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The Impact of Debt Sustainability and the Level of Debt on Emerging Markets Spreads

Nazim Belhocine and Salvatore Dell'Erba

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The Impact of Debt Sustainability and the Level of Debt on Emerging Markets Spreads[1]

Prepared by Nazim Belhocine and Salvatore Dell'Erba

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Abstract

How do financial markets respond to concerns over debt sustainability and the level of public debt in emerging markets? We introduce a measure of debt sustainability – the difference between the debt stabilizing primary balance and the primary balance–in an otherwise standard spread regression model applied to a panel of 26 emerging market economies. We find that debt sustainability is an important determinant of spreads. In addition, using a panel smooth transition regression model, we find that the sensitivity of spreads to debt sustainability doubles as public debt increases above 45 percent of GDP. These results suggest that market interest rates react more to debt sustainability concerns in a country with a high level of debt compared to a country with a low level of debt.

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Author's E-Mail Address: NBelhocine@imf.org, SDellErba@imf.org

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I. INTRODUCTION

While many studies have analyzed the determinants of spreads in emerging markets, there has been limited attention paid to the impact of debt sustainability on spreads, and in particular to its relationship to the level of public debt. This paper attempts to fill this gap by investigating the extent to which financial markets react to debt sustainability– defined as the difference between the debt stabilizing primary balance and the actual primary balance–and to its link to the level of debt.

This study makes several contributions to the existing literature. First, the paper introduces explicitly a measure of debt sustainability to explain spreads. Most studies use the level of public debt as the stock variable that is most likely to influence spreads. However, a stock variable has no forward looking content. By incorporating a measure of debt sustainability, we allow for the likely future path of debt to be a factor in the pricing of sovereign debt. Our debt sustainability measure is defined as the difference between the debt stabilizing primary balance and the primary balance. We extend our results by looking at another measure, the debt *consolidating* primary balance–defined as the primary balance that needs to be maintained for a pre-specified number of years for debt to reach a certain set level.

Second, the paper extends the basic spread specification model using a panel smooth transition regression (PSTR) introduced by González et al. (2005), to better account for the interaction between the level of debt and the measure of debt sustainability in explaining sovereign spreads. This approach allows the measure of debt sustainability to have differing regression slopes for a certain range of debt levels above and below an endogenously estimated inflection point. As discussed below, the PSTR is a generalization of the threshold panel model of Hansen (1999); it allows the regression coefficients to change gradually when moving from one regime to another instead of changing discontinuously. As such, this regression technique defines a region over which the elasticity of the estimate varies continuously, taking the shape of a logistic function, and identifies an inflection point, instead of a threshold, where the regime switch is most pronounced. Spreads movements and financial market reactions are likely to be best represented by smooth transition models than by a discontinuous regime model, especially when the frequency of the data is low.

Third, in contrast to most studies which use low frequency data on ex-post observations to explain the behavior of emerging market spreads, this paper uses as explanatory variables macroeconomic forecasts to proxy expectations of countries' fundamentals. Indeed, the pricing of sovereign bonds should ultimately be a function of market expectations of fundamentals, not simply of ex-post realizations of these fundamentals. An added advantage of using real-time data is that it prevents simultaneity problems which can arise from the use of actual data. A final advantage with the real-time data series used in this paper is that it originates from the bi-yearly IMF World Economic Outlook data vintages and as such, it doubles the number of observations compared to the papers in the literature which use annual data.

The paper finds that debt sustainability is a major determinant of spreads with an elasticity of about 25 basis points for each 1 percentage point departure of the primary balance from its debt stabilizing level. In other words, fiscal consolidation of 1 percentage point in the primary balance would eliminate about 25 basis points in the pricing of debt. In addition, the panel smooth transition regression identifies a level of debt-to-GDP of 45 percent beyond which spreads reach 54 basis points, double the level found in the baseline model. The impact on spreads of the departure of the primary balance from its debt stabilizing level increases smoothly in a logistic way from a debt level of 25 percent of GDP to reach a maximum of 54 basis points when debt-to-GDP exceeds 45 percent. We conclude that financial markets' concerns about debt sustainability become even larger as debt levels increase beyond 45 percent of GDP. These findings suggest that policymakers in emerging economies should adopt prudent fiscal policies that keep public debt levels low in order to avoid a potentially damaging rise in their sovereign spreads. Finally, the findings were robust to the use of a different definition of debt sustainability, to the reliance on a different concept of the interest rate on public debt, as well as to the potential impact of episodes of sovereign debt crises.

The rest of the paper is organized as follows. Section II surveys the literature on determinants of spreads. Section III describes the empirical model and the definition of debt sustainability. Section IV defines the variables used in the estimation and the data sources. Section V presents the estimation and inference results. Section VI introduces the smooth transition regression approach and investigates the impact of the debt level on the perception of financial market of debt sustainability. Section VII discusses the findings in relation to the literature on prudent levels of debt in emerging markets. Section VIII extends the findings by using a different measure of debt sustainability, a different measure of interest rates on public debt, and discusses the robustness of the findings to episodes of sovereign crises. Section IX concludes.

II. Literature Review

There is an extensive literature on the determinants of sovereign spreads that can be divided into two strands. The first examines the impact of a broad set of macroeconomic fundamentals on sovereign spreads using low frequency data and the second investigates the short and long-term determinants of sovereign spreads by looking at domestic and external factors using higher frequency data.

Edwards (1984) initiated the first strand by showing that the pricing of a sovereign default by a risk-neutral investor, expressed as market spread over risk-free world interest rate, is a linear function of fundamentals that act as determinants of the probability of default. Using a panel of emerging markets, he found that external debt and international reserves are the key determinants of sovereign spreads, followed by the debt service and the country's investment ratio. Various studies have since expanded the set of variables, countries, periods, and improved the econometric estimation. For instance Min (1998) finds that a larger set of macroeconomic variables matter, including domestic inflation rate, net foreign assets, terms of trade index, and the real exchange rate. Jahjah and Yue (2004) show that exchange rate policy has an impact on sovereign bond spreads as an overvalued real exchange rate significantly increases sovereign spreads, with the size of this effect being higher under a fixed-exchange rate. Hallerberg and Wolff (2008) show that deficits have a significant determinant on risk premia in countries of the European Monetary Union (EMU), with fiscal deficits mattering less in countries with better fiscal institutions. Similarly, Iara and Wolff (2010) show that EMU countries with stronger fiscal rules have exhibited lower sovereign bond spreads. Akitoby and Stratmann (2008) show that current expenditure and revenues matter for spreads while Baldacci et al. (2008) show that political instability is also related to sovereign spreads. Faini (2006) investigates the interest rate spillover effects of fiscal policy changes in EMU countries and finds evidence that the impact from high debt countries is significant when sustainability of fiscal policies are in doubt. Ghosh et al. (2013) find that fiscal space, defined as the difference between the current debt ratio and an endogenously calculated debt limit from a stochastic model of sovereign defaults, is a better explanatory variable of sovereign spreads and CDS rates in the eurozone countries than just the public debt ratio. Alper and Forni (2012) and Baldacci et al. (2012) extend the existing emerging markets literature by using forecasts of fiscal and other macroeconomic variables and find large spillover effects into emerging markets' long-term yields from debt levels in both advanced economies and other emerging markets.

The second strand of literature uses higher frequency data and various econometric techniques to look at a wider set of issues to explain spreads. For instance, some papers explore the role of global factors. Using monthly data from the 1990s and historical monthly data on bonds during 1870–1913, Mauro et al. (2002) contrast the spreads on sovereign bonds from both periods and show that sharp changes in spreads in the 1990s tend to be mostly related to global events, whereas they were primarily related to country-specific events in 1870–1913. Hartelius et al. (2008) show that external global factors (including interest rate expectations and stock market volatility) account for over half of spread dynamics. However, using quarterly data, Uribe and Yue (2006) find that global factors transmit external shocks to individual country risk through the rating system and that world interest rate and domestic fundamentals account for 40 percent of movements in bond spreads. A notable absence in their empirical implementation is a measure of country debt as it's not found to improve the overall fit of the model. Most likely, the level of indebtedness is already captured by the inclusion of credit ratings variables.[2] More recently, IMF (2011) has analyzed the relationship between indicators of sovereign risk (spreads on sovereign

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[2] Indeed, the pricing of sovereign bonds have been found to be related to credit ratings. In a pioneering study, Cantor and Packer (1996) investigate the determinants of credit ratings and their link with sovereign spreads, using cross-sectional data for 49 countries. Their results show that credit ratings are mostly explained by a set of six macroeconomic variables: per capita income, GDP growth, inflation, external debt, level of economic development, and default history. Eichengreen and Mody (1998) find that countries with higher credit ratings have lower spreads. However, Gonzalez-Rosada and Levy-Yeyati (2008) and Cavallo et al. (2008) have questioned the result on the basis of endogeneity of rating changes to sovereign spreads.

CDS and on relative asset swap (RAS)) using monthly data for G7 countries and confirmed that global and financial factors dominate macroeconomic and fiscal fundamentals in explaining the variation in their measures of spreads. Jaramillo and Weber (2012) identify a threshold level of tranquil versus turbulent times on a sample of monthly emerging market data from 2005 to 2011 and find that fiscal variables matter when the level of global risk aversion is elevated. Comelli (2012) estimates sovereign bond spreads of 28 emerging economies using monthly data over the period January 1998-December 2011 and test the ability of the model to generate accurate in-sample predictions for emerging economies bond spreads. His findings are similar to Jaramillo and Weber (2012) in that the impact and significance of country specific and global explanatory variables on bond spreads varies across economic periods.

Other papers have looked at the identification of short and long-term determinants of sovereign bond spreads with a dynamic error correction model (examples include Dell'Aricia et al. (2000), Ferrucci (2003) and Bellas et al. (2010)). These studies find that global liquidity conditions—measured for example by the volatility of the stock market and the U.S. government securities' yields—have a large impact on short-term sovereign bond spreads. On the other hand macroeconomic factors that affect a sovereign's solvency and liquidity, as well as political risk, are found to be significant determinants of emerging market sovereign bond spreads in the long run. These macroeconomic factors include external debt to GDP ratio, the degree of openness, the ratio of amortizations to reserves, the country's financial conditions and the ratio of the current account to GDP; the interest payments to external debt ratio and the fraction of short-term external debt are also correlated with sovereign spreads, albeit more weakly.

III. Empirical Model

We follow the literature in relating spreads to country fundamentals and global factors. Given the use of projections as explanatory variables for spreads and the focus on debt sustainability, we specify the spread regression as follows:

$$S_{i,t} = \alpha_i + \beta_1(pb_{i,t} - pb^*_{i,t}) + \sum_{j}^{J} \beta_j X_{j,i,t} + \sum_{k=2}^{K} \beta_k \, E_t\left[\sum_{\tau=1}^{T} X_{k,i,t+\tau}\right] + \epsilon_{i,t}$$

where $S_{i,t}$ is the EMBI spread of country *i* at time *t*, α_i is the country fixed effects, pb_t is the primary balance for country *i* at time *t*, $pb^*_{i,t}$ is the debt stabilizing primary balance for country *i* at time *t*, $X_{j,i,t}$ is the set of j global factors variables, $X_{k,i,t}$ is the set of *k* fiscal and macroeconomic variables and E_t is the expectation operator applied to τ ahead forecasts of $X_{k,i,t}$.

The methodology for calculating the debt-stabilizing primary balance pb_t^* is widely used, including in the Fund's debt sustainability framework. The starting point is the fundamental equation of debt evolution:[3]

$$d_t - d_{t-1} = \frac{i_t - \gamma_t}{1 + \gamma_t} d_{t-1} - pb_t$$

where d_t is the debt-to-GDP ratio at time t, i_t is the weighted-average interest rate on total debt, corrected for the impact of the exchange rate as described in Escolano et al. (2011), $\gamma_t$is the nominal GDP growth rate, and pb_t is the primary balance at time t. Assuming a constant debt level implies setting d_t equal to d_{t-1}. Rearranging the debt equation leads to the following expression:

$$pb_t^* = \frac{i_t - \gamma_t}{1 + \gamma_t} d_{t-1}.$$

IV. DATA DESCRIPTION

Our dependent variable is the secondary market sovereign spreads from J.P. Morgan's EMBI Global (EMBIG) defined as the difference between the weighted average yield to maturity of sovereign bonds minus the yield of the U.S. Treasury bond of similar maturity.[4] Data on EMBI spreads are available since 1994 although the starting point differs across countries. We choose to focus on the EMBI spread since, as argued in Baldacci et al. (2012), this variable has important implications for actual borrowing costs in emerging markets (Eichengreen and Mody (1998), Durbing and Ng (2004)) and for the conduct of monetary policy (Favero and Giavazzi, 2004). To control for the impact of outliers, we remove the top 2.5 percent observations which corresponds to spreads above 2500 basis points.

Our control variables follow Baldacci et al. (2012): total debt to GDP; external reserves to GDP and the current account to GDP; CPI inflation and real GDP growth. All variables are stationary by construction, since they are either ratios or growth rates. We construct a real-time dataset of these factors using different vintages of the World Economic Outlook (WEO), which are released twice a year, typically in April and October, thus doubling the amount of observations compared to the literature which uses annual data. As discussed in the introduction, the use of projections has an advantage in that the pricing of sovereign bonds should ultimately be a

[3] For further discussion, see Escolano (2010) and Escolano et al. (2011).

[4] To be included in the EMBIG index, countries have to satisfy one of the following criteria: (i) be classified as low or middle per capita income by the World Bank; (ii) regardless of their World Bank-defined income, have restructured external or local debt in the past 10 years. For a given bond to be included in the instrument, they have to have a face value of over US$500 million, with maturity of more than two years and six months, and verifiable daily prices and cash flows.

function of market expectations of fundamentals, not of ex-post realization of these fundamentals. The underlying assumption is that investors' expectations are aligned with the WEO projections, which seem reasonable for most countries considered since alternative data sources are not as common, while WEO projections are correlated with investors' consensus forecasts. We use only the one-year ahead projection since projections beyond a one-year horizon showed no explanatory power, likely due to poor quality forecasts. We collected forecasts of fundamental variables for 26 emerging market economies on a semi-annual basis for the period 1994-2011.[5] As a result, period t in our specification denotes semi-annual observations. In addition, the EMBI spread is sampled the month after the release of the forecast for the macroeconomic variables $X_{k,i,t}$ in order to allow financial markets to absorb new forecasts before setting a new level for credit risk.[6] Since the macroeconomic forecasts are made before the EMBI spread is realized, and given the reliance on real-time data instead of ex-post realizations, the estimation setup minimizes potential issues related to simultaneity and endogeneity. Finally, we introduce in the analysis a proxy for global risk aversion produced by the Chicago Board Options Exchange Volatility Index (VIX), which is a measure of investors' attitude toward risk (McGuire and Schrijvers (2003)).

In calculating a market-perceived debt stabilizing primary balance, we compute i_t by taking the weighted average of domestic and external market interest rates, using as weights the share of each type of debt in total debt. In using a market rate on debt instead of the more conventional effective interest rate - measured as the government interest expenditure divided by the stock of public debt - we are following the approach adopted by Favero and Giavazzi (2004) and Alper and Forni (2011) to best proxy financial markets' perception of sovereign risk. In any case, we show in Section VIII that the results of the estimation hold when using the effective interest rate. For domestic market interest rates, we use the money market rate obtained from the International Financial Statistics database and for external market interest rates, we use the EMBIG yields.[7] To control for outliers in the observations of the debt sustainability measure (pb^*-pb), we strip out the top and bottom 2.5 percent observations.

A summary of the descriptive statistics is provided in Table 1.

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[5] The data on emerging market economies covered the following countries: Argentina, Brazil, Bulgaria, Chile, China, Colombia, Ecuador, Egypt, Hungary, Indonesia, Kazakhstan, Malaysia, Mexico, Pakistan, Panama, Peru, Philippines, Poland, Russia, Serbia, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, and Vietnam.

[6] Using semi-annual averages of the spreads does not alter the results. This timing was adopted to make spreads as close as possible to the data release date.

[7] Money market data was the most comprehensive data available, both time and country-wise. Data for domestic bonds returns either from Bloomberg or DataStream were not available for a long-enough period of time (typically, they started after 2000) and for a large set of countries (typically covering only about 10 emerging markets). When money market data was lacking or of a short-horizon, which was the case for 5 countries, we have instead used the central bank discount rate.

Table 1. Summary Statistics of the Variables Used

	Mean	SD	Min	Max	N
EMBI spreads (basis points)	355.21	333.34	25.14	2499.91	546
EMBI yields (percent)	7.36	3.58	0.89	35.11	546
VIX	22.69	10.67	10.81	62.63	546
International reserves/GDP	17.30	12.10	0.94	69.93	544
CPI inflation	6.04	5.47	0.08	40.45	546
Real GDP growth	4.24	1.71	-4.56	12.56	546
Primary balance/GDP	0.93	2.33	-5.71	10.37	547
Total public debt/GDP	43.52	20.90	3.89	107.15	546
Money market interest rate	10.11	8.50	0.14	55.00	543
PB*-PB	-0.51	2.88	-10.91	6.91	546

V. Impact of Debt Sustainability on Spreads

Table 2 shows the estimation results of two models: model 1 represents the basic spread regression without the debt sustainability variable while model 2 incorporates the debt sustainability variable described in Section III.

All coefficients in model 1 are significant but the level of reserves and the primary balance.[8] The coefficients are also of the expected signs. Notice that growth has the largest impact on spreads: an increase of 1 percentage point in growth lowers spreads by 48.8 basis points. On the other hand, public debt-to-GDP has the least impact on spreads. Overall, these findings are comparable to the ones found in the literature discussed in Section II, but for the level of reserves, likely due to the use of the forecasts instead of realized levels. The goodness of fit is also comparable to what was found in the literature.

Moving to model 2, notice that the measure of debt sustainability displays a very strong and significant impact on spreads: a 1 percentage point consolidation that brings the primary balance close to its debt stabilizing level would reduce spreads by 24.5 basis points. All the other coefficients are broadly in the same range, but growth, which has a lower coefficient. We conclude that sovereign risk pricing in financial markets is mostly affected by the expected growth and fiscal sustainability concerns.

[8] Other variables that are not systematically controlled for and are often used in the literature were found insignificant. These include the Fed Fund rate, the overall fiscal balance, the terms of trade, and measures of fiscal institutions. The presentation aims to be parsimonious and focused on the variables that have been found most relevant in explaining spreads in our estimation so these results were not shown and are available upon request.

Table 2. Spread Regressions With and Without the Debt Sustainability Term

VARIABLES	(1) Model 1	(2) Model 2
VIX	9.78***	9.85***
	(1.317)	(1.247)
Real growth	-48.80***	-25.61***
	(7.509)	(7.424)
Inflation	14.95***	18.34***
	(2.709)	(2.506)
Reserves/GDP	-2.62	-1.04
	(2.361)	(1.966)
Debt/GDP	5.47***	6.10***
	(1.375)	(1.065)
Primary balance/GDP	-1.79	1.70
	(2.078)	(5.283)
PB*-PB		24.50***
		(8.500)
Observations	544	544
R-squared	0.481	0.545
Number of id	26	26
AIC	7052	6983
Log likelihood	-3520	-3485

Dependent variable is the EMBI spread. The coefficients measure the impact of the variables in basis points. Robust standard errors in parentheses.*** denotes significance at 1% level, ** 5% level and * 10% level.

VI. Exploring the Role of the Debt Level in the Response of Spreads to Debt Sustainability

The previous section has identified debt sustainability as a major variable in the determination of spreads. However, debt sustainability alone is likely to be a partial explanatory variable for spreads since it does not take into account the relevance of the level at which debt is being stabilized (Faini, 2006). Indeed, debt is sustainable so long as the debt-to-GDP ratio does not increase indefinitely. While this condition meets the intertemporal budget constraint, stabilizing debt at a high level makes countries vulnerable to shocks and changes of market sentiments, which in turn is priced into the default risk. In particular, many studies have shown that emerging markets cannot sustain high levels of debt (see Section VII below for a comprehensive discussion and the relevant references).

The spread regression is not specified to allow for the relationship between debt sustainability and risk of defaults to change with changes in the level of debt. To do so requires a nonlinear model. One possible venue is to estimate a given nonlinear functional form, such as a quadratic model. However such an approach requires knowledge of the shape of the nonlinearity prior to estimation. An alternative approach is to use a threshold model to test for any nonlinearity. One popular approach is the one introduced by Hansen (1999) who explores the statistical properties of threshold regressions for non-dynamic panels with individual-specific fixed effect and aims at capturing a threshold effect that might occur as a result of the non-linearity. However, this approach identifies jumps in the data that display discontinuity. It is likely that the non-linearity of spreads with regards to debt and fiscal sustainability is better described by a process which only builds up progressively. To account for this smoothness, we rely on a logistic panel smooth transition regression introduced by González et al. (2005) as a generalization of the threshold panel model of Hansen (1999). This approach allows the regression coefficient to change gradually when moving from one regime to another instead of changing discontinuously. As such, this regression technique defines a region over which the elasticity of the estimate varies continuously, taking the shape of a logistic function, and identifies an inflection point where the regime switching is most pronounced.[9] A description of this estimation technique and the non-linearity relevance of the debt variable are provided in the Appendix.

The new specification takes the form of the following model:

$$S_{i,t} = \alpha_i + \beta_1(pb_t - pb_t^*) + \beta'_{2,t}(pb_t - pb_t^*) + \sum_{j}^{J} \beta_j X_{j,i,t} + \sum_{k=2}^{K} \beta_k \, E_t\left[\sum_{\tau}^{T} X_{k,i,t+\tau}\right] + \epsilon_{i,t}$$

where the non-linearity is specified by an interaction term between debt sustainability and the level of debt taking the following form:

$$\beta_{2,t}{}' = \beta_2\left(1 + e^{-\gamma(b_t - b^*)}\right)^{-1}$$

with β_2 , γ and $b*$ are estimated using non-linear estimators, and where $b*$ is the threshold variable and gamma the coefficient determining the shape of the logistic function (see Appendix for more details) .

Table 3 shows the results of the estimation, referred to as model 3. The findings are very close to those of model 2: the VIX, growth, inflation are significant while debt and the partial effect of debt sustainability become insignificant with all the variables of the expected sign. Most importantly however, model 3 shows that the interaction term is large at 53.69 and significant. The model also identifies an inflection point in the debt level at about 35 percent of GDP.

[9] An early application of this approach was suggested by Giavazzi and Favero (2004) for Brazil, using time-series econometrics, who show that Brazilian EMBI spreads react non-linearly to global risk aversion, with the non-linearity linked to the level of fiscal fundamentals.

Table 3. Logistic Smooth Transition Regression Results

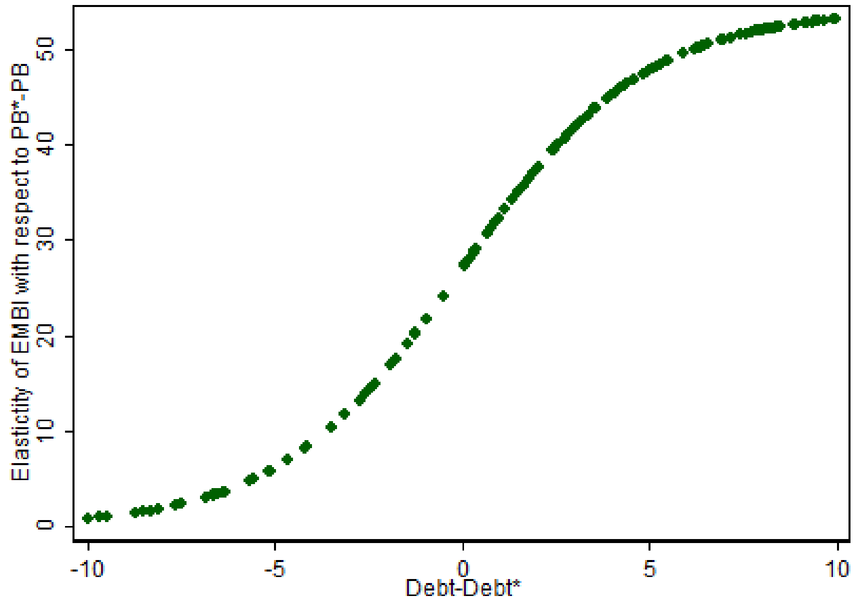
VARIABLES	Model 3
VIX	11.28***
	(1.82)
Real growth	-39.84***
	(10.28)
Inflation	18.43***
	(4.39)
Reserves/GDP	-0.27
	(1.62)
Debt/GDP	0.91
	(2.90)
PB*-PB	0.51
	(4.66)
Interaction term	53.69***
	(9.87)
γ	0.41
Debt/GDP*	34.45
Observations	545
R-squared	0.590
Number of id	26
AIC	6962
Log likelihood	-3478

Dependent variable is the EMBI spread. The coefficients measure the impact of the variables in basis points. Robust standard errors in parentheses.*** denotes significance at 1% level, ** 5% level and * 10% level.

Figure 1 explores further the behavior of the interaction coefficient. Notice that at the inflection point where the debt level is equal to 34.45 percent of GDP, the value of the coefficient is about 26.8 (one-half of the 53.69 level reported for the coefficient on the interaction term in Table 3), close to the level found in model 2 without the interaction term. An increase in debt of about 10 percentage points above the threshold will lead to more than a doubling of the response of spreads: a 1 percentage point increase in the gap between the primary balance and its debt stabilizing level leads to a 53.69 basis points increase in spreads. As a result, countries that have debt levels higher than 45 percent of GDP would effectively add 53.69 basis points to the spreads that they face for each 1 percentage point departure of the primary balance from its debt stabilizing level. When debt is below 25 percent, the impact of debt sustainability is muted.

We conclude that financial markets react more to concerns over debt sustainability when debt levels are above 35 percent of GDP to reach a maximum when debt is above 45 percent of GDP.

Figure 1. Elasticity of Spreads with Respect to the Debt Stabilizing Primary Balance as the Debt Varies Around its Identified Threshold



VII. Discussion And Contribution

The previous section has identified the level of debt of 45 percent of GDP as a level following which spreads become the largest in reaction to debt sustainability concerns. This result is in line with many findings in the literature on the prudent level of debt that emerging markets should hold. Because emerging market economies experience more volatility in key macroeconomic variables (including fiscal revenues and high inflation episodes), have generally weaker institutions, tend to rely relatively more on external borrowing, and have a history of default, the level of public debt ratio that they can typically sustain is much lower than that of advanced economies. Many studies have tried to quantify safe debt limits using different methods. These approaches imply that the concept of safe debt is specific to the methodology adopted and a function of the variable on which the incidence of debt falls. Table 4 summarizes the thresholds identified across various papers reviewed below, together with the sample used and the empirical approach used. One can distinguish four different general methods that were used in the literature to identify safe debt levels in emerging markets.

Cross-country (parametric) methods

Research conducted by IMF staff to identify an appropriate debt limit has looked at the incidence of increasing debt levels on various macroeconomic variables. For example, Detragiache and Spilimbergo (2001) use a panel probability regression approach on a set of 69 countries over 1971-1998 and find that the likelihood of a debt crisis or a debt correction rises when the external debt ratio is above 40 percent. On the other hand, using a panel regression approach on

93 developing countries from 1969 to 1998, Patillo et al. (2002) find that, on average, debt ratios above 30–35 percent have a negative impact on growth. Reinhart et al. (2003) posit that the threshold level of debt beyond which countries become highly vulnerable to a change in investor's confidence is related to the country's default and inflation history. They estimate this safe level for external debt to be in the range of 35–40 percent of GNP and refer to the incapacity of emerging markets to sustain higher debt levels as "debt intolerance".

Event studies and non-parametric approaches

The use of non-parametric methods to devise an early warning system by IMF (2002) concludes that an external debt limit of 40 percent of GDP best discriminates between periods of crises and non-crises. A similar methodology applied to a broader definition of fiscal crises by Baldacci et al. (2011) identifies a threshold around 45 percent for total public debt. Manasse et al. (2003) use a binary recursive tree analysis and find that episodes where external debt is more than 50 percent of GDP incur the largest default risk. Taking a different approach, IMF (2008) conducts an event analysis and finds that the effectiveness of fiscal policy as a countercyclical tool is smaller in emerging markets with high public debt – defined as 25 percent of GDP.

Structural models and other methods

Mendoza and Oviedo (2009) calibrate a dynamic stochastic general equilibrium model and find that the "natural debt limit", i.e. the debt level that is consistent with solvency in all states of the world, is around 35 percent for a typical emerging market. A related methodology assesses whether a government is overborrowing in the sense that its debt stock exceeds the present discounted value of its expected future primary surpluses. IMF (2003) estimates that the average benchmark debt-to-GDP ratio (i.e. the debt-to-GDP ratio which is equal to the present discounted value of projected primary surpluses) among emerging markets is only 25 percent of GDP and that the average emerging market economy has a ratio of public debt to GDP that is 2.5 times larger than its fiscal policy track record would suggest is warranted.

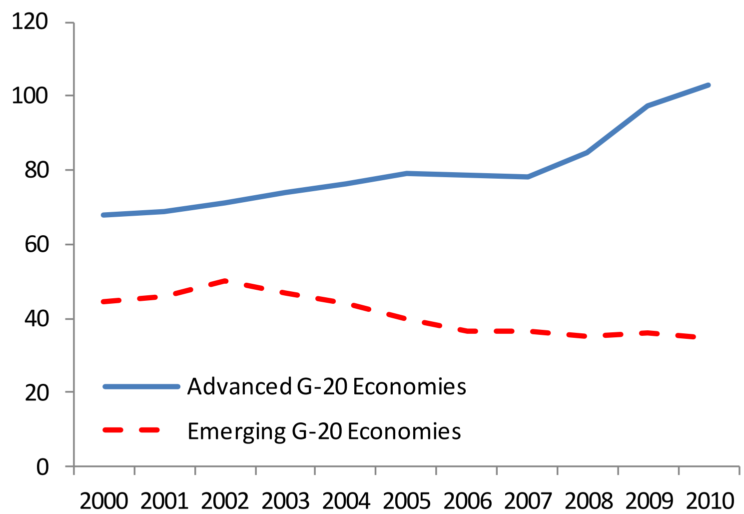
Table 4. Summary of Debt Thresholds Identified in the Literature for Emerging Market Economies

Authors	Dependent variable	Empirical approach	Country sample	Threshold (debt/GDP)	Definition of public debt
Detragiache and Spilimbergo (2001)	Debt crises	Probit approach	69 Emerging markets (1971-1998)	40	External debt
Patillo et al. (2002)	Growth	Panel regression	93 developing countries (1969-1998)	35-40	External debt
IMF (2002)	Debt crises	Binary recursive tree	Developing countries (1979-2001)	40	External debt
IMF (2003)	Debt-to-GDP	Sustainable primary surpluses	Emerging countries (1985–2002)	25	Total debt
Manasse et al. (2003)	Debt crises	Classification and Regression Tree analysis	47 Emerging markets (1970-2002)	50	External debt
Reinhart et al. (2003)	Institutional Investor Ratings	Cross-section regression	53 developing and industrial countries (1979-2002)	35-40	External debt
IMF (2008)	Cyclically adjusted primary balance	Event study	20 Emerging markets (1970-2007)	25	Total debt
Mendoza and Oviedo (2009)	Debt-to-GDP	Dynamic stochastic general equilibrium model	6 emerging markets (1981-2005)	35	Total debt
Baldacci et al. (2011)	Fiscal crises	Minimize noise-to-signal ratio	52 emerging market economies (1970-2010)	45	Total debt

Historical benchmarks

A more straight forward method to assess a debt threshold consists in looking at the historical level of debt as a mean to gauge the feasible and sustainable levels of debt. Figure 2, reports the average public debt level in G-20 emerging and advanced countries for the period 1989-2010. Notice that the average level of debt for G-20 emerging markets has been lower than advanced G-20 economies, averaging 43 percent of GDP for the period considered. The median level was close to 40 percent of GDP for the same period. These levels could serve as useful benchmarks for public debt in emerging G20 countries as they proved to be sustainable during this period.

Figure 2. Gross Debt Ratios in G20 Countries (PPP-Weighted Averages)



The limitations of all these studies which have attempted to determine debt benchmarks beyond which macroeconomic stability and/or fiscal sustainability are at risk are numerous. In particular, it makes clear that the concept of a debt limit is not universal as it depends on the particular channel through which high debt levels adversely affect macroeconomic and financial stability. This helps explain why safe debt limit estimates vary substantially in the literature. For instance, the level of debt beyond which public debt starts to hamper growth is different from the level of debt associated with a high probability of default.

This paper is related to the literature on the relationship between debt levels and fiscal solvency risks which has typically relied on probit-type models. However, these models provide an estimate of the probability of occurrence of a credit event. To translate this into a safe debt limit requires choosing (subjectively) a probability benchmark beyond which the event is considered to have happened. In this paper, we have departed from the probabilistic approach by using an econometric method which does not require the identification of a credit event. This method, an extension of the threshold regression introduced by Hansen (1999), is a smooth transition model from one regime to another which avoids the presence of "kinks" that can be interpreted as tipping points or thresholds. Nonetheless, the smooth transition model retains the notion of a "fast change" where the logistic function shows an inflection point. This specification allows for the impact of debt sustainability on spreads to differ for different levels of debt-to-GDP.

Another difference in our approach in identifying a prudent debt level is that it focuses indirectly on rollover risk given how we have defined the interest rate and the use of spreads as a dependent variable. More specifically, we have assessed the extent to which financial markets are sensitive to sovereign debt levels, once debt sustainability is taken into account. In other words, the paper examined whether there is a debt range beyond which market access conditions for emerging markets would significantly worsen. As such, this approach has not been attempted in the literature and focuses on the perception of financial markets of safe debt levels.

VIII. Extensions and Robustness

Debt Consolidating Primary Balance

In light of the discussion in the previous Section, we explore further the impact of using a different definition of debt sustainability on the effect on spreads and its sensitivity to the level of debt. We focus on a definition of sustainability which measures the gap between the primary balance ratio that would bring the debt ratio to a pre-specified level within a given period and the observed primary balance. This indicator is regularly used in the European Union to assess the sustainability of fiscal policy in member countries (European Commission, 2009) with a target debt ratio of 60 percent and a period consistent with the surveillance horizon under the Stability and Growth Pact. This approach is also broadly similar with the one used by the IMF in its publication of the *Fiscal Monitor* (IMF, 2012).[10] We refer to this measure as the debt consolidating primary balance.

The following formula can be used to calculate the primary balance $pb^\wedge$ that must be maintained for N years to reach a target debt ratio of d_N^* if the initial debt ratio is d_0 (European Commission, 2009):

$$pb^\wedge = \frac{\lambda}{(1+\lambda)^{-N}-1}\left((1+\lambda)^{-N}d_N^* - d_0\right)$$

where

$$\lambda = \frac{i-\gamma}{1+\gamma}.$$

[10] The *Fiscal Monitor* uses cyclically adjusted primary balances instead of primary balance and a gradual adjustment for about 10 years to the targeted debt stabilizing primary balance followed by a 10-year period of constant primary balance at the debt stabilizing level.

Given the literature survey of the previous section and the often used benchmark level of 40 percent of GDP for emerging markets (IMF, 2012), we set d_0 to 40. We also assume that the required adjustment in the primary balance to achieve the indicative debt threshold of 40 percent of GDP takes place over 15 years (or if lower than 40%, to stabilize it at the current level). About 50 percent of the sample countries had debt to GDP levels by end-2011 higher than 40 percent. A shorter adjustment period leads to unrealistic fiscal consolidation plan for many countries. Notice that a longer adjustment period led to a convergence of the estimated coefficients to similar values.

We also explore the existence of non-linearities by investigating the role of debt in determining the response of the debt consolidating primary balance using the following specification, which mimics the one used in Section VI:

$$S_{i,t} = \alpha_i + \beta_1(pb_t - \hat{pb_t}) + \beta_2\left(1 + e^{-\gamma(b_t - b^*)}\right)^{-1}(pb_t - \hat{pb_t}) + \sum_{j}^{J} \beta_j X_{j,i,t} + \sum_{k=2}^{K} \beta_k \, E_t\left[\sum_{\tau}^{T} X_{k,i,t+\tau}\right] + \epsilon_{i,t}$$

Table 5 summarizes the estimation where model 4 represents the spread regression with this new definition of debt sustainability and model 5 represents the smooth transition regression model. Contrasting model 4 with model 2 shows that there are no major differences between the two regressions, although the response of the debt consolidating primary balance is slightly higher than the debt stabilizing primary balance by about 3 basis points (27.13 versus 24.50). Moving to model 5, we notice that the inflection point of debt is marginally lower by about 2 percentage points of GDP (32 percent versus 34.45) while the interaction coefficient is higher by 6 basis points (59.05 versus 53.69). The slightly lower debt level identified using the debt consolidating primary balance definition may stem from the fact that this criterion is more stringent as it employs a concept of debt sustainability that aims to lower the debt level instead of keeping it constant.

Table 5. Logistic Smooth Transition Regression Results

VARIABLES	Model 4	Model 5
VIX	9.42***	10.13***
	(-1.18)	(2.13)
Real growth	-25.98***	-47.32***
	(-8.37)	(12.49)
Inflation	19.74***	17.39***
	(-2.66)	(5.21)
Reserves/GDP	-1.54	-0.88
	(-1.92)	(1.74)
Debt/GDP	4.72***	-3.99
	(-1.25)	(3.41)
PB^-PB	27.13***	-4.01
	(-7.88)	(-7.15)
Interaction term		59.05***
		(12.47)
γ		0.31
Debt/GDP*		32.01
Observations	545	545
R-squared	0.537	0.581
Number of id	26	26
AIC	6978	6988
Log likelihood	-3483	-3491

Dependent variable is the EMBI spread. The coefficients measure the impact of the variables in basis points. Robust standard errors in parentheses.*** denotes significance at 1% level, ** 5% level and * 10% level.

Figure 3 plots the interaction term coefficient. Notice that, as before, at debt levels below 10 percentage points of GDP under the inflection point, the interaction term is zero. We conclude that using a debt consolidating measure of debt sustainability leads to broadly comparable results to the ones obtained using a debt stabilizing measure of debt sustainability.

Using the Effective Interest Rate

As discussed in Section IV, in calculating the debt stabilizing primary balance, we compute i_t using a market rate on debt instead of the more conventional effective interest rate - measured as the government interest expenditure divided by the stock of public debt. Our purpose in using a market rate was to proxy the market-perceived interest rate. In this section, we investigate whether the results of the estimation still hold when using the effective interest rate.

Figure 3. Elasticity of Spreads with Respect to the Debt Consolidating Primary Balance as the Debt Varies Around its Identified Threshold

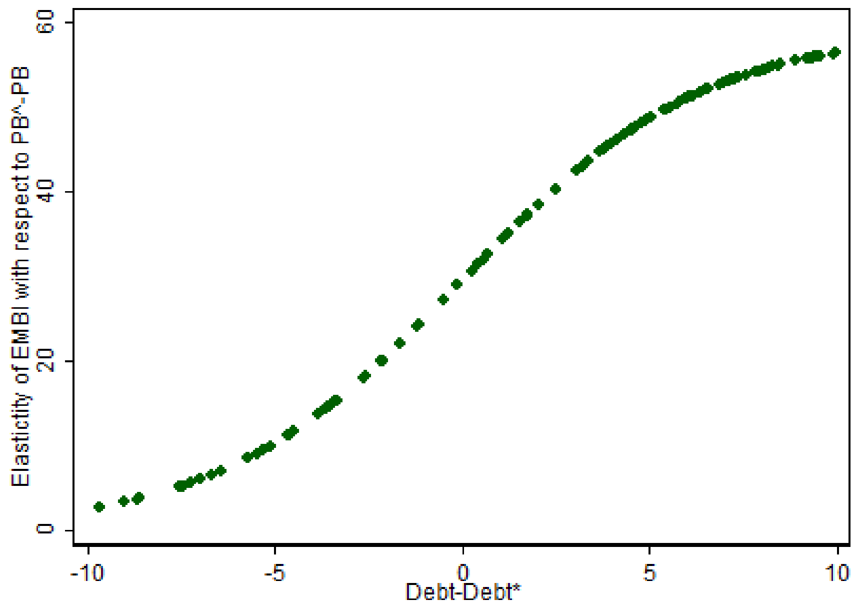


Table 6 shows the estimation results when using the effective interest rate to calculate the debt sustainability measure, referred to as model 6. All variables are of the expected signs with coefficient levels and significance levels similar to model 3 and 5. The coefficient on the interaction term is nonetheless less strong than the other two models (27.39 compared to 53.69 for model 3 and 59.05 for model 5). Nonetheless, the inflection point on the debt-to-GDP variable is close to the other models at 34.54 percent of GDP. We conclude that although using the effective interest rate instead of the market interest rate reduces the response of the interaction term, it does not affect the threshold level of debt-to-GDP.

Controlling for Crises Countries and Outliers

In this section, we investigate the robustness of the results of Model 3 to the impact of sovereign debt crises. Table 7 shows the results of removing one country at a time. The countries shown are the ones that have experienced at least one sovereign debt crisis since 1993. Notice that the all coefficients are broadly stable and keep their level of significance across all experiments. The threshold level of debt is also stable, oscillating between 32 and 35 percent of GDP. The interaction term is also relatively stable, oscillating between 43 and 57 basis points.

Table 6. Logistic Smooth Transition Regression Results

VARIABLES	Model 3	Model 5	Model 6
VIX	11.28***	10.13***	10.92***
	(1.82)	(2.13)	(1.80)
Real growth	-39.84***	-47.32***	-53.47***
	(10.28)	(12.49)	(11.83)
Inflation	18.43***	17.39***	15.98***
	(4.39)	(5.21)	(4.66)
Reserves/GDP	-0.27	-0.88	-1.36
	(1.62)	(1.74)	(1.67)
Debt/GDP	0.91	-3.99	1.78
	(2.90)	(3.41)	(3.02)
Debt sustainability measure	0.51	-4.01	-6.04
	(4.66)	-7.15	-4.86
Interaction term	53.69***	59.05***	27.39***
	(9.87)	(12.47)	(8.79)
γ	0.41	0.31	0.40
Debt/GDP*	34.45	32.01	34.54
Observations	545	545	550
R-squared	0.537	0.581	0.497
Number of id	26	26	26
AIC	6978	6988	7109
Log likelihood	-3483	-3491	-3551

Dependent variable is the EMBI spread. Debt sustainability measure refers to pb*-pb for models 3 and 6 and to pb^-pb for model 5. The coefficients measure the impact of the variables in basis points. Robust standard errors in parentheses.*** denotes significance at 1% level, ** 5% level and * 10% level.

IX. CONCLUSION

This paper explored the question of how do financial markets react to concerns over debt sustainability and the level of public debt in emerging markets. It uses a measure of debt sustainability – the difference between the debt stabilizing primary balance and the actual primary balance – in an otherwise standard spread regression model applied to a panel of 26 emerging market economies. The paper finds that debt sustainability is a major determinant of spreads with an elasticity of about 25 basis points for each 1 percentage point departure of the primary balance from its debt stabilizing level. In addition, using a panel smooth transition regression model, the paper finds that spreads become significantly more sensitive to debt sustainability concerns as public debt increases, reaching 59 basis points for debt-to-GDP above 45 percent, double the level found in the baseline model. These findings were robust to the use of a different definition of debt sustainability and of the interest rate on public debt, as well as on the impact of sovereign debt crises. We conclude that market interest rates react more to debt sustainability concerns in a country with a high level of debt compared to a country with a low level of debt. These results suggest that policymakers in emerging economies should adopt prudent fiscal policies that keep public debt levels low in order to avoid a potentially damaging rise in their sovereign spreads.

Table 7. Impact of Removing One Country at a Time on the Regression Results

VARIABLES	Removing ARG	Removing BRA	Removing RUS	Removing URY	Removing UKR	Removing TUR	Removing ECU
VIX	11.686***	11.260***	11.892***	11.403***	8.4430***	11.428***	11.165***
	(1.855)	(1.824)	(2.089)	(1.786)	(1.321)	(1.848)	(1.879)
Real growth	-41.69***	-39.97***	-39.34***	-38.22***	-23.35***	-38.41***	-45.05***
	(9.954)	(10.26)	(11.04)	(10.11)	(7.053)	(10.12)	(10.75)
Inflation	20.589***	18.526***	18.674***	17.242***	17.716***	19.981***	17.543***
	(4.236)	(4.412)	(4.414)	(4.456)	(4.580)	(4.490)	(4.401)
Reserves/GDP	0.1063	-0.173	0.3839	-0.162	-0.880	0.0465	-0.288
	(1.593)	(1.619)	(1.638)	(1.620)	(1.058)	(1.619)	(1.674)
Debt/GDP	3.9004	0.7967	0.3495	1.0913	0.7292	1.7118	2.0967
	(2.564)	(2.892)	(3.650)	(2.901)	(2.353)	(3.047)	(3.036)
PB*-PB	0.2071	0.6315	4.0307	1.0893	1.1459	1.0417	-1.739
	(4.412)	(4.671)	(5.841)	(4.654)	(3.699)	(4.647)	(4.661)
Interaction term	42.724***	50.539***	57.198***	56.591***	48.057***	56.735***	53.242***
	(7.720)	(10.33)	(10.97)	(10.24)	(8.661)	(10.25)	(9.934)
Debt/GDP*	31.58	34.39	34.35	35.07	32.42	34.22	34.52
Observations	524	522	521	526	521	526	526
R-squared	0.615	0.599	0.580	0.584	0.590	0.595	0.587
Number of id	26	26	26	26	26	26	26
AIC	6610	6644	6675	6717	6532	6717	6716
Log likelihood	-3302	-3319	-3334	-3356	-3263	-3356	-3355

Dependent variable is the EMBI spread. The coefficients measure the impact of the variables in basis points. Robust standard errors in parentheses.*** denotes significance at 1% level, ** 5% level and * 10% level. ARG denotes Argentina, BRA denotes Brazil, RUS denotes Russia, URY denotes Uruguay, UKR denotes Ukraine, TUR denotes Turkey and ECU denotes Ecuador.

APPENDIX

The Panel Smooth Transition Regression

The Panel Smooth Transition Regression (PSTR) model, introduced by Gonzalez et al. (2004), is a generalization of the Panel Threshold Regression (PTR) model originally developed by Hansen (1999). While the PTR models regime shifts by allowing the regression coefficients to be a *discrete* function of an observable variable, the PSTR model models regime shifts as a *continuous* function of an observable variable, called the transition function. This function is ultimately bounded by two "extreme" regimes.

The basic PSTR model can be represented as follows:

$$y_{it} = \alpha_i + \beta_0 x_{it} + \beta_1 x_{it} g(q_{it}, \gamma, c) + u_{it}$$

where y_{it} is the dependent variable; α_i is an individual specific fixed effect; x_{it} is a vector of time-varying exogenous variables; u_{it} is the error term; $g(q_{it}, \gamma, c)$ is the transition function, which is a continuous function of transition variable q_{it} and is bounded between 0 and 1. Following Gonzalez et al. (2004), the transition function is specified as a logistic function:

$$g(q_{it}, \gamma, c) = \frac{1}{1 + \exp\left[-\gamma(q_{it} - c)\right]}, \gamma > 0$$

where c is the location parameter, called also the threshold parameter, and γ the slope of the logistic function. The threshold parameter allows the inflection point of the logistic function to be different than zero.

This specification shows that the model is more flexible than a simple interaction term. Notice that when the parameter $\gamma \to \infty$, the function $g(q_{it}, \gamma, c)$ reduces to an indicator function and the regression model is the Hansen's (1999) PTR model; when the parameter $\gamma \to 0$ the model collapses into a homogeneous linear panel model.

In the regression of Section IV, the response of the EMBI spread (y_{it}) with respect to fiscal space (x_{it}) is allowed to vary with the level of debt (q_{it}) where c is the threshold level of debt.

The total effect of x_{it} on the dependent variable is given by:

$$\frac{\partial y_{it}}{\partial x_{it}} = \beta_0 + \beta_1\, g(q_{it}, \gamma, c)$$

where β_0 represents the impact of x_{it} when the value of the transition function is zero (lower bound); $\beta_0 + \beta_1$ is the impact of x_{it} when the value of the transition function is one (upper bound). Between these two extreme values, the impact of x_{it} is an average of these two parameters and changes according to a smooth logistic function.

Specification Tests

Before describing the estimation procedure, we discuss the specification tests for the PSTR model suggested by González et al. (2004). The first test concerns testing linearity against the PSTR model. In order to do so, the transition function $g(q_{it}, \gamma, c)$ is replaced with its first-order Taylor expansion around $\gamma = 0$, and a test is performed with the auxiliary regression of whether the parameters associated with the transition function are equal to zero. After doing so, the model can be re-written as:

$$y_{it} = \alpha_i + \beta'_0 x_{it} + \beta'_1 x_{it} q_{it} + u_{it}$$

where β'_0 and β'_1 are new parameters proportional to the slope parameter γ. The test for linearity boils down to the test of the hypothesis $H_0: \beta'_1 = 0$. As explained by Gonzàlez et al. (2004), the test can be carried out to detect which variables are more likely to give rise to non-linearity; among a set of candidate transition variables, the ones for which the test detects the strongest rejection of the null can be chosen as transition variables.

A second specification test concerns the number of regimes. If the linearity hypothesis is rejected, then one can test whether there is more than one transition function. For example, if there are at least two regimes, then the baseline model can be rewritten as:

$$y_{it} = \alpha_i + \beta_0 x_{it} + \beta_1 x_{it} g_1(q_{it}, \gamma_1, c_1) + \beta_2 x_{it} g_2(q_{it}, \gamma_2, c_2) + u_{it}.$$

Following similar reasoning behind the linearity test, one can substitute the transition function $g_2(q_{it}, \gamma_2, c_2)$ with its first-order Taylor expansion and test in the ensuing auxiliary regression:

$$y_{it} = \alpha_i + \beta_0 x_{it} + \beta_1 x_{it} g_1(q_{it}, \gamma_1, c_1) + \beta'_2 x_{it} q_{it} + u_{it}$$

the hypothesis $H_0: \beta'_2 = 0$.

Following the sequencing approach suggested by Gonzàlez et al. (2004), we test across the following transition variables: debt/GDP, real growth, and the VIX.[11] The results are reported in Table A.1. Among the various variables chosen, the debt/GDP shows the largest value of the test statistics. Notice also that the debt/GDP variable shows a rejection of the hypotheses of more than one regime. Given the advantages of estimating a parsimonious model, we chose debt/GDP as the variable to use in the transition function with a model featuring only one transition function.

[11] The primary gap (pb*-pb) was unsuccessfully tested as a transition variables as the estimation did not converge.

Table A.1. Tests of Number of Regimes

	Debt/GDP		Growth		VIX	
	Test	P-Value	Test	P-Value	Test	P-Value
H_0 : r=0 vs H_1 : r=1	32.627	0.000	32.328	0.000	10.76	0.000
H_0 : r=1 vs H_1 : r=2	5.233	0.264	27.362	0.000	6.242	0.182

Rows report the test determining the number of regimes in the PSTR model and columns report the candidate threshold variable. The dependent variable is the EMBI spread and the regressions include the Debt/GDP, the VIX, Real GDP Growth, and the threshold variable. The first row tests the hypothesis of linearity (r=0) versus the alternative hypothesis of one regime (r=1). The second row tests the hypothesis of one regime (r=1) versus the alternative hypothesis of two regimes (r=2). The Wald-Test is distributed as an F[1,TN-N-(r+1)] under the null hypothesis. The column p-value reports the associated p-values.

Estimation

The estimation of the PSTR model proceeds as follows. In a first step, the fixed effects are eliminated through a standard de-meaning of the variables. Then, a non-linear least squares (NLS) estimation is applied to the transformed data. We can write the model after subtracting the individual means as:

$$\widetilde{y_{it}} = \beta_0 \widetilde{x_{it}} + \beta_1 x_{it} g\widetilde{(q_{it}, \gamma}, c) + \widetilde{u_{it}}$$

where $\widetilde{y_{it}} = y_{it} - \overline{y_{it}}$; $\widetilde{x_{it}} = x_{it} - \overline{x_{it}}$ and $x_{it} g(\widetilde{q_{it}, \gamma}, c) = x_{it} g(q_{it}, \gamma, c) - \overline{x_{it} g(q_{it}, \gamma, c)}$. However, since the demeaning of the variables is based on the value of γ and c, then the demeaning has to be performed at each iteration of the NLS estimation. The coefficients (β_0, β_1) of the PSTR model are conditional on the slope and the location parameters of the transition function. Therefore, the values of γ and c are obtained by minimizing the concentrated sum of squared errors:

$$Q(\gamma, c) = \sum_{i=1}^{N} \sum_{t=1}^{T} (\widetilde{y_{it}} - \beta_0 \widetilde{x_{it}} - \beta_1 x_{it} g\widetilde{(q_{it}, \gamma}, c))^2$$

and the coefficients (β_0, β_1) are then obtained by ordinary least squares at each iteration of the non-linear optimization.

Results

In Table A.2 we report the results from the estimation of the model in Section VI. While in the main text we report only the coefficients $(\beta_0 + \beta_{1,t})$ associated with fiscal space, here we report the fully specified model which includes the interaction with the remaining variables. As we can see, the model is robust to the inclusion of the debt variable among the main regressors, showing that the non-linearity is not simply a feature of omitted variables. Furthermore, we notice that the debt variable becomes significant only when it crosses the threshold value. Among other variables significant in the high regime, we report also inflation, while interestingly, the impact of the VIX index on spreads is not conditional on the value of the debt.

Table A.2. Fully Specified PSTR Models

	Model 3		Model 6	
VARIABLES	β_0	$\beta_0+\beta_1$	β_0	$\beta_0+\beta_1$
VIX	11.281***	10.266***	10.920***	11.180***
	(1.820)	(2.270)	(1.801)	(2.363)
Real GDP growth	-39.84***	-12.86	-53.47***	-35.61***
	(10.28)	(12.84)	(11.83)	(14.03)
Inflation	18.433***	24.951***	15.985***	23.327***
	(4.397)	(4.494)	(4.669)	(5.069)
Reserves/GDP	-0.273	-2.005	-1.362	-7.333***
	(1.625)	(2.279)	(1.671)	(2.653)
Debt/GDP	0.9163	5.3429***	1.7871	7.0630***
	(2.904)	(2.498)	(3.028)	(2.738)
PB*-PB	0.5166	53.696***	-6.039	27.395***
	(4.660)	(9.870)	(4.857)	(8.791)
γ	0.41		0.40	
Debt/GDP*	34.45		34.54	
Observations	545		550	
R-squared	0.590		0.497	
Number of id	26		26	
AIC	6962		7109	
Log likelihood	-3478		-3551	

The dependent variable is the EMBI spread. Robust standard errors are in parentheses. Model 3 is the PSTR model with the debt-stabilizing primary balance. Model 6 is the PSTR model in which the debt-stabilizing primary balance is calculated using the effective interest rate. β0+ β1,t is the estimated impact of the debt-stabilizing primary gap at the maximum regime of the transition function, γ is the slope of the transition function while Debt/GDP* is its threshold value. *** denotes significance at 1% level, ** 5% level and * 10% level.

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