

How much is too much?
The fiscal space in emerging market economies

Gustavo Ganiko, Karl Melgarejo y Carlos Montoro

Secretaría Técnica del Consejo Fiscal del Perú

Documento de Investigación N° 002-2016
Serie de Documentos de Investigación
Noviembre 2016

Los puntos de vista expresados en este documento de trabajo corresponden a los autores y no reflejan necesariamente la posición del Consejo Fiscal del Perú.

The views expressed in this paper are those of the authors and do not reflect necessarily the position of the Fiscal Council of Peru.

Documento de Investigación N° 002-2016
Serie de Documentos de Investigación
Noviembre 2016

Los puntos de vista expresados en este documento de trabajo corresponden a los autores y no reflejan necesariamente la posición del Consejo Fiscal del Perú.

The views expressed in this paper are those of the authors and do not reflect necessarily the position of the Fiscal Council of Peru.

How much is too much?

The fiscal space in emerging market economies [†]

Gustavo Ganiko
Fiscal Council of Peru

Karl Melgarejo
Fiscal Council of Peru

Carlos Montoro
Fiscal Council of Peru and
Central Reserve Bank of Peru

November 25, 2016

Abstract

How much fiscal space do emerging market economies have to maintain expansive fiscal policies? This is a key question given the observed increase in public debt since 2007. To answer this question we estimate a debt limit for emerging market economies, from which the public debt to GDP ratio would have an explosive trajectory, in the spirit of Ghosh, Kim, Mendoza, Ostry and Qureshi (2013). For this, we estimate the determinants of the public debt ratio dynamics, the primary balance and the effective cost of debt, for 26 emerging market economies during the 2000-2015 period. We propose an alternative measure, the stochastic debt limit, which takes into account the uncertainty and sensitivity of the debt limit to macroeconomic and financial conditions. The main results are: i) There is evidence of “fiscal fatigue”, namely the loss of control of the debt growth via fiscal adjustments as the debt ratio increases; ii) the debt ratio is an important determinant of the effective cost of public debt; and iii) the debt limit as traditional measured (deterministic) is between 68-97 percentage points of GDP, and between 5-89 percentage points for the stochastic case, which gives evidence of limited fiscal space for the majority of the economies analyzed.

JEL classification: E62, H63, H62

Key words: fiscal policy, fiscal sustainability, fiscal space.

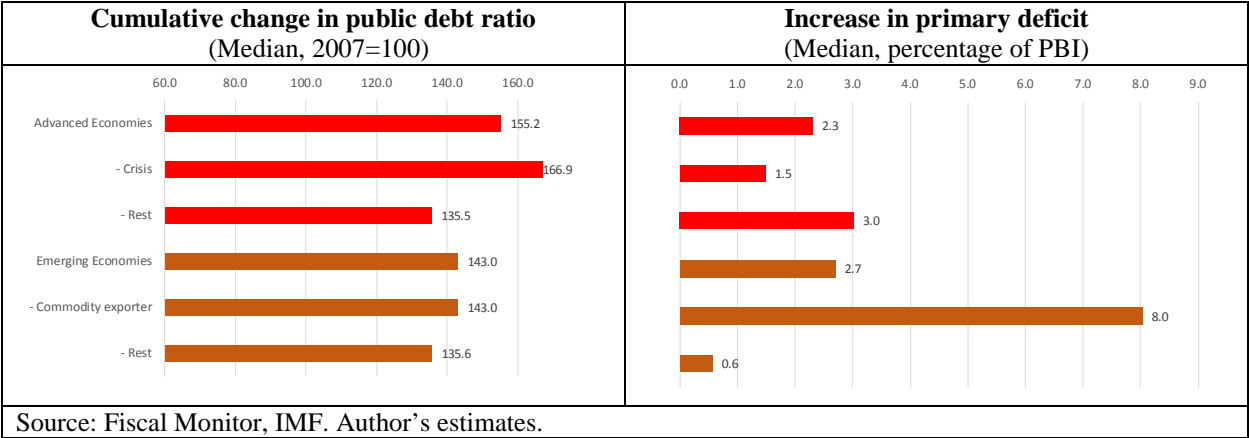
[†] The views expressed in this article are those of the authors and do not necessarily reflect those of the Fiscal Council of Peru. An earlier version of this paper has been published as working paper in Spanish under the title: “Estimación del espacio fiscal en economías emergentes: el caso peruano”, available at www.cf.gob.pe. We thank comments from Paul Castillo, Nikita Cespedes, Claudia Cooper, Javier Escobal, Waldo Mendoza, Eduardo Moreno, Carolina Trivelli, Marco Vega, Richard Webb and participants of the Research Seminar of the Central Reserve Bank of Peru and Ministry of Economy and Finance of Peru, the 2016 Peruvian Economy Association Conference and the 2016 Central Reserve Bank of Peru Annual Research Conference.

^a Corresponding author. Email: carlos.montoro@cf.gob.pe , carlos.montoro@bcpr.gob.pe.

1. Introduction

Since 2007 public debt levels have increased significantly, both in advanced and emerging market economies. We show in graph 1 that the public debt ratio to Gross Domestic Product (GDP) (the debt ratio hereinafter) has increased by 55 and 43 percent for the median of advanced and emerging market economies, respectively, being the advanced economies that had a financial crisis those with a larger increase in debt ratios (67 percent). In the same period, primary deficits have also increased, especially in commodity-producing emerging market economies, mainly due to the impact of the commodity prices fall on fiscal revenues.

Graph 1: general government public debt and primary balance: 2015 vs. 2007



In this context of higher debt ratios and growing deficits some questions are key: How much fiscal space (if any) do emerging market economies have to maintain expansive fiscal policies? Which conditions affect this fiscal space? Are the paths of public debt in emerging market economies sustainable? To answer these questions, we estimate a debt ratio threshold (the debt limit) above which the accumulation of public debt would have a negative impact on the economy.

There are mainly three approaches to estimate this kind of public debt threshold. The first is associated to debt sustainability, the second takes into account the relationship between public debt and economic growth, and the third examines the incidence in a debt crisis. In the first approach a debt ratio threshold is estimated from which the dynamics of the public debt becomes explosive. For this, we analyze the determinants of the dynamics of the debt ratio: the primary balance and the financing costs (adjusted by economic growth). In particular, under this approach the debt ratio is sustainable if the response of the primary balance to increases in debt is greater than the adjusted interest rate growth (Bohn 1998). Ghosh et al (2013) propose this methodology and estimate a debt limit between 150 and 200 percentage points of GDP for a sample of advanced economies. They

also find that for some advanced economies, such as Greece, Italy, Japan and Portugal, the debt limit is not defined, which means that the paths of the debt ratio are explosive. Other authors such as Zandi et al (2011), Fournier and Fall (2015) and Pommier (2015) have used this methodology to estimate the debt limit for other samples of advanced economies.

In the second approach, a threshold of public debt is estimated above which there is a negative effect on economic growth. On the one hand, public debt can stimulate aggregate demand in the short run, but after a certain level it may discourage investment due to the fear of higher taxes to finance the debt service (debt overhang), or because it limits the funds available for public investment, or due to greater uncertainty about economic policies, (Clements et al, 2003; and Greenidge et al, 2012). Pattillo et al (2002) found that the average impact of public debt on per capita growth is negative from debt ratios around 35 to 40 percent for a sample of developing countries. Cecchetti et al (2011) and Reinhart and Rogoff (2010) found that debt ratios above 85-90 percent have negative effects on growth¹.

The third approach takes into account the impact of public debt on the likelihood of a debt crises. Detragiache and Spilimbergo (2001) and IMF (2002) found that the probability of debt default increases when the ratio of external debt is above 40 percent. Similarly, Mendoza and Oviedo (2009) and IMF (2008) found thresholds of 25 and 35 percent, respectively, for total debt.

In the first approach, Ghosh et al (2013) estimate a fiscal reaction function to capture the responsiveness of the primary balance to increases in debt. The authors found that this reaction function in advanced economies exhibits the phenomenon of "fiscal fatigue": the government's ability to control debt growth through increases in the primary balance diminishes as the debt ratio exceeds a certain level. This can be explained by the restrictions that governments may face to impose higher taxes as well as the inability to perform spending cuts. The intersection of the fiscal reaction function with a financing costs curve defines the debt limit, above which the trajectory of the debt ratio is explosive. Fiscal space is defined as the difference between the debt limit and the debt ratio.

The Bank for International Settlements (BIS, 2016) has emphasized the importance of estimating the fiscal space under this methodology and the limitations of this approach: estimates of debt limits are subject to a considerable degree of uncertainty and these limits are sensitive to economic and financial conditions in the countries, which can change abruptly. For this reason, the BIS recommends that "*the debt limits should not be interpreted as boundaries that can be safely*

¹ Cecchetti et al (2010) estimated an 85 percent of GDP threshold for a sample of 18 OECD countries for the 1980-2010 period. Reinhart y Rogoff (2010) found a 90 percent of GDP threshold for a sample of 44 countries, both develop and developing economies, using data for around 200 years.

tested"². For this reason a prudent fiscal policy should establish mechanisms to maintain a debt level away from this limit³. It is also worth mentioning that the debt limit, as defined by this methodology, takes into account an extreme event: the limit from which the debt would follow an explosive trajectory. Policymakers could take into account other factors to define their own debt limits, such as the impact of debt accumulation on financing costs or on the sovereign debt rating.

In this paper we adapt the framework proposed by Ghosh et al (2013) to estimate the debt limit in a sample of 26 emerging market economies. For this, we take into account the following characteristics of these economies: i) the commodity dependence of the fiscal accounts; ii) the sensitivity of financing costs to the debt ratio and to external conditions, such as the volatility of global financial markets and risk-free international interest rate; iii) the fact that emerging market economies are mainly financed in foreign currency, so the exchange rate is an important determinant factor of financing costs; iv) the uncertainty and sensitivity of the estimates of the debt limit. In particular, we propose the estimation of a stochastic debt limit that captures the uncertainty and sensitivity to macroeconomic and financial conditions, taking into account the main criticisms to previous studies based on this approach.

The main results are the following: a) the primary balance responds positively (but decreasingly) to the debt ratio, which is evidence of fiscal fatigue; b) the debt ratio is an important determinant of the financing costs of public debt; c) the debt limit as traditionally measured (deterministic) is between 68-97 percentage points of the GDP, and between 5-89 percentage points of the GDP for the stochastic case, which gives evidence of limited fiscal space for most of the emerging market economies analyzed, values that are below the estimated range for advanced economies; d) the estimated fiscal space for China and Peru are the highest in our sample, whilst the estimated for Turkey is the lowest; and d) the estimates of the debt limit and the fiscal space are very sensitive to external and internal conditions.

In the next section we present the analytical framework used to determine the debt limit in emerging market economies. In section 3 we show the estimation for the financing costs and the fiscal reaction functions. Then, we set up the econometric strategy to compute the stochastic debt limit. In section 4 we describe the estimates of both types of debt limits, the "deterministic" and the "stochastic" limit, and the corresponding fiscal space. We finish this section with a counterfactual exercise to explain the difference in fiscal space values across countries. In the last section we present our conclusions.

² In particular, the BIS mentions in its 2016 Annual Report, pp 98: "...policymakers should be aware that having fiscal space –as determined by current methods- does not mean it is possible or advisable to use it all...".

³ For example, Zandi et al (2011) pointed out based on historical experience that advanced economies must maintain a buffer of at least 125 percentage points of GDP fiscal space.

2. The analytical framework of the debt limit

The analytical framework follows the methodology proposed by Ghosh et al (2013), but adapted for emerging market economies, which is based on the determinants of the public debt dynamics. The evolution of the public debt is given by the intertemporal budget constraint:

$$\Delta d_t = \phi_t d_{t-1} - pb_t \quad (1)$$

where d_t is the debt ratio (public debt / GDP), $\phi_t = \frac{\tilde{r}_t - g_t}{1 + g_t}$ is the growth-adjusted interest rate, \tilde{r}_t is the debt's effective (nominal) interest rate, g_t is the nominal GDP growth rate and pb_t is the primary balance as percentage of GDP. Equation (1) is an accounting identity which shows that growth in the debt ratio is given by the difference between the financing costs (the first term on the RHS) and the primary balance to GDP ratio.

We assume the effective nominal interest rate depends, among other controls, on the lagged debt ratio, which captures the positive relationship between the financing costs and the debt ratio observed in emerging market economies due the increase in the risk perception:

$$\tilde{r}_t = \tilde{r}(d_{t-1}, controls) \quad (2)$$

Among other factors that could affect the effective nominal interest rate is the risk-free international interest rate, the global financial volatility and the exchange rate. The exchange rate is a relevant control for emerging market economies due to the “original sin”, that is the inability to borrow abroad in their own currency. As an important portion of debt is issued in foreign currency, exchange rate fluctuations affect financing costs.

We also assume, as stated by Bohn (1998, 2008), that the primary balance depends, among other controls, on the lagged debt ratio:

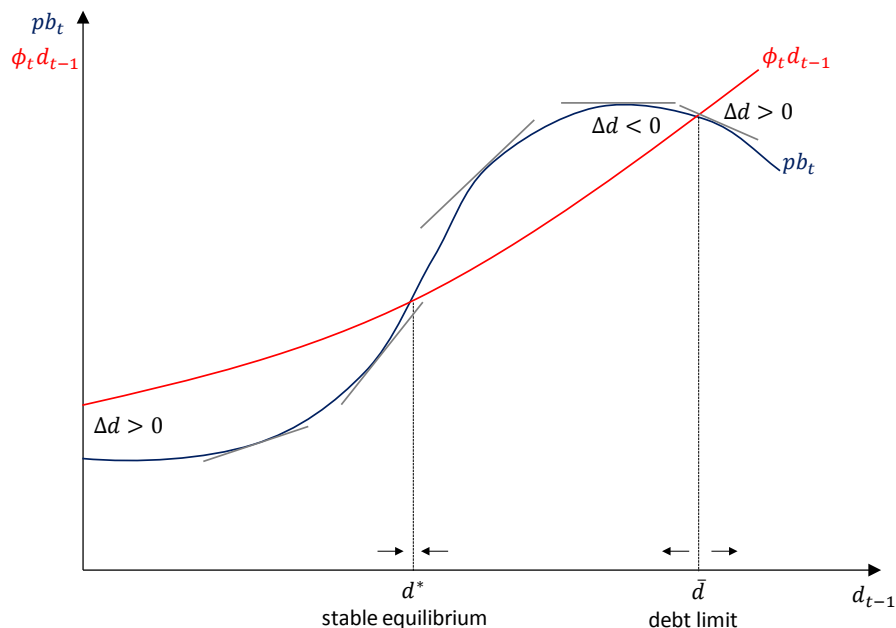
$$pb_t = pb(d_{t-1}, controls) \quad (3)$$

Potential controls for the fiscal reaction function are the output gap and, for commodity exporter countries, the relevant gap of commodity prices from their long-run levels. A positive output gap or a positive commodity price gap imply government revenues that are higher than their structural levels, which generates *ceteris paribus* larger primary balances.

We show in graph 2 the dynamics of the financing costs, defined by $\phi_t d_{t-1}$, and the primary balance (pb_t), as function of the lagged debt ratio. In this graph the interest rate is an increasing and convex function of the debt ratio, that is $\tilde{r}'(d_{t-1}) > 0$ and $\tilde{r}''(d_{t-1}) > 0$. On the other hand, the shape of the fiscal reaction function captures the “fiscal fatigue” characteristic found by Ghosh et al (2013) in advanced economies: the response of the primary balance to changes in the debt ratio, measured by the slope of the pb_t curve, is increasing for low levels of debt. As the debt ratio increases, this response decreases, which could be even negative above certain threshold,

when the government loses its capacity to control the debt growth through increases in the primary balance.

Graph 2: determination of the debt limit

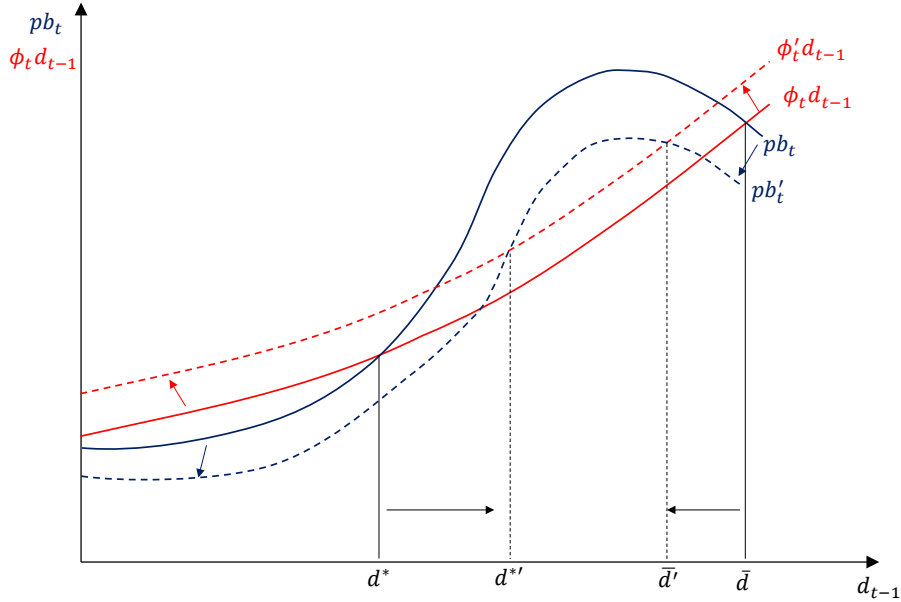


The difference between both curves defines the change in the debt ratio (Δd_t). When $\phi_t d_{t-1}$ is above (below) pb_t , the change in the debt ratio is positive (negative). As seen in graph (2), the intersection of both curves defines two possible equilibria outcomes such that the debt ratio is constant ($\Delta d_t=0$). The first equilibrium on the left (d^*) is a stable equilibrium: if we depart from a point close to the left (right) of d^* , d_t increases (reduces) to the equilibrium level d^* . In the same way we can show the second equilibrium (\bar{d}) is unstable: departing from a point close to the left (right) of \bar{d} , d_t diminishes (increases) moving away from \bar{d} . This way, d^* defines the “stable debt equilibrium” and \bar{d} the “debt limit”. The former is the level to which debt will converge if departing from the neighborhood of that value, whilst the latter is the level from which debt would increase unboundedly. The fiscal space is defined as the distance between the debt limit and the current (or forecasted) level of public debt.

In graph 3 we show a comparative static analysis of the public debt equilibria. On one hand, increases in global financial volatility, the international interest rate or the country risk premium, would generate an upward move of the financing costs curve. That is, the financing costs would be higher for each level of the debt ratio. Similarly, shocks that reduce persistently the primary balance, such as a decrease in the output gap or the relevant commodity price gap, would move the pb_t curve downwards. This would imply, according to the fiscal reaction function, a lower primary balance for each level of the debt ratio. These changes in the economic and financial conditions generate an increase in the “stable debt equilibrium”, from d^* to $d^{*'}$, and a reduction

of the debt limit, from \bar{d} to \bar{d}' . That is, a worsening of the fiscal conditions, either those that affect government revenues or the financing costs, increase the equilibrium public debt ratio. The effect is the opposite for the debt limit: adverse economic and financial conditions reduce this threshold.

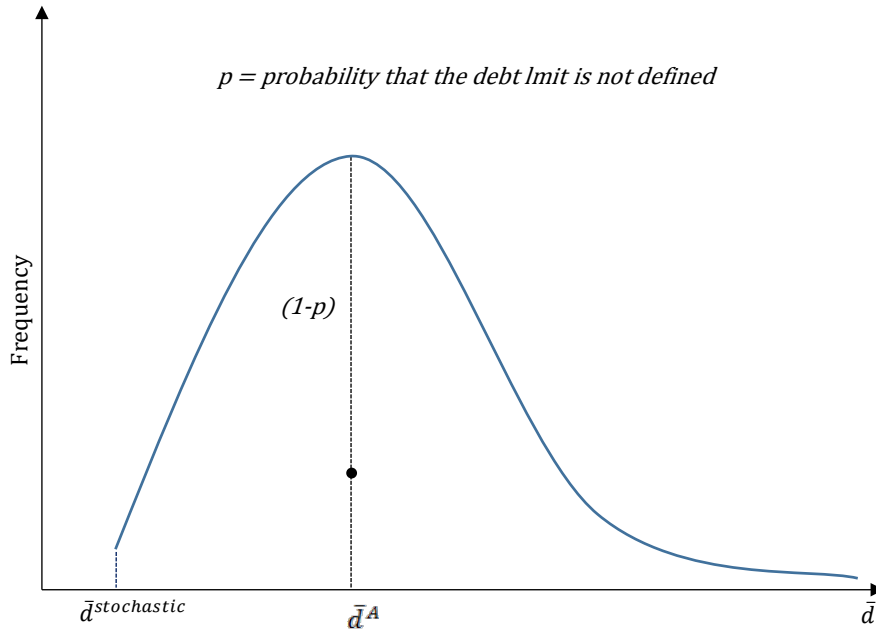
Graph 3: comparative static of the public debt dynamics



This analysis also shows that the debt limit is not fixed, but it depends not only on macroeconomic conditions and the parameters of the model, but also on how international investors react, particularly in scenarios of high volatility and/or increase in the level of public debt. Therefore, although at an early stage the debt ratio could be found below the debt limit, changes in economic and financial conditions can reduce the debt limit below the initial debt ratio. In this situation, the debt ratio would start to grow unsustainably even without changes in fiscal policy. Taking into account this caveat, we propose an alternative indicator of the debt limit that captures the uncertainty and sensitivity to the economic and financial environment, which we call the stochastic debt limit.

In graph 4 we show an example of the distribution function of the debt limit, taking into account the uncertainty of the parameters as well as the historical dispersion of the control variables in equations (2) y (3). In this graph we show that there is a probability p that the debt limit is not well defined, which is when the curves do not intersect. Then, $1-p$ equals the area below the distribution function of the debt limit. For a value of the debt limit \bar{d}^A , for example, the area to the right of that point corresponds to the probability of falling into an explosive trajectory. We define the stochastic debt limit as the greatest value of the debt ratio that minimizes the probability of an explosive trajectory. Under this definition, the stochastic debt limit is equivalent to the minimum value of the debt limit that is defined in the distribution function.

Graph 4: distribution of the debt limit and the stochastic debt limit



3. Econometric strategy

The empirical implementation of the debt limit requires estimating the financing costs equation and the fiscal reaction function described in the previous section. Each equation is estimated using a panel data model with fixed effects and annual data for a sample of 26 emerging market economies over the 2000-2015 period (for the wider version, see Appendix 3). The countries in the sample are: Argentina, Brazil, Chile, China, Colombia, Costa Rica, Croatia, Slovakia, Guatemala, the Philippines, Hungary, India, Indonesia, Latvia, Lithuania, Malaysia, Mexico, Peru, Poland, Romania, Russia, South Africa, Sri Lanka, Turkey, Uruguay and Vietnam.

3.1 The financing costs

To construct the growth-adjusted interest rate, ϕ_t , the usual procedure in the related literature (eg Ghosh et al, 2013; Zandi et al, 2011; Fournier and Fall, 2015;xc and Pommier, 2015) is to use the historical effective interest rate or the 10-year sovereign bonds yield. This procedure has some drawbacks. First, the effective interest rate as an average of historical rates does not fully incorporate the financial market reaction to higher levels of debt in the future⁴. Second, the 10-

⁴ It should be mentioned that alternatively, Ghosh et al (2013) calculate interest rates with model that incorporates the risk of default under a number of assumptions. However, they do not contrast the validity of this model with empirical evidence.

year yield would not be a good reference of the financing costs in emerging market economies, because debt issuance is usually made on average for less than 10 years⁵.

Different from previous work, in our procedure we decompose the effective nominal interest rate \tilde{r}_t into two components. The first is the implicit historical interest rate r_t^H , which is obtained by dividing interest payments between the stock of public debt from the previous year. The second component corresponds to the market nominal interest rate r_t^M , which is determined in the financial market when issuing new debt. The effective nominal interest rate is given by the following equation:

$$\tilde{r}_t = \lambda_t r_t^H + (1 - \lambda_t) r_t^M \quad (4)$$

where $\lambda_t = 1$ if $D_t \leq D_{t_0}$ and $\lambda_t = D_{t_0}/D_t$ if $D_t > D_{t_0}$, being D_{t_0} the nominal value of the debt stock at the beginning of the analysis (eg at the end of the estimation sample). According to equation (4), the effective nominal interest rate is equal to the implicit historical interest rate for debt levels lower or equal to the initial debt level, and the relative weight of this interest rate diminishes as new debt is issued and the debt level increases.

The market nominal interest rate is modeled with three components: the risk-free interest rate (r_t^f), represented by the US Treasury bonds interest rate⁶; the country risk premium measured by the EMBI Global ($EMBIG_t$); and the exchange rate depreciation (Δs_t).

$$r_t^M \approx r_t^f + EMBIG_t + \Delta s_t \quad (5)$$

In this case, we assume that new public debt issues are made in foreign currency, based on the facts that emerging market economies lack of "hard" currencies and the local markets are much less liquid. Alternatively, assuming the uncovered interest rate parity condition holds gives a similar result.⁷

The EMBIG is modeled as a function of the lagged debt ratio and a set of control variables that can have a significant impact on the perception of sovereign risk⁸. As shown in the graph A7 in

⁵ For example, the duration of the EMBI Global, varies between countries in the sample; from about 3 years for Latvia, India and Lithuania; around 6 years for China and Brazil; and to about 10 years for Uruguay and Peru.

⁶ We use the US Treasury bond with a maturity similar to the duration of the EMBI-G in each country. We use interpolated yields when no data is available for a specific duration.

⁷ The uncovered interest parity condition states that by financial arbitrage bonds yields in domestic and foreign currency are similar when considering the expected depreciation of the nominal exchange rate. Burnside (2014) finds statistical evidence against this hypothesis for 8 out of 18 developed countries. However, for emerging market economies, it is only rejected for 8 out of 26 cases. Additionally, he finds evidence that the "failure" of this hypothesis in the group of developed countries would be related to currency risk premium.

⁸ In this regard, several studies found a significant effect of macroeconomic conditions, particularly fiscal, on risk perception and interest rates of sovereign bonds. Among the works based on emerging market economies are: Baldacci and Kumar (2010); Escolano et al (2014); Jaramillo and Weber (2012).

Appendix 1, there is a positive correlation between EMBI Global and the lag in the debt ratio for the selected sample, which intensifies as the level of debt increases⁹.

$$EMBIG_t = f(d_{t-1}, controls) \quad (6)$$

We estimate equation (6) with panel data for a sample of 26 emerging economies for the 2001-2015 period¹⁰, using instrumental variables and fixed effects to capture structural characteristics of each economy that are invariant over time, which could be correlated with the control variables. To correct potential endogeneity problems between the EMBIG and the debt ratio we use the first lag of the fiscal variables as instruments.

The estimation results are reported in table 1. The columns show the estimated coefficients when incorporating different control variables. The positive coefficient of the squared lagged debt ratio indicates that the impact of the level of debt on the perception of sovereign risk is positive and increasing with the level of debt; that is, the relationship is not linear and convex¹¹. Importantly, this result is robust when including different control variables. The negative coefficient of the output gap shows that the expansive phase of business cycle reduces the perception of sovereign risk; while the recession increases it. On the other hand, a raise in the level of inflation also increases the perception of risk. With regard to financial variables, an increase in the 10-year US Treasury bonds interest rate¹² increases the perception of sovereign risk, and if this increase occurs in a period of high financial volatility (e.g. when the VIX is rising), the magnitude of the impact is higher.

Among other control variables, a higher real exchange rate (i.e. an overvalued currency) increases sovereign risk, since it signals a high level of spending and low savings in an economy. The effect of this variable is important and significant even when incorporating variables such as the current account and foreign direct investment, which also capture the balance between saving and spending in the economy. The fiscal balance multiplied by the dummy variable “debt”¹³, which captures the effect of the fiscal balance when the debt level is very high, has a positive impact on sovereign risk. The sign of this coefficient differs from the estimated in other studies¹⁴, which can be explained by the fact that emerging countries with high debt levels are often under restructuring

⁹ Although the probability of default is not explicitly modelled, the positive relationship between the EMBIG and the debt ratio captures the impact of the latter on default risk and consequently on financing costs.

¹⁰ The sample of countries diminishes when including more control variables due to the limited availability of data for some countries. See Appendix 3.

¹¹ We also used a set of linear specifications for the debt ratio. Nevertheless all of them were inferior in terms of statistical significance.

¹² We used the 10-year yield for each country, rather than the bond yield with similar EMBI-G duration, because it is widely regarded as a good representative of the financial conditions internationally, being a long-term asset with low risk and high liquidity.

¹³ This variable takes the value of 1 when the debt ratio is above 60 percent of GDP, and zero otherwise.

¹⁴ See for example Baldacci y Kumar (2010).

programs and drastic fiscal adjustments (with the IMF for example), at a high cost in economic and social terms, thereby generating a greater perception of sovereign risk¹⁵.

Table 1: Estimated coefficients – financing costs function

Dependent variable: EMBI-G (Basic Points)	(1)	(2)	(3)	(4)
Debt (% of GDP) squared (L1)	0.12 *** (0.02)	0.17 *** (0.02)	0.17 *** (0.02)	0.17 *** (0.02)
GDP gap (% of Potential GDP)	-359.01 *** (60.43)	-270.75 *** (51.57)	-328.95 *** (49.35)	-423.06 *** (84.54)
Inflation eop (%)	26.35 *** (5.97)	18.42 *** (5.69)	33.29 *** (7.29)	25.19 ** (10.82)
VIX (%)	10.22 *** (3.19)			
VIX (%) * US Treasury 10y (%)		2.74 *** (0.60)	2.27 *** (0.57)	2.12 *** (0.66)
REER Index (L1)		13.10 *** (1.34)	10.91 *** (1.39)	12.16 *** (2.27)
Debt Dummy * Overall Balance (% of GDP)			77.45 *** (25.36)	67.10 (44.50)
Current Account (% of GDP) (L1)				-4.62 (8.86)
Market Capitalization (% of GDP) (L1)				1.03 (0.97)
Foreign Direct Investment (% of GDP)				7.47 * (4.22)
Constant	-337.23 *** (102.03)	-1594.47 *** (155.07)	-1383.81 *** (152.63)	-1549.37 *** (234.49)
R ²	0.4595	0.6691	0.7859	0.807
Sample (TxN)	280	239	239	191
Countries (N)	26	21	21	19

Estimation: Instrumental variables, two-stage least squares and fixed effect panel-data

Standard errors in parenthesis. Significance levels: *10%, **5%; ***1%.

EMBI-G: Emerging Markets Bonds – Global (basic points).

L1: First lag.

REER: Real effective exchange rate.

Units: Basic points for the EMBIG and percentage points for the rest of variables.

Country fixed effects not reported.

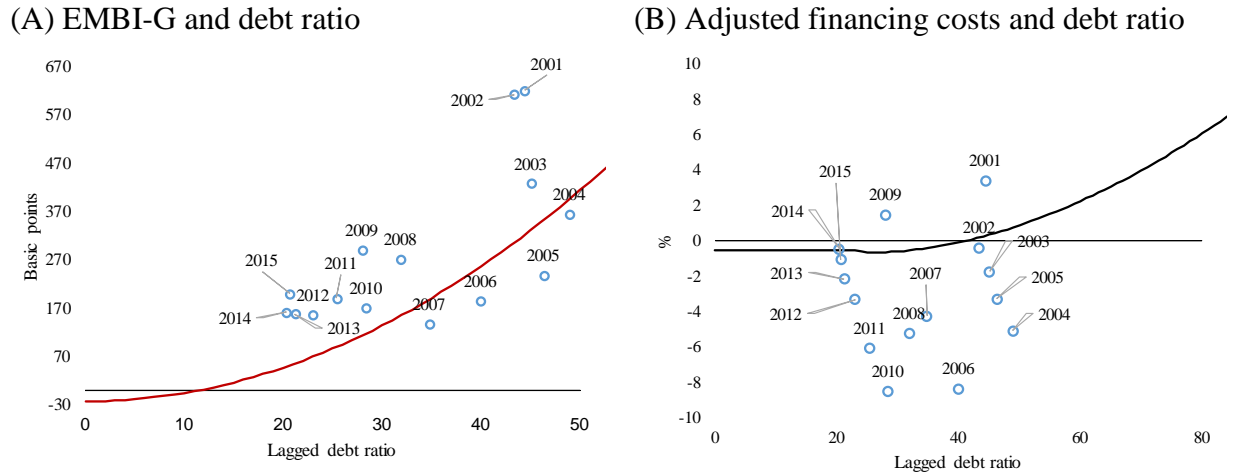
Authors' estimates.

We choose for the simulation exercises and the estimation of the debt limit the model with higher R² and more statistically significant coefficients, which corresponds to the specification (3).

¹⁵ For example, Przeworski and Vreeland (2000) found that governments that adopt agreements programs with the IMF, recorded a decrease in their level of economic growth. As an explanation, they suggest that this result is not due itself to the adoption of adjustment programs with the IMF; but due to the tightening of fiscal policy, some of them related to these IMF programs.

As an illustration, we show in graph 5 the results for simulating the EMBI-G and the financing costs function for Peru during 2001-2015 using equations (4), (5) and (6), and the assumptions described in table A1 of Appendix 2. On one hand, the estimates of the EMBI-G are low relative to the historical data and even negative for debt ratios below 10 percent. This result is explained mainly by the low value for the US Treasury yield used in the exercise (1.9 percent)¹⁶. On the other hand, the discrepancies between the estimates and the actual historical data for the financing costs are mainly explained by the differences between the nominal GDP growth observed in each year and the potential growth rate used in the simulation¹⁷.

Graph 5: Estimates of EMBI-Global and financing costs in Peru



Note: Each curve shows estimates for the EMBI-Global and financing costs for a given level of debt ratio. Circumferences represents historical data.

Source: Authors' estimation.

3.2 Fiscal reaction function

We estimate the following fiscal reaction function:

$$pb_{i,t} = \alpha_i + \beta_1 d_{i,t-1} + \beta_2 d_{i,t-1}^2 + X_{i,t}B + \varepsilon_{i,t} \quad (7)$$

$$\varepsilon_{i,t} = \rho \varepsilon_{i,t-1} + v_{i,t} \quad (8)$$

where α_i is the fixed effect specific for each country, $d_{i,t-1}$ is the lagged debt ratio, the matrix $X_{i,t}$ has the control variables, whilst $\varepsilon_{i,t}$ is a perturbation term. Different from Ghosh et al (2013), who use a cubic polynomial on the lagged debt ratio, our baseline model has a quadratic

¹⁶ This value corresponds to the average during the first semester of 2016. If we use instead the average for the sample period (3.6 percent), the spread increases by 77 basis points for all levels of debt, reaching 50 basis points at the zero debt ratio.

¹⁷ In the case of Peru, the nominal GDP growth exceeded 13 percent in 2006 and 2010, significantly reducing the effective cost; while in 2001 and 2009, it was below 3 percent, raising the effective cost. The nominal growth used for the simulation is 6.1 percent (see table A1 in Appendix 2), equivalent to the potential nominal GDP growth.

relationship between the primary balance and this variable¹⁸. The autoregressive process for $\varepsilon_{i,t}$ captures the persistence found in the primary balance data.

Among the controls, we include variables that are usually used in the related literature (Ghosh et al, 2013; Pommier, 2015); such as the output gap, which captures the cyclical dependence of the primary balances, and the expenditure gap as a measure of temporary government disbursements.

We also capture the dependence of emerging economies' fiscal accounts on commodity prices by including a measure of the relevant commodity price gap, measured by the gap respect to their respective long-run value and weighted by its participation of commodities exports in total exports for each country¹⁹.

We estimate the fiscal reaction function using a panel data model with fixed effects, using annual data for the 2000-2015 sample. The data sources are the IMF, the World Bank and the United Nations²⁰. The coverage for the fiscal accounts is the General Government.

We show in Graph 6 the dispersion of the data used for the estimation. Both the primary balance and the debt ratio show a heterogeneous behavior among countries in the sample. The inclusion of fixed effects, which generate individual intercepts for each country, captures the observed heterogeneity observed in the primary balance. On the time dimension, the graphical analysis suggests a generalized reduction in primary balances after the 2008 financial crisis, while public debt shows an increasing trend from 2013.

In table 2 we show the results of the estimation of the reaction function using different control variables. The results indicate that the coefficients associated with the nonlinear relationship between debt and primary balance are statistically significant. Based on the estimated coefficients, there is evidence of "fiscal fatigue": the response of the primary balance to changes in debt is positive but decreasing to low levels of the debt ratio, but becomes negative for debt levels higher than 150 percent of GDP.

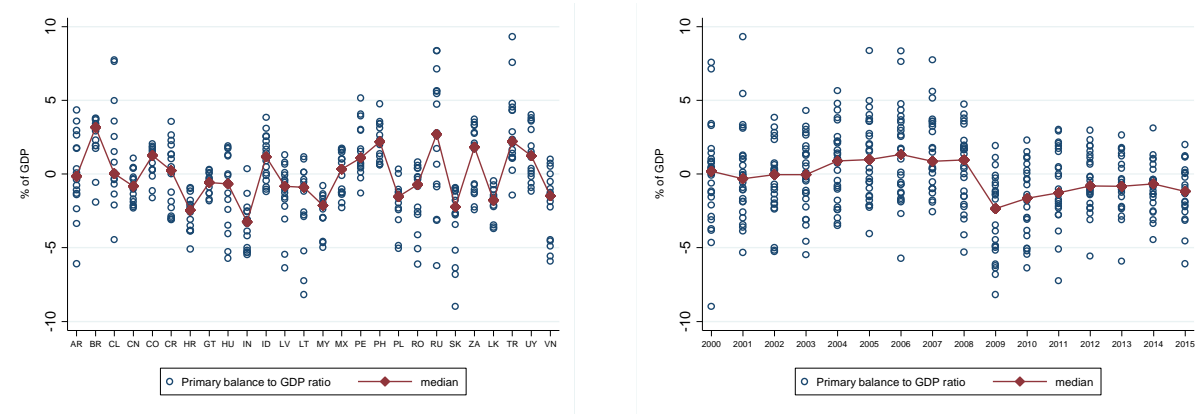
¹⁸ The estimated cubic term of the lagged debt ratio was not statistically significant in our sample.

¹⁹ We use the World Bank's price indexes for mining and energy commodities to estimate the commodity price gaps. We estimate the trend values with a moving average (7, 1,3) using the World Bank's commodity prices forecast. The energy index is composed by coal, crude oil and natural gas, whilst the mining index is composed by aluminum, copper, iron, nickel, steel, tin and zinc. On the other hand, the share of commodity exports in total exports is built from the database of the United Nations, using the A04 and A17 codes SITC Rev. 3.

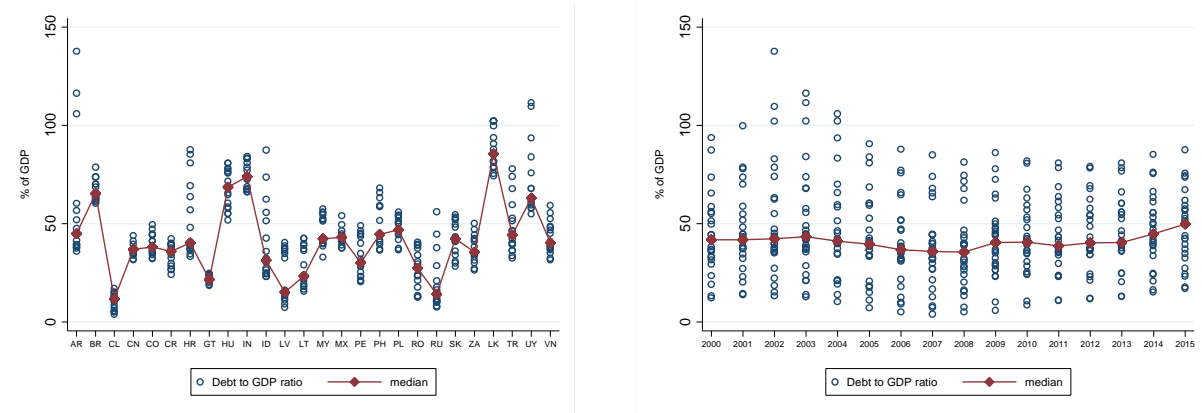
²⁰ See appendix 1 for more details on the data used.

Graph 6: fiscal accounts data

General government primary balance (percentage of GDP, 2000-2015)



General government debt (percentage of GDP, 2000-2015)



Source: IMF (2016).

The coefficients associated with the control variables are statistically significant and have the expected sign. The cyclical component of fiscal policy, captured by the estimated coefficient of the output gap is positive, suggesting that, on average, emerging economies adopted a counter-cyclical fiscal policy during the years 2000-2015. Meanwhile, the coefficients associated to price indices of minerals and energy are positive, reflecting the dependence that fiscal balances have on international prices for countries that are exporters of these commodities.

Temporary increases in government spending, captured by the gap of non-financial expenditure, have an impact on primary balances. Also, greater trade openness imply larger primary surpluses²¹. Finally, primary balances were lower on average by 1.5 percent of GDP between 2009-2015, as

²¹ Trade openness is constructed as the sum of exports and imports as a percentage of GDP.

captured by a crisis is a dummy variable that takes the value of 1 in each country after the financial crisis of 2008.

Table 2: Estimation of the fiscal reaction function with fixed effects

	(1)	(2)	(3)	(4)
Lagged debt (% of GDP)	0.160 *** (0.03)	0.081 *** (0.03)	0.120 *** (0.04)	0.146 *** (0.03)
Lagged debt ² (% of GDP)	-0.001 *** (0.00)	-0.000 * (0.00)	-0.001 ** (0.00)	-0.001 *** (0.00)
Output gap	0.735 *** (0.13)	1.404 *** (0.12)	0.617 *** (0.13)	0.517 *** (0.13)
Minerals index	0.147 *** (0.02)	0.125 *** (0.02)	0.136 *** (0.02)	0.125 *** (0.02)
Energy index	0.092 *** (0.02)	0.085 *** (0.01)	0.112 *** (0.02)	0.069 *** (0.02)
Non-financial expenditure gap		-0.709 *** (0.05)		
Trade (% of GDP)			0.036 *** (0.01)	
Crisis (2009-2015)				-1.503 *** (0.28)
Constant	-5.964 *** (0.35)	-3.586 *** (0.28)	-7.614 *** (0.42)	-4.565 *** (0.36)
NxT	384	384	354	384
T	26	26	26	26
AR coef	0.6	0.7	0.6	0.6
R2 adj	0.3	0.5	0.3	0.3
AIC	1306.2	1155.7	1200.9	1276.1
BIC	1329.9	1183.4	1228.0	1303.7

Author's estimates.

Dependent variable is general government primary balance to GDP (%).

In all specifications country specific FE included and error term assumed to follow an AR (1) process.

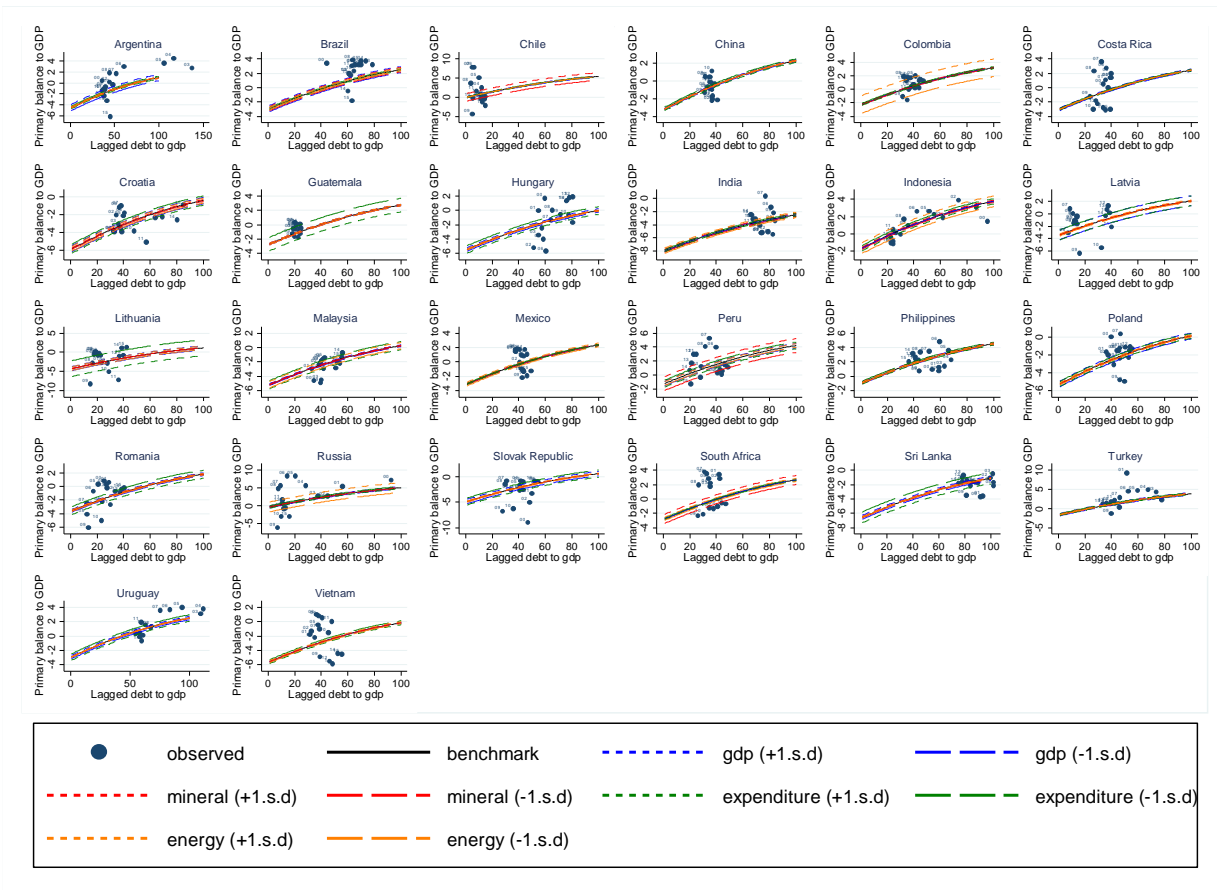
Units: Percentage points.

Standard error in parentheses, significance levels: *15%, **5% and ***1%.

We select the model with the lowest AIC and BIC, which corresponds to specification (2), for the estimation of the debt limit and the simulation exercises. In graph 7 we show a simulation of the fiscal reaction function for each country in the sample with a sensitivity analysis to the control variables. We assume in the baseline scenario that all control variables of the model are equal to

zero, and we consider ± 1 standard deviation²² for the sensitivity analysis. It shows that commodity prices are the main source of volatility in the fiscal reaction function for exporting countries of these products. In particular, it is noted that the primary balances of, Peru and South Africa are mainly exposed to changes in the price of minerals, while the primary balances of Colombia and Russia are exposed to changes in oil prices (energy).

Graph 7: Fiscal reaction function and sensitivity analysis
(Percentage of GDP, 2000-2015)



Source: IMF (2016) and author's estimates.

3.3 Stochastic simulation

There are two sources of uncertainty in the estimates shown above. On one side there is the uncertainty associated with the estimates of the coefficients, which feed on the residuals of each model, and on the other hand there is the dispersion associated to the control variables and those used to construct the financing costs (control variables henceforth). Both of them generate uncertainty in model predictions, in turn influencing the estimate of the debt limit.

²² The standard deviations are calculated for the period 2011-2015, which captures the adverse episode of consecutive falls in the commodity price indices.

Given the implicit independence assumption between these two sources of uncertainty, we simulate separately 1000 scenarios for the estimated coefficients and 1000 for the control variables by using a multivariate normal distribution. This is a type of distribution for a vector of correlated variables, in which each variable follows a univariate normal distribution.

Regarding the simulation of the coefficients, we perform a bootstrap exercise for all the estimated coefficients by drawing 1000 samples with replacement and by clusters from the current dataset. This technic allows us to obtain the variance-covariance matrix of all the coefficients, especially for those that belong to different equations. The multivariate normal distribution specification for a vector of coefficients \mathcal{B} is as follows:

$$\mathcal{B} \sim N(\hat{\beta}, \Phi)$$

where:

\mathcal{B} is the vector of simulated coefficients: $\mathcal{B}' = [\beta_1, \beta_2, \dots, \beta_p]$

$\hat{\beta}$ is the vector of expected values of the coefficients: $\hat{\beta}' = [E[\beta_1], E[\beta_2], \dots, E[\beta_p]]$

Φ is the bootstrapped variance-covariance matrix: $\Phi = [Cov[\beta_l, \beta_j]]$, $l = 1, \dots, p$; $j = 1, \dots, p$

p is the number of the estimated coefficients

In the case of the control variables we use the historical averages and the variance-covariance matrix for each country during the years 2000-2015. This procedure ensures that the occurrence of extreme events in the simulations takes into account the estimated historical correlation in each country. The multivariate normal distribution specification for a vector of control variables X_i for a country i is as follows:

$$X_i \sim N(\mu_i, \Sigma_i)$$

where:

X_i is the control variables vector: $X'_i = [X_{i1}, X_{i2}, \dots, X_{ik}]$

μ_i is the expected values vector: $\mu'_i = [E[X_{i1}], E[X_{i2}], \dots, E[X_{ik}]]$

Σ_i is the variance-covariance matrix: $\Sigma_i = [Cov[X_{il}, X_{ij}]]$, $l = 1, 2, \dots, k$; $j = 1, 2, \dots, k$

$i = 1, 2, \dots, 26$ represents the i th country in the sample

k is the number of control variables

Finally, with these simulations we are able to generate one million (10^6) scenarios for each country by including the 1000 simulated vectors of coefficients in each of the 1000 simulated vectors of

control variables. Therefore, each simulated scenario for the control variables incorporates the uncertainty associated with the estimation of the coefficients.

4. Debt limit and fiscal space

In this section we describe the estimates of both types of debt limits, the "deterministic" and the "stochastic" limit. The "deterministic" debt limit is estimated from the intersection between the financing costs and the fiscal reaction function, as estimated for each emerging economy in the sample. For this, we elaborate predictions of equations (4), (5), (6) and (7) for different levels of debt (from 0 to 200 percent of GDP), using the definition for financing costs and the assumptions on controls variables described in table A1 of the Appendix. As explained in section 2, there are two intersections between these curves, which define respectively the stable equilibrium debt and the debt limit. Fiscal space is defined as the distance between the debt limit and the current (or projected) debt ratio.

To estimate the "stochastic" debt limit we follow the procedure described in section 3.3. We generate one million (10^6) scenarios by 1000 simulations for the estimated coefficients and 1000 simulations for the control variables. In each scenario we obtain the intersections between the two curves, thus generating a million values for the equilibrium debt and the debt limit. This process is repeated for each country so the simulation allows us to generate a histogram for the debt limit in each country. With these values we compute the stochastic debt limit, which was defined in section 2 as the greatest value of the debt ratio that minimizes the probability of an explosive trajectory.

It is important to mention that we choose a small level of significance in this estimation in order to overweigh the cost of incorrectly rejecting a low debt ratio as a debt limit (Type I error) versus the cost of incorrectly retaining a low debt ratio as a debt limit (Type II error).

4.1 Deterministic debt limit

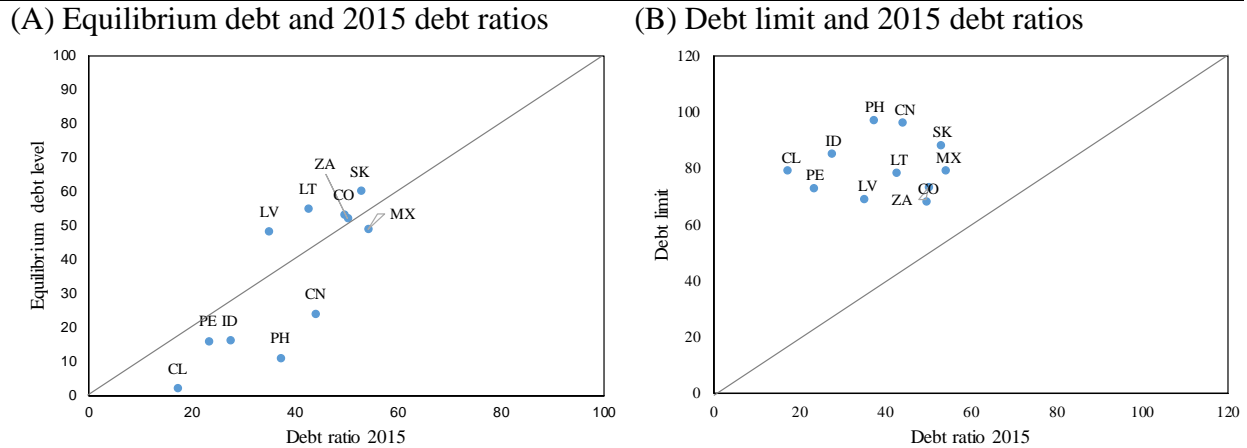
In graph 9 we show the 2015 debt ratios compared with the stable equilibrium debt and debt limits estimates for the emerging economies in the sample. It is worth mentioning that the sample of countries narrows from 26 to 18 due to data availability (see Appendix 3). And from these 18 countries the debt limit is not determined in 7, which mostly have at least one of the following problems: high fiscal deficits, low growth or high nominal interest rates²³.

As shown in graph 9 (A), six countries reached in 2015 a debt ratio higher than the equilibrium debt level. This result can be explained by the significant increase of the fiscal deficit recorded in recent years in almost all these countries; unlike those countries with a debt ratio lower than the equilibrium debt level, which some have registered even a reduction of the fiscal deficit in recent

²³ Deterministic debt limits are not determined in the following countries: Brazil, Croatia, Hungary, India, Poland, Romania and Turkey. Brazil, India and Croatia have high levels of fiscal deficit. Hungary suffers from a low nominal growth. While Brazil and Turkey have high interest rates.

years (with the exception of Colombia and Latvia). On the other hand, as shown in graph 9 (B), the 2015 debt ratio is below the estimated deterministic debt limit for all countries in which this measured is determined. The difference between these two variables becomes the deterministic fiscal space, which is reported in graph 10.

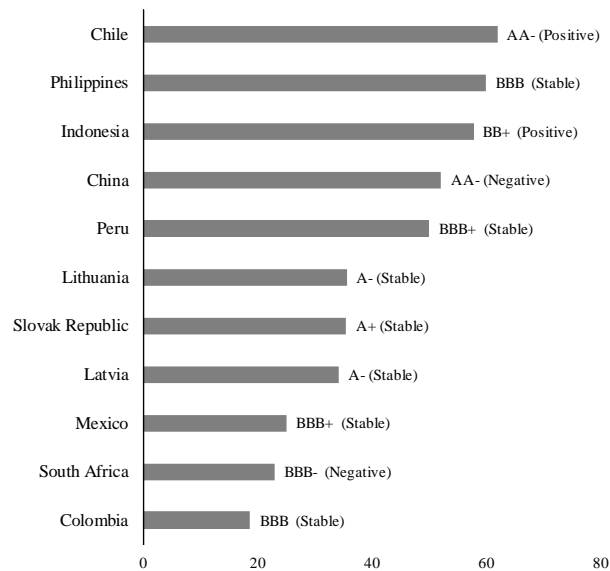
Graph 9: Deterministic stable equilibrium debt and debt limit in emerging economies



Note: Chile (CL); China (CN); Colombia (CO); Indonesia (ID); Latvia (LV); Lithuania (LT); Mexico (MX); Peru (PE); Philippines (PH); Slovakia (SK); South Africa (ZA).

Source: Author's elaboration

Graph 10: Deterministic fiscal space in emerging economies (percentage of GDP)



Note: Sovereign rating for long-term public debt in foreign currency long-term (S&P)

Source: Author's calculations

The estimates of the deterministic fiscal space are correlated with sovereign debt ratings issued by credit rating agency Standard & Poor's. Countries with higher (lower) fiscal space tend to have a

better (low) credit rating. However, there are some discrepancies, as in the cases of Indonesia, Lithuania, Latvia and Slovakia. Similar problems have been reported in other studies, suggesting that credit ratings may incorporate not only the current state of public finances, but also the recent fiscal history of each country and / or future government action on tax matters.

Again, it is noted to be very careful in interpreting these measures as a space that can be consumed completely, as the uncertainty about the model parameters, the historical volatility of the control variables and the behavior of financial agents, can drastically reduce unexpectedly this measure of fiscal space.

4.2 Stochastic debt limit

In graph 11 we show histograms for the debt limit in the 18 countries that are suitable for the simulations (suitable in terms of data availability, see Appendix 3). Additionally, the graph also shows the stochastic debt limit and the 2015 debt ratio for each country. The letter “ p ” in each country shows the frequency of the events in which the debt limit was not defined.

We use a 1 percent level of significance to determine the stochastic debt limit, which was defined as the greatest value of the debt ratio that minimizes the probability of an explosive trajectory, given that the debt limit is well defined (with probability $1-p$). As mentioned before, we consider this level of significance to be prudent relative to the usual 5 or 10 percent used in the econometric literature, given that a small significance value over-weights the cost of incorrectly rejecting a low debt ratio as a debt limit (Type I error) versus the cost of incorrectly retaining a low debt ratio as a debt limit (Type II error).

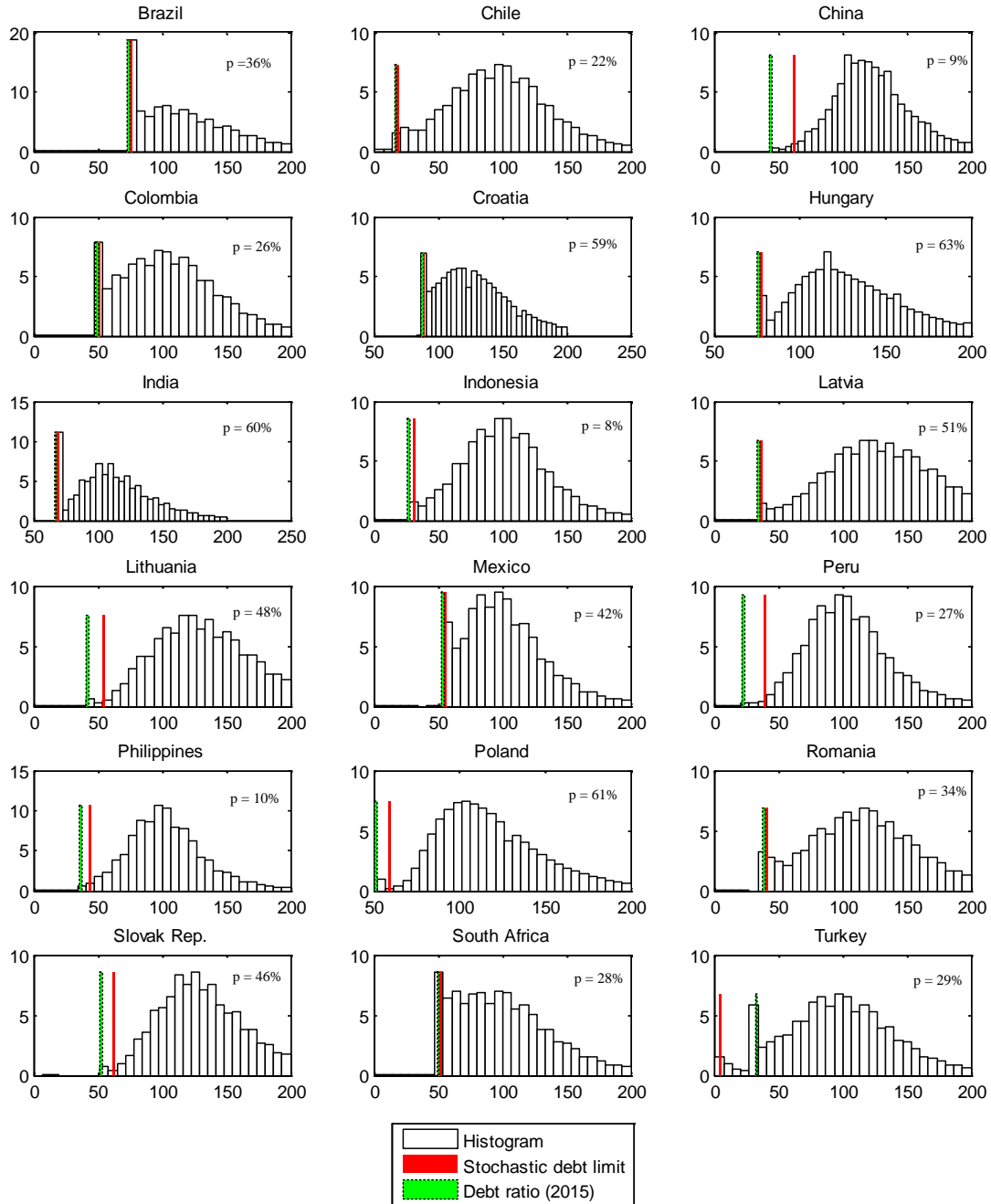
The shape of the distribution is different in each country, which reflects the differences in economic structures. Those countries that are more volatile and less diversified will tend to show fatter tails and therefore a higher frequency of extreme events. On the other hand, in some cases the distribution seems to be incomplete and this is because histograms are built from the events in which the debt limit is well defined (with probability $1-p$). When the debt limit is not well defined both curves do not intersect.

In graph 12A we compare the estimates of the deterministic and the stochastic debt limits, ranging from 68 to 97 percent of GDP in the first case and from 5 to 89 percent of GDP in the second one²⁴. It is noteworthy that the difference between these two measures are sizeable in some cases, which highlights the flaws associated to the deterministic debt limit. Given that the deterministic approach does not take into account the uncertainty surrounding the estimations, these results could lead us to conclude that there is ample fiscal space instead of the lack thereof in some countries. It is also important to note that we are able to compute stochastic debt limits also for

²⁴ The lowest stochastic debt limit corresponds to Turkey, in which the distribution shows an edge peak for very low debt ratios. If we raise the level of significance to 3.4 percent in order to avoid this area of extreme events, the stochastic debt limit increases from 5 to 34 percent and the fiscal space widens from -28 to 1 percent. More analysis is required in order to find out which factors are driving this anomaly.

those economies without well-defined deterministic limits (N.D. in the graph), which is also an advantage of the stochastic approach.

Graph 11: Debt limit – empirical distributions and stochastic limits in emerging economies



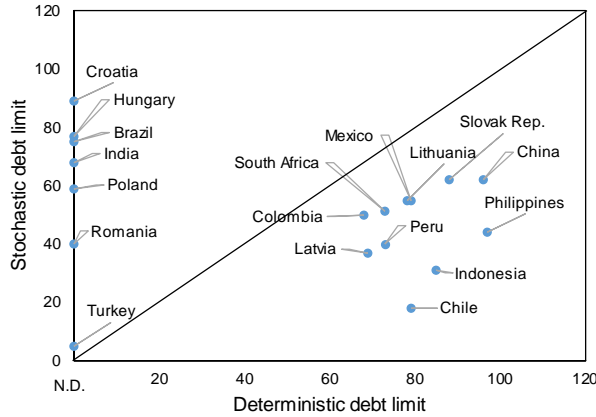
Source: Author's estimates.

In graph 12B we show the variables used to estimate the fiscal space: the debt ratio in 2015 and the stochastic debt limit. Seven countries are located above the 45° line, which implies a positive fiscal space. Other ten countries (almost along the 45° line) have almost no fiscal space. And just one country lies beneath this line, which means a negative fiscal space. In graph 13 we show a

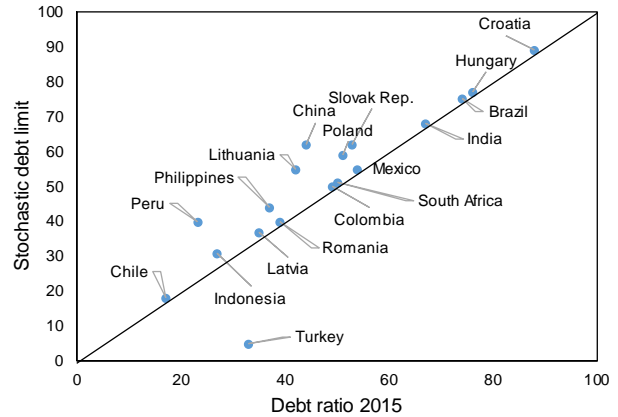
ranking for the estimated fiscal space values, with their corresponding estimates of the stochastic debt limit.

Graph 12: Deterministic and stochastic debt limits in emerging economies

(A) Deterministic and stochastic debt limit

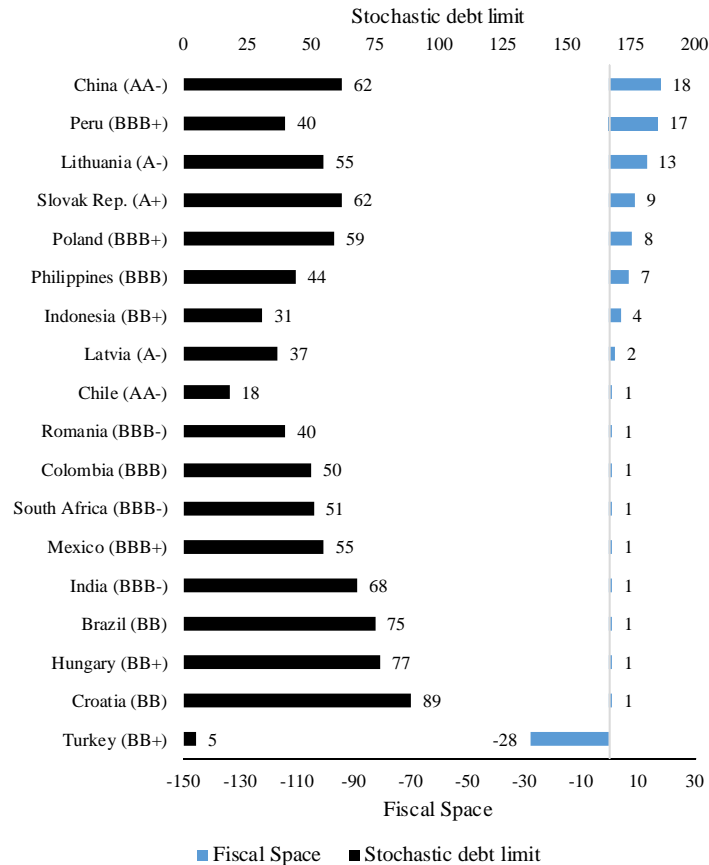


(B) Stochastic debt limit and 2015 debt ratios



Note: N.D. stands for Not Defined.
Source: Author's elaboration

Graph 13: Fiscal space and stochastic debt limit (percentage of GDP)



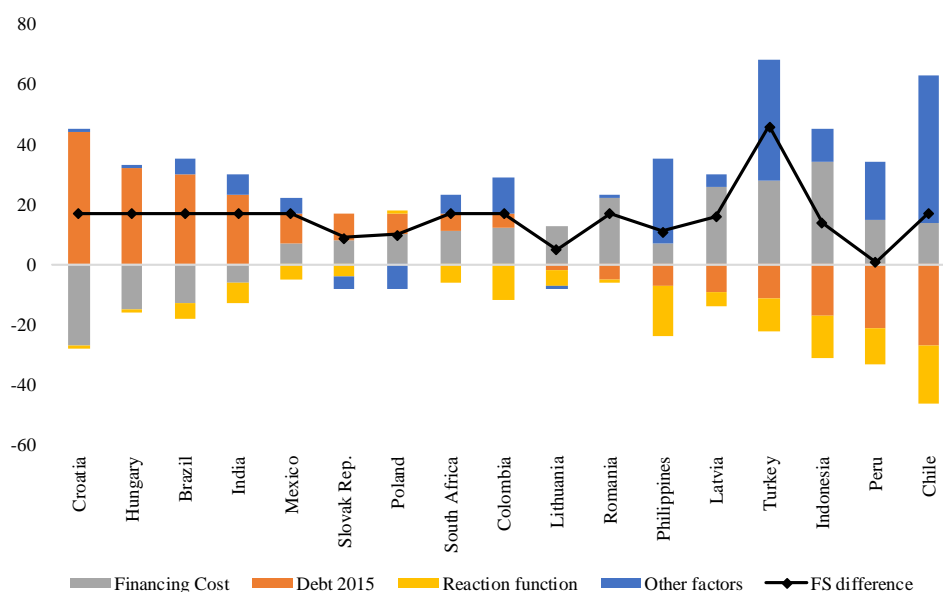
Note: Sovereign rating for long-term public debt in foreign currency long-term (S&P)
Source: Author's estimates

Two countries in this ranking (China and Peru) exhibit the largest fiscal space (around 18 percent of their GDP²⁵), followed by five countries with smaller but still positive fiscal space (more than 4 percent but less than 15 percent). Ten countries have almost no fiscal space (between 1 or 2 percent) and just one country has a negative fiscal space, which means that the level of debt in this country is already in an unsustainable path. The overestimation of the deterministic space relative to the stochastic case are the highest in countries such as Chile, Indonesia and Philippines (no less than 50 percent of GDP) and the lowest in Colombia (18 percent of GDP).

4.3 Counterfactual analysis

In this section we identify the factors that explain the difference in the fiscal space estimates across countries by comparing China (the country with higher value) with the rest of the countries analyzed. Three factors are considered in this exercise: the initial level of debt, the determinants of the financing cost of debt, the determinants of the fiscal reaction function, and other factors (which could include the interaction of the previous ones and/or other variables). We re-estimate the fiscal space in China by plugging the information of these factors for each country in the sample (a counterfactual exercise), allowing us to quantify the impact on the Chinese fiscal space. By doing this, we are able to infer which factor are more relevant in explaining fiscal space measures among these economies.

Graph 14: Chinese fiscal space with respect to other emerging countries (percentage of GDP)



Note: FS stand for Fiscal Space. A positive value implies a positive contribution to the Chinese fiscal space relative to another country. The contrary applies to a negative value.
Source: Author's calculations

²⁵ For China, this measure does not consider local governments' *off-budget* fiscal activities. According to some estimates for 2012 (see Zhang and Barnett 2014), the debt ratio rises to 45 percent of GDP when those activities are included, that is 11 percentage points above the official ratio for that year.

Excluding “other factors”, the 2015 debt ratio is the main component in explaining fiscal space gaps. In graph 14 we sort out countries in the sample according to the contribution of the 2015 debt ratio, ranking from -27 to +44 percentage points. The second component is the financing costs, which ranks from -27 to +34 percentage points. The contribution of the reaction function varies from -19 to +1 percentage points. According to these findings, fiscal space in China is higher mainly because of its low current debt ratio and low financing costs, and less due to its capacity to improve its primary balance, with respect to the rest of emerging market economies. Therefore, given that the debt level is already given and fixed in this exercise, emerging market economies could widen its fiscal space by improving the determinants of the financing cost of debt, which in turn leads to a lower level of debt afterwards.

5. Conclusions

In this paper we estimate the debt limit, defined as the level from which the ratio of government debt to GDP would follow an explosive path, for a sample of 18 emerging economies for the period 2000-2015. For this, we adapt the methodology proposed by Ghosh et al (2013) to emerging economies, taking into account particular factors that explain the dynamics of public debt in these countries, such as for example the dependence of fiscal accounts to commodity prices, the sensitivity of financing costs to debt levels and to external conditions such as the volatility of global financial markets, the international interest rate and the exchange rate. We also propose an alternative measure, which we call the stochastic debt limit, which captures the uncertainty and sensitivity to macroeconomic and financial conditions.

We found evidence of "fiscal fatigue", defined as the loss of ability to control debt growth through increases in the primary balance as the debt ratio increases. We also found that the ratio of public debt is a major determinant of the cost of public funding.

We estimate that by the end of 2015 the debt limit as measured in the traditional way (deterministic) is in the range of 68-97 percentage points of GDP for the emerging economies analyzed in which this threshold is defined, values below the range estimated for developed countries (150-200 percentage points of GDP). We also find that the deterministic fiscal space, defined as the difference between the deterministic debt limit debt and the debt ratio, is in the range of 19-62 percentage points of GDP for these countries.

It is noteworthy that these measures of debt limit and fiscal space are very sensitive to external and internal conditions. Being the variables that most influence the fiscal space in emerging economies; commodity prices, the exchange rate, the international interest rate and the volatility of global financial markets.

Our stochastic approach shows that the debt limit is much lower when the volatility of the control variables and the uncertainty on the estimations are taken into account. The estimates of the

stochastic debt limit lies in the range of 5-89 percent points of GDP for the emerging economies in the sample. The fiscal space calculated with this limit is in the range of -28 to 18 percentage points of GDP, lower than the deterministic estimates in each country. The difference in the values of fiscal space across countries are associated basically to the current level of debt and to the determinants of the financing costs.

It is worth mentioning that this debt limit should not be considered as a risk-free boundary. Market expectations of debt sustainability may suddenly deteriorate as the fiscal space is reduced by increasing the debt ratio, creating a negative feedback loop between higher financing costs and less fiscal space. Therefore, fiscal space estimates should be considered as fiscal buffers to be used only in extreme situations, in which the cost associated to an economic recession overcomes the cost of higher financing costs. The contrary applies to sound economic conditions, the debt level should be reduced in this situations, strengthening the capacity to undertake an expansionary fiscal policy when it is needed.

References

- Bank for International Settlements (BIS) (2016): “Annual Report”, (Basel, Bank for International Settlements).
- Bohn, H. (1998): “The behavior of U.S. public debt and deficits.” *The Quarterly Journal of Economics*, 113(3): 949–963.
- Bohn, H. (2008): “The Sustainability of Fiscal Policy in the United States.” In Reinhard Neck and Jan-Egbert Sturm, eds., “Sustainability of public debt,” Cambridge, Mass.: MIT Press.
- Burnside, C. (2014): “The Carry Trade in Industrialized and Emerging Markets.” In Claudio Raddatz, Diego Saravia and Jaume Ventura (eds.). *Global Liquidity, Spillovers to Emerging Markets and Policy Responses*. Santiago, Chile: Central Bank of Chile.
- Cecchetti, S., M Mohanty and F. Zampolli (2011): “The real effects of debt”, BIS Working Papers N° 352 (Basel: Bank for International Settlements).
- Clements, B., R. Bhattacharya and T. Nguyen (2003): “External debt, public investment and growth in low-income countries”, IMF Working Paper WP/03/249 (Washington: International Monetary Fund).
- Detragiache, E. and A. Spilimbergo (2001): “Crises and liquidity: evidence and interpretation”, IMF Working Paper WP/01/2 (Washington: International Monetary Fund).
- Fournier, J. and F. Fall (2015), "Limits to government debt sustainability", *OECD Economics Department Working Papers*, No. 1229, OECD Publishing, Paris.
- International Monetary Fund (2002): “Assessing sustainability” (Washington: International Monetary Fund).
- International Monetary Fund (2008): “The macroeconomic effects of discretionary fiscal policy” in *World Economic Outlook*, Chapter 5 (Washington: International Monetary Fund).
- International Monetary Fund (2016a): “Monitor Fiscal”, (Washington: International Monetary Fund).
- International Monetary Fund (2016b): “World Economic Outlook”, (Washington: International Monetary Fund).
- Greenidge, K., R. Craigwell, Ch. Thomas and L. Drakes (2012): “Threshold effects of sovereign debt: evidence from the Caribbean”, IMF Working Paper WP/12/157 (Washington: International Monetary Fund).

Ghosh, A. J. Kim, E. Mendoza, J. Ostry and M. Qureshi (2013): “Fiscal fatigue, fiscal space and debt sustainability in advanced economies”, *The Economic Journal*, 123, F4-F30.

Jaramillo, L., and A. Weber (2012): “Bond Yields in Emerging Economies: It Matters What State You Are In”, IMF Working Paper WP/12/198 (Washington: International Monetary Fund).

Mauro, P., Romeu, R., Binder, A. and S. Zaman (2013): “*A Modern History of Fiscal Prudence and Profligacy*”, IMF Working Paper WP/13/5 (Washington: International Monetary Fund).

Mendoza, E. and M. Oviedo (2009): "Public Debt, Fiscal Solvency and Macroeconomic Uncertainty in Latin America The Cases of Brazil, Colombia, Costa Rica and Mexico," *Economía Mexicana NUEVA ÉPOCA*, vol. 0(2), pages 133-173, July-Dece.

Pattillo, C., H. Poirson and L. Ricci (2002): “External debt and growth”, IMF Working Paper WP/02/69 (Washington: International Monetary Fund).

Pommier, S. (2015): “Public debt sustainability in advanced economies: a stochastic simulation of fiscal spaces after the 2008 financial crisis”, mimeo.

Przeworski, A., and J. Vreeland (2000). “The effect of IMF programs on economic growth”, *Journal of Development Economics*, Vol. 62 2000 385–421.

Reinhart, C. and K. Rogoff (2010): “Growth in time of debt”, *American Economic Review: Papers & Proceedings*, 100, pp 573-578.

Zandi, M., X. Cheng and T. Packard (2011): “Fiscal Space”, Moody’s Analytics Special Report.

Zhang, Y. and Steven Barnett (2014): “Fiscal Vulnerabilities and Risks from Local Government Finance in China”, IMF Working Paper WP/14/4 (Washington: International Monetary Fund).

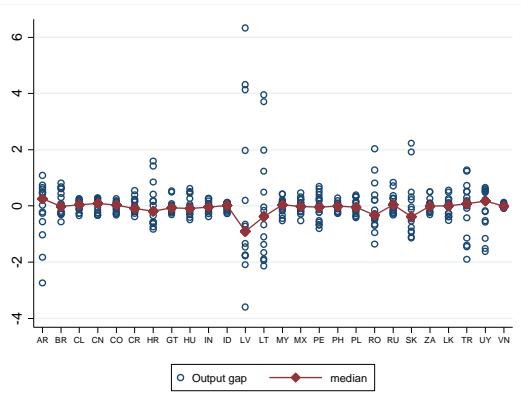
Appendix 1: database

The main sources of the macro-fiscal variables are the following databases: World Economic Outlook (WEO) April 2016, World Development Indicators World Bank, Mauro et al (2013), Bank for International Settlements (BIS) and Central Bank Reserve of Peru (BCRP). The mineral and energy price indices are built from World Bank's database of commodities prices and the base business (Comtrade) of the United Nations. The financial variables were obtained from the Bloomberg platform and FRED-Federal Reserve Bank of St. Louis database.

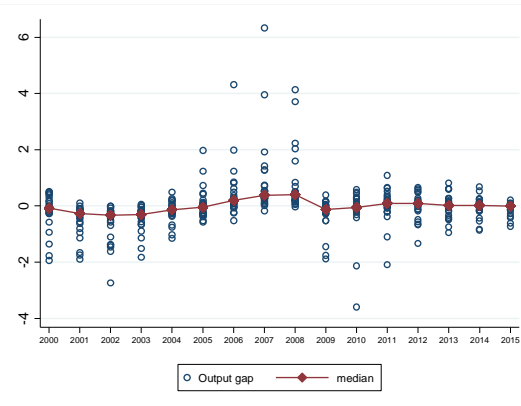
To calculate the output and spending gaps we use the Hodrick-Prescott (HP) filter and medium-term projections of the WEO.

Graph A1: Output gap
(percentage of GDP, 2000-2015)

(A) By country



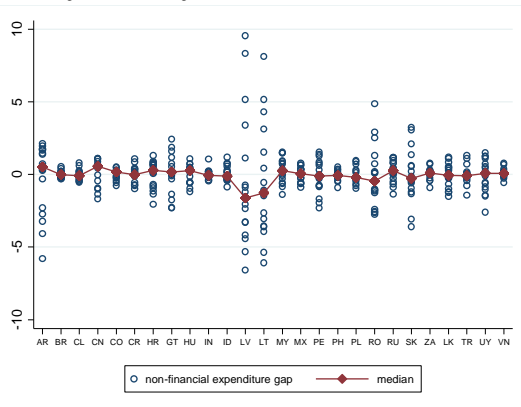
(B) By year



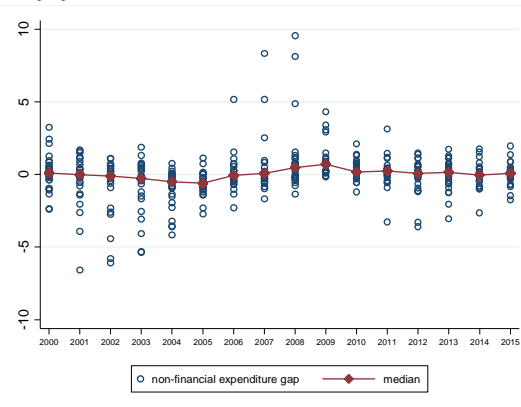
Source: IMF. Author's estimates

Graph A2: Expenditure gap
(percentage of GDP PBI, 2000-2015)

(A) By country



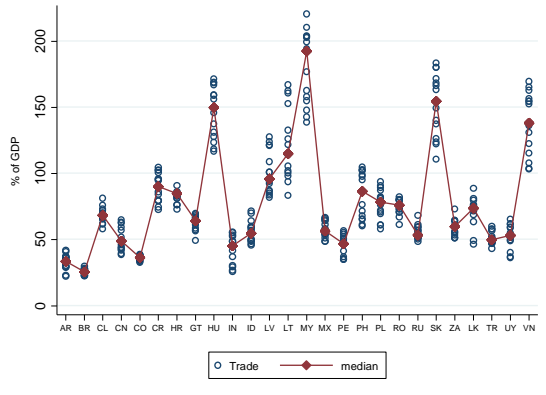
(B) By year



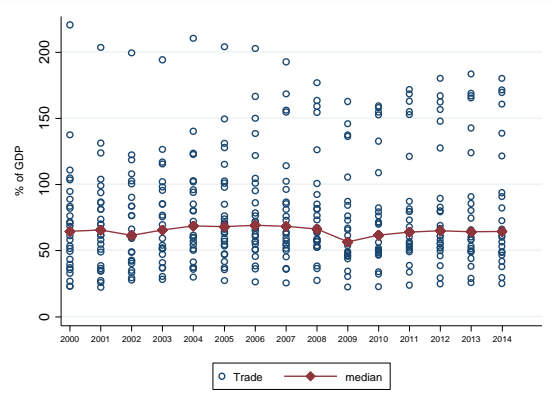
Source: IMF. Author's estimates

Graph A3: Trade openness
(percentage of GDP PBI, 2000-2015)

(A) By country



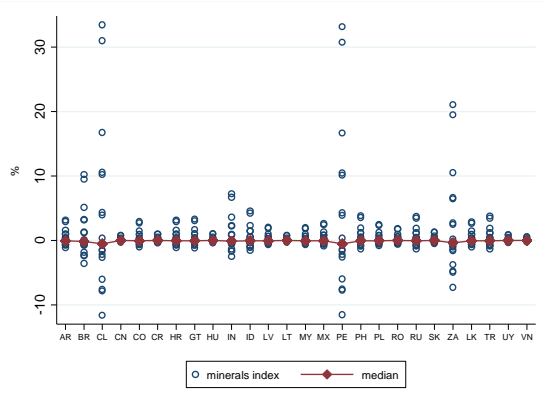
(B) By year



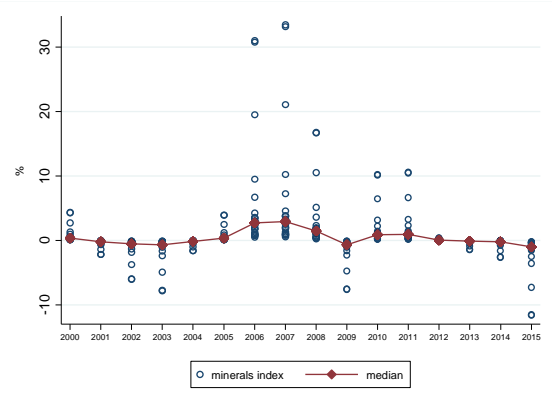
Source: World Bank. Author's estimates

Graph A4: Minerals index
(deviations from trend values, 2000-2015)

(A) By country



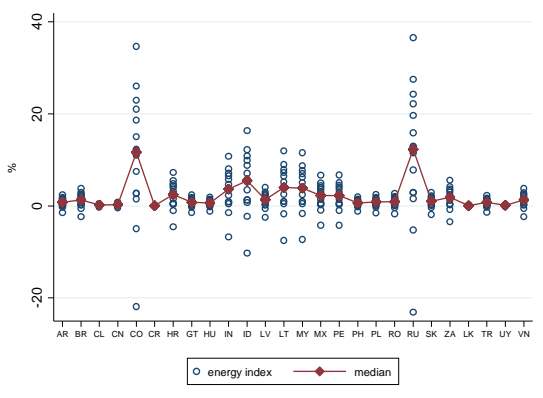
(B) By year



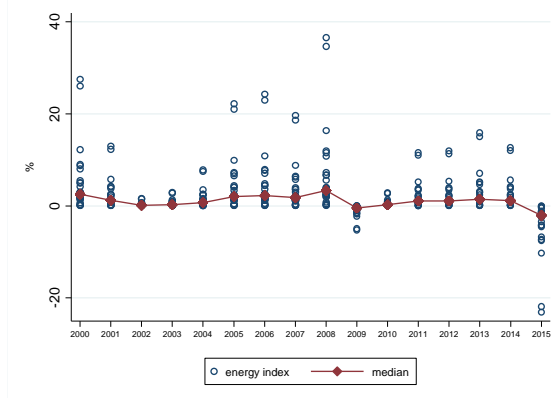
Source: World Bank and United Nations. Author's estimates

Graph A5: Energy Index
(deviations from trend values, 2000-2015)

(A) By country



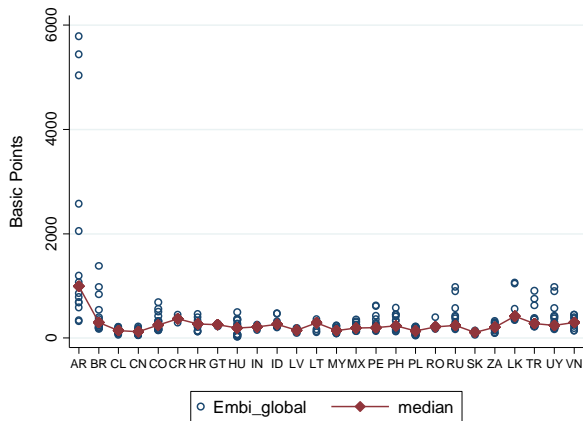
(B) By year



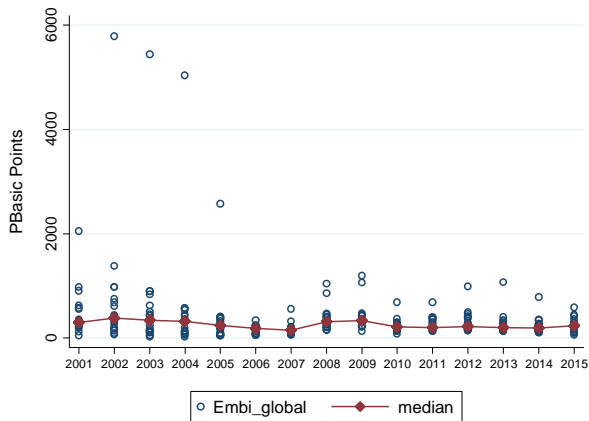
Source: World Bank and United Nations. Author's estimates

Graph A6: EMBI Global
(basic points 2001-2015)

(A) By country

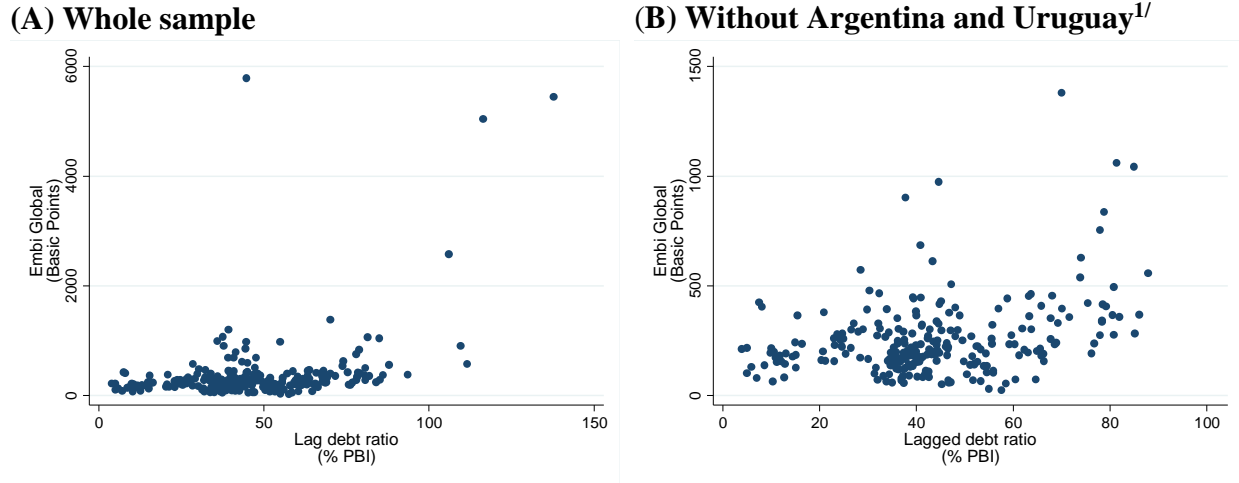


(B) By year



Source: Bloomberg. Author's elaboration.

Graph A7: EMBI Global and public debt ratio
(basic points 2001-2015)



1/ We exclude these two countries only to better visualize the relationship between these two variables in the graph.
Source: Bloomberg and IMF. Author's calculations.

Appendix 2: control variables assumptions used in the deterministic debt limit

Table A1: Control variables and assumptions

Country	Variables	Assumption	Value
All (without Peru)	All	2000-2015 Average	Varies with each country
Peru	US-Treasury-10Y (%)	Jan-Jun 2016 Average	1.9
Peru	Nominal Exchange rate deprec. (%)	Consistent with PPP	2.0
Peru	VIX	2001-2015 Average	20.5
Peru	Inflation (%)	Central Bank target	2.0
Peru	GDP gap (%)	Steady state assumption	0.0
Peru	Historical interest rate (%)	2015 data	5.5
Peru	REER (%)	2015 data (BIS)	102.0
Peru	Nominal GDP growth (%)	IMF potential growth data	6.1
Peru	Mineral Price Index gap	2000-2015 Average	13.1
Peru	Energy Price Index gap	2000-2015 Average	2.6
Peru	Gov. Expenditure gap	2000-2015 Average	0.1

Note: We do not use averages values for the Peruvian variables given that we able to obtain more information to better estimate steady state values for this country. In most cases these assumptions are more restrictive than the averages values (e.g. nominal GDP growth, nominal exchange rate depreciation, among others).

Source: Authors' elaboration.

Appendix 3: data availability

	DATABASE			DEBT LIMIT ESTIMATION						
	Countries in FC data	Countries in FR data	Countries in DATABASE	COUNTRIES IN EACH REGRESSION		Restricting variable in FC regression	Restricting variable when estimating debt limit	Considering all restricting variables	FINAL SAMPLE	
				FC	FR	Without REER	Without hist. interest rate	SUITABLE COUNTRIES	Countries with deterministic debt limit	Countries with stochastic debt limit
Albania	Yes	No	No	--	--	--	--	--	--	--
Argentina	Yes	Yes	Yes	Yes	Yes	Yes	No	--	--	--
Brazil	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Chile	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
China	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Colombia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Costa Rica	Yes	Yes	Yes	No	Yes	No	Yes	--	--	--
Croatia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Czech Republic	Yes	No	No	--	--	--	--	--	--	--
Estonia	Yes	No	No	--	--	--	--	--	--	--
Guatemala	Yes	Yes	Yes	No	Yes	No	No	--	--	--
Hungary	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
India	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Indonesia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Korea	Yes	No	No	--	--	--	--	--	--	--
Latvia	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Lithuania	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Malaysia	Yes	Yes	Yes	Yes	Yes	Yes	No	--	--	--
Mexico	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Peru	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Philippines	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Poland	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Romania	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Russia	Yes	Yes	Yes	Yes	Yes	Yes	No	--	--	--
Slovak Republic	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Slovenia	Yes	No	No	--	--	--	--	--	--	--
South Africa	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sri Lanka	Yes	Yes	Yes	No	Yes	No	No	--	--	--
Thailand	Yes	No	No	--	--	--	--	--	--	--
Turkey	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Uruguay	Yes	Yes	Yes	No	Yes	No	No	--	--	--
Vietnam	Yes	Yes	Yes	No	Yes	No	No	--	--	--
SAMPLE	32	26	26	21	26	21	19	18	11	18

Note: FC stands for financing costs (of debt); FR stands for fiscal reaction (function); REER stands for real effective exchange rate