Journal of Financial Stability 20 (2015) 1–13

Contents lists available at ScienceDirect

Journal of Financial Stability

journal homepage: www.elsevier.com/locate/jfstabil

# Macroeconomic effects on emerging-markets sovereign credit spreads

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ARTICLE INFO

*Article history:*
Received 30 December 2014
Received in revised form 27 April 2015
Accepted 18 June 2015
Available online 28 June 2015

*JEL classification:*
F34

*Keywords:*
Sovereign spreads
Credit risk
Country market value

ABSTRACT

This paper investigates the explanatory and forecasting power of macroeconomic fundamentals on emerging market sovereign credit spreads. We pay special attention to a new set of macroeconomic factors related to market values that reflect investor expectations concerning future economic performance. The model we propose captures a significant part of the empirical variation in spreads. Importantly, it also includes a powerful forecasting component that extends up to 12 months outside the sample period. The forward-looking variables that we construct are significant and complement and enhance the explanatory content of the conventional variables found in the extant literature.



## 1. Introduction

This paper examines the explanatory and forecasting power of forward looking macro variables on sovereign credit spreads. While intuition and financial theory suggest that these variables should affect spreads, they have not been used in this type of study before.

The variables we construct follow Clark and Kassimatis (2011) (hereafter C&K), who have developed a theoretical framework and practical methodology for calculating the expected (forward-looking) macroeconomic market value of a sovereign country's economy. They show that a value weighted index composed of the individual country values can be used to generate explanatory information, incremental to what is available in traded asset prices, that is significant for explaining individual asset returns over an asset universe that includes stocks, bonds, money markets and commodities. They also show that the individual macroeconomic market values that they calculate are analogous to the market values of private companies quoted on the world's stock markets. Corporate market values and the information they provide, such as rates of return and volatility are standard inputs in corporate credit models. Following this intuition we follow C&K to estimate the market values and rates of return of each economy in our sample. We then use this information to construct other macroeconomic variables analogous to those that figure in the corporate credit literature. First, from the country's rate of return we calculate the economy's volatility that we use along with the country's macroeconomic value in the Merton (1974) structural model to estimate a theoretical financial risk premium for each country. Second, we estimate the correlation coefficient between returns to the economy and exchange rates. This correlation coefficient is a variable that has been shown to have important explanatory power in the corporate credit spread literature.[2] Finally, we test the relevance of these forward looking variables for explaining and forecasting sovereign credit spreads.

In the absence of appropriate forward looking macroeconomic market values, researchers focusing on fundamentals have had to rely on proxies to fill the gap. For example, firm value is an important variable in the corporate credit literature, but its macroeconomic analog, country market value, which is a relatively recent innovation, has not been used before. Most studies use GDP or the change in GDP as a proxy measure for the size and productivity of a country. Although related to the market value of a country's productive apparatus, GDP is a very imperfect proxy. It is a flow variable gross of depreciation and provisions for loss that does not distinguish between production costs and the value of output, while the market value of financial theory is a stock variable that incorporates the effects of production costs, output value, depreciation and

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[2] See, for example, Galai and Wiener (2012).

http://dx.doi.org/10.1016/j.jfs.2015.06.002
1572-3089/

expected losses. Similarly, besides GDP, the main variables used in the literature for the effectiveness of a county to generate the foreign currency necessary to service the external debt are the trade balance or the current account balance. While these variables are related to the profitability of a country, they provide only a partial and potentially misleading view of a country's performance. For example, a country's profits can be positive when the current account balance is negative and vice versa.[3]

The innovation of our paper is that we introduce for the first time a set of macroeconomic variables that financial theory suggests should be important determinants of credit risk to explain sovereign credit spreads. The contribution of the paper takes two directions. First, by using the concept of forward looking macroeconomic market values, we have moved the sovereign debt literature closer to the literature on corporate debt and the financial models that drive the analysis. Second, we reinforce the evidence that, in spite of some perceived shortcomings,[4] macroeconomic fundamentals are important determinants of sovereign credit spreads in emerging markets.[5] We show that when macroeconomic fundamentals are correctly specified they play a more significant role in the determination of sovereign credit spreads than previously thought. We find that the new set of macroeconomic factors related to market values that reflect investor expectations concerning future economic performance are statistically significant determinants of sovereign spreads and their significance is robust to the inclusion of the other conventional macro and financial variables found elsewhere in the literature. Standing alone they explain more than 41% of sovereign credit spreads. Combined with other conventional variables the explanatory power increases to 78%. Moreover, we find that they have forecasting power that extends up to 6 months outside the sample period. The model we propose can explain 80% of sovereign spreads six months into the future and the new set of macroeconomic factors increases the accuracy of predicting large jumps in the spread over a 6 month horizon.

The paper is organized as follows: Section 2 reviews the literature on the determinants of sovereign bond yields, Section 3 presents the procedure used to derive the new macroeconomic factors, Section 4 discusses the data and estimation methodology. Section 5 reports our results, which we discuss in Section 6.

## 2. Literature review

The empirical literature on sovereign credit spreads considers local and global factors. Local factors can be divided into macroeconomic fundamentals and solvency and liquidity factors. We begin the review of the literature with the local factors.

### 2.1. Local factors

#### 2.1.1. Macroeconomic determinants

Since a higher level of output means improved capacity to service the economy's debt, many studies find that GDP growth or some similar activity based indicator is a significant determinant of sovereign spreads (e.g. Baek et al., 2005; Beck, 2001; Gibson et al., 2012; Eichler and Maltritz, 2013). The terms of trade (i.e. price of exports relative to the price of imports) are another important determinant of sovereign spreads because they affect the economy's capacity to generate the foreign currency income necessary to service foreign debt (Bulow and Rogoff, 1989). Hilscher and Nosbusch (2010) empirically examine this relationship and find that the terms of trade as well as the volatility of the terms of trade are significant factors affecting sovereign spreads for 31 emerging economies. Min (1998), Baldacci et al. (2011) and Gibson et al. (2012) among others, also report that the terms of trade have a significant, inverse relationship with sovereign spreads.

The trade balance and the current account balance are more general measures of the economy's capacity to generate foreign income to service the country's debt. The empirical results on their effect on sovereign spreads, however, are ambiguous. Eichler and Maltritz (2013) find that the trade balance affects only medium-to-long term spreads but not short term spreads. They argue that in the short run, capital inflows alleviate solvency problems. However, a capital account surplus means a current account deficit, which is why the effect of the current account on spreads is ambiguous. Beck (2001), counter-intuitively, finds that current account surpluses are associated with higher spreads.

Given its well known effects on relative prices, resource allocation and exchange rates, inflation is a source of increased economic and financial uncertainty that can also affect spreads. Min (1998), for example, finds that inflation is one of the macro variables driving spreads for a number of Latin American and Asian countries. He argues that inflation can serve as a proxy for economic management in the sense that well-managed economies experience low inflation rates. Beck (2001) also finds that inflation is a significant determinant of spreads but in his framework it is expected inflation that matters. On the other hand, Diaz and Gemmill (2006) who examine the global and local determinants of the creditworthiness of four Latin American economies, find that inflation is not a significant determinant of sovereign spreads.

#### 2.1.2. Solvency, Liquidity and other factors

Debt to GDP is the main solvency indicator that figures in most empirical studies on the determinants of sovereign spreads (Hilscher and Nosbusch, 2010; Edwards, 1986; Min, 1998; Eichengreen and Mody, 2000; Eichler and Maltritz, 2013). The main liquidity factor is reserves to GDP. Hilscher and Nosbusch (2010), Min (1998), Diaz and Gemmill (2006), Baldacci et al. (2011), Cline and Barnes (1997), among others, find that reserves to GDP is a significant explanatory variable for sovereign spreads. Other studies, such as Bandiera et al. (2010), Bernoth et al. (2012), and Min (1998), use time to maturity as a determinant of a bond's risk.

Other factors include political risk indicators, currency mismatches and default history. For political risk indicators, most authors consider ratings provided by an agency such as Standard and Poor's or the Institutional Investor magazine. Empirical studies find that they add explanatory power beyond that of other macro variables. For example, Kamin and von Kleist (1999) find that emerging economies with relatively favorable credit ratings, experience spreads which differ considerably to those with less favorable ratings. Gonzalez-Rozada and Levy-Yeyati (2008) find that the long-term foreign debt S&P ratings have explanatory power for spreads in 33 emerging economies. Baldacci et al. (2011) employ

[3] See, for example, Eq. (4) and footnote 9.

[4] Much of this literature is related to the behavior of Eurozone countries in the recent financial crisis. For example, De Grauwe and Ji (2013) find that models perform poorly mainly for Eurozone countries because they cannot issue currency and thus, cannot guarantee payment of their debt obligations. Dell'Erba et al. (2013) find that spreads are affected not only by debt levels but debt currency composition as well. They argue that Eurozone countries issuing euro-denominated debt effectively borrow in foreign currency because they have no control over currency issuance. Ang and Longstaff (2013) find that there is a systemic component in sovereign credit risk that is attributed to financial markets rather than fundamentals. Similarly, Arghyrou and Kontonikas (2012), and Philippas and Siriopoulos (2013) find a contagion effect in the Euro sovereign bond market, unrelated to fundamentals, while Janus et al. (2013) find that trading in CDSs is driven by heterogeneous investor beliefs and overconfidence.

[5] Dell'Erba et al. (2013), for example, find that the correlation between spreads and debt levels in foreign currency is much stronger for emerging economies than advanced economies.

a measure of political risk which is based on the Heritage Foundation economic freedom index and the World Bank governance index. They also find that political risk is an important determinant of spreads. Elgin and Uras (2013) find that the size of the shadow economy, which is part of the political risk of a country, is positively related to sovereign default risk.

Default history and currency mismatches, the discrepancy between the currency composition of a firm or nation's assets and liabilities, figure prominently as important factors that can lead to financial crises, especially in developing countries. Reinhart et al. (2003) argue that a country's history of default is a key predictor of future default because some countries tend to be "serial defaulters". Therefore, countries with recent default episodes usually have higher spreads. Currency mismatches create currency risk and can contribute to financial crises in firms as well as countries (e.g. Caballero and Krishnamurthy, 2005; Catao and Sutton, 2002; Duffie et al., 2003; Gibson and Sundaresan, 2001; Gray et al., 2007; Havrylyshyn and Beddies, 2003; Hilscher and Nosbusch, 2010; Longstaff et al., 2011; Diaz and Gemmill, 2006).[6]

### 2.2. Global factors

Longstaff et al. (2011) find that sovereign credit risk is primarily affected by global factors rather than domestic factors. The authors use principal component analysis and find that the first principal component of monthly sovereign CDS spread changes accounts for 64% of the variation in credit spreads. Westphalen (2002) also finds that a large part of the variation in spreads from 26 economies can be explained by a single (unidentified) factor. This finding suggests that variation in spreads is due to systematic factors. Longstaff et al. (2011) report that sovereign credit spreads from 26 economies are more related to U.S. stock and high-yield markets and the VIX index than to local factors such as local equity index returns. However, the authors note that their sample covers a period of global liquidity where investors reached for high yields. In different periods, local factors may be more important in explaining sovereign credit spreads. Pan and Singleton (2008), who also document a strong relationship between sovereign credit risk and the VIX index, find that in certain periods investors develop a bigger appetite for credit exposure at a global level. It is during such periods that sovereign credit spreads co-move the most.

The most commonly used global variables in empirical bond and CDS spread studies are the VIX index, which proxies for volatility in global markets, the yield on a long-term US Treasury bond, which proxies for changes in the US economy, the default yield spread defined as the spread between corporate bonds with low and high credit rating, the returns on a US stock market index, which proxies for the global economic condition and the global business cycle, the TED spread, which proxies for changes in global liquidity, and an equity risk premium proxy, such as the earnings price ratio on a stock market index (see, for example, Longstaff et al., 2011; Gonzalez-Rozada and Levy-Yeyati, 2008; Hilscher and Nosbusch, 2010; Baldacci et al., 2011; Beck, 2001; Eichengreen and Mody, 2000).

### 2.3. Discussion

As comprehensive as this literature is, it suffers from some important shortcomings. The local variables suffer from missing variable bias. While the variables used are intuitively appealing, they fail to address the determinants of credit risk reflected in the theoretical models developed in the corporate finance literature. Specifically, in these models the borrower's capacity to repay depends to a large extent on his wealth (market value) and its volatility (return volatility). This is implicit in the reduced form credit models and explicit in the structural models such as Merton (1974). Most studies on sovereign credit spreads use GDP as a proxy for these variables, but for reasons explained in the introduction of this paper, GDP is not a satisfactory proxy. Multi-currency borrowing is another potential source of omitted variable bias. In a multicurrency environment, the probability of insolvency and the costs of financing depend on the correlation between the company's rate of return and the exchange rate with respect to the borrowed currency (see Galai and Wiener, 2012). This type of analysis has been applied empirically on corporations (e.g. Cornell and Shapiro, 1983; Levich, 2001) but not on sovereigns because up to now no reliable proxy for country returns has been available. This paper attempts to fill this gap in the literature by constructing the relevant variables and testing their relevance to sovereign credit spreads.

## 3. Generating the macroeconomic variables

### 3.1. Market value and annual rate of return

In this section we follow C&K to estimate macroeconomic market value and derive the forward looking macroeconomic variables to be used in the empirical testing. The forward looking concept of macroeconomic market value distinguishes between the value of the economy in local currency and the value of the economy in foreign currency, i.e. US dollars (USD). The value of the economy in local currency reflects the internal organization of the economy in question with respect to wages, taxes, subsidies, tariffs, monetary policy, etc. Combined with human and natural resources, it determines the composition and quantities of what is produced and consumed. Values measured in local currency reflect this organization and resource endowment, which may or may not correspond to values in other economies or on international markets. This is analogous to the situation of the individual firm with its own set of resources, wages, internal transfer prices, cross subsidies, etc., which determine the composition and quantity of its output and its inputs.

Assuming that all transactions take place on the first day of the period, C&K have shown that the market value of an open national economy at time T in local currency, denoted $V_T$, is given by:

$$V_T = (B_T - A_T) + E(B_{T+1} - A_{T+1})R^{-1} + \cdots + E(B_n - A_n)R^{-(n-T)} \quad (1)$$

where $B_t$ is total income for period $t$ from the sale of the economy's output of final good and services, $A_t$ is total expenditure for period $t$ by the economy for the purchase of final goods and services and $R = 1 + r$, where $r$ is a nominal rate that represents the economy's required rate of return.

Similarly, the value of the economy in US dollars (USD), where asterisks denote USD, is given by:

$$V_T^* = (B_T^* - A_T^*) + E(B_{T+1}^* - A_{T+1}^*)R^{*-1} + \cdots + E(B_n^* - A_n^*)R^{*-(n-T)} \quad (2)$$

Using forward rate parity and interest rate parity, we show in Appendix 1 that this can be reduced to:

$$V_T^* = S_T V_T \quad (3)$$

where $S_T$ denotes the spot exchange rate at time $T$ expressed as the price of 1 unit of local currency in USD.[7]

[6] On the relationship between firms' rate of return and exchange rate changes, see also: Dominguez and Tesar (2006). Allayannis and Weston (2001) examine the effect of the hedging activities of firms on the financial exposure stemming from foreign currency denominated debt.

[7] The dynamics for Eq. (3) are presented in Appendix 2.

It is important to understand that $V_T^*$ represents the expected *net* value of the economy measured in USD. This value, as shown in C&K (2011), is analogous to the market capitalization of a quoted stock. It contains two forward looking elements. The first is reflected in $S_T$, the spot exchange rate, through the well-known interest rate parity and forward rate parity relations.[8] The second forward looking element is reflected in $V_T$, the expected *net* value of the economy measured in local currency. The problem here is that only historical data in the national accounts is available to calculate $V$. The historical values, however, do contain forward looking information that reflects expectations. Businessmen use depreciation and provisions for losses and obsolescence to provide for changes in the economic environment that might occur and affect their balance sheets. These provisions are not real losses but estimates of what might happen in the future. As such, they are forecasts incorporated in the *ex post* data and represent the link between historical outcomes and expectations for the future.[9]

For the implementation of the model presented in Section 3.3.1, we follow the procedure outlined in C&K (2011) to generate annual estimates of the USD market value of each of our sample countries. Knowing the USD market value, we then estimate macroeconomic profits and the annual rate of return of each economy. Macroeconomic profits are equal to exports ($X^*$) minus imports ($M^*$) plus net investment.[10] The annual rate of return on the economy is equal to profits in year $T$ divided by the market value of the economy in year $T-1$[11]:

$$\frac{X_T^* - M_T^* + V_T^* - V_{T-1}^*}{V_{T-1}^*} \tag{4}$$

### 3.2. The country financial risk premium

The country default risk premium developed in this section is analogous to the corporate default risk premiums developed in the structural models based on Merton (1974). The key argument in this model is that on the expiry date if the value of shareholder equity falls below the debt to be paid, the shareholder will default. His gain is the difference between the debt payout and the value of the equity that he loses. The situation is somewhat different for sovereign debt because international law is such that it is very difficult for creditors to takeover assets owned by the sovereign debtor. However, foreign creditors can take actions that are costly for the sovereign in terms of litigation, reduced access to export and import financing and financial markets, etc. In other words the sovereign debtor is vulnerable through the exposure of the overall economy to its external sector.[12] Thus, if we denote $\delta$ as the proportion of the total value of the economy accruing to the external sector, $\delta V_T^*$ is the amount at risk (for the empirical estimation of $\delta V_T^*$, see Section 3.3.2).

Using $\delta V_T^*$ as the underlying security, the market value of country debt can be calculated directly:

$$B_0 = \delta V_0^* N(-d_1) + K e^{-rt} N(d_2) \tag{5}$$

where $B$ is the dollar market value of the debt, $t$ is the time to expiration, $r$ is the USD risk free rate of interest, $K$ is the nominal dollar amount of foreign debt outstanding and $N(d)$ is the value of the standardized, normal cumulative distribution evaluated at $d$ with

$$d_1 = \frac{\ln(\delta V_0/K) + (r + (\sigma^2/2))t}{\sigma\sqrt{t}} \tag{6}$$

and

$$d_2 = \frac{\ln(\delta V_0/K) + (r - (\sigma^2/2))t}{\sigma\sqrt{t}} \tag{7}$$

Knowing the market value of the country's foreign debt, we calculate the risk adjusted required rate of return on this debt as

$$\text{Risk-adjusted required rate of return on foreign debt} = r_a = \frac{\ln(K/B_0)}{t} \tag{8}$$

The risk-adjusted required rate of return on foreign debt is the yield that equates the present value of nominal debt with its market value. The financial risk premium for the country is the difference between the risk-adjusted cost of debt ($r_a$) and the risk free USD rate: $r_a - r$.[13]

### 3.3. Variable estimation

#### 3.3.1. Market value and the economy's rate of return

For the individual countries, the capital stock in local currency is equal to $V_T = \sum_{t=0}^{T-1}(V_{t+1}^* - V_t^*)$. It is constructed using the standard perpetual inventory methodology (PIM) from time series data (see: OECD, Measuring Capital, 2001, for details of the PIM methodology). Briefly, starting with historical data on gross investment in local currency, including gross fixed capital formation and change in stocks, depreciation was subtracted to obtain net investment over the period. This net investment was then added to the value of the economy in local currency outstanding at the beginning of the period to obtain the value of the economy outstanding at the end of the period.[14] We compute the initial capital stock from time 0 until the period preceding the first available data point from the following regression:

$$\text{Profits}_t = X_t - M_t + (V_t - V_{t-1}) = c + \hat{r}V_t + u_t \tag{9}$$

where Profits are estimated as in footnote 9, $c$ is a constant representing profits generated with the capital outstanding at the end of time 0, the period preceding the first year of the sample period, $\hat{r}$ represents the estimated return for the sample period and $u_t$ is a random error. If we capitalize the constant from Eq. (9), i.e. $c/\hat{r}$, we obtain the capital value of the country outstanding at the end of year 0. For the regression we use 10 years in order to capture a complete trade cycle.[15] The capital value in local currency at the end of year 1 is equal to the capital value at the end of year 0 plus the

[8] It is generally recognized that forward rates contain relevant information that reflects expectations. Whether or not forward rate parity holds exactly is an unresolved empirical question.

[9] In Appendix 3 we present a formal relationship between the ex post and ex ante measures.

[10] See Clark and Kassimatis (2011), Eqs. (8) and (4A*). Substitute the values for $T+1$ into (2) and remember that $B_T^*$ and $A_T^*$ are known (all transactions take place on the first day of the period), gives $V_T^* = B_T^* - A_T^* + V_{T+1}^* R^{*-1}$. Multiplying this by $(1+r)$ and rearranging gives profits at the end of the period: $r^* V_T^* = X_T^* - M_T^* + (V_{T+1}^* - V_T^*)$, where $(V_{T+1}^* - V_T^*)$ represent *net* investment over the period.

[11] Dividing profits earned over the period by the net capital value of the economy at the beginning of the period gives the rate of return. The relevant data for most of the macroeconomic series in this paper as well as for several other countries can be found at: https://countrymetrics.wordpress.com/blog/.

[12] See, for example, Clark and Zenaidi (1999).

[13] To make the premium comparable to the yield spread, we discretize the risk premium.

[14] This application of PIM is similar to that outlined in Kraay et al. (2005), Caselli and Feyrer (2007), in their estimation of the amount of the world capital stock, use an alternative application of PIM.

[15] As a practical matter, the effect of the capital outstanding in time on country returns disappears after a maximum of 10 years in all cases. For countries with very high inflation it can disappear in two or three years. The constants in this study were calculated for 1965, well before the test period. Thus, estimation errors have little or no effect on our results.

**Table 1**
Average market values and GDP for sample countries and the US.
The second column of the table reports the average market value estimated as discussed in Section 3.1, from 1995 to 2010 for each national economy in billions of US$. We also report the estimated market value of the US for comparison. The third column reports for each country the average market value from 1995 to 2010 as a percentage of the average market value of the US economy. The fourth column reports for each country the average GDP for the same period as a percentage of the average US GDP. Both market values and GDP are in current values (not deflated).

| | Average market values (in billion US$) | Average MV/average US MV (in %) | Average GDP/average US GDP (in %) |
|---|---|---|---|
| Argentina | 254.8 | 1.45 | 2.25 |
| Brazil | 778.9 | 4.43 | 8.76 |
| Chile | 146.5 | 0.83 | 1.00 |
| China | 4396.4 | 25.0 | 20.3 |
| Colombia | 138.7 | 0.79 | 1.28 |
| Cote D' Ivoire | 14.1 | 0.08 | 0.14 |
| Dominican Rep. | 24.5 | 0.14 | 0.26 |
| Ecuador | 29.1 | 0.17 | 0.29 |
| Egypt | 112.7 | 0.64 | 0.97 |
| El Salvador | 17.1 | 0.10 | 0.14 |
| Hungary | 110.9 | 0.63 | 0.76 |
| Indonesia | 331.4 | 1.88 | 2.66 |
| Mexico | 694.8 | 3.95 | 6.23 |
| Nigeria | 35.5 | 0.20 | 0.83 |
| Pakistan | 83.0 | 0.47 | 0.90 |
| Peru | 90.7 | 0.52 | 0.71 |
| Philippines | 136.3 | 0.77 | 0.97 |
| Poland | 316.4 | 1.80 | 2.43 |
| South Africa | 203.4 | 1.16 | 1.78 |
| Turkey | 270.0 | 1.54 | 3.48 |
| Uruguay | 16.2 | 0.09 | 0.20 |
| Venezuela | 112.9 | 0.64 | 1.43 |
| USA | 17587.6 | | |

net investment in local currency for year 1, where net investment is equal to gross fixed capital formation plus change in inventories less depreciation and provision for loss and obsolescence. For year 2, $V$ is equal to capital value outstanding at the end of year 1 plus the net investment for year 2 and so on. The value of the economy in current USD was obtained by implementing Eq. (3) and multiplying by the end of period exchange rate.

The second column of Table 1 reports average market values per country for the period 1995–2010. For comparison we also report the average market value for the US during the same period. To assess the plausibility of these estimates, the next two columns report the ratio of the average market value per country over the average US market value, and the average GDP per country over the average US GDP for the sample period. Although market value and GDP are not directly comparable because market value is a stock measure where GDP is a flow measure, the two are related because GDP is a function of the country's productive capacity. The figures reported in Table 1 suggest that the procedure we follow produces plausible estimates of the value of each economy.

To calculate the economy's rate of return (RT) we apply Eq. (4). Descriptive statistics of this variable are reported in Table 4.

### 3.3.2. Financial risk premium

Next, we estimate the financial risk premium. From Eqs. (5)–(8), estimating the financial risk premium for each country for each year requires estimates of $\delta V^*$, the economy's volatility, and the values of $K$ and $t$.

The proportion of the total value of the economy accruing to the external sector, $\delta V^*$, is found by multiplying $V^*$ by the percentage of imports in GDP.[16] The economy's volatility is estimated as the standard deviation of the log returns of the economy measured over an 18 year rolling window.[17] For example, the rolling window for 1995 runs from 1977 to 1994; for 1996, from 1978 to 1995; etc.

Total outstanding country debt is composed of many different coupons, maturities and amortization schedules. To make the debt data consistent with its application in the options pricing formula, we define $K$, the economy's total nominal foreign debt, as the sum of the principal repayments plus the sum of the interest payments over the life of all outstanding debt. Projections of the principal and interest payments for our sample countries are available in "Global Development Finance Country Tables" (formerly World Debt Tables).

Since we are dealing with a series of discrete payments rather than a zero coupon bond, we also have to estimate the maturity of the debt. This can be calculated as its risk neutral duration using the following formula:

$$K\,e^{-rt} = \sum_{T=1}^{n} CFT\,e^{-rT} \qquad (10)$$

where $K$ is the total nominal value of outstanding debt including principal and interest, $t$ is its maturity, $r$ is the continuously compounded USD risk free rate of interest and $CF_T$ is the debt service payment (interest plus principal) for each year. We then solve Eq. (10) for $t$ to find the debt's risk neutral duration. This gives:

$$t = \frac{\ln(K/\sum_{T=1}^{n} CFT\ e^{-rT})}{r} \qquad (11)$$

Choosing the appropriate risk free rate is a problem. Ideally, each cash flow should be discounted at the spot rate corresponding to its maturity. Unfortunately, US government instruments of this type are only available for a limited number of maturities. Thus, a more practical estimate of the risk-free rate would be the yield to maturity on a government bond whose cash flow profile mimics that of the country's debt service (i.e., the percent of total payments period by period is the same for both). In this case the value of $t$ (the risk neutral duration) for the country's debt would be the same as the bond's duration. As a practical matter, we have found that the annual average yield to maturity on a US government 10-year constant maturity is a reliable proxy whose yield to maturity reflects the relevant term structure over its life. Thus, when implementing Eqs. (5) and (10), we use this yield.

Next we provide some information about our estimates of the financial risk premium. The 2nd and 3rd columns of Table 2 report the average median December spread and its standard deviation, while the 4th and 5th columns of the table report the average financial risk premium (FP) for each country and its standard deviation. Note that these two are not directly comparable because FP refers to all the foreign debt of each country, both sovereign and private and only considers credit risk. MD, on the other hand, is the actual spread on selected US denominated debt and incorporates all sources of risk.

### 3.3.3. The correlation coefficient between returns to the economy and the exchange rate

Galai and Wiener (2012) have argued that in a multicurrency environment, a company wishing to minimize the probability of insolvency (and thus the costs of financing) should elect to finance activities in its own currency and, where this is not possible, in a currency that is highly correlated with the company's rate of return. This financing is *ex ante* cheaper because it results in a lower probability of default. It also demonstrates the negative consequences of

[16] An alternative value for $\delta$, which gives similar results, is the percentage of (imports + exports)/2 in GDP.

[17] Eighteen years guarantees at least one and possibly two trade cycles but is not so long that the earliest observations are no longer relevant.

**Table 2**
Statistics for the median spread in December and the financial risk premium at the end of each year for each country in our sample.
MD is the median December yield spread on US denominated debt reported by JP Morgan's EMBI database. FP is the financial risk premium at the end of year. The financial risk premium is the difference between the risk adjusted cost of debt estimated using Merton's structural model and the risk free rate (see Section 3.2).

| | MD | | FP | |
|---|---|---|---|---|
| | Average | St. dev | Average | St. dev |
| Argentina | 13.60% | 14.02% | 30.63% | 11.42% |
| Brazil | 5.28% | 3.22% | 35.09% | 12.30% |
| Chile | 1.49% | 0.74% | 4.43% | 3.69% |
| China | 1.15% | 0.50% | 0.09% | 0.16% |
| Colombia | 4.00% | 2.04% | 15.33% | 9.58% |
| Cote D' Ivoire | 22.87% | 8.21% | 11.38% | 6.18% |
| Dominican Rep. | 6.45% | 5.07% | 4.16% | 1.74% |
| Ecuador | 11.96% | 10.26% | 15.24% | 9.46% |
| Egypt | 1.72% | 1.29% | 1.78% | 2.35% |
| El Salvador | 3.32% | 2.24% | 1.91% | 1.07% |
| Hungary | 0.65% | 0.36% | 0.10% | 0.11% |
| Indonesia | 3.12% | 2.26% | 5.77% | 1.25% |
| Mexico | 2.55% | 1.07% | 8.45% | 9.70% |
| Nigeria | 5.79% | 3.53% | 22.93% | 7.22% |
| Pakistan | 5.92% | 6.00% | 6.74% | 3.51% |
| Peru | 3.76% | 2.07% | 15.10% | 10.02% |
| Philippines | 3.71% | 1.58% | 2.97% | 1.53% |
| Poland | 1.28% | 0.88% | 10.99% | 9.57% |
| South Africa | 2.60% | 1.73% | 1.10% | 1.68% |
| Turkey | 4.18% | 2.21% | 27.86% | 12.87% |
| Uruguay | 4.64% | 3.52% | 20.96% | 14.27% |
| Venezuela | 7.40% | 4.18% | 21.57% | 8.12% |

overusing loans denominated in currencies negatively correlated with the company's returns. This argument also applies to a country. Thus, we generate this variable by calculating the correlation coefficient between returns to the economy (RT) and the percentage change in the exchange rate using a rolling window of ten years of historical data. The descriptive statistics are reported in Table 4.

## 4. Choice of variables, methodology and data description

Our sample consists of 22 emerging markets listed in Table 3 and includes all the emerging economies for which we have the required data. Including as many economies as possible in our sample increases the number of observations for statistical inference

**Table 3**
Sample countries and data availability for each country.

| Country | Period | No. of observations |
|---|---|---|
| Argentina | 1995–2010 | 16 |
| Brazil | 1995–2010 | 16 |
| Chile | 2000–2010 | 11 |
| China | 1995–2010 | 16 |
| Colombia | 1998–2010 | 13 |
| Cote D' Ivoire | 1999–2007 | 9 |
| Dominican Republic | 2002–2010 | 9 |
| Ecuador | 1996–2010 | 15 |
| Egypt | 2002–2010 | 9 |
| El Salvador | 2003–2010 | 8 |
| Hungary | 2000–2004 | 5 |
| Indonesia | 2005–2010 | 6 |
| Mexico | 1995–2010 | 16 |
| Nigeria | 1995–2006 | 12 |
| Pakistan | 2002–2010 | 9 |
| Peru | 1998–2010 | 13 |
| Philippines | 1998–2010 | 13 |
| Poland | 2001–2008 | 8 |
| South Africa | 1997–2010 | 14 |
| Turkey | 1997–2010 | 14 |
| Uruguay | 2002–2010 | 9 |
| Venezuela | 1995–2010 | 16 |
| *Sum* | | 257 |

and acts as a robustness test for our results. The maximum sample period per country is 1995–2010, depending on data availability.[18] Table 3 also reports the years for which we have data for each country. We use annual observations for our analysis and the total number of observations is 257. The dependent variable is the median December yield spread on US denominated debt reported by JP Morgan's EMBI database, which makes our results comparable with those of Hilscher and Nosbusch (2010). One important difference is that our sample includes the 2008 financial crisis.

The new, forward-looking explanatory variables developed in the preceding sections are:

- The market value of each economy annually (MV) and the change in the market value of the economy (DMV).
- The returns to each economy (RT).
- The correlation coefficient between returns to the economy and the exchange rate, (CO) described above, is the proxy for currency mismatches.
- The financial risk premium (FP).
- The risk neutral duration of all external debt (DU) as in Eq. (10) to account for time to maturity.

Based on the discussion developed in the preceding sections, we expect MV (DMV), RT, and CO to be negatively correlated with spreads. We expect a positive correlation for FP. We have no prior on the sign of DU. In the literature on sovereign debt, a longer maturity is considered as a signal of higher debt quality. However, in the Merton (1974) model developed above, the effect of DU (noted as $t$ in Eq. (5)) on the theoretical spread can be positive or negative depending on the ratio of the market value of the economy to the amount of debt outstanding and the volatility of the market value of the economy.[19]

Table 4 reports the basic statistics for the credit spreads and the new variables developed in this paper. It is evident from Table 4 that our sample includes a diverse group of economies. Spreads range from 0.003 to 0.457 with a standard deviation of 0.07, showing that the risk profile of the economies we consider varies considerably. This diversity is reflected in the new explanatory variables as well. DMV has a mean of 74.2, a standard deviation (SD) of 249.45, a maximum of 2310.1 and a minimum of −255.8. RT ranges from −0.67 to 1.806 with a mean of 0.21 and an SD of 0.279 while CO goes from −0.998 to 0.905 with a mean of −0.015 and an SD of 0.42. FP has a minimum of 0.00, a maximum of 0.506, a mean of 0.135 and an SD of 0.134. Only debt maturity (DU) shows relatively low levels of range and volatility. Most maturities are medium term, ranging from 2.4 to 8.4 years with an average of 5.39 and an SD of 1.31.

In the literature review of Section 2 we identified a wide range of local and global control variables that have been used in previous studies. The local variables include GDP growth, terms of trade, current account (trade) balance, inflation, Debt/GDP, Reserves/GDP, political risk, default history, and time to maturity. The global variables include the VIX index, the long term US treasury bond yield, the corporate bond default yield spread, and the TED spread. In the empirical testing that follows, we use all these variables as control factors except the current account balance and inflation. We exclude the current account balance because it is already included directly as a component of macroeconomic profits and because it has an ambiguous effect on spreads when it stands alone (see Section 2). We exclude inflation first, because its effect on economic

[18] We use a large number of variables to construct our variables and some of them are not available for the whole sample period.
[19] See Cox and Rubenstein (1985, p. 383).

**Table 4**
Descriptive statistics.
The variables reported in the table are the following: MD: median December yield spread on US denominated debt reported by JP Morgan's EMBI database. DMV: change in market value of the economy estimated as discussed in Section 3.1. RT: returns to each economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1). CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data. FP: financial risk premium (see Section 3.2). DU: estimated duration of all external debt (see Section 3.3).

| | MD | DMV | RT | CO | FP | DU |
|---|---|---|---|---|---|---|
| Mean | 0.056 | 74.230 | 0.208 | −0.015 | 0.135 | 5.392 |
| Median | 0.032 | 13.304 | 0.178 | 0.000 | 0.080 | 5.375 |
| Maximum | 0.457 | 2310.1 | 1.806 | 0.905 | 0.506 | 8.376 |
| Minimum | 0.003 | −255.76 | −0.670 | −0.998 | 0.000 | 2.401 |
| Std. dev. | 0.070 | 249.45 | 0.279 | 0.420 | 0.134 | 1.311 |
| Skewness | 3.044 | 6.100 | 1.853 | −0.407 | 0.880 | −0.016 |
| Kurtosis | 13.456 | 45.479 | 11.984 | 2.630 | 2.711 | 2.519 |
| Observations | 257 | 257 | 257 | 257 | 257 | 257 |

**Table 5**
List of control variables.

*Local variables*
- The change in real GDP (DGDPR).
- Terms of trade (TT) and the change in the terms of trade (DTT)
- Debt over GDP (DG)
- Reserves over GDP (RG)
- Years since last default (DF) to account for default history. For this variable, we follow Hilscher and Nosbusch (2010) and cap the variable at 11.
- The September country rankings published by Institutional Investor (II) to measure political risk. To make the rankings series compatible with the assumptions of the linear regression model, we use the logistic transformation of the rankings (Cosset and Roy, 1991).

*Global variables*
- The VIX index (VIX).
- The median US 10 year Treasury benchmark bond yield for December of each year (US10Y) to account for the yield on the long term treasury bond.
- The default yield spread (DYS) calculated as the difference between the median Barclays US BAA yield for December and the median Barclays US AAA yield for December.
- The median TED spread for December; i.e. the spread between the 3-month T-bill rate and the 3-month interbank rate (TED).

**Table 7**
Regressions of future economic activity variables on economic market value and the financial risk premium.
The table reports regressions of future economic activity variables on the financial risk premium (FR), the change in the financial risk premium (DFP), market value of the economy (MV) and the change in the market value (DMV). The economic activity variables are the change in GDP (DGDP), real gross fixed capital formation (GFCF) and the change in foreign direct investment (DFDI). For the estimation we employ OLS and adjust standard errors using the Newey–West estimator. For the countries included in the sample and the sample period for each county, see Table 3.

| | $DGDP_{t+1}$ | $GFCF_{t+1}$ | $DFDI_{t+1}$ |
|---|---|---|---|
| $a$ | −9.245 (1.32) | 0.197*** (27.36) | −1.226** (−2.33) |
| $FP_t$ | 0.250 (0.55) | −0.112*** (−3.35) | 2.987 (1.23) |
| $DFP_t$ | −1.724(−1.55) | 0.039 (0.44) | −19.008** (−2.37) |
| $MV_t$ | 0.100*** (19.85) | 0.0003*** (6.11) | 0.005*** (6.82) |
| $DMV_t$ | 37.726 (1.63) | 0.054*** (2.89) | 0.823 (0.41) |
| Obs. | 257 | 257 | 257 |
| $R^2$-adj. | 0.81 | 0.49 | 0.44 |

** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

performance is directly reflected in the exchange rate, and, second, because it has an ambiguous effect on spreads when it stands alone.

Table 5 presents the list of local and global control variables used in the empirical testing. Table 6 presents the correlation coefficients between the variables used in the regressions. From this table we can see that except for RT and DMV multicollinearity is generally not a problem in our sample.

To assess the effect of the variables we construct on spreads, we estimate the following model:

$$MD_t = a + b_1 DMV_t + b_2 FP_t + b_3 RT_t + b_4 CO_t + b_5 DU_t + b_i X_t + e_t \tag{12}$$

where $MD_t$ is the median December yield spread on US denominated debt reported by JP, $DMV_t$ is the change in market value of the economy during year $t$, $FP_t$ is the financial risk premium at the end of year $t$, $RT_t$ is returns to the economy calculated as macroeconomic profits over year t divided by market value of the previous year, $CO_t$ is the correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years

**Table 6**
Pearson correlations between local variables.
The variables reported in the table are the following: MD: median December yield spread on US denominated debt reported by JP Morgan's EMBI database; DMV: change in market value of the economy estimated as discussed in Section 3.1; RT: returns to each economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1); CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data; DU: estimated duration of all external debt (see Section 3.3); FP: financial risk premium (see Section 3.2); DG: external debt over GDP; RG: reserves over GDP; DF: years since last default and capped at 11; II: the logistic transformation of the September country rankings published by Institutional Investor; TT: terms of trade; DGDP: the change in real GDP.

| | MD | DMV | RT | CO | DU | FP | DG | RG | DF | II | TT |
|---|---|---|---|---|---|---|---|---|---|---|---|
| DMV | −0.182 | | | | | | | | | | |
| RT | −0.126 | 0.873 | | | | | | | | | |
| CO | −0.152 | −0.175 | −0.188 | | | | | | | | |
| DU | 0.227 | −0.287 | −0.293 | 0.183 | | | | | | | |
| FP | 0.294 | −0.203 | −0.195 | −0.200 | −0.025 | | | | | | |
| DG | 0.543 | −0.323 | −0.251 | −0.150 | 0.311 | 0.382 | | | | | |
| RG | −0.262 | 0.599 | 0.629 | −0.133 | −0.001 | −0.251 | −0.094 | | | | |
| DF | −0.475 | 0.180 | 0.134 | −0.111 | −0.278 | −0.220 | −0.334 | 0.099 | | | |
| II | −0.568 | 0.391 | 0.311 | −0.041 | −0.537 | −0.482 | −0.580 | 0.310 | 0.630 | | |
| TT | 0.048 | −0.114 | −0.141 | 0.101 | −0.096 | −0.149 | −0.227 | −0.011 | −0.026 | 0.205 | |
| DGDPR | 0.161 | −0.611 | −0.675 | 0.091 | 0.246 | 0.254 | 0.311 | −0.414 | −0.176 | −0.294 | 0.095 |

**Table 8**
Regressions of spreads on local and global factors.
The dependent variable is the median December yield spread on US denominated debt reported by JP Morgan's EMBI database for a number of countries. All regressions are estimated with feasible GLS, which corrects for cross-section heteroscedasticity. The sample period is 1995–2010. The independent variables are: DMV: change in market value of the economy estimated as discussed in Section 3.1. RT: returns to each economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1), CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data, DU: estimated duration of all external debt (see Section 3.3), FP: financial risk premium (see Section 3.2), DG: external debt over GDP, RG: reserves over GDP, DF: years since last default and capped at 11, II: the logistic transformation of the September country rankings published by Institutional Investor, TT: terms of trade, DTT: change in the terms of trade, DGDP: change in real GDP, US10Y: the median US 10 year Treasury benchmark bond yield for December of each year, TED: the median TED spread for December; i.e. the spread between the 3-month T-bill rate and the 3-month interbank rate, VIX: the VIX index, DYS: the default yield spread calculated as the difference between the median Barclays US BAA yield for December and the median Barclays US AAA yield for December. Figures in parentheses are *t*-ratios.

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) |
|---|---|---|---|---|---|---|---|
| *C* | 0.007 | −0.003 | 0.004 | 0.027* | 0.020 | 0.012 | 0.021 |
| | (0.97) | (−0.67) | (0.21) | (1.83) | (1.00) | (1.14) | (1.81) |
| DMV | −0.0002*** | −0.00003 | | | | | |
| | (−4.53) | (−0.77) | | | | | |
| RT | −0.013** | −0.025*** | | −0.019*** | −0.013** | −0.018*** | −0.013** |
| | (−1.97) | (−4.54) | | (−3.21) | (−2.29) | (−3.03) | (−2.28) |
| CO | −0.019*** | −0.005* | | −0.007*** | −0.006** | −0.008*** | −0.006** |
| | (−4.23) | (−1.64) | | (−2.62) | (−2.06) | (−3.00) | (−2.07) |
| FP | | 0.114*** | | 0.040** | 0.044** | 0.029** | 0.045** |
| | | (9.90) | | (2.41) | (2.05) | (1.97) | (2.13) |
| DU | 0.007*** | 0.006*** | | −0.0004 | 0.0004 | | |
| | (5.26) | (5.58) | | (−0.39) | (0.25) | | |
| DGDP | | | 0.019*** | 0.017*** | 0.002 | | |
| | | | (3.93) | (3.46) | (0.32) | | |
| TT | | | 0.0002*** | 0.0002*** | 0.0002** | 0.0003*** | 0.0002** |
| | | | (3.11) | (2.83) | (2.50) | (3.68) | (2.51) |
| DTT | | | −0.0001*** | −0.0008 | −0.0003 | | |
| | | | (−0.81) | (−0.56) | (−0.25) | | |
| DG | | | 0.055*** | 0.049*** | 0.057*** | 0.035*** | 0.055*** |
| | | | (4.95) | (4.63) | (3.96) | (4.19) | (3.88) |
| RG | | | −0.123*** | −0.104*** | −0.051** | −0.089*** | −0.049** |
| | | | (−5.48) | (−5.10) | (−2.01) | (−4.35) | (−2.31) |
| DF | | | −0.002** | −0.002*** | −0.0002 | | |
| | | | (−2.31) | (−2.93) | (−0.19) | | |
| II | | | −0.033*** | −0.029*** | −0.022*** | −0.035*** | −0.020*** |
| | | | (−11.80) | (−6.59) | (−2.61) | (−11.20) | (−2.91) |
| VIX | | | 0.0007* | 0.0007** | 0.0008** | 0.001*** | 0.001*** |
| | | | (1.76) | (2.33) | (2.56) | (7.79) | (8.73) |
| US10Y | | | −0.200 | −0.458*** | −0.703*** | −0.615*** | −0.714*** |
| | | | (−0.85) | (−2.78) | (−3.54) | (−4.62) | (−4.91) |
| DYS | | | 0.462 | 0.247 | 0.115 | | |
| | | | (1.30) | (0.95) | (0.42) | | |
| TED | | | 0.479* | 0.611** | 0.203 | | |
| | | | (1.68) | (2.56) | (0.68) | | |
| Fixed effects | No | No | No | No | Yes | No | Yes |
| Fixed effects *F* test | | | | | 8.28*** | | 10.18*** |
| Obs. | 257 | 257 | 257 | 257 | 257 | 257 | 257 |
| $R^2$-adj. | 0.19 | 0.41 | 0.56 | 0.66 | 0.75 | 0.66 | 0.78 |

* Statistical significance at 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

of historical data, $DU_t$ is the estimated duration of all external debt and $X_t$ is a vector of local and global control variables, reported in Table 5.

Since our sample represents a diverse collection of emerging countries, at various stages of development with differing structures and characteristics, heteroskedasticity is a concern. To account for this the model is estimated using feasible generalized least squares (FGLS), which corrects for cross-section heteroscedasticity.[20]

## 5. Results

### 5.1. Preliminary tests

If the variables we construct are indeed forward-looking and affect future spreads, they should also be related to future economic activity.[21] In this section we test this proposition. The main variables in our analysis are the market value of an economy and the financial risk premium so, we test if these variables can explain future economic activity measured by the change in GDP, real gross fixed capital formation as a percentage of GDP and the change in FDI. Improved economic conditions should result in higher GDP, higher levels of investment and increased capital inflows. Thus, the macroeconomic market value should have a positive impact on GDP, investment and FDI while the financial risk premium should

[20] Under the assumption that the disturbances have different variances for each panel and are constant within panels, FGLS is asymptotically efficient. Assuming that the volatility of bond spreads does not change substantially over time but is variable across countries is confirmed by Wald test results of the residuals.

[21] We thank an anonymous referee for raising this point.

have a negative impact on these variables. To test this hypothesis we run the following regressions:

$$DGDP_{t+1} = a + bFP_t + cDFP_t + dMV_t + fDMV_t + e_t \quad (13a)$$

$$GFCF_{t+1} = a + bFP_t + cDFP_t + dMV_t + fDMV_t + e_t \quad (13b)$$

$$DFDI_{t+1} = a + bFP_t + cDFP_t + dMV_t + fDMV_t + e_t \quad (13c)$$

where $DGDP_{t+1}$ is the change in *GDP* from year *t* to year *t* + 1, $GFCF_{t+1}$ is real gross fixed capital formation in year *t* + 1, $DFDI_{t+1}$ is the change in foreign direct investment from year *t* to year *t* + 1, $FP_t$ and $DFP_t$ are the financial risk premium in year *t* and the change in the financial risk premium from year *t* − 1 to year *t* respectively, and $MV_t$ and $DMV_t$ are the market value of an economy in year *t* and the change in the market value of an economy from year *t* − 1 to year *t*. All variables are expressed in US dollars. For the estimation we stack the data and estimate the regression using OLS. Standard errors are adjusted for serial correlation and heteroscedasticity with the use of the Newey–West estimator. The results are reported in Table 7.

In all three equations, our variables can explain a substantial part of future economic activity. In the first equation, only MV is statistically significant with a *t*-ratio of 19.85 and can explain 81% of the future change in GDP. This is hardly surprising. GDP represents the income of an economy. This income is generated from the capital stock of this economy which is measured by MV. So, as long as MV can measure the value of the capital stock of an economy with a certain degree of accuracy, it is natural to find such a strong relationship between the value of the capital stock in year *t* and the income generated from this capital stock in year *t* + 1. Considering that GDP is not included directly or indirectly in the calculation of any of the independent variables, this is clear evidence that our variables are relevant in explaining future economic activity. The second and third columns of the table provide further evidence that both FP and MV are significant predictors of a country's future economic activity. Overall, the results reported in the table are evidence that the variables we construct are indeed related to future economic activity and as such, they should also be related to sovereign spreads.

**Table 9**
Regressions of spreads on local and global factors using winsorized series.
The dependent variable is the median December yield spread on US denominated debt reported by JP Morgan's EMBI database for a number of countries. All regressions are estimated with feasible GLS, which corrects for cross-section heteroscedasticity. The sample period is 1995–2010. The independent variables are: DMV: change in market value of the economy estimated as discussed in Section 3.1. RT: returns to each economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1), CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data, DU: estimated duration of all external debt (see Section 3.3), FP: financial risk premium (see Section 3.2), DG: external debt over GDP, RG: reserves over GDP, II: the logistic transformation of the September country rankings published by Institutional Investor, TT: terms of trade, US10Y: the median US 10 year Treasury benchmark bond yield for December of each year and VIX: the VIX index. Figures in parentheses are *t*-ratios.

| Winsorized variable | FP | DMV | FP |
|---|---|---|---|
| | (1) | (2) | (3) |
| C | −0.004 | −0.003 | 0.021* |
| | (−0.65) | (−0.55) | (1.82) |
| DMV | −0.00003 | −0.00004 | |
| | (−0.78) | (−0.89) | |
| RT | −0.025*** | −0.025*** | −0.013** |
| | (−4.52) | (−4.46) | (−2.26) |
| CO | −0.005* | −0.006* | −0.006** |
| | (−1.64) | (−1.70) | (−2.10) |
| FP | 0.114*** | 0.113*** | 0.043** |
| | (9.94) | (9.74) | (2.03) |
| DU | 0.006*** | 0.006*** | |
| | (5.56) | (5.42) | |
| TT | | | 0.0002** |
| | | | (2.52) |
| DG | | | 0.055*** |
| | | | (3.89) |
| RG | | | −0.049** |
| | | | (−2.31) |
| II | | | −0.020*** |
| | | | (−2.95) |
| VIX | | | 0.001*** |
| | | | (8.74) |
| US10Y | | | −0.714*** |
| | | | (−4.91) |
| Obs. | 257 | 257 | 257 |
| $R^2$-adj. | 0.41 | 0.41 | 0.78 |

* Statistical significance at 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

## 5.2. In sample tests

The independent variables in column (1) of Table 8 are those derived from the model developed in Section 3, except for the financial risk premium. They can explain 19% of the variation in spreads. In column (2) we include the financial risk premium, noted FP. While most of the variables used to construct FP are already included in the regression of column (1) directly or indirectly, we find that including FP more than doubles the explanatory power of the model. This is evidence supporting the structural models found in the literature and suggests that they provide incremental information with respect to the individual variables used to estimate them. Including FP in the regression renders DMV insignificant and dropping it from the regression has no effect on the explanatory power of the model.[22]

Column 3 reports the regression where we use only variables cited in the literature as important determinants of spreads. Following Hilscher and Nosbusch (2010), the global variables we include are the VIX index, the 10-year US Treasury note yield, the TED spread and the US default yield spread. The results we report in column (3) are similar to the results reported by Hilscher and Nosbusch (2010). Adding our variables (column 4) increases the adjusted $R^2$ of the regression from 56% to 66%, which is further evidence of the incremental information generated by the forward looking variables in Section 3.

Beck (2001) argues that long term structural variables which determine spreads can be captured by country specific intercepts using fixed effects estimation. Using fixed effects (column 5) also serves as a robustness test for the results reported in column 4. The results in columns 4 and 5 suggest that DU, DF, DTT, DGDP, TED and DYS are statistically insignificant. The use of fixed effects is strongly supported by an *F*-test reported at the bottom of the table. A $\chi^2$ test for the joint significance of the statistically insignificant variables does not reject the null of no significance with a probability of 99%. Dropping them in columns 6 and 7 gives an adjusted $R^2$ of 66% and 78% without and with fixed effects respectively.[23]

The conclusion is that the variables RT (return to the economy), CO (the correlation coefficient between returns to the economy and the exchange rate) and FP (the financial risk premium developed in Section 3) are significant determinants of the sovereign risk spread that improve the explanatory power of the other models proposed

[22] In the context of our analysis, insignificant variables are dropped mainly to avoid problems of multicollinearity. In column 4 of Table 8 we include 11 local variables in the regression so, multicollinearity could be a concern.

[23] We dropped these variables one at a time to see if that affects the significance of the others. It didn't.

**Table 10**
Regressions of out-of-sample spreads on local and global factors.
The dependent variable is the out-of-sample median spread for the month reported in the second row of the table; for example, the dependent variable for the results reported in the 2nd column is the median January spread for each country and the independent variables refer to the end of the previous year. All regressions are estimated with feasible GLS, which corrects for cross-section heteroscedasticity. The sample period is 1995–2010. The independent variables are: RT: returns to each economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1), CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data, FP: financial risk premium (see Section 3.2), TT: terms of trade, DG: external debt over GDP, RG: reserves over GDP, II: the logistic transformation of the September country rankings published by Institutional Investor, VIX: the VIX index, US10Y: the median US 10 year Treasury benchmark bond yield for December of each year. Figures in parentheses are *t*-ratios.

| Local variables | (1) January | (2) February | (3) March | (4) April | (5) May | (6) June |
|---|---|---|---|---|---|---|
| *c* | 0.025** | 0.022* | 0.026** | 0.019* | 0.019* | 0.024** |
| | (2.14) | (1.86) | (2.19) | (1.76) | (1.78) | (2.33) |
| RT | −0.014*** | −0.015*** | −0.014*** | −0.012*** | −0.014** | −0.017*** |
| | (−2.71) | (−3.15) | (−2.62) | (−2.62) | (−2.58) | (−3.16) |
| CO | −0.008** | −0.009*** | −0.007** | −0.009*** | −0.011*** | −0.011*** |
| | (−2.49) | (−3.06) | (−2.46) | (3.19) | (−3.32) | (−3.81) |
| FP | 0.035** | 0.051*** | 0.030 | 0.038** | 0.033* | 0.039** |
| | (1.97) | (2.63) | (1.42) | (2.03) | (1.73) | (2.25) |
| TT | 0.0002** | 0.0002*** | 0.0002** | 0.0001** | 0.0002** | 0.0001** |
| | (2.22) | (2.60) | (2.40) | (2.35) | (2.58) | (2.17) |
| DG | 0.041*** | 0.043*** | 0.054*** | 0.045*** | 0.043*** | 0.030*** |
| | (3.38) | (3.37) | (3.54) | (4.61) | (4.10) | (3.37) |
| RG | −0.051** | −0.045** | −0.045** | −0.059*** | −0.045** | −0.044** |
| | (−2.39) | (−2.15) | (−2.23) | (−2.96) | (−2.25) | (−2.29) |
| II | −0.018*** | −0.016** | −0.013* | −0.008 | −0.011* | −0.009 |
| | (−2.85) | (−2.52) | (−1.92) | (−1.40) | (−1.73) | (−1.51) |
| VIX | 0.001*** | 0.0009*** | 0.0008*** | 0.0007*** | 0.0005*** | 0.0004*** |
| | (10.26) | (10.02) | (8.68) | (8.79) | (6.78) | (5.49) |
| US10Y | −0.543*** | −0.577*** | −0.664*** | −0.308** | −0.264* | −0.129 |
| | (−4.32) | (−4.75) | (−4.76) | (−2.30) | (−1.80) | (−0.94) |
| Fixed effects | Yes | Yes | Yes | Yes | Yes | Yes |
| Fixed effects *F* test | 10.99*** | 10.44*** | 13.44*** | 12.18*** | 11.81*** | 11.67*** |
| Obs. | 257 | 257 | 257 | 257 | 257 | 257 |
| $R^2$-adj. | 0.77 | 0.77 | 0.79 | 0.80 | 0.79 | 0.80 |

* Statistical significance at 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

in the literature. Since these variables are not included in the factors commonly used in similar studies, they contain significant, incremental information that improves our understanding of the driving forces behind spreads. Another conclusion drawn from Table 8 is that studies on the determinants of sovereign risk should employ information derived from structural models as well as fundamental local and global variables.

### 5.3. The effect of outliers

As a first robustness test, we re-estimate our model controlling for outliers. Specifically, we winsorize the 1% highest and 1% lowest values of the financial risk premium and the change in market value and re-estimate.[24] The results are reported in Table 9. In the first column of the table we estimate the model reported in column 1 of Table 8, where we winsorize the financial risk premium. In the second column, we estimate the same specification winsorizing the change in the market value. The results in both columns are qualitatively and quantitatively very similar to the ones reported in Table 8, which suggests that outliers play no role in our results. DMV remains statistically insignificant at any reasonable level of significance so it is dropped from the model. In the last column of the table we estimate the model reported in column 7 of Table 8, with FP winsorized. Again, there is no effect on the results which suggests that outliers are not a concern for our analysis.

### 5.4. Out of sample tests

To further test the robustness of the results reported up to now, we examine if the model developed in column 7 of Table 8 can explain out-of-sample spreads. Out-of-sample testing is a way to verify the explanatory power of an econometric model. Different or weaker results to those obtained in the in-sample tests call into question the explanatory power of the model while similar results reinforce it. Similar results are also indicators of the model's forecasting power.[25]

In Table 10, we regress median spreads of January, February, etc. on factors from December of the previous year. The new macro variables, RT, CO and FP as well as several other control variables, remain highly statistically significant in these regressions. Importantly, the results show that the model we propose explains between 77% and 80% of spreads up to six months into the out-of-sample period. Overall, they support the robustness of the in-sample results reported in Table 8. Second, they confirm the Hausman test that endogeneity is not a problem. Tests (not reported here but available on request) suggest that the explanatory power of the model begins to drop about 7 months into the future.

[24] We choose to winsorize rather than to trim the sample so we do not lose observations.

[25] The Hausman test for endogeneity, not reported here but available on request, suggests that endogeneity is not a problem in the model. Using out-of-sample spreads where, by definition, all variables are lagged, is a robustness test for the Hausman test for potential endogeneity.

**Table 11**
Predictive power of macro variables.
All models are estimated using the Berndt, Hall, Hall and Hausman algorithm. The sample period is 1995–2010. The dependent variable takes the value of 1 if the change in the spreads from December to June is greater than (i) 150 basis points, (ii) 250 basis points, and (iii) 300 basis points. The independent variables are: DMV: change in market value of the economy (see Section 3.1), RT: returns to economy calculated as macroeconomic profits over the year divided by market value of the previous year (see Section 3.1), CO: correlation coefficient between returns to the economy (variable RT) and the exchange rate using ten years of historical data, FP: financial risk premium (see Section 3.2), DU: estimated duration of all external debt (see Section 3.3), TT: terms of trade, DG: external debt over GDP, RG: reserves over GDP, II: the logistic transformation of the September country rankings published by Institutional Investor, VIX: the VIX index, and US10Y: the median US 10 year Treasury benchmark bond yield for December of each year. Figures in parentheses are *t*-ratios. No. of 1s is the number of cases where the dependent variable takes the value of 1. Panel B reports the number of correct 0s and 1s estimated if the independent variables are the control variables only.

| | $\Delta S > 150$ bps | $\Delta S > 250$ bps | $\Delta S > 300$ bps |
|---|---|---|---|
| *Panel A* | | | |
| DMV | 0.0027 | 0.0099 | 0.0214 |
| | (1.10) | (0.88) | (1.49) |
| RT | −1.4535 | −4.6591* | −5.8996** |
| | (−1.04) | (−1.70) | (−2.38) |
| CO | −3.1146*** | −6.3697** | −5.5594* |
| | (−3.02) | (−2.20) | (−1.71) |
| FP | 3.0385 | 10.9533** | 12.239** |
| | (0.99) | (2.52) | (2.29) |
| DU | 1.6336*** | 3.6367** | 1.6014** |
| | (3.78) | (2.14) | (2.37) |
| TT | 0.0076 | −0.0008 | 0.0294 |
| | (0.38) | (−0.04) | (1.28) |
| DG | −0.6755 | −0.2237 | −0.3285 |
| | (−0.41) | (−0.12) | (−0.17) |
| RG | −23.780*** | −86.9779** | −91.6128* |
| | (−2.67) | (−2.47) | (−1.91) |
| II | 0.8928 | 1.2380 | −2.9038 |
| | (1.14) | (1.09) | (−0.72) |
| VIX | 0.0014 | −0.1119 | −0.0967* |
| | (0.97) | (−1.31) | (−1.67) |
| US10Y | 82.644* | 265.87** | 254.84* |
| | (1.93) | (2.16) | (1.79) |
| McFadden $R^2$ | 0.39 | 0.78 | 0.74 |
| Accuracy | 95.3% | 99.22% | 99.6% |
| Observations | 257 | 257 | 257 |
| No. of 1s | 16 | 8 | 6 |
| Correct 0s | 100% | 99.6% | 100% |
| Correct 1s | 31.3% | 87.5% | 83.3% |
| *Panel B: Results with control variables only* | | | |
| Correct 0s | 100% | 99.6% | 99.6% |
| Correct 1s | 0% | 0% | 16.7% |

* Statistical significance at 10% level.
** Statistical significance at the 5% level.
*** Statistical significance at the 1% level.

### 5.5. Forecasting power

As an additional robustness test on the relationship between the new macro variables and sovereign spreads, we assess their forecasting power. We examine the predictive power of these variables by testing if they can predict deterioration in the creditworthiness of an economy over a period of 6 months. Specifically, we estimate a logit model where the dependent variable takes the value of one if the change in the spreads from December to June is greater than (i) 150 basis points, (ii) 250 basis points, and (iii) 300 basis points. In each case, we include in the model all the control variables from Table 8 and assess the predictive power of the model with and without the new macro variables we have constructed. The results are reported in Table 11.

Except for DMV, all the other new macro variables we constructed are statistically significant in most cases and have the correct sign. It is worth noting that most of the control variables are not statistically significant in any of the equations. The most interesting result is that the predictive power of the model with respect to sharp increases in spreads is quite high and comes almost exclusively from the new macro variables we constructed. It predicts 100% of 0's (changes of less than 150, 250 and 300 bps, respectively). Most importantly, the model predicts 31.3%, 87.5% and 83.3% of 1's (increases greater than or equal to 150, 250 and 300 bps, respectively). The fact that the predictability improves considerably for the larger increases in spreads ($\Delta S \geq 250, 300$ bps) is evidence of the forward-looking nature of the new macro variables and their ability to predict large, adverse moves in a country's economic situation, a quality much appreciated by traders and policy-makers. As a final test of the predictive power of the new macro variables, we estimate the same equations with the control variables only. Panel B shows that without the new macro variables the predictive power of the model virtually disappears.

## 6. Conclusion

This paper proposes a new set of macroeconomic factors related to market values that reflect investor expectations concerning future economic performance to explain spreads on emerging market sovereign debt. The forward-looking variables that we construct are significant and complement and enhance the explanatory content of the conventional variables found in the extant literature. Higher expected macroeconomic returns reduce spreads while higher financial risk premiums increase them. Higher correlation between the country's rate of return and the exchange rate reduce spreads. The overall model itself captures a significant part of the empirical variation in spreads, and importantly for policy makers and market participants, it also includes a powerful forecasting component that extends up to 6 months outside the sample period.

Our results bring up some interesting policy implications. The first is the importance of the rate of return (RT) on the value of the economy measured in foreign currency (USD). Remember that the market value of the economy in USD is analogous to the market capitalization of a quoted stock measured as the net present value of expected income and expenditure from time 0 to time n.[26] Thus, RT reflects not only how effectively the economy is currently being managed. As a forward looking variable, it also reflects how the economy is expected to be managed in the future and figures directly as a key determinant of future spreads. As such, the effect of economic and financial policy on the economy's rate of return in foreign currency should be a major policy concern.

However, it is not only the level of RT that should concern the policy-maker. The volatility of RT should concern him as well. Remember from Eqs. (5)–(7) that the volatility of RT is one of the variables that determines the market value of outstanding debt. The partial derivative of Eq. (5) with respect to the volatility of RT is negative.[27] From Eq. (8) we see that the lower bond price raises the risk-adjusted required rate of return on foreign debt and, consequently, the financial risk premium (FP). Thus, the policy-maker should be sensitive to policies and policy changes that cause RT to fluctuate and increase its volatility.

Finally, the variable CO, the correlation between RT and the exchange rate, is shown to reduce spreads and *ex ante* cost of borrowing.[28] Thus, a country wishing to minimize the costs of

[26] The value of the economy in local currency reflects the internal organization of the economy and is analogous to the situation of the individual firm with its own set of resources, wages, internal transfer prices, cross subsidies, etc., which determine the composition and quantity of its output and its inputs.

[27] $\frac{\partial B}{\partial \sigma} < 0$.

[28] This is, to our knowledge, the first empirical evidence in support of Galai and Wiener's (2012) argument that in a multicurrency environment, a company (country) wishing to minimize the probability of insolvency (and thus the costs of financing) should elect to finance activities in its own currency and, where this is

financing should elect to finance activities in its own currency and, where this is not possible, in a currency that is highly correlated with the rate of return on the economy.

## Appendix 1. Expected market value and the exchange rate

Eqs. (1) and (2) in the text, reproduced here for convenience, show the market value of an open national economy at the beginning of time $T$ in local currency:

$$V_T = (B_T - A_T) + E(B_{T+1} - A_{T+1})R^{-1} + \cdots + E(B_n - A_n)R^{-(n-T)} \quad (1A.1)$$

and the value of the economy in US dollars (USD), where asterisks denote USD:

$$V_T^* = (B_T^* - A_T^*) + E(B_{T+1}^* - A_{T+1}^*)R^{*-1} + \cdots + E(B_n^* - A_n^*)R^{*-(n-T)} \quad (1A.2)$$

Let $S_t$ denote the spot exchange rate at time $t$ expressed as the price of 1 unit of local currency in USD and $F_{T,t}$ the forward exchange rate (the price of 1 unit of local currency in USD) at time $T$ for delivery at time $t$. By definition $B_t^* = S_t B_t$ and $A_t^* = S_t A_t$. Make these substitutions into Eq. (1A.1), take expectations and apply forward rate parity,[29] $E(S_t) = F_{T,t}$, and interest rate parity, $F_{T,t} = S_T(R^{*t-T}/R^{t-T})$. Then, substituting $V_T$ from Eq. (1A.1) and simplifying gives Eq. (3) in the text.

## Appendix 2. The dynamics of the country level valuation model

To gain some insight into the foregoing analysis and the forces it reflects, consider its dynamics. Both $V$ and $S$ are nominal random variables that cannot be negative. An inspection of the data for a wide range of countries suggests that besides the random element there is a trend (growth) component in their evolution as well. Processes such as these can be represented by geometric Brownian motion

$$dS(t) = \beta S(t)dt + \omega S(t)dw(t) \quad (2A.1)$$

$$dV(t) = \alpha V(t)dt + \psi V(t)dx(t) \quad (2A.2)$$

The parameters $\alpha$ and $\beta$ reflect the expected growth rates of $S$ and $V$ respectively with $\psi$ and $\omega$ as the respective standard deviations. The variables $dw$ and $dx$ are standard Wiener processes with zero mean and variance of $dt$. The relationship between $S$ and $V$ is reflected in $dw(t)dx(t) = \rho dt$ where $\rho$ is the instantaneous correlation between $S$ and $V$.

From Eq. (3) let $V^*(t) = S(t)V(t)$ for any $t$. Using, Ito's lemma and Eqs. (2A.1) and (2A.2) gives[30]

$$dV^*(t) = (\alpha + \beta + \psi\omega\rho)V^*(t)dt + \sqrt{\omega^2 + \psi^2 + 2\omega\psi\rho}\,V^*(t)dz(t) \quad (2A.3)$$

where $dz(t) = (\omega dw + \psi dx)/\left(\sqrt{\omega^2 + \psi^2 + 2\omega\psi\rho}\right)$. Eq. (2A.3) shows that the evolution of the market value of the economy in USD depends on the growth rates and volatilities of the exchange rate and the value of the economy in local currency as well as on the correlation between the two. The growth (drift component $= (\alpha + \beta + \psi\omega\rho)$) of the dollar value of the economy depends on $\alpha$ and $\beta$ as well as on the volatilities of $S(t)$ and $V(t)$ and the correlation between them. The volatility of the dollar value of the economy $\sqrt{\omega^2 + \psi^2 + 2\omega\psi\rho}$ depends on the individual volatilities and correlation as well.

Thus, the model captures the internal dynamics of the country's economy reflected in $V$. It also captures the dynamics of the evaluation of $V$ by the international markets reflected in $S$, and, finally, it captures the interaction between the two reflected in the correlation coefficient.

## Appendix 3. Establishing the forward looking component of historical accounting data

To establish the link between the economy's past performance and the forward looking component in historical accounting data, we start by simplifying Eq. (1), the forward looking measure of the economy's value. Substituting the values for $T+1$ into Eq. (1) and remembering that $B_T$ and $A_T$ are known (all transactions take place on the first day of the period), gives

$$V_T = B_T - A_T + V_{T+1}R^{-1} \quad (3A.1)$$

We now look at what has been invested in the economy (the accounting or historical value of the economy) in local currency, compounded at the economy's internal rate of return, denoted as $W_T$.[31] This retrospective representation of the value of the economy gives[32]:

$$W_T = -(B_0 - A_0)R^T - (B_1 - A_1)R^{T-1} - \cdots - (B_{T-1} - A_{T-1})R \quad (3A.2)$$

Substituting the value of $W_{T+1}$ into Eq. (3A.2) and rearranging gives

$$W_T = B_T - A_T + W_{T+1}R^{-1} \quad (3A.3)$$

Eqs. (3A.1) and (3A.3) are equivalent if expectations do not change between time 0 and time $T$. However, a change in expectations can cause a discrepancy between the two. Things may not work out as planned and losses occur or things may work out better than planned and gains occur. Capital gains or losses cause a discrepancy between the *ex post* and the *ex ante* measures of capital. For example, a rise in the price of oil or in the interest rate can cause serious capital losses across wide sectors of the economy. Other things being equal, the losses would be reflected immediately in the expectations of Eq. (3A.1) but not in Eq. (3A.3). In practice, however, there is a strong link between the two. Businessmen use depreciation and provisions for losses and obsolescence to provide for changes in the economic environment that might occur and affect their balance sheets. These provisions are not real losses but estimates of what might happen in the future. As such, they are forecasts incorporated in the *ex post* data and represent the link between Eqs. (3A.1) and (3A.3), the *ex ante* and the *ex post* measures of capital in local currency.

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not possible, in a currency that is highly correlated with the rate of return on the economy. This financing is *ex ante* cheaper because it results in a lower probability of default. It also demonstrates the negative consequences of overusing loans denominated in currencies negatively correlated with the returns on the economy.

[29] To avoid complicating the presentation unnecessarily, we assume no risk premium and zero correlation.

[30] Since economies and exchange rates typically have no fixed maturity date, $V$ does not depend directly on time and, therefore, the time derivative disappears.

[31] As with the expected values, in order to simplify the exposition, we assume that the real interest rate and the inflation rate are constant so that compounding takes place at a constant rate.

[32] The sign changes because we are looking retrospectively at what has been invested in the economy. For example, the economy earns its internal rate of return, so at time 0: $W_0 = 0 = (B_0 - A_0) + (B_1 - A_1)R^{-1} + \cdots + (B_n - A_n)R^{-n}$
It follows from the discounted cash flow formula that for any T between 0 and n

$$W_0 = 0 = (B_0 - A_0) + (B_1 - A_1)R^{-1} + \cdots + W_T R^{-T}.$$

Rearranging gives Eq. (3A.2).

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