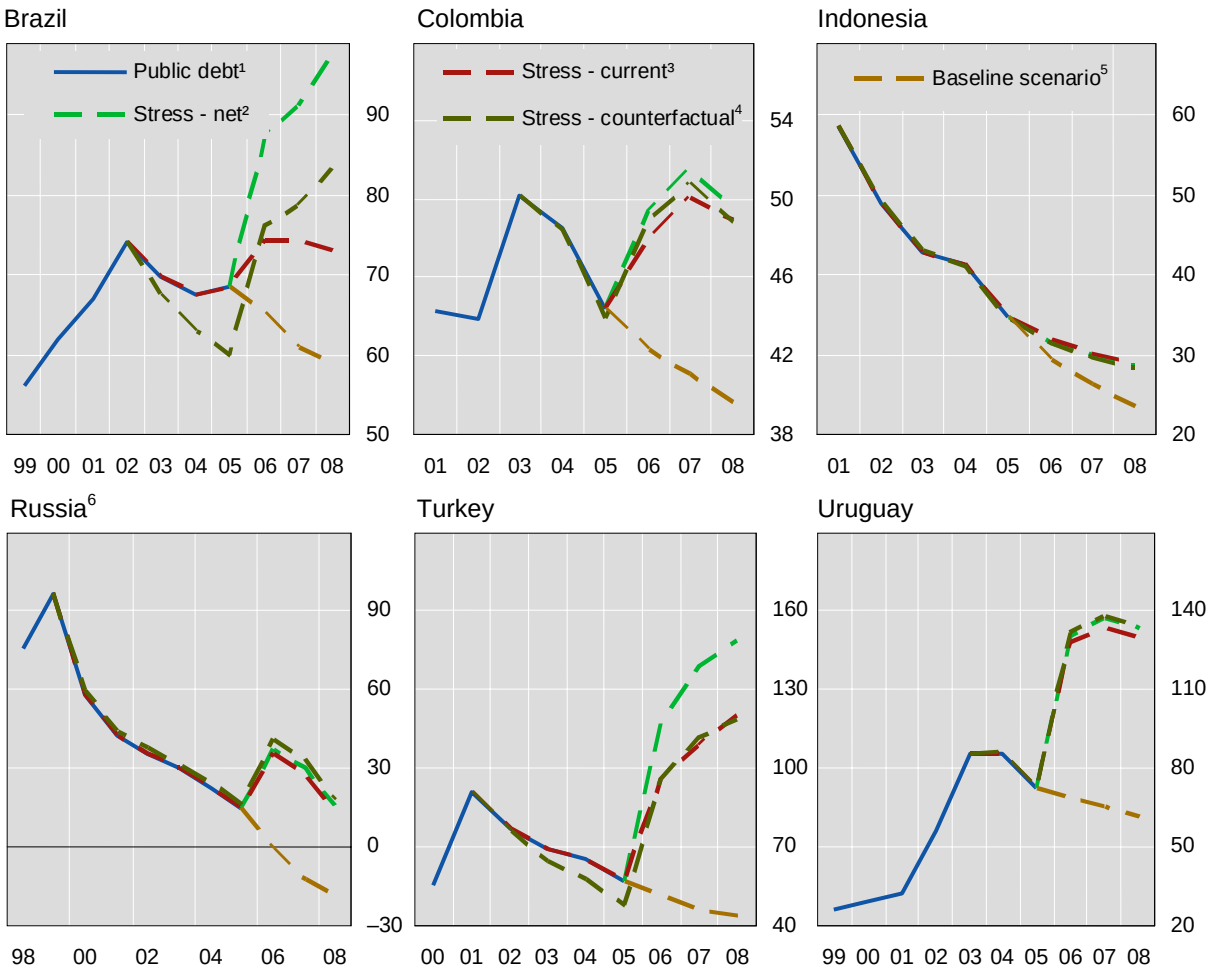
Source: Authors' calculations based on IMF data.

Figure 9 and Table 4 present the results. Looking again at Brazil as illustrative, the blue dotted line represents the baseline scenario and the orange dotted line stands for debt dynamics under the stress scenario. Both debt evolutions employed the path of α under debt composition for the year 2005. As expected under the baseline scenario – conveying the continuation of favourable conditions – quasi-gross debt gradually decreases towards 60% of GDP, while debt increases under the stress scenario and then stabilises above 70%.

Figure 9

Baseline and stress scenarios, selected countries

As a percentage of GDP



[1] Public debt net of reserves (quasi-gross debt). [2] Stress with debt composition net of composition effect. [3] Stress with current debt composition. [4] Stress under counterfactual debt composition, defined as the year of major outstanding debt as it appears in Figure 1. [5] Current structure. [6] Gross public debt used for calculations.

Source: Authors' calculations based on national data.

What would the impact of the turmoil have been if the debt structure had been kept unaltered relative to the year of crisis? The red line provides a first, but inadequate, approximation. It represents the impact of the stress test with the debt structure net of the pure CE (but leaving EE operating) and starting from the current level of debt (2005). Notice that the evolution is much more explosive under the current debt structure. Had debt management not been proactive,[11] the increase would have been much larger (to over 95%), as the red line shows, setting the debt on an explosive path. The gap between both lines – more than 20 pp of GDP over a three-year horizon – is indicative of the importance of a less forex-exposed debt structure.

[11] To be more precise, the 2002 debt composition permits the exchange rate to affect the structure but nets out the pure composition effect.

Table 4

Comparison of stress scenarios

	Brazil				Colombia				Indonesia			
	2005	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Baseline scenario[1]	0.69	0.65	0.61	0.59	0.44	0.42	0.41	0.40	0.35	0.29	0.26	0.24
Replica												
Under current structure	0.69	0.74	0.74	0.73	0.44	0.48	0.50	0.49	0.35	0.32	0.30	0.29
Under counterfactual	0.60	0.76	0.79	0.83	0.44	0.49	0.51	0.49	0.34	0.31	0.30	0.28
Gap[2]	–0.09	0.02	0.04	0.10	–0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00
Two standard deviations												
Under current structure	0.69	0.73	0.69	0.68	0.44	0.48	0.50	0.53	0.35	0.29	0.23	0.19
Under counterfactual	0.60	0.76	0.74	0.73	0.44	0.50	0.52	0.55	0.34	0.28	0.23	0.19
Gap[2]	–0.09	0.04	0.04	0.05	–0.01	0.01	0.02	0.02	0.00	0.00	0.00	0.00
Aggregated stress												
Under current structure	0.69	0.81	0.84	0.83	0.44	0.55	0.54	0.51	0.35	0.43	0.37	0.29
Under counterfactual	0.60	0.89	0.95	0.93	0.44	0.59	0.59	0.56	0.34	0.41	0.35	0.28
Gap[2]	–0.09	0.08	0.11	0.10	–0.01	0.04	0.05	0.05	0.00	–0.02	–0.02	–0.02

For footnotes, see the end of the table.

Table 4 (cont)

Comparison of stress scenarios

	Russia				Turkey				Uruguay			
	2005	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**	**2005**	**2006**	**2007**	**2008**
Baseline scenario[1]	0.15	–0.01	–0.12	–0.20	0.57	0.52	0.46	0.44	0.72	0.68	0.65	0.62
Replica												
Under current structure	0.15	0.35	0.28	0.13	0.57	0.96	1.09	1.20	0.72	1.27	1.33	1.30
Under counterfactual	0.16	0.41	0.33	0.18	0.47	0.95	1.11	1.18	0.72	1.31	1.37	1.34
Gap[2]	0.02	0.06	0.05	0.04	–0.10	0.00	0.03	–0.01	0.00	0.04	0.05	0.04
Two standard deviations												
Under current structure	0.15	0.18	0.09	–0.01	0.57	0.82	1.18	1.77	0.72	0.93	1.01	1.09
Under counterfactual	0.16	0.21	0.11	0.00	0.47	0.69	0.99	1.47	0.72	0.95	1.03	1.11
Gap[2]	0.02	0.03	0.02	0.01	–0.10	–0.13	–0.19	–0.30	0.00	0.02	0.02	0.03
Aggregated stress												
Under current structure	0.15	0.25	0.18	0.06	0.57	0.72	0.69	0.12	0.72	1.18	1.14	0.98
Under counterfactual	0.16	0.29	0.22	0.09	0.47	0.68	0.66	0.11	0.72	1.21	1.18	1.01
Gap[2]	0.02	0.04	0.03	0.03	–0.10	–0.04	–0.03	–0.01	0.00	0.03	0.04	0.03

[1] Under current debt composition. [2] Represents the difference between stress under 2002 debt composition (counterfactual) and stress under current debt composition.

Source: Authors' calculations based on national data.

Why is the red line misleading? We have seen in the counterfactual exercise that netting out pure composition effects would have resulted in a lower debt ratio in the case of Brazil, owing to the sustained real exchange rate appreciation. Thus, we have to compare the effective lower reduction in debt due to the proactive debt management policies to the prospective gains during a financial crisis. More precisely, the green line represents the debt dynamics assuming no pure composition effect – as in the red line – plus the level of debt resulting from the counterfactual exercise. This, in our view, is the right gauge to measure vulnerability reduction due to proactive debt management. In practical terms, this amounts to taking the end-point of the green line as a reference and projecting it forward under the stress scenario.

The green line thus extended has a path similar to the red line, but it starts from a lower level. Consequently, the difference in the debt ratio is very small in the first year, and then widens to around 10 pp of GDP. We can take this figure as the net gain from Brazil's debt management policy. In other words, the short-term costs of implementing proactive policies in order to decrease the share of forex debt in total debt are more than compensated for by the long-term gains of implementing them.

For the other five countries, the forecasts under the baseline scenario are as follows. Colombia, Turkey and Uruguay decrease their debt towards 40%, 45% and 60% of GDP, respectively (blue line). Despite the evolution of its currency and the composition of its debt, Indonesia also reduces its debt to 25% of GDP. Finally, the forecast for Russia is especially favourable, as the gross debt decreases sharply to 25% of GDP – that is, not only is quasi-gross debt negative, but so is gross debt.

We can employ the stress scenario for the remaining countries in the same manner, although the results are less clear. Recall that the more interesting conclusions derive from comparison of the evolution of debt under the debt composition of the year of crisis (green line) and under the debt composition of 2005 (orange line). The comparison favours debt recomposition only in Russia, where the debt level is not currently a problem, and in Uruguay, to a lesser extent than in Brazil (see Table 4). Nevertheless, in some countries, such as Colombia, the benefit of the proactive policies implemented until 2005 gives rise to a scant average decrease in debt of 1 pp of GDP accumulated in the forecasted period. In the case of Turkey the accumulated differences after three years are negative (–1 pp GDP), although they were previously positive. In the case of Indonesia, the gap is negligible throughout the forecast scenario.

It is important to keep in mind here the caveats we mentioned above because the direct inference from these results is that, except for Brazil, debt recomposition efforts do not seem to pay off in terms of vulnerability reduction under stress. Again, we base these caveats on the impact of these debt trajectories on expectations. It is difficult to assume that the reaction of the markets would be the same comparing the mild deterioration implied by the orange line with the sharp increase in debt under a less favourable debt structure. As a consequence, the evolution of the financial variables is reasonably expected to be worse in the second case. This endogeneity implies that the computation of net gains is a floor rather than a midpoint estimate.

To check the robustness of the stress test, we repeat the exercise, considering two alternative assumptions for the design of the stress scenarios. First, following the methodology employed in most of the IMF's Article IV, we add two standard deviations from the sample series to the corresponding data of the baseline scenario, denoted as 2SD.[12] Second, we build a scenario on the average stress scenario (average stress, for short) for each variable of the six countries based on the historical criterion of the previous subsection.

[12] Two standard deviations from the sample of each variable from the year of crisis to 2005 are added to each variable from 2006 to 2008 (both inclusive).

Table 4 shows the outcomes corresponding to these two new criteria. The results in general are quite robust under the three different alternatives, in terms of both the size of the shock and the direction vis-à-vis the two new stress scenarios designed. Indonesia and Turkey are the exceptions. For Indonesia, the exercise is not robust under the assumption of average stress, as public debt to GDP is lower under the stress scenario than under the baseline scenario. For Turkey, the gap between the stress under the debt structure of the year of crisis – that is, the counterfactual scenario – and the stress under the debt structure of 2005 becomes negative, implying less resilience to a negative shock. For the other simulations, the results are almost the same and, in some cases – such as the results of the scenario based on averages for Colombia – show a lower debt under the current composition than under the previous composition.

5. Conclusions

In this paper, we have evaluated the impact of the shift of public debt away from foreign currency on the vulnerability of a group of selected emerging countries, which not so long ago underwent deep financial turbulence.

We first emphasised that the ratio of public debt to GDP and, even more dramatically, the share of forex debt have been reduced in these emerging markets in a context of favourable financial conditions. Exchange rate appreciations helped to reduce both ratios. However, the proactive debt management of fiscal authorities – aimed at reducing the vulnerability of the debt composition – has been the dominant factor in quantitative terms in most of these countries. Clearly, a favourable external environment and exchange rate evolutions have facilitated this process, since expected exchange rate appreciation favours issuing debt in domestic currency. The development of local debt markets has both benefited from and facilitated this proactive debt management.

The changes in debt structure are expected to have important implications for the reduction of financial vulnerability in public finances. However, our approach to this issue has uncovered a paradox related to the recent bias towards local debt. By reducing forex debt through proactive policies, governments have not taken full advantage of the real exchange appreciation enjoyed by their economies after the crises. Otherwise, the debt ratios in the analysed countries would have been lower than they are currently – and the difference is sizeable in certain cases.

This opportunity cost underscores the dramatic shift in debt management strategies in most of these countries. In the past, governments used periods of benign external financial conditions to issue external debt, usually beyond what would be advisable and prudent from a fiscal point of view, and have thus set the stage for future financial problems and crises. They are now prepared to refrain from this temptation and even to dismiss part of the impact of the exchange rate appreciation on the debt ratios in the short term in order to strengthen their underlying financial position. This change in strategy thus contributes to a structural reinforcement of public finances and helps countries redeem themselves from the “original sin.”

Fiscal authorities and analysts must take into account this short-term “opportunity cost” of shifting towards local debt so that they can assess the net benefits of proactive debt management policies. The stress tests suggest that even after controlling for these short-term costs, there is a reduction in vulnerability derived from the proactive shift towards local debt, measured in most cases by the difference in the ratio of debt to GDP in a situation of stress, although the magnitude in ratio for some of the countries analysed is small.

In interpreting the results, we have to take into account some qualifications. First, there is an important caveat that reinforces these results. Built into this exercise is a central assumption: the evolution of the variables that drive the debt-to-GDP ratio is independent of the ratio or

structure of debt. However, the behaviour of the financial variables is very much influenced by perceptions of debt vulnerability, a situation that is true both in the counterfactual and in the stress tests. More precisely, with a higher share of forex debt, the exchange rate appreciations would presumably have been lower in the later years and the deterioration of the financial variables in the stress test would have been higher. Another qualification is that the probability of turbulence is expected to increase under a debt structure very sensitive to financial volatility. These caveats taken together imply that the estimated reduction in vulnerability is a minimum boundary, and therefore that the effective vulnerability reduction is higher.

On the whole, we showed that the move to local debt is positive in terms of vulnerability reduction. This finding can be considered an important breakthrough in emerging markets and used to improve their resilience in the face of eventual financial shocks as well as to reduce the shocks' occurrence.

References

Alfaro, L and F Kanczuk (2006): *Sovereign debt: Indexation and maturity*, Inter-American Development Bank (IADB) Working Paper no 560.

De Bolle, M, B Rother and I Hakobyan (2006): *The level and composition of public sector debt in emerging market crises*, IMF Working Paper 06/186.

Calvo, G, A Izquierdo and E Talvi (2002): *Sudden stops, the real exchange rate and fiscal sustainability: Argentina's lessons*, NBER Working Paper 9828.

Celasun, O, X Debrun and J Ostry (2006): *Primary surplus behaviour and risks to fiscal sustainability in emerging market countries: a "fan-chart" approach*, IMF Working Paper 06/67.

Cowan, K, E Levy-Yeyati, U Panizza and F Sturzenegger (2006): *Sovereign debt in the Americas: new data and stylized facts*, IADB Working Paper no 577.

Eichengreen, B and R Hausmann (1999): "Exchange rates and financial fragility", in Federal Reserve Bank of Kansas City (ed.), *New Challenges for Monetary Policy*, pp 329–68.

García, M and R Rigobon (2004): *A risk management approach to emerging markets' sovereign debt sustainability with an application to Brazilian data*, NBER Working Paper series no 10336.

Hostland, D and P Karam (2005): *Assessing debt sustainability in emerging market economies using stochastic simulation methods*, IMF Working Paper 05/226.

Inter-American Development Bank (IADB) (2006): "Living with debt. How to limit the risks of sovereign finance", in E. Borensztein, E. Levy and U. Panizza (coords), *Economic and social progress in Latin America: 2007 report*.

International Monetary Fund (IMF) (2003): *External debt statistics: Guide for compilers and users*, June.

——— (2003–2006): Article IV Staff Country Reports, various, www.imf.org.

——— (2006): *World Economic Outlook (Financial Systems and Economic Cycles)*, September.

LatinFocus Consensus Forecast (2006), July.

Jeanneau, S and C Tovar (2006): "Domestic bond markets in Latin America: achievements and challenges", *BIS Quarterly Review*, June.

Manasse, P and N Roubini (2005): *"Rules of thumb" for sovereign debt crises*, IMF Working Paper 05/42.

Tovar, C (2005): "International government debt denominated in local currency: recent developments in Latin America", *BIS Quarterly Review*, December.