Sovereign Risk Premia *

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Abstract

Emerging countries tend to default when their economic conditions worsen. If harsh economic conditions in an emerging country correspond to similar conditions for the U.S. investor, then foreign sovereign bonds are particularly risky. We explore how this mechanism impacts the data and influences a model of optimal borrowing and default. Empirically, the higher the correlation between past foreign bond and U.S. market returns, the higher the average sovereign excess returns. The market price of sovereign risk appears in line with its corporate counterpart. In the model, sovereign defaults and bond prices depend not only on the borrowers' economic conditions, but also on the lenders' time-varying risk aversion.

JEL Codes: F3, F4, E4.

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I. Introduction

Most empirical and theoretical studies of sovereign yields assume that investors are risk-neutral and thus that expected returns on sovereign bonds should equal the risk-free rate. If investors are risk-neutral, sovereign bond prices depend on expected default probabilities, recovery rates, as well as risk-free rates. This simple reasoning is commonly applied to the six trillion U.S. dollar public sector debt in emerging countries. Yet, its premises are flatly rejected by sovereign bond prices: in this paper, we demonstrate the impact of risk aversion.

The importance of risk aversion is intuitive. There is a tendency for emerging countries to default when they experience adverse economic conditions. If these adverse economic conditions correspond to an economic downturn in the U.S., then countries tend to default when risk-averse U.S. investors experience harsh economic conditions. In this scenario, sovereign bonds are particularly risky, and U.S. investors expect compensation for that risk through a high return. Alternatively, if poor economic conditions in a foreign country correspond to thriving times for U.S. investors, then sovereign bonds are less risky and may even hedge U.S. aggregate risk. As a result, sovereign bond prices must also depend on the timing of the bond payoffs. The intuition starts off the correlation between macroeconomic conditions in emerging countries and in the U.S., but most emerging countries lack high frequency macroeconomic data. To address this issue, we thus turn to financial series.

We build portfolios of sovereign bond indices by sorting countries along two dimensions: their covariance with U.S. economic conditions and their default probabilities. For the first sort, we compute bond betas, which are defined as the slope coefficients in regressions of past one-month sovereign bond excess returns on one-month U.S. equity excess returns at daily frequency. For the second sort, we use Standard and Poor's credit ratings. After sorting countries along these two dimensions, we obtain six portfolios and a large cross-section of holding period excess returns. Our sample focuses on the benchmark JP Morgan's Emerging Market Bond Indices (EMBI) and thus starts in December 1993 and ends in May 2011. If investors were risk-neutral, all average excess returns should be zero. However, in the data we examine, we find just the opposite, with returns ranging from 4% to 15%. The spread in average excess returns between low and high default probability countries is about 5 percent per year. The spread in average excess returns between low and high bond beta countries is more than 5 percent per year. The results are robust to different sorting variables, different weighting schemes, and different credit ratings. Although the sample encompasses several defaults and some turbulent economic times, large excess returns could theoretically correspond to "Peso" events, i.e. series of defaults waiting to happen. We address this possibility in two steps: first, we conduct a thorough asset pricing experiment, and second, we build a model that rules out a "Peso" explanation of our empirical findings.

We find that average sovereign bond excess returns compensate investors for taking on aggregate risk and that the price of sovereign risk is fully consistent with the price of corporate risk. Average EMBI excess returns correspond to the covariances between returns and one risk factor, either the U.S. stock market or the U.S. corporate bond market. The higher the covariances between sovereign returns and U.S. equity (or U.S. BBB corporate bond) returns, the higher the average sovereign returns. Market prices of risk are positive and significant, and pricing errors are not statistically different from zero. The market price of bond risk is not statistically different from the mean of the U.S. BBB corporate bond excess return, as implied by a simple no-arbitrage condition. Moreover, as in other asset markets, the price of risk increases in bad times, as measured by a high value of the equity option-implied volatility (VIX) index. We obtain consistent results in panel regressions of country-level EMBI returns, i.e., without forming any portfolio at all, as well as with world equity and bond market risk factors, thus extending our results beyond U.S. investors. All our findings point towards a risk-based explanation of sovereign bond returns and thus a new determinant of sovereign bond prices.

To uncover the implications of our findings in terms of optimal borrowing and default and confront "Peso" explanations of excess returns, we build on the seminal work of Eaton and Gersovitz (1981) and provide a numerical illustration of a model with endogenous default and time-varying risk premia. In the model, a small open economy borrows from a large developed country (the U.S., for example). We assume that investors are risk averse and have external habit preferences, as in Campbell and Cochrane (1999). The rest of the model builds on Aguiar and Gopinath (2006) and Arellano (2008). Every period, foreign countries decide to either default and face exclusion from financial markets, or repay their debt and consider borrowing again.

The key novelty of our model appears in the link between lenders' risk premia and borrowers' optimal default decisions. In the model, defaults depend partly on lenders' risk aversion. To illustrate this point, let us assume that business cycles are positively correlated. In this case, sovereign bonds are risky. When lenders experience a series of bad consumption growth shocks, their consumption becomes closer to their subsistence level and their risk aversion increases. If lenders are very risk averse, both risk premia and interest rates are high. Since it is very costly to borrow, emerging countries tend to default when they experience adverse conditions. As a result, when shocks across countries are positively correlated, defaults in emerging countries are more likely when lenders' risk aversion is high. In times of extreme risk-aversion, it looks as if lenders are pushing borrowers to default. As lenders' risk aversion influences borrowers' default decisions, it also naturally impacts optimal debt quantities and prices. Risk aversion thus implies that borrowing and default decisions depend on both the borrowers' and lenders' economic conditions. Sovereign risk premia deliver a novel link across countries: opening up capital markets exposes emerging countries to U.S. business cycle risk.

In order to analyze the model's results and compare them with actual data, we replicate on simulated series our portfolio and benchmark asset pricing experiment. Several independent simulations are run with different emerging economies. The only source of heterogeneity across small open economies is their correlation with the U.S. business cycle. Portfolios of simulated sovereign bonds are built by ranking countries on their U.S. stock market betas, as in the data. The model delivers a cross-section of average excess returns. Countries that are risky from the lenders' perspective offer higher returns. But bond issuances and defaults are endogenous choices: countries facing high borrowing costs choose to borrow less, thereby lowering their default probabilities. In the simulations (as in the data), high beta countries pay higher interest rates even if they do not borrow more in equilibrium. The model also sheds light on "Peso" explanations of sovereign bond returns. A version of the model with risk-neutral investors delivers sizable excess returns in small samples with lower default probabilities than in the long run, but it cannot reproduce the cross-section of excess returns obtained by ranking countries on stock market betas. The model thus reinforces our empirical results, pointing to risk as a key determinant of sovereign bond prices.

The paper is organized as follows. Section II reviews the literature. Section III describes the data, our empirical methodology, and our portfolios of sovereign bonds. Section IV shows that one risk factor explains most of the cross-sectional variation in average excess returns across our portfolios. In Section V, we describe a model with endogenous default and time-varying risk premia. Section VI presents a simulation of the model that qualitatively replicates our empirical findings. Section VII concludes. Our portfolios of sovereign bond excess returns are available on our websites. A separate appendix, also available online, reports the additional robustness checks mentioned in the paper, along with details on the calibration and simulation of the model.

II. Related Literature

This paper is related to two strands of literature on sovereign debt. First, this paper contributes to a large body of empirical work on emerging market bond spreads.[1] We do not attempt to survey this literature but focus instead on the two papers that are most related to ours, i.e. Pan and Singleton (2008) and Longstaff, Pan, Pedersen, and Singleton (2011). In these seminal

[1] Uribe and Yue (2006) point out that U.S. interest rates play an important role in driving sovereign risk and the business cycle of emerging markets. Other papers on the empirical determinants of sovereign spreads include Edwards (1984), Boehmer and Megginson (1990), Adler and Qi (2003), Bekaert, Harvey, and Lundblad (2007), Remolona, Scatigna, and Wu (2008) , Favero, Pagano, and von Thadden (2010), Hilscher and Nosbusch (2010), Broner, Martin, and Ventura (2010), Andrade and Chhaochharia (2011), Ang and Longstaff (2011), and Acharya, Drechsler and Schnabl (2011). See Almeida and Philippon (2007) for related evidence on corporate bond spreads and its implications on corporate capital structure, and see Coval, Jurek, and Stafford (2009) for related evidence in structured finance.

papers, the authors report that global factors explain a large fraction of the changes in emerging market credit default swap (CDS) spreads. We extend their work to a larger and longer sample of sovereign bond returns and, most importantly, show that the market price of sovereign risk is in line with the market price of corporate risk, leaving no arbitrage opportunities on average bond excess returns. This key result is obtained in a very general setting. Our estimation does not rely on an affine sovereign credit valuation model, a constant recovery rate, or an exogenously specified law of motion for the default probability, but simply tests the Euler equation of a U.S. investor on a novel cross-section of sovereign bond returns.

Second, our paper builds on the theoretical literature on optimal sovereign lending with defaults.[2] Here, the papers closest to ours are Aguiar and Gopinath (2006) and Arellano (2008). In these papers, as in most of the literature, investors are assumed to be risk-neutral. A limited number of papers, however, consider risk aversion. We rapidly list them here, starting from the reduced-form approaches. Andrade (2009) specifies an exogenous pricing kernel. Broner, Lorenzoni, and Schmukler (2008) do not specify investor preferences but propose a three-period model to determine the optimal term structure of sovereign debt when returns are negatively correlated to pricing kernels. In her seminal paper, Arellano (2008) mostly focuses on risk-neutral investors, but also considers a reduced form of the lenders' stochastic discount factor that is similar to constant relative risk-aversion. Lizarazo (2010) investigates decreasing absolute risk aversion in the same model. The large cross-section of average excess returns that we report in the next section is, however, not consistent with such preferences. By introducing habit preferences, we obtain large and time-varying risk premia that are consistent with the data and illustrate the role of risk-aversion in cross-country linkages.

This paper thus also builds on the macro-finance literature. When investors are risk-neutral, there is no role for covariances in sovereign bond prices, and expected excess returns are zero.

[2]Recent papers in this segment of the literature include Bulow and Rogoff (1989), Atkeson (1991), Kehoe and Levine (1993), Zame (1993), Cole and Kehoe (2000), Alvarez and Jermann (2000), Duffie, Pedersen, and Singleton (2003), Bolton and Jeanne (2007), Amador (2008), Fostel and Geanakoplos (2008), Arellano and Ramanarayanan (2009), Benjamin and Wright (2009), Pouzo (2009), Chien and Lustig (2010), Yue (2010), and Broner, Martin and Ventura (2010).

With constant risk-aversion, the large spread in returns due to covariances would imply a very large risk aversion coefficient and an implausible risk-free rate, as Mehra and Prescott (1985) and Weil (1989) find on equity markets. Campbell and Cochrane (1999) preferences offer a solution to the equity premium puzzle, endogenously delivering a volatile stochastic discount factor that implies high Sharpe ratios. Moreover, these preferences entail time-varying risk aversion, and thus a time-variation in the market price of risk, as we find in the data.[3] Our paper thus combines the international macroeconomics and finance literatures in order to shed new light on sovereign debt.

III. The Cross-Section of EMBI Returns

We take the perspective of a U.S. investor who borrows in U.S. dollars to invest in sovereign bonds issued in U.S. dollars by emerging countries. We describe the data and methodology, and then report the main characteristics of our cross-section of sovereign excess returns.

III. A. Data and Notation

Data on Emerging Markets JP Morgan publishes country-specific indices that market participants consider as benchmarks. The JP Morgan EMBI indices cover low or middle income per capita countries, and thus our main dataset contains 41 countries: Argentina, Belize, Brazil, Bulgaria, Chile, China, Colombia, Cote D'Ivoire, Croatia, Dominican Republic, Ecuador, Egypt, El Salvador, Gabon, Ghana, Hungary, Indonesia, Iraq, Kazakhstan, Lebanon, Malaysia, Mexico, Morocco, Pakistan, Panama, Peru, Philippines, Poland, Russia, Serbia, South Africa, South Korea, Sri Lanka, Thailand, Trinidad and Tobago, Tunisia, Turkey, Ukraine, Uruguay, Venezuela, Vietnam.

[3]There are at least two other classes of dynamic asset pricing models that account for several asset pricing puzzles: the long-run risk framework of Bansal and Yaron (2004) and the disaster risk framework of Rietz (1988) and Barro (2006). These two classes of models deliver volatile stochastic discount factors and high risk premia. They are legitimate candidates to describe the representative investor in models of sovereign lending.

The JP Morgan EMBI Global total return index includes accrued dividends and cash payments. In each country, the index is a market capitalization-weighted aggregate of U.S. dollar-denominated Brady Bonds, Eurobonds, traded loans, and local market debt instruments issued by sovereign and quasi-sovereign entities and mostly uncollateralized. These bonds are liquid debt instruments that are actively traded. Their notional sizes are at least equal to $500 million. Each issue included in the EMBI Global index must have at least 2.5 years until maturity when it enters the index and at least one year until maturity to remain in the index. Moreover, JP Morgan sets liquidity criteria such as easily accessible and verifiable daily prices either from an inter-dealer broker or a certified JP Morgan source [see Cavanagh and Long (1999) for additional information on the EMBI indices].

We rely on Standard and Poor's credit ratings to assess the default probability of each country. They take the form of letter grades ranging from AAA (highest credit worthiness) to SD (selective default). They are available for a large set of countries over a long time period. We collect Standard and Poor's ratings for all the 41 countries in the EMBI index, except Cote d'Ivoire and Iraq. We focus on ratings for long-term debt denominated in foreign currencies and convert ratings into numbers ranging from 1 (highest credit worthiness) to 23 (lowest credit worthiness).[4] Our sample contains several default episodes.[5]

Ratings are not traded prices. This obvious fact has two consequences. First, ratings are not tailored to a particular investor. For example, they are the same for a U.S. and a Japanese investor. As a result, ratings do not not take into account the timing of a potential sovereign default: a country that might default in good times for the U.S. has the same rating as a country

[4]The conversion from letters to numbers is the following: AAA = 1, AA+ = 2, AA = 3, AA- = 4, A+ = 5, A = 6, A- = 7, BBB+ = 8, BBB = 9, BBB- = 10, BB+ = 11, BB = 12, BB- = 13, B+ = 14, B = 15, B- = 16, CCC+ = 17, CCC = 18, CCC- = 19, CC+ = 20, CC = 21, CC- = 22, SD = 23.

[5]Argentina, Belize the Dominican Republic, Ecuador, Russia and Uruguay and Venezuela defaulted on their external debt during our sample period. Argentina was in default status from November 2001 to May 2005; Belize from December 2006 to February 2007; the Dominican Republic from February 2005 to June 2005; Ecuador in July 2000 for only one month and from December 2008 to June 2009; Russia from January 1999 to November 2000; Uruguay in May 2003 for only one month; and Venezuela from January 2005 to March 2005. In the event of a default, as long as the affected instrument continues to satisfy the inclusion criteria, it remains in the index using daily executable market prices. Pakistan, Indonesia, and Belize have also defaulted since 1993 but they entered the EMBI dataset only after their defaults.

that might default in bad times. Second, for most countries, credit ratings do not encompass all the information on expected defaults. They are not updated on a regular basis, but rather when new information or events suggest the need for additional Standard and Poor's studies and grade revisions.

It is common to rely on CDSs and debt-to-GDP ratios to complement the Standard and Poor's ratings. However, these two measures do not seem appropriate for our study. CDS are insurance contracts against the event that a sovereign nation defaults on its debt over a given horizon. These contracts are traded in U.S. dollars. As a result, their prices reflect both the magnitude and the timing of expected defaults. More crucially, CDS data are only available from 2001 on, and for a small subset of the EMBI Global countries with limited liquidity at first [see Pan and Singleton (2008) for a study of three countries over the 2001-2006 period]. Debt-to-output ratios are available for a subset of countries at annual frequency. These ratios do not predict default probabilities and returns as well as Standard and Poor's ratings. To check, however, that high debt levels do not drive our results, we report debt to output ratios. We focus on public and publicly guaranteed external debt, which is most likely not collateralized, consistent with our EMBI indices. Our series come from the World Bank Global Development Finance indicators.

Notation Before turning to our portfolio-building strategy, we introduce some useful notation. Let $r^{e,i}$ denote the log excess return of a U.S. investor who borrows funds in U.S. dollars at the risk-free rate r^f in order to buy country i's EMBI bond, then sells this bond after one month, and pays back the debt. The log excess return is equal to:

$$r_{t+1}^{e,i} = p_{t+1}^i - p_t^i - r_t^f,$$

where p_t^i denotes the log market price of an EMBI bond in country i at date t. The bond beta (β_{EMBI}^i) of each country i is the slope coefficient in a regression of EMBI bond excess returns on U.S. equity excess returns:

$$r_t^{e,i} = \alpha^i + \beta_{EMBI}^i r_t^{e,m} + \varepsilon_t,$$

where $r_t^{e,m}$ denotes the log total excess return on the MSCI U.S. equity index. Data are daily and holding periods are one month. Betas are computed on 200-day rolling windows and their time-series is denoted $\beta_{EMBI,t}^i$. As a timing convention, date-t betas are estimated with returns up to date t. For each regression, betas exist only if at least 100 observations for both the left- and right-hand side variables are available over the previous 200-day rolling window period.

III. B. Portfolios of EMBI Excess Returns

Sorts We build portfolios of EMBI excess returns by sorting countries along two dimensions: their probabilities of defaults and their bond betas. First, at the end of each period t, we sort all countries in the sample in two groups on the basis of their bond betas, $\beta_{EMBI,t}$. The first group contains the countries with the lowest $\beta_{EMBI,t}$; the second group contains the countries with the highest $\beta_{EMBI,t}$. Second, we sort all countries within each of the two groups into three portfolios ranked from low to high probabilities of default; portfolios 1, 2, and 3 contain countries with the lowest betas, while portfolios 4, 5, and 6 contain countries with the highest betas. Portfolios 1 and 4 contain countries with the lowest default probabilities, while portfolios 3 and 6 contain countries with the highest default probabilities. Average ratings range from 7 (i.e., a Standard and Poor's AA- rating) to 15 (i.e., a B rating). Portfolios are re-balanced at the end of every month, using information available at that point. For example, Mexico turns out to be a high beta country on average, while Thailand is a rather low beta country. This is not very surprising considering the strong connection between the U.S. and Mexican economies. The composition of portfolios changes every month, although there is stability in the portfolio allocation. The probability of switching portfolios is close to 10% on average: countries change portfolios every 10 months on average.

We compute the EMBI excess return $r^{e,j}_{t+1}$ for portfolio j ($j = 1, 2, ..., 6$) by taking the average of the EMBI excess returns between t and $t + 1$ that are in portfolio j. We need at least six countries in the sample to build our six portfolios and thus start in January 1995. The size of our sample varies over time, reaching a maximum of 35 countries.

Table 1 provides an overview of our six EMBI portfolios. For each portfolio j, we report the average foreign bond beta β^j_{EMBI} (Panel A), the average Standard and Poor's credit rating (Panel B), the average total excess return $r^{e,j}$ (Panel C), and the average public external debt-to-GDP ratio (Panel D). All returns are reported in U.S. dollars and the moments are annualized: we multiply the means of monthly returns by 12 and standard deviations by $\sqrt{12}$. The Sharpe ratio is the ratio of the annualized mean to the annualized standard deviation.

Average Excess Returns Our portfolios highlight two simple empirical facts that appear clearly in Table 1. First, excess returns increase from low to high betas: portfolio 1, 2, and 3 (low betas) offer lower excess returns than portfolios 4, 5, and 6 (high betas). The average excess return on all the low beta portfolios is 494 basis points per annum. For the high beta portfolios, it is 1,061 basis points. As a result, there is on average a 567 basis points (i.e., 5.7%) difference between the high and low beta portfolios. Bilateral comparisons (portfolio 1 vs. portfolio 4, 2 vs. 5, and 3 vs. 6) all show that, for similar credit ratings, high beta bonds always offer higher returns. Second, excess returns also increase with default probabilities: portfolios 1 and 4 (low default probabilities) offer lower excess returns than portfolios 3 and 6 (high default probabilities). For low beta countries, the spread between low and high default probabilities entails a 317 basis point difference in returns; this difference jumps to 619 basis points for high beta countries.

These spreads are economically significant, although standard errors on the averages are large. We compute those standard errors by bootstrapping, assuming that returns are $i.i.d.$, in order to take into account the small sample size. Standard errors range from 175 to 509 basis points per year. The average excess returns are at least two standard errors away from zero. Focusing on the differences between high and low beta portfolios, once we control for ratings,

Table 1: EMBI Portfolios Sorted on Credit Ratings and Bond Market Betas

Portfolios	1	2	3	4	5	6
β^j_{EMBI}		Low			High	
S&P	Low	Medium	High	Low	Medium	High
			Panel A: EMBI Bond Market Beta, β^j_{EMBI}			
Mean	0.09	0.13	0.10	0.39	0.47	0.64
Std. Dev.	0.16	0.20	0.20	0.33	0.31	0.38
			Panel B: S&P Default Rating, dp^j			
Mean	7.15	9.60	13.10	10.05	12.25	15.22
Std. Dev.	1.52	1.00	1.03	1.68	0.96	1.47
			Panel C: Excess Return, $r^{e,j}$			
Mean	3.75	4.13	6.92	8.44	8.78	14.62
s.e	[1.75]	[2.15]	[2.76]	[2.98]	[3.90]	[5.09]
Std. Dev.	7.34	9.08	11.42	11.80	15.25	20.72
SR	0.51	0.45	0.61	0.71	0.58	0.71
			Panel D: Sovereign External Debt/GNP			
Mean	0.11	0.16	0.33	0.27	0.30	0.33
Std. Dev.	0.05	0.09	0.08	0.09	0.08	0.09

Notes: This table reports, for each portfolio j, the average beta β_{EMBI} from a regression of EMBI excess returns on the U.S. stock market excess returns (Panel A), the average Standard and Poor's credit rating (Panel B), the average EMBI log total excess return (Panel C), and the public external debt to GDP ratio (Panel D). Excess returns are annualized and reported in percentage points. For excess returns, the table also reports standard errors on the averages, as well as standard deviations and Sharpe ratios, computed as ratios of annualized means to annualized standard deviations. Standard errors are obtained by bootstrapping, assuming that returns are *i.i.d*. The portfolios are constructed by sorting EMBI countries on two dimensions: every month countries are sorted on their probability of default, measured by the S&P credit rating, and on β_{EMBI}. Note that Standard and Poor's uses letter grades to describe a country's credit worthiness. We index Standard and Poor's letter grade classification with numbers going from 1 to 23. Data are monthly, from JP Morgan, Standard and Poor's and the World Bank (Datastream). The sample period is 1/1995–5/2011.

we obtain an average spread of 468 basis points between portfolios 1 and 4, 465 basis points between portfolios 2 and 5, and 770 basis points between portfolios 3 and 6. The small sample standard errors on these spreads are respectively 230, 289, and 354 basis points. As a result, spreads across portfolios are also close to two standard errors away from zero.

Patton and Timmermann (2010) propose a precise test of these cross-sectional properties. We use their non-parametric test to examine whether there exists a monotonic mapping between the observable variables used to sort EMBI countries into portfolios and expected returns. The test rejects at standard significance levels the null of the absence of a monotonic relationship between portfolio ranks and returns against the alternative of an increasing pattern (the p-value is 1.5%).

Other Moments We also check whether our portfolios differ in several other dimensions: higher moments, debt levels, market capitalization, duration, and maturity.

Sovereign bond returns present large negative skewness and large positive kurtosis. Both characteristics are due to the 1998 and 2008 crises.[6] The low default probability portfolios exhibit the most pronounced deviations from normality. The low skewness and high kurtosis of these returns is reminiscent of crash risk. We do not, however, pursue a disaster risk explanation of sovereign spreads, in the vein of Rietz (1988), Barro (2006), Gabaix (2008), and Martin (2008) because there is no significant difference in skewness or kurtosis between the high and low beta portfolios. However, crash risk is an interesting avenue for future research on sovereign bonds.

We obtain the largest difference in returns between high and low beta portfolios with poor ratings (portfolios 3 and 6) while these two portfolios exhibit the same average debt level. Ratings, however, appear related to debt levels, which increase inside each beta group. We obtain similar results with other debt indices. Total external debt (also from the World Bank) and net general government debt (from the IMF) levels tend to increase inside each beta group, but net general government debt levels are lower in portfolio 6 than in portfolio 3.

Our benchmark portfolios tend to differ also in terms of market capitalization, duration, and maturity. These differences may account for part of the cross-section of excess returns across portfolios, but they are unlikely to explain the whole cross-section of excess returns.

High beta, high default probability portfolios tend to have lower market capitalizations than their low beta counterpart. Their higher returns may thus correspond to potential liquidity risk

[6]These characteristics are also apparent at the country level. Some countries like Hungary, Malaysia, and Thailand exhibit very large kurtosis. The same three countries present the largest positive skewness measures. Clearly, our sample comprises two large crises: the Asian financial crisis in 1998 and the mortgage crisis in 2008–2009. Both crises implied first sharp increases in EMBI spreads (i.e., lower emerging market bond prices) and thus very low returns.

premia. Yet, inside each beta group, there is no monotonic variation in market capitalization even though returns increase with default probabilities (as measured by low ratings) and there is no difference in market capitalization between other low and high beta portfolios. Mapping market capitalizations into returns is thus not obvious, but liquidity remains a valid concern and we explore it further below.

We also note that our portfolios differ in terms of duration and maturities. Portfolios with high betas and high default probabilities (low ratings) tend to exhibit longer durations and maturities. These higher durations may also explain part of the cross-section of returns. The difference in duration is, however, limited (from 5.2 years for the first portfolio to 6.4 years for the last portfolio). A pure term premium, as measured for example from the U.S. government bond yield curve, is unlikely to account for the large spread in returns that we observe on emerging markets sovereign bonds. The spread in returns between 5- and 7- year U.S. government bonds (0.4%) is an order of magnitude smaller than the spread we obtain between our first and last portfolios (above 10%). Term premia certainly matter, but they must interact with sovereign risk premia in order to account for the cross-section of EMBI returns. On a sample of 11 emerging markets, Broner et al. (2010) estimate that the excess returns on 9-year bonds are on average 1.5% higher than on 6-year bonds. Again, this spread is much lower than the one we obtain between our corner portfolios.

Transaction Costs Finally, note that our average returns do not take into account transaction costs. Unfortunately, we do not have bid-ask spreads on EMBI indices and JP Morgan does not make the historical composition of the EMBI indices publicly available. Transaction costs, however, are important, and would reduce the Sharpe ratios on these portfolios. We obtain an order of magnitudes for these transaction costs using emerging market sovereign bonds available in Bloomberg. These bond prices are not as reliable as the JP Morgan indices. They contain clear outliers and our data set does not conform to the strict liquidity requirements that JP Morgan enforces. But they offer a glimpse at transaction costs on sovereign emerging markets.

Building portfolios of equally-weighted individual bonds (using the same methodology as for indices), we obtain median bid-ask spreads ranging from 40 basis points to 64 basis points.

These transaction costs impact the overall level but do not seem to affect the spread in returns. We use here a simple back-of-the-envelop approach. Our portfolios exhibit an average of 10 changes per year. Assuming an average bid-ask spread of 50 basis points (equal to the median spread observed on Bloomberg prices), transaction costs would amount to 500 basis points per year and per portfolio. They would reduce our cross-section of excess returns from the 2.6% to 14.6% range to the -2.4% to 9.6% range. Note that there is no difference in transaction costs between the first and last portfolio; the median bid-ask spreads are 60.4 basis points vs. 63.6 basis points. Bid-ask spreads thus have no significant impact on the difference between corner portfolios. Even if we were to assume a difference of 200 basis points per year across portfolios (although, again, without any evidence pointing in this direction), the spread in returns would only decrease from 12% to 10%. It is thus highly unlikely that transaction costs would eliminate the cross-section of excess returns we report. We acknowledge that these numbers are back-of-the-envelop estimates: we cannot rule out a larger or smaller impact of transaction costs on our EMBI returns since we do not – and cannot – have the exact same individual bonds and weights that JP Morgan used to build EMBI series. Yet, the liquidity filters used by JP Morgan suggest that our estimates transaction costs are certainly conservative.

We note that liquidity and term premia may differ systematically across our portfolios and that these risk premia may account for at least part of the cross-section of excess returns. We do not disentangle sovereign risk from liquidity and term risk premia; doing so is beyond the scope of this paper. We also note that the lower skewness and higher kurtosis of the low beta portfolios may be indicative of "peso" explanations of excess returns: in this logic, high average returns in sample simply correspond to luck, with large and negative returns waiting to happen, such that all excess returns would be zero in a very long sample. Although many countries in our sample have experienced difficult economic times and actual defaults, "peso" explanations are a valid concern in small samples. We examine this issue thoroughly: we rely on both an empirical asset pricing exercise (Section IV) and model simulations (Section VI) to show that "peso" stories are very unlikely explanations of our findings.

III. C. Robustness Checks

We end this section with several robustness checks, considering different weights and different sorts.

Value-Weighted Value-weighted (instead of equally-weighted) portfolios built using market betas and credit ratings deliver a cross-section of excess returns similar to our benchmark. Our results are not driven by a few small countries with exceptional returns.

S&P "Outlook" S&P "Outlooks," which assess the potential direction of future ratings, augment the precision of S&P ratings. "Outlooks" are converted into numbers that modify the current ratings. This additional information does not modify substantially our results.

Index Composition The composition of the EMBI indices changes over time. As a result, risk characteristics of the indices could potentially change because of large changes in duration. To address this issue, we exploit duration time series available starting in January 2004 and exclude from the sample, for each country, the three months around each change in duration of more than three years. Dropping those periods does not significantly change our results.

Bond Betas We also find a similar cross-section when we use bond betas and credit ratings. The bond market betas correspond to slope coefficients in regressions of sovereign bond returns on U.S. BBB corporate bond excess returns.[7] Here again, high beta sovereign bonds tend to

[7]We do not attempt here to summarize the large literature on corporate spreads. See Giesecke, Longstaff, Schaefer and Strebulaev (2011) for a survey and long historical time-series, see Gilchrist, Yankov and Zakrajsek (2009) and Philippon (2009) for recent evidence on the link between credit spreads and macroeconomic variables, and see Bhamra, Kuehn and Strebulaev (2010) for a recent model with counter-cyclical corporate spreads.

offer higher excess returns. The cross-section of excess returns is very similar to the one in Table 1.

Ratings Rating agencies offer only imperfect measures of default probabilities. We thus check the robustness of our findings by using different rating agencies or CDS rates. Moody's and Fitch's ratings lead to similar results as in our benchmark sample, i.e. large differences in excess returns between low and high beta portfolios for each rating dimension. CDS prices offer a high-frequency and market-based proxy for risk-weighted expected default probabilities but are available for a much smaller number of countries (27 maximum) and a shorter time window (from March 2003 to May 2011 at best). We obtain, again, large differences in excess returns between low and high beta portfolios for each CDS price dimension. Thus, it is unlikely that our cross-section of excess returns along the beta-dimension is simply due to mis-measured default probabilities.

Constant Betas Sorting on sovereign betas and rebalancing portfolios is the key innovation of this section. We run two additional experiments to make this point. First, we sort countries on average bond betas, instead of time-varying betas, maintaining the same sample as for our benchmark portfolios. For each country, we compute the average of all its time-varying betas. We obtain a cross-section of excess returns, albeit smaller than with time-varying betas. The caveat is that such portfolios exhibit forward-looking bias: in order to compute the mean beta, we use information not available to the investor. Second, in order to avoid the forward-looking bias, we fix each country's beta to the first available value in our sample. As a result, we maintain the same sample as before, but the betas are now constant for each country and known at the time of the investment decision. If we sort portfolios using these fixed betas, we do not obtain a clear cross-section of excess returns. The reason is that there is time-variation in actual betas and these dynamics are informative about returns.

Overall, our results appear very robust. There is a clear difference in average excess returns between the high and low beta portfolios. At the end of the next section, we also run asset pricing tests at the country level to check that our results are not mechanically driven by our portfolio building exercise. They are not. Portfolios simply offer a convenient way to focus on systematic risk.

To summarize this section, by sorting countries along their Standard and Poor's ratings and market betas, we have obtained a rich cross-section of average excess returns. We now turn to the dynamic properties of these portfolio returns.

IV. Systematic Risk in EMBI Excess Returns

In this section, we show that covariances of sovereign bond returns with either U.S. stock market returns or U.S. corporate bond returns account for a large share of our cross-section of average excess returns.

IV. A. Asset Pricing Methodology

Linear factor models of asset pricing predict that average excess returns on a cross-section of assets can be attributed to risk premia associated with their exposure to a small number of risk factors. In the arbitrage pricing theory of Ross (1976), these factors capture common variation in individual asset returns. We test this prediction on sovereign bond returns.

Cross-Sectional Asset Pricing We use $R^{e,j}_{t+1}$ to denote the average excess return for a U.S. investor on portfolio j in period $t+1$. In the absence of arbitrage opportunities, there exists a strictly positive discount factor such that this excess return has a zero price and satisfies the following Euler equation:

$$E_t[M_{t+1}R^{e,j}_{t+1}] = 0,$$

where M denotes the stochastic discount factor (SDF) of the U.S. investor. We further assume that the log stochastic discount factor m is linear in the pricing factors f:

$$m_{t+1} = 1 - b(f_{t+1} - \mu),$$

where b is the vector of factor loadings and μ denotes the factor means. This linear factor model implies a beta pricing model: the log expected excess return is equal to the factor price λ times the beta of each portfolio β^j:

$$E[\widetilde{r^{e,j}}] = \lambda' \beta^j,$$

where $\widetilde{r^{e,j}}$ denotes the log excess return on portfolio j corrected for its Jensen term, Σ_{ff} is the variance-covariance matrix of the factors, $\lambda = \Sigma_{ff} b$, and β^j denotes the regression coefficients of the returns $R^{e,j}$ on the factors. To estimate the factor prices λ and the portfolio betas β, we use two different procedures: a generalized method of moments (GMM) applied to linear factor models, following Hansen (1982), and a two-stage (OLS) estimation, following Fama and MacBeth (1973), henceforth FMB.

We use a single risk factor to account for the returns on our EMBI portfolios. This risk factor is either the log total return on the U.S. stock market or the log total return on the Merrill Lynch U.S. BBB corporate bond index. The Euler equation thus implies that expected excess returns are fully explained by the covariances between bond returns and the risk factor. We interpret past ratings and past betas as signals on those key covariances and we show that, even if we formed portfolios on two dimensions, we can account for the cross-section of excess returns with a unique risk factor. This is also true in the model presented in the next section. Before we jump to our results, let us pause to think more precisely about the validity of our asset pricing experiment, particularly its generalization to foreign investors.

Foreign Investors According to the 2008 survey of U.S. Portfolio Holdings of Foreign Securities published by the U.S. Treasury, U.S. investors own $42 billion of long-term government debt issued in U.S. dollars by the emerging countries in our sample. U.S. investors are not the only buyers of sovereign bonds: they only own a fraction of all EMBI bonds, whose total market capitalization was $243 billions at the end of 2008. Our empirical work does not assume that U.S. investors are the only buyers of sovereign bonds.

For our asset pricing experiment to be valid, we only need to assume free-portfolio formation and the law of one price. These two conditions, which are fairly general and even less restrictive than the absence of arbitrage, are enough in order to postulate the existence of a SDF that prices our returns [see Cochrane (2001), chapter 4]. Under these conditions, there exists a unique SDF in the space of traded assets. Our objective is then to find a reasonable approximation of this SDF.

Our results can be extended to non-U.S. investors who also buy emerging market sovereign bonds. The extension to foreign investors is straightforward if all shocks that affect U.S. and foreign investors are spanned by financial markets. Let us illustrate this point through a simple example.

Assume that U.K. investors buy Argentinean sovereign bonds. Let Q denote the real exchange rate in U.S. good per U.K. good. When Q increases, the dollar depreciates in real terms. Let $r_{t+1}^{U.K.} = r_{t+1} - \Delta q_{t+1}$ denote the log return of a U.K. investor buying sovereign bonds issued in U.S. dollars (i.e., paying U.S. goods). We now consider two cases.

In the first case, we assume that all U.S. and U.K. shocks are spanned by financial markets, i.e., markets are complete across these two countries. In this case, the change in the real exchange rate corresponds to the ratio of the foreign to domestic SDFs.[8] If sovereign bonds are priced from the perspective of U.S. investors, then they are also priced for U.K. investors:

[8] The proof is simple. For any return $R^{\star}$ (measured in U.K. goods), the Euler equations of the U.K. and U.S. investors hold:

$$E_t[M_{t+1} R^{\star}_{t+1} Q_{t+1}/Q_t] = 1 \text{ and } E_t[M^{U.K.}_{t+1} R^{\star}_{t+1}] = 1.$$

When markets are complete, the SDF is unique. This implies that: $Q_{t+1}/Q_t = M^{U.K.}_{t+1}/M_{t+1}$.

$P_t = E_t[M_{t+1}X_{t+1}]$ implies $P_t/Q_t = E_t[M^{U.K.}_{t+1}X_{t+1}/Q_{t+1}]$. Assuming lognormality, we can then decompose the expected excess return of U.K. investors as the sum of two risk premia:

$$E_t(r^{U.K.}_{t+1}) - r^{f,U.K.}_t + \frac{1}{2}Var_t(r^{U.K.}_{t+1}) = \underbrace{-cov_t(m_{t+1}, r_{t+1})}_{\text{U.S. sovereign risk premium}} \underbrace{-cov_t(m^{U.K.}_{t+1}, -\Delta q_{t+1}) + \frac{1}{2}Var_t(\Delta q_{t+1})}_{\text{currency risk premium}},$$

where $r^{f,U.K.}$ denotes the risk-free rate in the U.K. The sovereign risk premium (the first term on the right-hand side) is the one we study in this paper. The currency risk premium does not depend here on emerging market defaults and can be studied separately. Our assumption of lognormality is for expositional clarity only.

In the second case, financial markets are incomplete, i.e., they do not span all the shocks between the U.S. and the U.K. Here, an additional risk premium appears on the right-hand side of the above equation. It corresponds to the covariance between the sovereign bond return in an emerging country and the difference in log SDFs that is not spanned by changes in exchange rates: $-cov_t(r_{t+1}, m^{U.K.}_{t+1} - m_{t+1} - \Delta q_{t+1})$. In other terms, an additional risk premium exists if defaults in Argentina, for example, affect the U.S. and U.K. economies differently and if this difference is not captured by the U.S./U.K. exchange rate. It is an interesting case, but we do not know of any model where it arises.

If exchange rates are defined as the ratio of two pricing kernels (i.e., if markets are complete across foreign investors, which is most likely among developed countries), then our asset pricing experiment offers the most direct measure of sovereign risk premia. Sovereign bonds can be bought by other investors too: the foreign stochastic discount factor that prices sovereign bonds from a foreign investor's perspective is the U.S. pricing kernel multiplied by the change in exchange rates. In order to take the perspective of other investors, the exchange rate risk needs to be added. We check that the same sovereign portfolios are priced using global equity or bond indices of developed countries. The case of incomplete markets is more difficult and we leave it for future research. Instead, we show now that the Euler equation for a U.S. investor offers new insights on emerging markets' sovereign debt.

IV. B. Asset Pricing Results

Table 2 reports our asset pricing results. Panel A reports estimates of the market price of risk λ and the SDF factor loadings b, the adjusted R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests (in percentage points). The left-hand side of the table reports results obtained with the U.S. stock market return as sole risk factor, while the right-hand side of the table pertains to results obtained with the U.S. BBB bond return as sole risk factor.

Market Prices of Risk Panel A shows that the market price of equity risk is equal to 2,047 basis points per annum. The FMB standard error is 704 basis points. The market price of bond risk is 722 basis points, with a standard error of 249 basis points. In both cases, the risk price is more than two standard errors away from zero, and thus highly statistically significant. Overall, asset pricing errors are small. The square root of the mean squared errors (RMSE) are either 100 or 131 basis points and the cross-sectional R^2s are either 90% or 84%. The null that the pricing errors are zero cannot be rejected, regardless of the estimation procedure and regardless of the risk factors.

Since both risk factors are returns, the no arbitrage condition implies that the risk prices should be equal to the factor average excess returns. This condition stems from the fact that the Euler equation applies to each risk factor too, which clearly has a regression coefficient β of 1 on itself. On the one hand, the market price of equity risk is much higher than the equity excess return in our sample (529 basis points). Standard errors are large but the market price and the mean excess returns differ at the 10% confidence level. On the other hand, the market price of bond risk is higher but not statistically different from the mean excess return of the factor, so the no-arbitrage condition is not rejected. The price of risk in sovereign bond markets in U.S. dollars appears consistent with its U.S. corporate bond counterpart.

Figure 1 plots predicted against realized excess returns for the six EMBI portfolios. The left (right) panel uses the U.S. stock (bond) market as the risk factor. The fit obtained with a bond return is less tight, but the implied market price of risk is reasonable.

Alphas and Betas in EMBI Returns Panel B of Table 2 reports the constants (denoted α^j) and the slope coefficients (denoted β^j_{US-Mkt} or $\beta^j_{US_{BBB}}$) obtained by running time-series regressions of each portfolio's excess returns $\widetilde{rx^{e,j}}$ on a constant and the U.S. stock market or U.S. bond risk factors.

Table 2 shows that the αs are small and not significantly different from zero. The null that the αs are jointly zero cannot be rejected. The second column reports the βs for our risk factors. The equity βs increase from 0.12 to 0.31 for the low β_{EMBI} group, while for the second β_{EMBI} group they increase from 0.37 for portfolio 4 to 0.70 for portfolio 6. The bond βs increase from 0.76 to 0.87 for the low β_{EMBI} group, while for the second β_{EMBI} group they increase from 1.06 for portfolio 4 to 1.84 for portfolio 6. Betas align with average excess returns for two reasons: pre-formation betas predict post-formation betas, and bonds with higher default probabilities tend to load more on the risk factors. Comparing portfolios 1 and 4, 2 and 5, and 3 and 6, we note that asset pricing (i.e., post-formation) betas are always higher in the second group.

Table 2 reports two p-values: in Panel A, the null hypothesis is that all the cross-sectional pricing errors are zero. These cross-sectional pricing errors correspond to the distance between expected excess returns and the 45-degree line in the classic asset pricing graph (expected excess returns as a function of realized excess returns). In Panel B, the null hypothesis is that all intercepts in the time-series regressions of returns on risk factors are jointly zero. We report p-values computed as 1 minus the value of the chi-square cumulative distribution function (for a given chi-square statistic and a given degree of freedom). As a result, large pricing errors or large constants in the time-series imply large chi-square statistics and low p-values. A p-value below 5% means that we can reject the null hypothesis that all pricing errors or constants in the time-series are jointly zero.

IV. C. Extensions

To sum up, we find that the large cross-section of EMBI portfolio returns corresponds to covariances of EMBI returns with risk factors, not luck. We now check the robustness of this result

Table 2: Asset Pricing: Benchmark Portfolios

	Risk Factor: U.S. Stock Market					Risk Factor: U.S. Bond Market				
	Panel A: Factor Prices and Loadings									
	$\lambda_{U.S.-Mkt}$	$b_{U.S.-Mkt}$	R^2	$RMSE$	p-value	$\lambda_{U.S.-BBB}$	$b_{U.S.-BBB}$	R^2	$RMSE$	p-value
GMM_1	20.47	0.66	92.38	1.00		7.22	1.65	86.97	1.31	
	[12.43]	[0.40]			67.86	[4.60]	[1.05]			59.31
GMM_2	18.93	0.61	89.21	1.19		4.78	1.09	24.30	3.15	
	[9.05]	[0.29]			68.31	[2.99]	[0.68]			69.43
FMB	20.47	0.66	90.95	1.00		7.22	1.64	84.38	1.31	
	[7.04]	[0.23]			78.12	[2.49]	[0.56]			54.08
	(7.36)	(0.24)			82.43	(2.58)	(0.59)			60.38
$Mean$	5.29					4.43				
	[4.26]					[1.84]				
	Panel B: Factor Betas									
Portfolio	$\alpha_0^j(\%)$	$\beta^j_{U.S.-Mkt}$	$R^2(\%)$	$\chi^2(\alpha)$	p-value	$\alpha_0^j(\%)$	$\beta^j_{U.S.-BBB}$	$R^2(\%)$	$\chi^2(\alpha)$	p-value
1	0.23	0.12	6.48			−0.17	0.76	38.93		
	[0.17]	[0.06]				[0.12]	[0.09]			
2	0.19	0.21	14.48			−0.20	0.85	32.14		
	[0.23]	[0.09]				[0.19]	[0.12]			
3	0.36	0.31	18.61			0.02	0.87	21.31		
	[0.25]	[0.10]				[0.23]	[0.13]			
4	0.44	0.37	25.15			0.03	1.06	29.44		
	[0.24]	[0.09]				[0.25]	[0.16]			
5	0.37	0.51	28.88			−0.10	1.31	27.07		
	[0.29]	[0.11]				[0.30]	[0.20]			
6	0.72	0.70	29.78			0.05	1.84	28.93		
	[0.46]	[0.18]				[0.50]	[0.38]			
All				4.88	55.90				5.79	44.69

Notes: This table reports asset pricing results obtained using either the U.S. stock market return (left-hand side) or the U.S.-BBB corporate bond return (right-hand side) as risk factors. Panel A reports results from GMM and Fama-McBeth asset pricing procedures. Market prices of risk λ, the adjusted R^2, the square-root of mean-squared errors $RMSE$ and the p-values of χ^2 tests on pricing errors are reported in percentage points. b denotes the vector of factor loadings. All excess EMBI returns are multiplied by 12 (annualized). The standard errors in brackets are Newey and West (1987) standard errors with the optimal number of lags according to Andrews (1991). Shanken (1992)-corrected standard errors are reported in parentheses. We do not include a constant in the second step of the FMB procedure. We also report the mean of the excess return on the risk factor and the corresponding standard error obtained by bootstrapping. Panel B reports OLS regression results. We regress each portfolio return on a constant (α) and the risk factor (the corresponding slope coefficient is denoted $\beta_{U.S.-Mkt}$ or $\beta_{U.S.-BBB}$). R^2s are reported in percentage points. The alphas are annualized and in percentage points. The χ^2 test statistic $\alpha' V_\alpha^{-1} \alpha$ tests the null that all intercepts are jointly zero. This statistic is constructed from the Newey-West variance-covariance matrix V_α (with one lag) for the system of equations [see Cochrane (2001), page 234]. Data are monthly, from JP Morgan in Datastream. The sample period is 1/1995–5/2011.

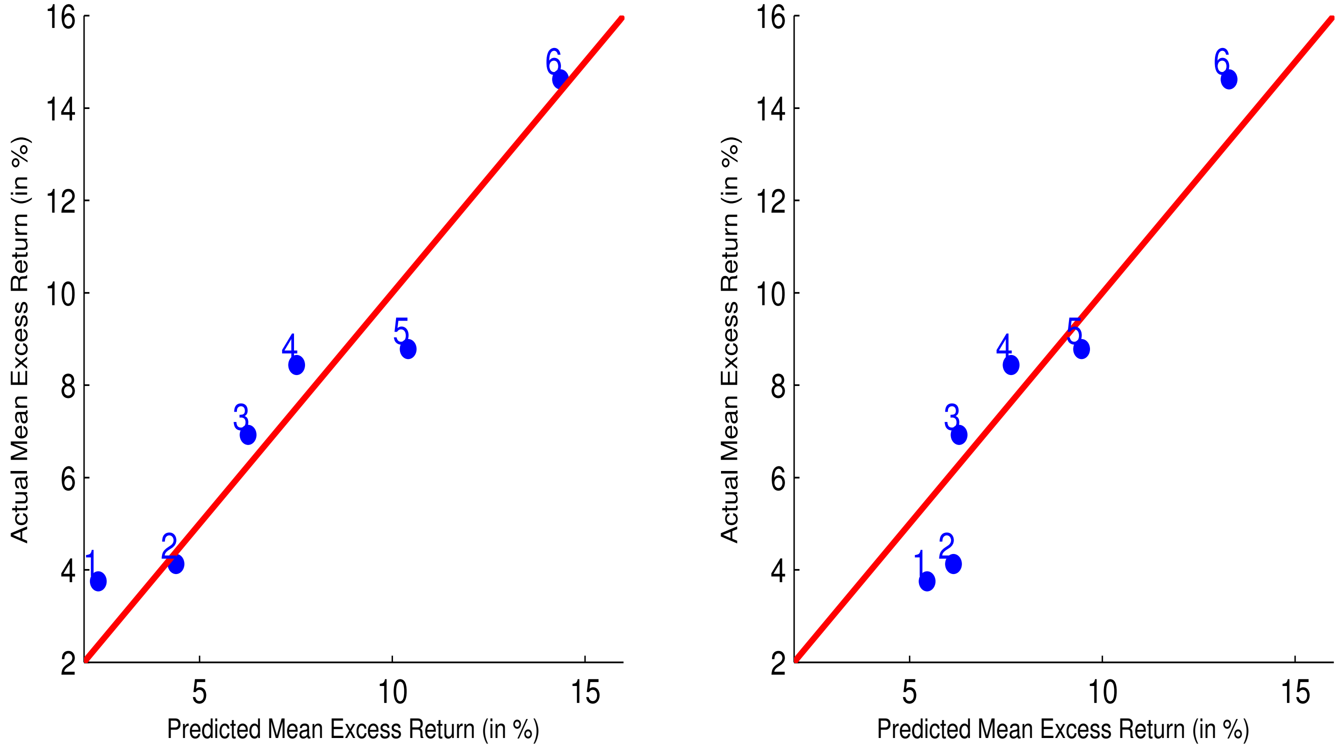

Figure 1: Predicted versus Realized Average Excess Returns

The figure plots realized average EMBI portfolio excess returns on the vertical axis against predicted average excess returns on the horizontal axis. The left panel uses the U.S. stock market as risk factor, while the right panel uses the U.S.-BBB bond return as risk factor. We regress each portfolio j's actual excess returns on a constant and our risk factor to obtain the slope coefficient β^j. Each predicted excess return then corresponds to the OLS estimate β^j multiplied by the estimated market price of risk. All returns are annualized. Data are monthly. The sample period is 1/1995–5/2011.

and consider potential extensions. We first rapidly describe the results obtained on different samples of portfolios and on country-level returns. We then turn to tests of the conditional Euler equation and tests of liquidity risk.

Different Samples We run the same asset pricing tests on a different set of portfolios: the EMBI returns sorted on U.S. bond (not stock) market betas and credit ratings. Using the same risk factors as before, results are very similar.

We also consider a smaller time-window of our benchmark portfolios, ending the sample in May 2007, i.e. before the mortgage crisis. The market prices of risk are positive and significant. They are a bit higher than in the whole sample and RMSE are larger. The null that pricing errors are zero cannot be rejected. The recent crisis features an increase in EMBI betas and thus tends to decrease the estimated market prices of risk. It brings them closer to the mean of the risk factors. But the crisis does not drive our main result; we would have reached a similar conclusion in a pre-crisis sample.

Country-level Results Our approach is the standard one in finance: there is nothing magic about our portfolios; they simply average out idiosyncratic risk and allow us to focus on risk premia. We stress that our results are not mechanically driven by our portfolio building exercise. To show this point, we run panel regressions and asset pricing tests at the country-level.

We run the original Fama and MacBeth (1973) procedure on country-level excess returns. This procedure does not correspond to implementable trading strategies (unlike our portfolios) but it confirms our previous results: the market prices of risk are positive and significant. The market price of equity risk is 2,228 basis points, close to the portfolio estimate. It is higher than the mean equity excess return. The market price of bond risk is 747 basis points, again close to the portfolio estimate. It is not statistically different from the mean excess return on the U.S. BBB risk factor. In both cases, the square root of the mean squared errors and the mean absolute pricing errors are much larger than on portfolios—no averaging out of idiosyncratic risk here— but the null hypothesis that all pricing errors are jointly zero cannot be rejected.

In panel tests, country-level EMBI excess return load significantly on the risk factors. In both cases, the worse the rating, the higher the loading on the risk factor. This result is robust and appears with or without country fixed effects. The slope coefficients are at least two standard errors away from 0. Country-level results are thus fully consistent with our main portfolio results. We now consider two potential extensions.

Foreign Investors We find similar results as before when check that our portfolio returns are priced from the perspective of foreign investors.[9] The market price of world equity risk is positive

[9]We use the MSCI World Index, which, despite its name, focuses on the equity market performance of 24 developed markets. We use the Bank of America Merrill Lynch BBB Global Corporate Index, which aggregates Canadian, Japanese, U.K., and U.S. corporate bonds. This bond index is only available starting in December 1996. These two indices are expressed in U.S. dollars.

and significant, but higher than the mean of the world equity excess return. The RMSE are almost the same as those obtained with the U.S. equity return. The market price of world bond risk is also positive and significant. At 7.12%, it is two standard errors away from zero, and less than one standard error above the mean of the bond excess return (4.16%). The RMSE are higher than those obtained with the U.S. bond index (167 basis points vs. 130 basis points), but we still cannot reject at 5% the null hypothesis that pricing errors are zero. The time-series constants are jointly insignificant.

Conditioning Information We find that the implied market prices of risk vary significantly through time: they tend to increase in bad times, when the implied U.S. stock market volatility is high. The conditional market price of risk (i.e., the one associated with the bond or equity returns multiplied by the lagged VIX index) are more than two standard errors away from zero. Time-varying risk-aversion is a potential interpretation of this finding. In bad times, investors are risk-averse and require a larger compensation per unit of risk. But a rise in the VIX index is also often associated with poor market liquidity.

Liquidity Risk In order to check if portfolio returns compensate investors for bearing some liquidity risk, two additional risk factors are considered: the change in the log VIX index and the TED spread, defined as the difference between Eurodollar yields and Treasury Bills, both at 3-month horizons. These two variables are often used to proxy for liquidity risk, even though they also capture some credit risk and/or time-varying risk aversion. They are added (one at the time) to our previous equity and bond factors.

We obtain mixed results. The change in the VIX index and the TED have, as expected, negative market prices of risk. The market price of risk of the VIX is borderline significant (when associated with the bond market return, not with the stock market), while the one of the TED spread is not. In the time-series, four out of six portfolio returns load significantly on the change in the VIX index but only the last portfolio loads significantly on the TED spread.

Disentangling liquidity risk from credit risk and time-varying risk aversion is the focus of a large literature and is beyond the scope of this paper. We do not rule out a liquidity-based explanation of EMBI returns, but our asset pricing results point towards a credit risk explanation, with a role for time-varying risk aversion.

V. Macroeconomic Impact of Sovereign Risk Premia

By sorting countries along their Standard and Poor's ratings and bond betas, we have obtained a cross-section of average excess returns that reflects different risk exposures: countries with high EMBI market betas offer higher excess returns. What does this risk premium imply for the amount of debt and the decision to default? We now provide a numerical illustration of a model with endogenous default and time-varying risk premia in order to study the implications of systematic risk on debt quantities and defaults.

We start from the seminal two-country model of Eaton and Gersovitz (1981) and its recent version in Aguiar and Gopinath (2006) and Arellano (2008). We depart from the previous literature and assume that lenders are risk averse, instead of being risk-neutral, and that emerging countries' business cycles differ in their correlations to the U.S. business cycle. This simple departure has key implications on sovereign bond prices and quantities. We do not claim that this framework is the only one able to account for our empirical findings, but it offers a fully-specified laboratory to understand our asset pricing results and study their macroeconomic implications.

In the model, there are N-1 small, emerging open economies, and one large developed economy. Our "small open economy" assumption is key: as in the papers above, the borrowing and default decisions of the small open economies have no impact on the large economy or on any other small economy. We solve for the optimal borrowing and default decision of each small economy, considering that the large economy is able to provide funds as requested. We introduce many small open economies in order to reproduce on simulated data the exact same portfolio and asset pricing experiments we report in the first sections of this paper. As the model shares many features of its predecessors, we present it succinctly, focusing on its novel aspects. We first describe our setup and then turn to our calibration.

V. A. Endowments

The superscript i denotes variables corresponding to one of the N-1 small open economies. Upper case variables denote levels, lower case variables denote logs.

In each small open economy, there is a representative agent who receives a stochastic endowment stream. Endowments are composed of a transitory component z_t^i and a time-varying mean (or permanent component) Γ_t^i. Aguiar and Gopinath (2006) considered each component separately; we consider them together in order to obtain both significant debt levels and yield spreads. Endowments evolve as $Y_t^i = e^{z_t^i}\Gamma_t^i$. The transitory component, z_t^i follows an AR(1) around a long run mean μ_z:

$$z_t^i = \mu_z(1-\alpha_z) + \alpha_z z_{t-1}^i + \epsilon_t^{z,i}.$$

The time-varying mean is described by: $\Gamma_t^i = G_t^i \Gamma_{t-1}^i$, where:

$$g_t^i = log(G_t^i) = \mu_g(1-\alpha_g) + \alpha_g g_{t-1}^i + \epsilon_t^{g,i}.$$

Note that a positive shock $\epsilon^{g,i}$ implies a permanent higher level of output. We assume that $\epsilon^{g,i}$ and $\epsilon^{z,i}$ are $i.i.d$ normal and that shocks to the transitory and permanent components are orthogonal ($E(\epsilon^{g,i'}\epsilon^{z,i}) = 0$). All emerging countries have the same endowment persistence and volatility: $E([\epsilon^{z,i}]^2) = \sigma_z^2$ and $E([\epsilon^{g,i}]^2) = \sigma_g^2$.

In the large developed economy, there is a representative agent that receives every period an exogenous endowment. Again, we assume that consumption in the large developed economy is not affected by the small emerging countries. There is, for example, no feedback effect of defaults on lenders' consumption. We assume that idiosyncratic shocks to the lenders' consumption growth are $i.i.d.$ log-normally distributed with mean g and volatility σ:

$$\Delta c_t = g + \epsilon_t.$$

We do not introduce a time-varying mean in the consumption growth of the large economy in order to limit the number of state variables and because consumption growth is closer to $i.i.d.$ in developed economies.

Emerging countries only differ according to their conditional correlation to the developed economy: $E(\epsilon^{z^{i'}}\epsilon) = \rho^i$. This is the key source of heterogeneity across countries in our model. Such heterogeneity exists in the data. Correlation coefficients between foreign and U.S. HP-filtered GDP series range in our sample from -0.3 to 0.6 on annual data, and from -0.3 to 0.5 on quarterly data. We thus assume that ρ varies between -0.5 and 0.5. This source of heterogeneity allows us to study the impact of default risk premia on optimal quantities and prices.

In the data, market betas are time-varying. In the model, however, we keep the correlation between the lenders and borrowers' endowment shocks constant. The simulated betas can still vary slightly because they are estimated on rolling windows of past U.S. equity and foreign bond returns, as we do on actual data. Time-varying mean growth rates of borrowers and time-varying risk-aversion of lenders introduce time-variation in the betas. We could, of course, extend the model by introducing variable correlation coefficients without changing its main message.

All variables in the model are real, and we abstract from monetary policies. In each emerging economy, a benevolent government maximizes the welfare of its representative household. We thus describe the preferences of the representative agent and considers that the government seeks to maximize them. To do so, the government can borrow resources from the developed country. The government, however, can only trade non contingent one-period zero-coupon bonds. These debt contracts are not enforceable: governments can choose to default on sovereign debt at any point in time.

V. B. Borrowers

Preferences The representative borrower in each small open economy maximizes the stream of discounted utilities U_t^i:[10]

$$U^i = E_0 \sum_{t=0}^{\infty} \beta^t U_t^i = E_0 \sum_{t=0}^{\infty} \beta^t \frac{(C_t^i)^{1-\gamma}}{1-\gamma},$$

where C_t^i denotes consumption at time t and β denotes the time discount factor. Note that β corresponds to the usual notation in macroeconomics, not the finance betas that we computed in the previous section. Since many models in macroeconomics do not give much attention to risk premia, these two notational habits have developed separately. More importantly, and as is common in the literature, we let lenders' and borrowers' discount factors differ: political economists argue that politicians tend to have shorter time horizons in small developing countries.[11]

Budget Constraint The representative household receives a stochastic stream of the tradable good Y_t^i in every period. The representative agent also receives a goods transfer from the government in a lump-sum fashion (i.e., any proceeds from international operations are rebated lump-sum from the government to its citizens). The government has access to international capital markets: at the beginning of period t, it can purchase $B_{t,t+1}^i$ one-period zero-coupon bonds at price Q_t. $B_{t,t+1}^i$ denotes the quantity of one-period zero-coupon bonds purchased at date t and coming to maturity at date $t+1$. A negative value $B_{t,t+1}^i < 0$ implies borrowing $Q_t B_{t,t+1}^i$ units of goods at t and promising to repay, conditional on not defaulting, $B_{t,t+1}^i$ units of $t+1$ good. The representative household's budget constraint conditional on not defaulting

[10] Although we use habit preferences to describe lenders, we keep standard preferences to describe borrowers for two reasons. First, unlike for developed economies, there is not much evidence of large Sharpe ratios measured in units of emerging markets' goods. As a result, there is no clear need for volatile stochastic discount factors. Second, departing from standard preferences entails large computational costs, because it adds at least one state variable. We thus leave the extension to non-standard preferences for future research.

[11] In Amador (2008), for example, a low value for the discount factor β corresponds to the high short-term discount rate of an incumbent party with low probability of remaining in power in a model where different parties alternate.

at time t is then:

$$C_t^i = Y_t^i - Q_t^i B_{t,t+1}^i + B_{t-1,t}^i. \tag{1}$$

Default Costs In case of default, the sovereign cannot selectively default on parts of its debt, and thus all current debt disappears. A sovereign that defaults at date t is excluded from international capital markets for a stochastic number of periods and suffers a direct output loss. In this case, consumption is constrained by the value of output during autarky, which is denoted $Y_t^{i,default}$, and the budget constraint is simply:

$$C_t^i = Y_t^{i,default}. \tag{2}$$

Mendoza and Yue (2008) propose a model where sovereign defaults endogenously produce output costs that are an increasing, strictly convex function of productivity shocks. In line with their work and following Arellano (2008), we assume an asymmetric direct output cost of default: $Y_t^{i,default} = min\{Y_t^i, (1-\theta)\overline{Y^i}\}$, where $\overline{Y^i}$ is the mean output level and θ a measure of the default cost.[12]

This assumption implies that defaults are more costly in good times; it thus affects both the size and the timing of debt in equilibrium. The intuition is simple. If the country defaults, its consumption is set to be low for the entire time of exclusion from capital markets according to the budget constraint in Equation (2). The drop in consumption is particularly large when the endowment is high. Hence, in good times, the utility cost of default (which lasts several periods) is likely to outweigh the utility benefit from not repaying the outstanding debt (which lasts one period) and the country has less incentives to default. In general equilibrium, lenders take that cost into account, and sovereign countries can borrow more in good times, a robust feature of emerging economies' business cycles [e.g., Neumeyer and Perri (2005), Uribe and Yue (2006), and Aguiar and Gopinath (2007)]. It also implies that countries tend to default when output is

[12] Aguiar and Gopinath (2006) assume a symmetric output cost of default; it delivers qualitatively similar results but the implied cross-section of sovereign bond returns is smaller.

below trend, as they actually do (Tomz, 2007).

V. C. Lenders

Lenders receive an exogenous stochastic endowment every period denoted C_t. They are risk-averse. In order to reproduce the large spread in returns between low and high beta countries, we rely on Campbell and Cochrane (1999) external habit preferences.[13] We assume that lenders maximize the stream of discounted utilities U_t:

$$U = E_t \sum_{t=0}^{\infty} \delta^t U_t = E_t \sum_{t=0}^{\infty} \delta^t \frac{(C_t - H_t)^{1-\gamma} - 1}{1-\gamma},$$

where δ denotes the lenders' discount factor and H_t the external habit or subsistence level, which depends on past consumption.

Why Not Power Utility? A model where borrowers and lenders share the same constant relative risk-aversion preferences does not produce a large enough spread in excess returns for reasonable risk-aversion parameters. This result parallels the equity premium puzzle in Mehra and Prescott (1985).

For illustration, assume that two countries share the same default probability and the same yield volatility. Then spreads between their bond returns depend on the covariance between the U.S. marginal utility of consumption and return differences. As a result, the maximum spread between these two countries is twice the product of the risk-aversion coefficient multiplied by the standard deviation of consumption growth (around 1.5%) and the standard deviation of the returns (around 13%). A risk-aversion coefficient of 2 would imply a maximum spread of around 80 basis points. This maximum spread is only attained when the correlation coefficients

[13] A large literature in finance study the role of habit preferences in the resolution of the equity premium puzzle. We do not attempt to summarize it here. We focus on examples of Campbell and Cochrane (1999) habit preferences. Recently, Wachter (2006) considers their implications for the term structure; Chen, Colin-Dufresne and Goldstein (2008) focus on credit spreads, and Verdelhan (2010) on exchange rates. Garleanu and Panageas (2008) propose a model that is observationally similar to Campbell and Cochrane (1999) but based on heterogenous agents with finite lives.

between each sovereign bond return and lenders' pricing kernels is 1 and -1, which is an unlikely extreme event. For an average correlation of 0.3, the maximum spread is 24 basis points. In order to generate a spread of 500 basis points as in the data, the model requires a very high risk-aversion coefficient. But it would then imply an implausible and volatile risk-free rate. This is the risk-free rate puzzle again. For a model that seeks to replicate the spread between the emerging market rate and the U.S. risk-free rate, it is a serious concern.

On the contrary, the introduction of habit preferences implies that lenders' risk-aversion is endogenously time-varying, and higher in adverse economies. As consumption declines toward the habit level, the curvature of the utility function rises, so risky assets prices fall and expected returns rise. Local risk aversion is sometimes very high, even if the risk-aversion coefficient remains low. The real interest rate is constant and equal to the mean real interest rate in the data.

Habit Preferences Following Campbell and Cochrane (1999), we assume that the external habit level depends on consumption growth through the following autoregressive process for the surplus consumption ratio, defined as the percentage gap between the endowment and habit levels ($S_t \equiv [C_t - H_t]/C_t$):

$$s_{t+1} = (1-\phi)\overline{s} + \phi s_t + \lambda(s_t)(\Delta c_{t+1} - g),$$

where s denotes the log surplus-consumption ratio, which is an autoregressive process with a persistence of ϕ. The sensitivity function $\lambda(s_t)$ describes how habits are formed from past aggregate consumption.[14] In this framework, adverse economic conditions are periods of low

[14] The sensitivity function $\lambda(s_t)$ governs the dynamic of the surplus consumption ratio:

$$\lambda(s_t) = \begin{cases} \frac{1}{\overline{S}}\sqrt{1-2(s_t-\overline{s})}-1 & \text{if } s_t \leq s_{max}, \\ 0 & \text{elsewhere,} \end{cases}$$

where s_{max} is the upper bound of the log surplus-consumption ratio. $\overline{S}$ measures the steady-state gap (in percentage) between consumption and habit levels. Note that the non-linearity of the surplus consumption ratio keeps habits always below consumption and marginal utilities always positive and finite. Assuming that $\overline{S} = \sigma\sqrt{\frac{\gamma}{1-\phi}}$ and surplus consumption ratios s (when consumption is close to the habit level or subsistence level), and "negative shocks" refer to negative consumption growth shocks ϵ.

Time-varying Risk Aversion This model implies constant risk-free rates and time-varying risk-aversion for the lenders. Since the habit level depends on aggregate consumption, the local curvature of the lenders' utility function is $\gamma_t = \gamma/S_t$. When the endowment is close to the subsistence level, the surplus consumption ratio is low and the lender is very risk-averse. The model implies a counter-cyclical market price of risk and is thus potentially consistent with our asset pricing results: in the data, market prices of risk also increase in bad times, as measured by a high value of the VIX index, which is often referred to as the "fear index" of investors. We interpret high levels of fear as high levels of risk aversion. Note, however, that this model does not produce enough variation in the conditional Sharpe ratio to match its empirical counterpart on stock markets [see Lettau and Ludvigson (2009) and Lustig and Verdelhan (2010) for additional evidence].

Lenders supply any quantity of funds demanded by the small open economy, but they require compensation for the risk they bear. Lenders cannot default. When lenders are risk-neutral, they charge the borrower the interest rate that makes them break-even in expected value: in this case, emerging market yields can be high but expected excess returns are zero by definition. In our model, lenders are risk-averse, and require not only a default premium, but also a *default risk premium*. They expect a higher return on average if defaults are more likely when their endowment is close to their subsistence level.

V. D. Default Sets and Bond Prices

The model has four state variables: two state variables describe the lender's endowment (for the z and g processes), one describes the borrower's surplus consumption ratio (s, and thus tracks risk-aversion), and the last one describes the amount of debt at the start of the period

$s_{max} = \overline{s} + (1 - \overline{S})/2$, the sensitivity function leads to a constant risk-free rate: $r^f = -\log(\delta) + \gamma g - \frac{\gamma^2 \sigma^2}{2\overline{S}^2}$.

(B). We stack the first three variables in a vector x. The default probability dp is endogenous and depends on the amount of outstanding debt B and on the endowment realization x. Each period, the government first decides to repay its debt or not. If it repays its debt, then it can borrow again.

Figure 2 plots optimal default policy sets $D(B)$ as a function of the beginning-of-period asset positions B and the endowment shocks z. We consider two different levels of the mean growth rate g: -3.4% and 4.6%; these are quarterly rates, which correspond to two standard deviations below and above the mean growth rate μ_g. Each frontier defines a default region, and countries default for values of debt and endowments that are below the frontier: for a given mean growth rate g (i.e., a particular frontier on this graph) and a given debt level, countries tend to default when they experience bad endowment shocks z. The higher the debt levels, the more likely the defaults. In other words, a country with little debt can sustain without defaulting larger negative shocks than a highly indebted country. But default policies also depend on overall economic conditions: in good times, when the mean growth rate is high, it takes a much larger negative shock for a country to default than during adverse economies, when the mean growth rate is low. Now that we have defined default sets, we turn to bond prices. We come back to this figure in the next section to study the impact of the lenders' risk-aversion.

Bond prices $Q(B', x)$ are a function of the current state vector x and the desired level of borrowing B'. If borrowers do not default at date $t+1$, lenders receive payoffs equal to the face value of the bonds, which is normalized to 1. In case of default at date $t+1$, payoffs are zero.[15] Starting from the investor's Euler equation, the bond price function is:

$$Q(B', x) = E[M' 1_{1-dp(B',x)}] = E[M']E[1_{1-dp(B',x)}] + cov[M', 1_{1-dp(B',x)}], \tag{3}$$

[15]This simplifying assumption can be relaxed: see Arellano and Ramanarayanan (2009) for an example of a convex recovery rate.

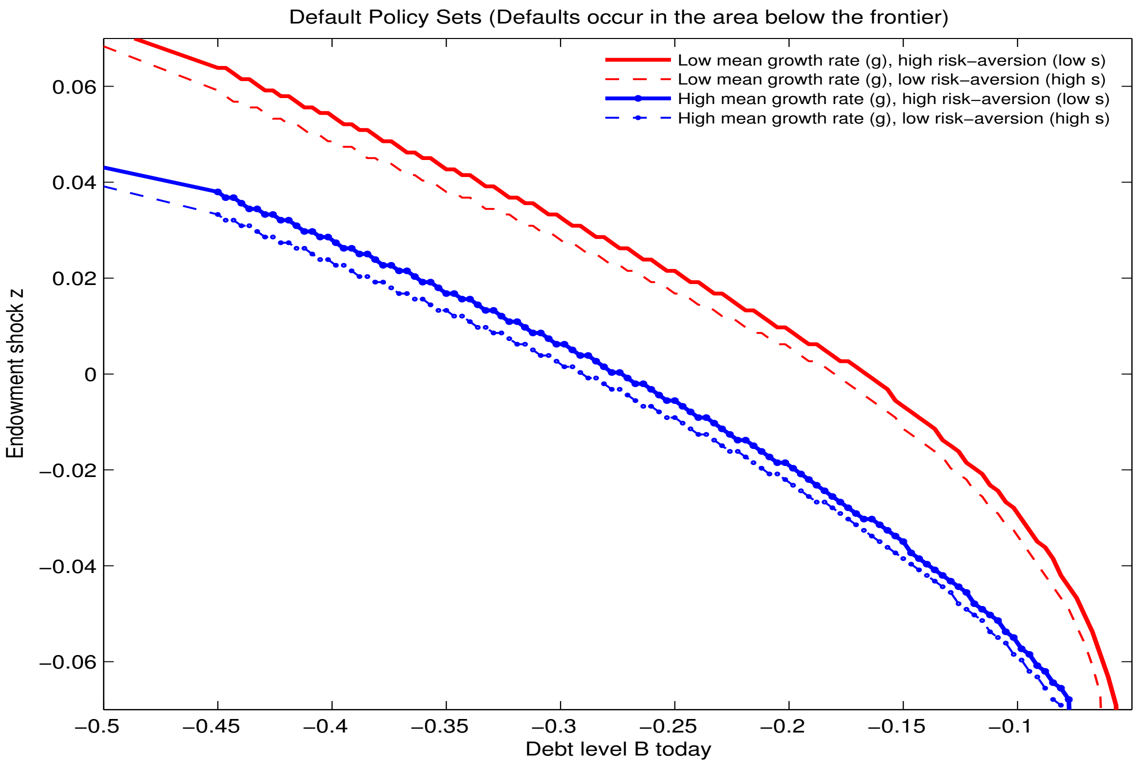

Figure 2: Default Policy Set

This figure plots the default policy set $D(B)$ as a function of the beginning-of-period asset positions B and consumption shocks z for different values of the mean endowment growth rate g and local risk-aversion of the lender. A low surplus-consumption ratio s is equivalent to a high risk-aversion coefficient of the lender. The cross-country correlation in consumption growth shocks ρ is equal to 0.5. We consider two values of the mean endowment growth rates: -3.4% and 4.6%; these are quarterly rates, which correspond to two standard deviations below and above the mean growth rate μ_g. We also consider two values for the log surplus-consumption ratio: 0.7% and 9.4%; these correspond to consumption levels that are respectively 0.7% and 9.4% above the habit (or subsistence) level. For a given adverse endowment shock, countries are more likely to default when they are more indebted, when the mean growth rate is low, and when lenders are more risk-averse.

where M' is the investors' stochastic discount factor and is equal to:

$$M' = \delta \frac{U_c(C', H')}{U_c(C, H)} = \delta(\frac{S'C'}{SC})^{-\gamma} = \delta e^{-\gamma[g + (\phi-1)(s_t - \bar{s}) + (1+\lambda(s_t))(\Delta c_{t+1} - g)]}.$$

A risk-free asset pays one unit of the consumption good in any state of nature and has a price equal to $Q^{rf} = E[M']$. If investors are risk-neutral, sovereign bond prices depend only on expected default probabilities: $Q(B', x) = E[1_{1-dp(B',x)}] \times Q^{rf}$. Risk aversion introduces a new component to sovereign bond pricing. For a given default probability, bond prices depend on the covariance between investors' stochastic discount factors and default events. If defaults tend to occur in bad times for investors (i.e., when their marginal utility of consumption is high), the covariance term in Equation (3) is negative, bond prices are low, and yields are high. Likewise, if defaults tend to occur in good times for investors, yields are low.

VI. Simulation

We simulate the model at a quarterly frequency. Parameters describing lenders' consumption growth and preferences (g, σ, γ, ϕ, δ, and r^f) are from Campbell and Cochrane (1999). Parameters describing the borrowers' endowments and constraints (α_g, σ_g, μ_g, α_z, σ_z, μ_z, β, θ, and π) are from Aguiar and Gopinath (2006, 2007). Given our interest in time-varying risk premia, we cannot log-linearize the model, and we resort to a discrete dynamic programming approach with four state variables. We use parallel computing (with 32 computers) to solve the model. As our calibration and simulation method are otherwise standard, we leave them out in the online appendix. To describe our results, we first focus on the impact of risk-aversion on equilibrium debt characteristics in a given country and then turn to portfolios of countries, as we did in the previous sections.

VI. A. Risk Aversion and Optimal Debt Price, Quantity, and Default

Risk-aversion implies a novel link between countries.

Optimal Default Default decisions depend on overall economic conditions, i.e., high or low mean growth rates and endowment shocks. This is the first order effect. But a second mechanism is also at play. In order to describe it, we first focus on low mean endowment growth rates (the upper frontiers in Figure 2). The solid line corresponds to a low value of the investors' log surplus consumption ratio (0.7%), i.e., a high curvature of the investor's utility function, akin to a very high coefficient of risk aversion. The dotted line corresponds to a high surplus consumption ratio (9.4%) and low risk aversion. In other words, these two values correspond to consumption levels that are respectively 0.7% and 9.4% above the habit (or subsistence) level.

The novelty is that the borrower's decision to default depends on the lenders' risk aversion. Graphically, the default frontier is higher when risk-aversion is high. What is the intuition for this result? If lenders are very risk averse, both risk premia and interest rates are high. Each period, borrowers decide to repay or default. Repaying past debt offers a foreign country the option to borrow again. Since it is now very costly to borrow, this option is less attractive. As a result, the emerging country tends to default even for mildly adverse shocks. On the contrary, when lenders are not risk-averse, both risk premia and interest rates are low. It is less costly to borrow and the emerging country can withstand larger adverse shocks without defaulting. The same logic applies when mean growth rates are higher, as shown in the lower two frontiers. In good times, defaults occur only when the country experiences a very negative temporary shock. But again, the impact of this shock depends on the lenders' risk aversion. A given shock might trigger a default when investors are very risk-averse but not otherwise.

We obtain naturally the opposite results when the correlation between borrowers and lenders business cycles is negative ($\rho = -0.5$). In this case, with high risk aversion, insurance premia are high and interest rates are low (since bad times in the emerging country are typically good times in the U.S.).

The model thus illustrates the link between lenders' risk aversion and borrowers' default decisions. When business cycles are positively correlated, default sets are larger the higher the lenders' risk aversion. For a given negative shock in an emerging country, defaults become more likely the higher the lenders' risk aversion. In equilibrium, it looks as if very risk-averse lenders push emerging countries towards default.

Equilibrium Bond Prices We turn now to bond prices. Default decisions depend on the interaction between temporary and permanent shocks and on lenders' risk aversion. These variables naturally affect bond prices. Figure 3 plots those bond prices as a function of borrowing levels (B'). The left panel focuses on the impact of the borrower's economic conditions, for a given low level of the lender's risk-aversion. The right panel focuses on the impact of risk aversion, for a given low mean growth rate of the borrower's endowment. We start with the left panel.

For a given debt level, bond prices are higher and interest rates lower when the emerging country experiences positive rather than negative temporary shocks. This first effect is large; in Figure 3 it corresponds to the difference between the two lines with round markers (upper part) and the two lines without markers (lower part). This effect is amplified by permanent shocks. Bad shocks during low average growth periods imply lower prices and higher yields than the same shocks during high average growth times. The impact of permanent shocks on bond prices corresponds to the difference between the solid and dotted lines. Sovereign yields are high in bad economic periods for the borrower because default probabilities are high. This would be the case if investors were risk-neutral too.

Let us focus now on the right-hand side panel. We next compare the price of a bond with and without the risk premium component (i.e., the covariance term in Equation 3). We consider an emerging country with a business cycle that is positively related to the investors' consumption growth (the correlation coefficient ρ is equal to 0.5). In a first approximation, these bond prices correspond to risk-neutral pricing.[16] As we expect, the risk premium lowers bond prices and increase yields: bonds issued by countries that tend to default more frequently when the investors' marginal utility is high are riskier and command higher yields. This cross-country link would not exist with risk-neutral investors. It is sizable only when risk-aversion is high and vanishes as risk aversion decreases.

In equilibrium, borrowers tend to default when they experience adverse economic shocks. Investors know expected default probabilities and require higher risk premia from borrowers that are more likely to default in bad times and whose default probabilities increase in bad times, from the investors' perspective.

[16]Note, however, that emerging countries dealing with risk-neutral investors would choose different debt quantities. In this figure, in order to highlight the impact of risk aversion for a given indebtedness, we simply compute artificial prices without the covariance term in Equation 3 but for the same debt dynamics.

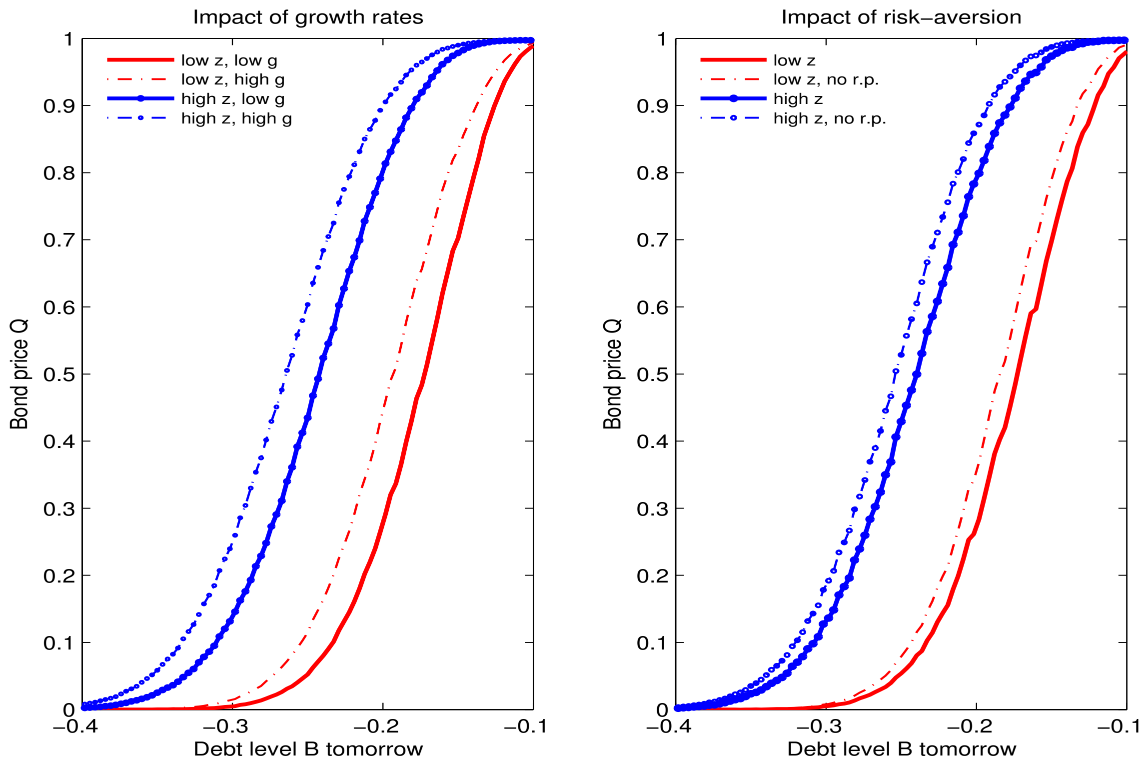

Figure 3: Bond Price Function

This figure present bond prices Q as a function of the amount of debt issued B. The cross-country correlation in endowment growth shocks ρ is equal to 0.5. In the left panel, we focus on the impact of the borrowers' economic conditions. Lines with circular markers correspond to high values of the transitory component of endowment z. Lines without markers correspond to low values of z. In each case, dotted lines correspond to high values of the permanent component of endowment growth g. In bad times, bond prices are low and yields are high, particularly so during periods of low average growth. In the right panel, we focus on the impact of the lenders' risk aversion. Solid lines correspond to bond prices. Dotted lines correspond to bond prices without their risk premium components. Lines with (without) markers correspond to high (low) values of z. Countries that tend to default more frequently in bad times for investors pay higher yields than other countries.

Business Cycles We now turn to the model's implications for real business cycle variables. We focus on the annualized volatility of HP-filtered output, output growth, consumption, and trade balance as a fraction of GDP, along with their first-order quarterly autocorrelation coefficients. As its predecessors, the model broadly matches these moments.[17]

The model delivers large amounts of average debt in equilibrium. Average debt levels range from around 27% of GDP for countries that are positively correlated to the U.S. to more than

[17]The volatility of HP-filtered output is 6.6% per year versus 5.4% on average in the data; its autocorrelation is 0.78, close to its empirical value (0.81). Consumption is more volatile than output in the model as in the data (1.6 times more volatile in the model and 1.3 times in the data). The trade balance is more volatile and less countercyclical in the model than in the data: as a fraction of output, the simulated trade balance has a standard deviation of 7.6% when shocks are uncorrelated between countries (the equivalent case to risk-neutrality). In the data, the average standard deviation of the trade balance ratio is 5%. The correlation of the trade balance with GDP is -0.13 in the model versus -0.3 in the data.

30% for countries that are negatively correlated to the U.S. This order of magnitude is in line with the amount of public external debt reported in Table 1. We compare the model to public external debt levels because all bonds in the model are issued by the government and bought by foreigners. Simulated maximum debt levels reach even higher values, up to 60%.

The model endogenously delivers default probabilities that range from 3% to 6%. Considering the large uncertainty that surrounds default probabilities, this range appears consistent with the data. We do not attempt to tweak the calibration in order to reach a target of 3% (which is a simple order of magnitude, mostly linked to the three defaults in Argentina over the last hundred years) or the 2% obtained in our short sample. Reinhart and Rogoff (2009) note that many countries (e.g., Indonesia, India, China, and the Phillipines) have spent more than 10% of their independent life in default and that Africa's record is much worse. Our model implies that emerging countries spend between almost 7% and 14% of their time in default.

The model produces excess returns that increase with the business cycle correlation. As expected, countries whose business cycles are positively (negatively) correlated with the U.S. offer positive (negative) excess returns to U.S. investors. The difference in excess returns across these two polar cases is 3.4%, thus sizable, but lower than in the data. The correlation of excess returns and trade balances is close to zero in the simulations and to 0.1 on average in the data. Likewise, the correlation of excess returns and output is on average equal to -0.1 in the simulations; it is equal to -0.2 on average in the data. The model delivers yield spreads, defined as differences between yields on foreign bonds and yields on U.S. bonds of similar maturities, that are in line with the data.

VI. B. Building Portfolios of Simulated Data

We solve our model for a set of 36 countries and use the simulated data to build portfolios that mimic the actual EMBI portfolios. We use stock market betas computed on rolling windows, as we did with actual data. We obtain betas by regressing foreign bond realized excess returns on a constant and simulated U.S. stock market excess returns. At the end of each period t, we thus sort all countries into six portfolios on the basis of market betas (β_{Mkt}). The portfolios are re-balanced at the end of every period. For each portfolio j, we compute the excess returns $r_{t+1}^{e,j}$ by taking the average of the excess returns in the portfolio. Excess returns correspond to the returns in emerging countries minus the risk-free rate in the large, developed economy.

Unlike on actual EMBI portfolios, here we sort bonds along only one dimension. The reason is simple: there is only one source of risk that is priced in the model: it is ultimately the correlation between consumption growth shocks in the U.S. and bond returns. In order to interpret the two-dimensional sort we used in the data, we would need to introduce a second source of heterogeneity across countries. If countries differ in terms of their endowment volatility (and the correlation is not zero), then expected default probabilities reflect risk premia: for a given beta, higher endowment volatilities entail higher default probabilities and higher expected excess returns. For example, if the volatility of temporary shocks (σ_z) doubles, the equilibrium default probability is multiplied by four and the average excess return more than doubles. As a result, introducing heterogeneity in endowment volatilities and sorting countries on default probabilities and market betas would produce a double cross-section of excess returns, similar to the one we obtain in the data by sorting on ratings. This two-dimensional cross-section would naturally be priced by a unique risk factor. To keep the model transparent though, we introduce only one key source of heterogeneity, the cross-country correlation of endowment shocks.

Table 3 provides an overview of the six portfolios. Panel A reports the average market beta (β_{Mkt}^j) for countries in portfolio j. Business cycles of countries with low β_{Mkt} are negatively correlated with the investors' consumption growth. These countries on average default more frequently when investors' consumption is high and above their habit levels. On the contrary, countries with high β_{Mkt} default more frequently when investors' consumption is low and close to their habit levels. Panel B reports average expected default probabilities. Sorting on β_{Mkt} implies a cross-section of average default probabilities, with a spread of 2 percentage points. Note that high beta countries have lower default probabilities than low beta countries.

Table 3: Portfolios of Simulated Data

Portfolios	1	2	3	4	5	6
			Panel A: Stock Market Beta: β_{Mkt} (Pre-Formation)			
Mean	−0.25	−0.12	−0.05	0.00	0.05	0.13
Std	0.20	0.15	0.11	0.10	0.10	0.13
			Panel B: Default Probability			
Mean	5.85	5.41	4.89	4.50	4.17	3.84
Std	1.33	1.21	1.09	1.02	0.96	0.91
			Panel C: Excess Return: r^e			
Mean	−1.24	−0.66	−0.14	0.29	0.52	0.65
Std	21.06	19.73	18.64	17.88	17.28	16.68
Std*	1.02	1.01	1.01	1.02	1.03	1.04
			Panel D: Debt/Output			
Mean	30.14	29.71	29.29	29.01	28.67	28.52
Std	7.09	6.92	6.78	6.73	6.73	6.67
			Panel E: Stock Market Beta: β_{Mkt} (Post-Formation)			
Mean	−0.14	−0.08	−0.04	0.00	0.03	0.05
Std	0.01	0.01	0.01	0.01	0.01	0.01

Notes: This table reports, for each portfolio j, the average slope coefficient β_{Mkt} (pre-formation) from a regression of one-quarter sovereign bonds' excess returns on the investors' stock market excess returns (Panel A), the average expected probability of default (Panel B), the average excess return (Panel C), the debt to output ratio (Panel D) and the post-formation betas (Panel E). Post-formation betas correspond to slope coefficients in regressions of quarterly portfolios' excess returns on quarterly investor's stock market excess returns. Probabilities of default, excess returns and debt ratios are reported in percentage points. Excess returns and default probabilities are annualized. For each variable, the table reports its mean and its standard deviation. For excess returns, the table also reports standard deviations (denoted $Std*$) in samples without defaults.

Cross-section of Simulated Excess Returns Panel C shows that the larger the market β^j_{Mkt}, the higher the excess returns. Higher beta countries are riskier because their bonds prices are lower during poor economic periods, and thus they should offer higher excess returns on average. The model produces average excess returns that range from -1.2% to 0.7% per annum. In the model, some countries are good hedges to U.S. consumption growth risk, and thus the negative average excess returns. In the data, our portfolios deliver positive excess returns on average, but they do not include transaction costs. Net excess returns on our first portfolios would likely turn out to be negative. More importantly, the difference in excess returns between low and high beta countries in the model is large and amounts to 190 basis points annually. Those excess returns, however, are lower than in the data. Matching means and variances of sovereign bond excess returns would certainly necessitate to look at longer maturities. Excess returns also appear much more volatile than in the data. This volatility reflects our assumption that recovery rates are zero in case of defaults. In samples without defaults, standard deviations are much lower and close to 1%.

The sizable cross section of simulated sovereign bond returns may appear unsurprising in light of our empirical results. Yet, its existence in a fully-specified model is not mechanical because debt levels, default decisions, and risk premia are all endogenous. The model allows for risk premia to exist but does not impose them. Countries facing high borrowing costs, for example, might decrease their debt levels, thus reducing their default probabilities and their risk premia to negligible levels. On the contrary, of course, the existence of sovereign risk premia in a fully-specified model reinforces the credibility of our initial empirical findings.

Asset Pricing We run the same asset pricing experiment on simulated data. We use the simulated U.S. stock market return as a risk factor and our six portfolios of simulated excess returns. The cross-sectional R^2 is equal to 95% and the market price of risk is positive and significant. As in the data, the estimated market price of risk is higher than the average U.S. simulated stock market return, but the spread is not as large. The model produces a cross-section of portfolio excess returns, with smaller spreads in returns than in the data; betas are also smaller. But we obtain a clear cross-section of portfolio betas, as reported in the last panel of Table 3. The model also implies a time-varying market price of risk, justifying our conditional asset pricing experiments. Overall, our model offers a natural interpretation of our empirical facts.

Our model starts from endowments and implies strong links between endowment shocks in emerging countries and their bond prices. Unfortunately, long and reliable macroeconomic time-series for those markets are not available. Yet, the model is useful as it derives the equilibrium domestic stock market returns and foreign bond returns such that we can connect to the financial data readily available for emerging markets. This macro-finance approach is helpful: it highlights the impact of risk premia on macroeconomics quantities. The case of risk-neutral investors is similar to the case of uncorrelated endowment shocks (or zero market betas); there, risk aversion does not matter. In our model, the amount of debt and the default probabilities change across countries, even if all borrowers face the same endowment volatilities. Their behaviors only differ because their risk premia differ. We find that average optimal default probabilities can increase or decrease by 1.5 percentage points around the risk-neutral benchmark. The average amount of debt varies by 1.3 percentage points around the same benchmark. The volatilities of the consumption growth or trade balances also vary. The impact of risk premia on macroeconomic quantities in this model are quite large considering that all debt matures in one period. We conjecture that the impact of risk premia would be even larger in a model with multi-period debt.

"Peso" Explanation? The model is also useful to revisit the small sample issue, or "Peso" problem: the high in-sample average excess returns on high market beta countries could simply exist because we do not observe the large and negative returns from defaults waiting to happen, not because investors are risk-averse. In order to rule out the "Peso" explanation, we replicate our empirical work on long time series of simulated data from a model with risk neutral investors. We randomly select, with replacement, 36 sub-samples with in-sample realized default probabilities that are half of the long-run default probability. Those sub-samples correspond to the "Peso" story: investors are risk-neutral but econometricians do not observe enough defaults. We build 6 portfolios by sorting countries on stock market betas, repeat the procedure 1000 times, and then compute averages and standard deviations of the portfolios' market betas, default probabilities and excess returns. Results are presented in Table 4. As expected, small-sample portfolios exhibit larger excess returns than their long-sample counterparts (because of the smaller number of defaults). But there is no clear cross-section of average realized excess returns across the 6 portfolios in the small, low-default-probability sample. A model with risk neutral investors applied to samples that do not contain enough defaults yet does not produce the mapping between stock market betas and average excess returns that we uncovered in our empirical work.

Table 4: Portfolios of Simulated Data: Risk-Neutral Investors and "Peso" Explanation?

Portfolios	1	2	3	4	5	6
			Panel I: Low-Default-Probability Sample			
			Stock market beta: β_{Mkt}			
Mean	-0.36	-0.05	-0.01	0.00	0.03	0.27
Std	0.21	0.05	0.01	0.01	0.03	0.15
			Default probability			
Mean	2.35	2.33	2.30	2.27	2.29	2.29
Std	6.67	6.61	6.57	6.52	6.56	5.47
			Excess return: r^e			
Mean	2.44	2.47	2.51	2.53	2.50	2.50
Std	6.80	6.73	6.69	6.64	6.68	5.57
			Panel II: Full Sample			
			Stock market beta: β_{Mkt}			
Mean	0.01	0.01	0.01	0.01	0.01	0.01
Std	0.23	0.23	0.23	0.23	0.23	0.23
			Default probability			
Mean	5.15	5.15	5.15	5.15	5.15	5.15
Std	22.54	22.54	22.54	22.54	22.54	22.54
			Excess return: r^e			
Mean	0.00	0.00	0.00	0.00	0.00	0.00
Std	22.91	22.91	22.91	22.91	22.91	22.91

Notes: This table reports, for each portfolio j, the average slope coefficient β_{Mkt} (pre-formation) from a regression of one-quarter sovereign bonds' excess returns on the investors' stock market excess returns, the average probability of default, and the average excess return. Probabilities of default and excess returns are reported in percentage points. Excess returns and default probabilities are annualized. For each variable, the table reports its mean and its standard deviation. For each country, we use simulated data from a model with risk-neutral investors and realized default probabilities not larger than half their full sample values. More precisely, we start from a long time series (120,000 quarters) of simulated data. We randomly select, with replacement, 36 sub-samples (1400 quarters) with in-sample realized default probabilities not greater than half of the realized default probability of the longer sample. We build 6 portfolios by sorting countries on stock market betas, repeat this procedure 1000 times, and then compute averages and standard deviations of the portfolios' market betas, default probabilities and excess returns. The top panel of this table reports the properties of the 6 portfolios built on samples with low probabilities of default and the bottom panel focuses on the whole sample.

Discrepancies We end this paper by highlighting the key discrepancies between the model and the data. First, average excess returns and spreads in excess returns between high and low default probability countries and between high and low beta countries are smaller than in the data. This discrepancy is likely due to the short maturity of simulated bonds: we only consider one-period (i.e., three-month) bonds, whereas the average maturity is close to 10 years in the data. Such a maturity difference matters: if their short sample is any guide, term structures of CDS rates are strongly upward-sloping on average, with 10-year rates being on average five times higher than short-term rates. As a result, we do not attempt to match actual returns with our one-period bonds. The model could be extended in this direction: Hatchondo and Martinez (2009) and Chatterjee and Eyigungor (2010) offer potential mechanisms to increase maturities without adding state variables. Second, the model does not take into account interest rate risk. Building macroeconomic models of the yield curve is still a challenge even for closed economies without default risk. This challenge is particularly obvious for emerging economies because their counter-cyclical real interest rates lead to downward sloping real yield curves in existing macroeconomic models. We thus leave the extension to rich yield curve dynamics for future research. Third, in the model, the cross-country correlation of endowment shocks is the sole source of heterogeneity across countries. It is constant, while there is time variation in the bond betas that we measure. This assumption appears to us as a natural first step. Adding volatility in these correlations would not add much to the economics of the model, which already produces some time-variation in betas because of the time-varying means of endowment growth rates and time-varying risk aversion. Likewise, adding heterogeneity in the endowment volatilities would offer a second source of cross-sectional variation in excess returns – and thus justify sorting countries along two dimensions – but it would not change the mechanism of the model.

VII. Conclusion

In this paper, we show that emerging market betas impact sovereign bond prices and that risk matters on these markets. In the data, countries with higher market betas pay higher borrowing rates. The difference in returns between countries with high and low betas is large, as large actually as the difference in returns between countries with low and high default probabilities. The market price of sovereign risk appears consistent with the market price of corporate default risk. The leading structural models of sovereign debt assume that investors are risk-neutral and thus cannot account for our empirical findings.

We provide a numerical illustration of a model with endogenous default and time-varying risk premia. In the model, borrowing countries only differ along one dimension: their endowments are more or less correlated to the lenders' consumption. Lenders' habit preferences lead to differences in returns between countries, albeit smaller than in the data. The model illustrates the impact of lenders' time-varying risk aversion on borrowers' default decisions.

Introducing risk-aversion offers a new perspective on puzzling facts about sovereign debt; risk-aversion implies, for example, that there is no linear relation between interest rates and debt levels, or between interest rates and output. An endogenously higher risk-aversion and thus higher market prices of risk offers an interpretation to the large increase in yields in the fall of 2008. Finally, the mechanism highlighted in this paper implies that currency unions might lead to higher borrowing costs since they imply higher business cycles' synchronization, and thus higher sovereign risk premia.

Our empirical methodology and our general equilibrium model are relevant to address default risk premia in other contexts. The literature on consumer bankruptcy faces endogenous decisions to default that are similar to the ones described in this paper. Notable examples include Chatterjee, Corbae, Nakajima, and Rios-Rull (2007) and Livshits, MacGee, and Tertilt (2007). Likewise, firm dynamics depend on financial market features and endogenous defaults, as shown in Cooley and Quadrini (2001). These papers, however, consider only risk-neutral financial intermediaries. Our work shows that lenders' risk aversion affect both optimal debt quantities and prices.

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