How costly is sovereign default? Evidence from financial markets

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Abstract

We use international stock and bond prices to measure the cost of sovereign default from the perspective of local corporations. This cost is defined as the sum of a long-run increase in the cost of corporate equity capital and a long-run reduction in the average growth rate of corporate earnings following sovereign default. Using a structural valuation model and maximum likelihood estimation, we find that financial markets assign a cost of sovereign default of 5.1% per year for Greece, Ireland, Italy, Portugal, and Spain in the 2006-2011 period. This cost translates to a 37% destruction of a country's equity capital upon sovereign default. Further we show that sovereign default is expected to be more costly for financial firms. For non-financials, the prospective cost of sovereign default is higher for firms with (i) higher need to tap capital markets, (ii) smaller firms, (iii) firms with lower fraction of foreign sales, and (iv) firms in more regulated industries. We repeat our analysis for emerging markets in the 1995-2011 period and find a prospective cost of sovereign default of 4.2% per year.

Keywords: Default Cost, Sovereign Spread, Earnings Yield, Value Discount

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"The problem historically has not been that countries have been too eager to renege on their financial obligations, but often too reluctant."

The Bank of Canada and The Bank of England, in Blustein (2005, p.102)

1 Introduction

Sovereign debt is fundamentally different from corporate debt because it is not enforceable in a court of law. Why are lenders willing to extend uncollateralized loans if they cannot seize assets upon default? It must be because borrowers face costs of some form if they fail to repay. However, as our opening quote suggests and we discuss in Section 2, these costs remain elusive in the data. Therefore, it is unclear why countries honor their foreign debts and why foreign borrowing is even possible to begin with. In this paper we propose a novel way to assess the costs of sovereign default and find that financial markets expect such costs to be large. To the extent that debtor governments share these expectations, or fear that they may become self-fulfilling, our results can explain why debtor governments sometimes resort to extreme and domestically unpopular measures to avoid defaulting on their foreign debt. A benevolent government's reluctance to default can explain why foreign borrowing is possible.

Here we depart from measuring realized costs of default and focus on the long-run prospective costs of default implied by market prices. Our approach is not constrained to examining changes around actual default events. This has two advantages. First, it allows use of much more data for assessing default costs. Second, our methodology is less affected by the endogeneity problem arising from the fact that countries choose to default in bad economic times as they substitute long term growth for immediate relief.[1]

We define the cost of sovereign default from a corporate perspective as the sum of a long-run reduction in expected earnings growth rates and a long-run increase in discount rates following sovereign default.[2] Using maximum likelihood estimation of a structural valuation equation, we find that financial markets assign a large cost to sovereign default. For the GIIPS countries (Greece, Ireland, Italy, Portugal, and Spain) in the 2006-2011 period, we

[1] Tomz and Wright (2007) present evidence that countries tend to default in bad times. Among others, Arellano (2008), Aguiar and Gopinath (2006), Kovrijnykh and Szentes (2007), Sandleris (2008), Andrade (2009), and Hatchondo and Martinez (2009) develop models in which countries optimally choose to default in bad times. Borensztein and Panizza (2009) and Levy-Yeyati and Panizza (2011) discuss how endogeneity associated with optimal default in bad times complicates the empirical determination of sovereign default costs.

[2] One caveat of our analysis is that, by looking at asset prices, we are restricted to the cost of sovereign default from a corporate perspective, abstracting from other important dimensions of economic performance such as unemployment and income distribution.

find that financial markets impute a cost of default of 5.1% per year (t-statistics=3.94). We repeat our analysis for emerging markets in the 1995-2011 period, and find a market-implied default cost of 4.2% per year (t-statistics=5.42).

The following calculation helps understand the economic magnitude of our results. Suppose that the fair stock market earnings yield of the GIIPS in the absence of sovereign default risk is 8.7% per year, which is the average for the rest of Europe in the 2006-2011 period. In that case, our estimate implies that the sovereign default would destroy $\frac{5.1\%}{5.1\%+8.7\%} = 37\%$ of the value of equity capital in the GIIPS countries. If financial markets expect such large costs of sovereign default, it becomes easier to understand why countries sometimes resort to drastic measures to avoid it, and why sovereign foreign borrowing is possible in the first place.

Our fundamental insight is that forward looking stock prices must price in any long-run negative consequences of sovereign default. That is, if sovereign default is costly, firms in countries subject to sovereign default risk must trade at a discount relative to comparable firms not subject to sovereign default risk. We define the (corporate) cost of sovereign default as the sum of a reduction in expected earnings growth rates and an increase in discount rates following sovereign default. We start by computing the current sovereign-risk discount in stock prices based on differences of earnings yields across firms subject to sovereign default risk and comparable firms not subject to sovereign default risk. This stock-based value discount reflects both the expected default cost conditioned on the occurrence of default, our object of interest, and the likelihood of sovereign default.

In order to disentangle the conditional costs of sovereign default from the likelihood of sovereign default, we analyze bond prices and stock prices jointly using a valuation model adapted from Andrade (2009). The model serves two purposes. First, the model provides a simple way to compute a bond-based risk-neutral probability of default based on (i) the yield spread of sovereign debt vis-à-vis risk-free debt, (ii) the interest rate on risk-free debt, (iii) the expected recovery rate on defaulted debt, and (iv) the average maturity of sovereign debt. Second, the model shows how to obtain a stock-based risk-neutral probability from the aforementioned bond-based risk-neutral probability. This matters because stocks and sovereign bonds are likely to have very different exposures to sovereign default risk. Therefore one cannot directly use the bond-based risk-neutral probability of sovereign default to disentangle the conditional cost of default from the likelihood of default embedded in stock-based value discounts.[3]

[3] We show that naively using the bond-based risk-neutral probability of sovereign default to price stocks subject to

Specifically, our valuation model provides a structural equation with two parameters linking the current discount in stock prices to the bond-based risk-neutral probability of sovereign default. One parameter is the conditional cost of sovereign default, defined as the sum of a reduction in expected earnings growth rates and an increase in discount rates following sovereign default. The second parameter governs the translation from a bond-based to a stock-based risk-neutral probability of default. We assume i.i.d. normal disturbances and estimate the valuation equation using maximum likelihood. Reported t-statistics are robust to heteroskedasticity and autocorrelation. Additionally we find that (for the GIIPS estimation) the null hypothesis of normally distributed disturbances cannot be rejected.

In further analysis we shed light on the mechanisms through which sovereign default is expected to be costly for corporations. In order to do so, we estimate the prospective costs of sovereign default using firms grouped by different criteria. We find that sovereign default is expected to be more costly for financial firms than for non-financial firms. This is consistent with the idea that the cost of sovereign default operates through the impact of default on local banks. These local banks may be holding large quantities of bonds issued by the defaulting sovereign and can't be selectively protected in the event of default. Among non-financial firms, sovereign default is expected to be more costly for firms that are more likely to need to tap capital markets. This idea is consistent with a disruption of the credit markets associated with the demise of local banks. Further we find a higher prospective cost of sovereign default for smaller firms. To the extent that smaller firms rely more on local bank financing than on other forms of financing, the higher cost of sovereign default for smaller firms is also consistent with local bank losses associated with sovereign default. All these results are consistent with theories in which sovereign default is costly because it causes protracted domestic banking crises (Gennaioli, Martin, Rossi, 2011; Brutti, 2011; Basu, 2009).[4]

Our results also indicate a higher prospective cost of sovereign default for firms with a higher fraction of their sales originating from the domestic market and for firms in highly regulated industries (Utilities and Telecommunications). Both results are consistent with

sovereign default risk leads to overestimation of the costs of sovereign default. The estimated cost of sovereign default increases from 5.1% to 8.5% per year for the GIIPS, and from 4.1% to 9.7% per year for the emerging markets.

[4] Reinhardt, Rogoff, and Savastano (2003) write: "External default can often cause lasting damage to a country's financial system [...] One of the reasons why countries go to great lenghts to avoid defaulting is precisely to protect their banking and financial systems ". Borensztein and Panizza (2009) present evidence that defaults are associated with severe banking crises. However, the direction of causality is difficult to ascertain. While Borensztein and Panizza (2009) argue for sovereign default causing banking crises, Reinhart and Rogoff (2010a) argue for banking crises causing sovereign default as governments undermine their own solvency when they bail-out domestic banks. Acharya, Drechsler, and Schnabl (2011) present evidence of bi-directional causality in their study of sovereign and bank CDS spreads in the Eurozone during 2007-2010.

"reputational spillovers" theories of sovereign debt (e.g., Cole and Kehoe, 1998; Sandleris, 2008), in which a government's decision to default reveals its "bad type". More regulated industries are more likely to be subject to government misbehavior in terms of contract breaches, while firms with higher fraction of business from abroad are less likely to be subject to it. In the limit, a firm with very little business in its domestic country can easily relocate its operations to other countries and thus evade the actions of its domestic government.

The paper proceeds as follows. In Section 2 we review the literature and further discuss how our results contribute to it.[5] In Section 3 we explain our valuation model and methodology. In Sections 4 and 5 we describe the GIIPS data and present our empirical estimations. Section 6 contains data and empirical estimations for emerging markets. In Section 7 we conclude.

2 Literature review

Classical theories of sovereign debt and default find little empirical support. These theories postulate that sovereigns honor their foreign debts because of the threat of creditor retaliation (Eaton and Gersovitz, 1981; Bulow and Rogoff, 1989). Creditor retaliation would impose costs in the form of temporary exclusion from future borrowing, large borrowing costs when countries re-enter international markets after default, and trade sanctions. However, sovereigns regain access to international capital markets fairly quickly after default, and punishment in the form of higher post-default borrowing costs is small (except for the short run) and eventually disappears (Panizza, Sturzenneger, and Zettelmeyer, 2009). Similarly, trade sanctions don't seem to be severe enough to serve as a first order deterrent to sovereign default (Tomz, 2007; Panizza et al., 2009).

It is difficult to find solid empirical evidence of large default costs even after broadening the scope outside the realm of the classical theories. A simple way of assessing broad default costs is to examine GDP before and after default. This can be done by looking at short term GDP movements, or long term GDP growth trends. It turns out that in the short run around default, while other variables determining economic growth can be plausibly assumed constant, default "coincides with the trough of the output contraction and marks the start of the economic recovery" (Levy-Yeyati and Panizza, 2011). As discussed by Borensztein

[5] For additional literature reviews, please refer to Eaton and Fernandez (1995), Obstfeld and Rogoff (Ch. 6, 1998), Sturzenegger and Zettelmeyer (2007a), Panizza, Sturzenegger and Zettelmeyer (2009), and Hatchondo and Martinez (2010).

and Panizza (2009) and Levy-Yeyati and Panizza (2011), part of the difficulty in empirically finding short term effects of sovereign default is because sovereign default is not an exogenous event, as countries tend to choose to default in bad economic times. If countries substitute long-term growth for immediate relief when they choose to default, it is not surprising to find an improvement in economic conditions immediately after default.

Examining changes in long run GDP growth trends before and after default is econometrically challenging because it is imperative to parse out the effects of simultaneous changes in the economic environment. For example, Argentina's unilateral default in early 2002 illustrates the difficulty in empirically measuring the cost of sovereign default by looking at changes in GDP growth trends. Figure 1 shows that Argentina's real GDP per capita declined at a rate of 3.9% per year from 1998 to 2001, before sovereign default. After a severe but quick contraction in 2002, 2003 real GDP per capita was close to 2001 levels.[6] Real GDP per capita grew at a rate of 6.2% per year from 2003 to 2007. So, economic growth was much stronger after default then before default. Figure 1 also shows that Argentina benefitted from a major positive terms of trade shock immediately after its sovereign default, and this shock (and potentially others) must be controlled for when one tries to assess the effect of sovereign default on long run GDP trends. Unfortunately for econometricians, sovereign defaults are not plentiful and any such empirical analysis is likely to have low power.

FIGURE 1

Since classical theories enjoy little empirical support, two groups of new theories attempt to explain sovereign default costs while assuming away creditor retaliation at the country level. These emerging theories can be divided in two groups. The first group postulates that foreign borrowing exists because of agency problems in debtor countries. That is, politicians governing borrowing countries choose to honor foreign debt because default does not suit their own self-interest, despite bringing net benefits for the debtor country.[7] The second

[6] Levy-Yeyati and Panizza's (2011) result showing that the default coincides with the trough of recessions notwithstanding, one could conjecture that Argentina's immediate 12% drop in real GDP per capita in 2002 is enough to explain why countries honor their foreign debts. However, note that GDP per capita does not include the debt write-off that default represents. Argentina defaulted on $81.8 billion debt. According to Hornbeck (2006), foreigners held 53% of this debt. Sturzenegger and Zettelmeyer (2007a, 2007b) calculate that the average haircut, weighted by face value, was 73%. Argentina's population in 2002 was 37.5 million. Therefore, defaulting on foreign debt was equivalent to writing off US$ 1,160 in debt per capita. Argentina's implied PPP conversion rate and GDP deflator were 1.04 and 132.431 in 2002. So, Argentina's default was equivalent to issuing a check of 910 pesos (1993 prices) to every individual in Argentina. When added to the 2002 GDP per capita of 6,270 pesos, the total is 7,180 pesos, which is larger than the 2001 GDP per capita of 7,110 pesos.

[7] There is some empirical support for agency-based theories. Borensztein and Panizza (2009) study 19 default episodes for which they have data on electoral results before and after default. They present evidence consistent with

group of emerging theories retains the assumption of benevolent governments and relies on some form of "domestic collateral damage" to deter sovereign default. The collateral damage would arise either from "reputational spill-overs" or from a protracted disruption in credit to the private sector. In the paragraphs below we further elaborate on these emerging theories, and discuss how our results relate to them.

Examples of agency-based theories of sovereign debt include Drazen (1998) and Guembel and Sussman (2009). In Drazen (1998) foreign creditors can directly punish politicians that declare default. Guembel and Sussman (2009) assume that local investors hold part of the sovereign's foreign debt, which is traded in secondary markets, and that a sovereign cannot selectively default on foreign debtholders.[8] In their model, as long as local debtholders have sufficient political power, politicians will choose not to default even if default has net benefits at the country level. This result is reminiscent of the view that "rentiers" wielding political power support policies that serve their interests at the expense of the real economy (Krugman, 2011a and 2011b).

Examples of reputational spill-over theories of domestic collateral damage include Cole and Kehoe (1998) and Sandleris (2008). In Cole and Kehoe (1998), sovereign default undermines not only the confidence of government creditors, but also the confidence of other economic agents with whom the government contracts (such as firms and laborers). Sovereign default could then lead to a long-term reduction in economic growth, because, for example, agents refrain from investing due to fear of future changes in taxation or outright expropriation. In a similar vein, Sandleris (2008) models a government that use debt repayments as a costly signal that sustains a "good equilibrium". In this good equilibrium, agents trust that the government will be willing and able to maintain "good fundamentals", for example, by controlling corruption and enforcing property rights.

Several papers envision domestic collateral damage through declines in foreign or domestic credit to the defaulting country's private sector.[9] Mendoza and Yue (2011) argue that foreign

politicians wanting to avoid default in order to extend their time in office. Kohlscheen (2007, 2010) documents that the mode of political organization helps to explain the ocurrence of sovereign default. Vaaler, Schrage, and Block (2005) find that sovereign spreads increase (decrease) if right-wing (left-wing) political incumbents appear more likely to be replaced by left-wing (right-wing) challengers.

[8] This assumption is also in Broner and Ventura (2011), Gennaioli, Martin, and Rossi (2011), and Brutti (2009). In contrast, Broner, Martin, and Ventura (2010) assume that governments are able to selectively default on foreigners only. In that case, Broner and Ventura (2010) show that secondary markets endogenously re-allocate bondholdings to domestic bondholders, who would end up holding 100% of it if the government threatens to default. This mechanism could deter default as it would just imply a domestic redistribution of wealth within the debtor country. Note, however, that Broner and Ventura (2011) state that "Today's institutional set-up favours our assumption of non-discriminatory enforcement [of sovereign default across local and foreign creditors]". In Argentina's sovereign default case, Hornbeck (2006) reports that foreigners held 53% of defaulted Argentine debt.

[9] Arteta and Hale (2008) and Kohlscheen and O'Connell (2007) document that sovereign default is associated with

lenders may cut credit to the private sector because they fear the imposition of capital or exchange controls following default. Thus, sovereign default would limit the ability of domestic firms to obtain capital to buy imported outputs. This would cause efficiency losses by forcing final good producers to operate using only domestic inputs, and by inducing labor to reallocate from the final goods sector to the sector producing domestic input.[10] Kumhof and Tanner (2005) argue that, for institutional reasons, domestic banks choose to be highly exposed to local government debt. This makes them vulnerable to sovereign default if sovereigns cannot perfectly discriminate between domestic and foreign debtholders when they default. Thus, sovereign default is costly because it weakens domestic banks' balance sheets, causing protracted domestic banking crises that choke off investment and output. Gennaioli, Martin, and Rossi (2011), Brutti (2011), and Basu (2009) present models explaining the domestic banking crisis channel of sovereign default costs.

Our results inform existing theory in the following ways. First, our findings are not supportive of agency-based theories of sovereign debt and default. Specifically, our results indicate that economists do not need to assume away government benevolence in order to explain a country's reluctance to default. We find that financial markets expect that sovereign default would inflict large costs onto domestic corporations, and thus to the domestic economy. To the extent that politicians share financial market beliefs, or fear that they can be self-fulfilling, it is reasonable to think that they are acting in their country's best interest when they choose not to default.

Second, our results support "domestic collateral damage" theories of sovereign debt and default. We find that a disruption to local credit markets seems to be a major component of the cost of sovereign default, which is consistent with the demise of local banks holding large amounts of defaulted sovereign debt. This is consistent with models by Gennaioli, Martin, and Rossi (2011), Brutti (2011), and Basu (2009). Further, our results suggest that firms with relatively higher exposure to government misbehavior face higher prospective costs of sovereign default. This is consistent with reputational spill-over theories by Cole and Kehoe (1998) and Sandleris (2008).

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a contraction in syndicated bank lending and trade credit by foreign banks to local firms. However, it is unclear how much of these effects are demand- rather than supply-driven. Sturzenegger and Zettelmeyer (2006), Borensztein and Panizza (2009), and Reinhardt and Rogoff (2010a) document that sovereign default is associated with domestic banking crises, but the direction of causality is difficult to ascertain.

[10] Rose (2005) finds that sovereign default is associated with a decline in bilateral trade betweem a debtor and its creditors. Martinez and Sandleris (2008) presents evidence that this trade decline is more likely associated with a decline in trade credit rather than with retaliatory trade sanctions (either overt or covert). This is because the pattern of trade decline is unrelated to the pattern of debt holdings.

3 Methodology

In this section we present our valuation model. The model, adapted from Andrade (2009), provides an equation with two parameters K_0 and K_1 linking stock value discounts to (i) sovereign spreads, (ii) expected recovery ratios on defaulted debt, (iii) risk-free rates, and (iv) average sovereign debt maturities. K_0 is the cost of sovereign default, and K_1 is an ancillary parameter governing the translation from a bond-based to a stock-based risk-neutral probabilities of sovereign default. For simplicity, we will refer to the country subject to default risk as GIIPS (Greece, Ireland, Italy, Portugal, and Spain), and to comparable countries not subject to default risk as REU (Rest of Europe).

Let a GIIPS country have foreign debt requiring a continuous and constant payment $c > 0$. The total foreign debt service is composed of coupon and principal payments. At each moment in time, the country retires a fraction $\frac{1}{L}$ of its total debt, and replaces it by newly issued debt with the same principal value and coupon rate. Leland (1994, 1998) shows that this framework allows for constant total debt service and finite average debt maturity L, while total payments are exponentially declining for each debt vintage.

The country can promote one (and only one) unilateral restructuring of its foreign debt. We refer to this unilateral restructuring as default for ease of language. As a result of default, the perpetual debt payment is reduced to $0 < \bar{c} < c$. That is, the recovery rate on defaulted sovereign bonds is $R = \frac{\bar{c}}{c}$. Let the post-default total payments also be composed of coupon and principal payments retired at a rate $\frac{1}{L}$, so that average debt maturity after default remains L. Let the average yield spread on outstanding sovereign debt be S_t and the risk-free rate be r. The proposition below demonstrates how the risk-neutral probability of default implied by sovereign debt values, denoted by Q_t, relates to S_t, R, L, and r.

Proposition 1 *The sovereign debt risk-neutral default probability is given by*

$$Q_t = \frac{S_t}{(1-R)\left(S_t + r + \frac{1}{L}\right)} \tag{1}$$

Proof. See Appendix A.■

Let the earnings flow of a generic REU stock follow a Geometric Brownian Motion (GBM) with trend μ_x. Let the discount rate of the stock (i.e., the cost of equity capital) be equal to d. Therefore, the earnings yield of this generic REU stock is $EY^{REU} = d - \mu_x$. For finite prices, let $EY^{REU} > 0$.

Now consider a GIIPS stock that is comparable to the generic REU stock above. For example, a GIIPS stock in the same industry as the REU stock.[11] Let the earnings of this comparable stock follow a GBM X_t with trend μ_x, volatility of earnings growth σ_x, and correlation ρ_x with the global pricing kernel. Let the global pricing kernel follow a GBM with trend equal to (minus) the international risk-free rate r and volatility equal to (minus) the global price of risk λ.[12] The intrinsic discount rate of the GIIPS stock is equal to $r+\lambda\rho_x\sigma_x = d$, because in the absence of sovereign default risk the GIIPS stock is comparable to the REU stock. For example, if the World CAPM holds, λ is the Sharpe Ratio of the World Market Portfolio and $\rho_x\sigma_x$ is proportional to the covariance of the GIIPS' stock earnings with the World Market Portfolio.

Default is costly for a GIIPS country. After default, the generic GIIPS stock faces both a higher intrinsic cost of equity capital ($\overline{d} > d$) and a lower earnings growth rate ($\overline{\mu_x} < \mu_x$) than their REU peers. Note that the earnings yield of the GIIPS stock declines to $\overline{EY^{GIIPS}} = \overline{d}-\overline{\mu_x}$.after default. We define the cost of default K_0 as the sum of the increase in the intrinsic cost of equity capital and the decrease in earnings growth rate following sovereign default:

$$K_0 \equiv \left(\overline{d} - d\right) + \left(\mu_x - \overline{\mu_x}\right) \tag{2}$$

Before default, the GIIPS stock has the same expected earnings growth rate and intrinsic systematic risk as the comparable REU stock. However, the GIIPS stock will trade at discount relative to its comparable REU stocks. This discount arises because stock prices are forward looking and reflect the possibility of a negative regime change following sovereign default. If the negative regime change tends to happen in bad economic times, there will be a systematic risk premium associated to the discount as well, above and beyond the likelihood of the regime change alone. Define the value discount in the GIIPS stock as:

$$VD_t \equiv 1 - \frac{EY^{REU}}{EY_t^{GIIPS}} \quad \text{or, equivalently,} \quad VD_t \equiv \frac{\left(\frac{P}{E}\right)^{REU} - \left(\frac{P}{E}\right)_t^{GIIPS}}{\left(\frac{P}{E}\right)^{REU}} \tag{3}$$

Note that the discount is positive if GIIPS stocks have lower prices (i.e., higher earnings yields) than comparable REU stocks, which is always the case in the valuation model. Proposition 2 below shows how this (stock-based) Value Discount is related to (bond-based)

[11] Bekaert, Harvey, Lundblad, and Siegel (2007, 2010, 2011) postulate that, in integrated markets, stocks in the same industry share the same expected earnings growth rate and the same correlation with the global pricing kernel.

[12] A large body of recent research indicates that systematic risk premia represent a substantial fraction of corporate and sovereign credit spreads (e.g., Driessen, 2005; Berndt et al., 2008; Chen, Collin-Dufresne, and Goldstein, 2009; Remolona, Scatigna, and Wu, 2008; Duffie et al., 2011; Borri and Verdelhan, 2011).

risk-neutral probability of sovereign default.

Proposition 2 *Let the GIIPS country default the first time a Geometric Brownian Motion Y_t with trend μ_y and volatility σ_y hits an exogenous lower barrier $\overline{Y}$.*[13] *Let the correlations of Y_t with the earnings flow of the GIIPS stock and with the global pricing kernel be ρ_{xy} and ρ_y, respectively. Then the equity value discount VD_t is equal to*

$$VD_t = \frac{K_0}{EY^{REU} + K_0} Q_t^{K_1} \tag{4}$$

where

$$K_1 = \frac{\frac{1}{2} - \frac{\mu_y - \lambda\sigma_y\rho_y}{\sigma_y^2} - \frac{\rho_{xy}\sigma_x}{\sigma_y} - \sqrt{\left[\frac{1}{2} - \frac{\mu_y - \lambda\sigma_y\rho_y}{\sigma_y^2} - \frac{\rho_{xy}\sigma_x}{\sigma_y}\right]^2 + \frac{2}{\sigma_y^2}(r + \lambda\sigma_x\rho_x - \mu_x)}}{\frac{1}{2} - \frac{\mu_y - \lambda\sigma_y\rho_y}{\sigma_y^2} - \sqrt{\left(\frac{1}{2} - \frac{\mu_y - \lambda\sigma_y\rho_y}{\sigma_y^2}\right)^2 + \frac{2}{\sigma_y^2} r}} > 0 \tag{5}$$

Proof. *See Appendix A.*■

Appendix A refers to Andrade (2009) for a rigorous derivation of Equation (4). The Appendix also contains an heuristic derivation that helps to clarify the equation's origin. Equation (4) shows that two parameters govern the link between the equity value discount and the sovereign debt risk-neutral probability of default. The parameter K_0, the cost of sovereign default as defined in Equation (2), determines the magnitude of the negative regime change associated with sovereign default. Note that the Value Discount at default (i.e., when $Q_t = 1$) is given by $\frac{K_0}{EY^{REU} + K_0}$.

The parameter K_1 governs the translation from a bond-based risk-neutral probability of default to a stock-based risk-neutral probability of default. Suppose for example that the price of risk is zero ($\lambda = 0$), and that the earnings of the GIIPS stock are uncorrelated with the process determining sovereign default and have zero drift ($\rho_{xy} = 0$ and $\mu_x = 0$). In that case, $K_1 = 1$. Therefore, in that case no adjustment is needed, and one can directly use the bond-based risk-neutral default probability to price the GIIPS stock. The parameter space is such that K_1 is always positive, but can be either above or below 1. That is, additional

[13] Andrade (2009) endogenizes $\overline{Y}$ by defining the country's net endowment as $Y_t - c$ and assuming that default causes a decrease in the trend and an increase in the volatility of Y_t. In this case, $\overline{Y}$ becomes an optimal stopping time when the country seeks to maximize the present value of its net endowment. In addition to Andrade's (2009) endogenization of the default barrier, several models in the sovereign default literature predict that default is much more likely to take place in bad economic times (e.g., Aguiar and Gopinath, 2006; Arellano, 2008; Hatchondo and Martinez, 2009). Furthermore, Tomz and Wright (2007) present empirical evidence showing that sovereign default tend to occur in bad economic times.

constraints in the parameter space are needed to pin down whether VD_t is a convex or concave function of Q_t.

Figure 2 plots Equation (4). The baseline set of parameters in both panels is $EY^{REU} = 0.08$, $K_0 = 0.04$, and $K_1 = 0.75$. Note VD_t is a concave function of Q_t in this baseline set. These baseline parameters imply that the Value Discount at default (when $Q = 1$) is equal to $\frac{0.04}{0.04+0.08} = 0.333$. The first panel illustrates the effect of changing K_0.Note that the Value Discount at default changes. The second panel illustrates the effect of changing K_1. Note that the Value Discount at default remains fixed at 0.333. The figure also shows that there is no relationship between VD_t and Q_t if either K_0 or K_1 are equal to zero.

FIGURE 2

Figure 2 can be used to illustrate the difficulty in assessing the cost of sovereign default using linear regressions. Consider two countries with $K_0 = 0.04$ and $K_1 = 0.375$, and facing $EY^{REU} = 0.08$. The second panel of Figure 2 illustrates how VD_t varies with Q_t. For example, suppose that Q_t varies from 0 to 0.25 for a given country labeled Country 1. Note that, for Country 1, changes in the risk-neutral probability of default are associated with very large changes in VD_t. On the other hand, suppose that Q_t varies from 0.5 to 0.75 for Country 2. In Country 2, changes in Q_t are associated with small changes VD_t. Now suppose an econometrician runs linear regressions of VD_t onto Q_t allowing for different slopes for each country. Of course, he/she will find that the slope for Country 1 is much higher than the slope for Country 2. Thus, the econometrician might be tempted to conclude that sovereign default is highly costly for the Country 1 but not too costly for Country 2. However, this would be false by construction. This example illustrates the potential benefit of studying this question through the lens of a structural model.

3.1 Estimation

If the model is taken literally, there is no room for the left-hand side of Equation (4) to deviate from its right-hand side. However, it is reasonable to think that specification or measurement errors create deviations from model predictions. For example, specification errors arise if stock earnings do not exactly follow a Geometric Brownian Motion[14], or because the earnings yield of the comparable REU stock is time-varying rather than constant.

[14] For example, if there is mean-reversion in stock earnings, as stock earnings can be temporarily high in a boom, or temporarily low in a recession.

Similarly, specification errors can also arise because we assume that expected recovery rates, average debt maturities, risk-free rates, and the price of risk are constant when in fact they are time-varying. Measurement errors arise because we cannot perfectly identify a comparable REU stock for each GIIPS stock, or because, due to accounting differences, reported corporate earnings are not measured identically across countries.

In order to apply the model to the data, and estimate the parameters K_0 and K_1, we re-write our equations allowing for time-variation in the parameters. We also re-write Equation (4) allowing for additive specification/measurement errors ε_t. Note that we do not impose that the average error ε_t is equal to zero. As Liu, Whited, and Zhang (2009, p.1110) point out, measurement and specification errors, unlike forecast errors, do not necessarily have mean equal to zero. So our estimation equation is:

$$VD_t = \frac{K_0}{EY_t^{REU} + K_0} Q_t^{K_1} + \varepsilon_t \tag{6}$$

where

$$Q_t = \frac{S_t}{(1 - R_t)\left(S_t + r_t + \frac{1}{L_t}\right)}$$

As explained in the next Section, we use value-weighted averaging to aggregate earnings yields from the firm-level to the country level. This generates a single VD_t for each country at each point in time. We assume that the errors ε_t are i.i.d. and normally distributed, and estimate the parameters K_0 and K_1 by maximum likelihood.[15]

4 Data

4.1 Value Discount

We compute a monthly stock-based Value Discount (VD_t) for each of the GIIPS countries. Our sample period is from January 2006 to March 2011. We start in 2006 because 2005 is the first fiscal year for which all European firms report their earnings under International Financial Reporting Standards (IFRS) as opposed to local accounting rules. Having the same accounting rules across all European firms reduces the measurement error when comparing earnings yields internationally.

We first compute an earnings yield for each European stock in each month of our sample.

[15] Note that maximum likelihood is equivalent to non-linear least squares when errors are i.i.d. normally distributed.

We use analysts earnings forecasts from I/B/E/S and stock price data from Datastream. Earnings yields are computed as the ratio of earnings forecasts divided by current stock prices. I/B/E/S tickers are matched to Datastream identifiers in three steps: first by ISIN, then by SEDOL, and finally by name (hand-matched).[16]

We use earnings forecasts rather than historical earnings to reduce measurement errors, because realized earnings are equal to forecasted earnings plus noise.[17] In our baseline results, we compute the earnings yield using the average earnings forecast for the fiscal years t, t+1, and t+2. We don't use earnings forecasts after fiscal years t+2 because many stocks don't have forecasts beyond fiscal year t+2. In robustness tests we repeat our analyses using either one-year forward earnings or using only t+2 earnings forecasts. These alternative choices reduce the sample as there is a (small) drop in coverage from t to t+1 and t+2. Following Bekaert et al. (2007, 2010, 2011), we discard negative earnings and truncate firm-level earnings yields. We truncate firm-level earnings yields at the 2% and 50% per year levels. This is roughly equivalent to winsorizing earnings yields at the 2.5% and 97.5% percentiles. The fraction of negative earnings forecasts is very small. Specifically, the total number of firm-month earnings forecasts is reduced by 1.7% for REU and 2.4% for GIIPS. In robustness checks, we repeat our estimation without discarding negative earnings or truncating earnings yields.

TABLE 1

Table 1 presents statistics that illustrate our sample coverage. We compare our sample of IBES-matched stocks to the sample of all Datastream stocks with non-missing, non-stale market capitalization data, and that enter the database before January 2011. We consider a Datastream datapoint to be stale if it does not change at all over the entire sample period, or if it is part of a sequence of at least 13 consecutive identical monthly values. On average, for each month we have 404 GIIPS stocks and 2385 REU stocks covering 93% and 91% of the Datastream market capitalization data in GIIPS and REU, respectively. In Appendix Table B.1 we compare the Level 4 ICB industry distribution of our sample stocks to the universe of all stocks with non-missing, non-stale market capitalization data in Datastream. Appendix Table B.1 shows that the industry composition in our sample is on average very close to the overall Datastream industry composition.

[16] We will post the I/B/E/S-Datastream match on the corresponding author's webpage.

[17] Liu, Nissim, and Thomas (2002) compare earnings yields of individual U.S. companies with their industry mean and find that the dispersion of earnings yields calculated from historical earnings is nearly twice that of earnings yields calculated from analyst forecasts. Additionally Liu et al. (2007) show that earnings forecasts substantially outperform historical earnings in describing valuations of European firms. Similarly, Kim and Ritter (1999) find much smaller IPO valuation errors using analyst earnings forecasts rather than historical earnings.

Finding comparable stocks

Our methodology requires us to identify a set of comparable REU stocks for each GIIPS stock in our sample. Following Bekaert, Harvey, Lundblad, and Siegel (2007, 2010, 2011), we group firms by ICB Level 4 industries. There are 39 such industries. Bekaert et al. (2007, 2010, 2011) postulate that, in integrated markets, stocks in the same industry have the same expected earnings growth rate and covariance with the global pricing kernel. This is a sufficient condition to make their earnings yields comparable. Furthermore, grouping firms by industry is by far the most common way to perform cross-sectional comparisons of stock multiples (e.g., Baker and Ruback, 1999; Kim and Ritter, 1999; Lie and Lie, 2002; Purnanandam and Swaminathan, 2004; Liu, Nissim, and Thomas, 2002 and 2007; Bris, Koskinen, and Nilsson, 2009). In robustness analyses, we change the set of comparable firms. We use either a coarser (ICB Level 3, 19 industries) or a finer industry definition (ICB Level 5, 90 industries) rather than ICB Level 4 industries. In addition, we further group stocks in the same ICB Level 4 industry into leverage, book-to-market, and size terciles. These terciles are calculated based on breakpoints computed by industry-month pairs and using REU stocks.[18]

For each of the GIIPS stocks and for each month, we compute the earnings yield of the comparable REU stocks. The median number of comparable REU stocks for each GIIPS stock is 68. We use the value-weighted average of the earnings yields of REU stocks in the same industry as the GIIPS stock and in the same month, following Bekaert et al. (2007, 2010, 2011). In additional robustness analysis we use the median as opposed to the value-weighted average earnings yield. So, for each stock j in a GIIPS country at a given point in time, we have its own earnings yield $EY_t^{GIIPS,j}$ and its comparable REU earnings yield $EY_t^{REU,j}$.

Aggregation

Following Bekaert et al. (2007, 2010, 2011), we use value-weighted averaging to aggregate $EY_t^{GIIPS,j}$ and $EY_t^{REU,j}$ up to the country-level at each point in time. This yields a country-

[18] We find that these additional groupings do not further reduce the dispersion of earnings yields appreciably. For example, we group REU stocks into ICB Level 4 industries and calculate the value-weighted earnings yield at each month. For all REU stocks and all months, we compute de-meaned earnings yields by subtracting the corresponding month-industry value-weighted average from the earnings yield. We then subdivide each month-industry group of stocks into leverage terciles. We define leverage as total debt divided by total assets as of the previous fiscal year for non-financials, and total liabilities divided by total assets as of the end of the previous fiscal year for financials. We create a dummy variable for each month-industry-leverage group. Finally, we regress the de-meaned earnings yield on the dummy variables and find that the (unadjusted) R^2 of this regression is just 0.76%. Note that this regression procedure is equivalent to an ANOVA decomposition of the de-meaned earnings yields using month-industry-leverage quintiles. This result is analogous to Alford (1992).

level earnings yield EY_t^{GIIPS} and a country-level comparable earnings yield EY_t^{REU} for each GIIPS country at each point in time. Pooling across all of the 5 GIIPS countries and 63 months, our data have 315 observations for EY_t^{REU} and EY_t^{GIIPS}. Finally, we compute the Value Discount for each of the GIIPS countries at each point in time as $VD_t \equiv 1 - \frac{EY_t^{REU}}{EY_t^{GIIPS}}$.

TABLE 2

Table 2 contains summary statistics. The average GIIPS earnings yield in our sample is 0.094. The average comparable REU yield is 0.087. Not surprisingly, EY_t^{GIIPS} and EY_t^{REU} are highly correlated (correlation=0.871). The average Value Discount is 0.058. Note that there is considerable dispersion in VD_t, as its standard deviation is 0.106. The correlation between VD_t and EY_t^{REU} is 0.389.

4.2 Risk-neutral Default Probability

We compute a monthly bond-based Risk-neutral Default Probability (Q_t) for each of the GIIPS countries. Our sample period is from January 2006 to March 2011. As Equation (1) shows, we need four pieces of information to compute Q_t: (i) the average sovereign debt spread S_t, (ii) the risk-free rate r_t, (iii) the average maturity of sovereign debt L_t, and (iv) the expected recovery ratio R_t. We obtain S_t, r_t, and L_t from J.P. Morgan Global Bond Indexes in Datastream, and R_t from Markit.

The average maturity L_t is the Average Life of each GIIPS bond index, read directly from the data. For each GIIPS and each month, we use L_t to construct a maturity-matched risk-free rate and a maturity-matched sovereign spread. The maturity-matched risk-free rate r_t is the yield-to-maturity of a German government bond with the same maturity as the average maturity of GIIPS debt L_t. The maturity-matched sovereign spread S_t is the difference between the yield-to-maturity of GIIPS J.P. Morgan Global Bond Index and the corresponding maturity matched risk-free rate r_t.

We use linear interpolations to find r_t and S_t. The linear interpolation has two nodes. One node is the overall J.P. Morgan Government Bond Index for Germany, and the other node is the 1 to 10-years GBI Index for Germany. Note that the 1 to 10-year Index has smaller average maturity and (typically) smaller yield-to-maturity than the overall German Index, as bonds with more than 10-years to maturity are discarded. If the GIIPS L_t is below the average life of the 1 to 10-year German Index, we use the yield-to-maturity of the 1-10 Germany Index as our maturity-matched risk-free rate r_t. If the GIIPS L_t is above the average life of the 1 to 10-year German Index, but below the average life of the overall German Index, we linearly interpolate to find r_t. If the GIIPS L_t is above the overall German Index's average life, we use the overall German Index's yield-to-maturity as the maturity-matched risk-free rate r_t. After finding r_t, we subtract it from the corresponding GIIPS' bond Index yield-to-maturity to find S_t.

We use recovery rates from CDS dealers surveyed by Markit. Dealers use these recovery rates in their own CDS valuations. These recovery rates are also used by market participants when they mark-to-market their positions, and to unwind a given CDS contract before its expiration. Markit provides the average recovery rate across dealers. We use recovery rates for 5-year CDS contracts. At each point in time, we average recovery rates across the different CDS contract restructuring clauses.

Table 2 presents summary statistics of the components of the risk-neutral probability of sovereign default. The average sovereign spread in our sample is 0.011, that is, 110 basis points. The mean average maturity L_t is 8.434 years. The average maturity-matched risk-free rate is 0.035 per year. The average expected recovery ratio is 0.395. Using Equation (1) we compute the (bond-based) Risk-Neutral Default Probability for each GIIPS at each point in time. The average Risk-Neutral Default Probability is 0.098. As expected given Equation (1), the Risk-neutral Default Probability is positively correlated with the sovereign spread and the expected recovery ratio, and negatively related to the average life and the risk-free rate. The correlations are 0.985, 0.358, -0.300, and -0.737, respectively.

Table 2 also shows that the coefficient of variability of the sovereign spread is several times larger than the coefficients of variability of all the other explanatory variables. This is why the correlation of the Risk-neutral Default Probability with the sovereign spread is much larger than its correlation with the other three variables. Consistent with Equation (1), the correlation between the (bond-based) Risk-neutral Default Probability and the (stock-based) Value Discount is positive and equal to 0.537.

4.3 Plots

In this section we describe our sample succinctly using two figures. Figure 3 plots the time series of sovereign spreads, (bond-based) risk-neutral default probabilities, and the stock-based Value Discount. The first two panels show that GIIPS sovereign spreads and risk-neutral default probabilities were nearly flat at low levels in 2006 and 2007, and start to climb from early 2008 onwards. Spreads spike in the beginning of 2009, recede for the following 8 months, then climb steadily to reach their highest levels at the end of our sample. Note that the risk-neutral default probability for Greece remains at around 0.6 from the second quarter of 2010 onwards, even though the sovereign spread keeps rising for another year or so. This apparent mismatch is due to the fact that the other determinants of Q_t (R_t, r_t, and L_t) are also time-varying, and that changes of a given magnitude in S_t result in smaller changes in Q_t for higher levels of S_t.

FIGURE 3

The third panel in Figure 3 shows that the stock-based Value Discount follows a pattern similar to the sovereign spread and the risk-neutral default probability. It starts flat at close to zero in 2006 and 2007, then climb from 2008 onwards. It spikes at the very end of 2008 (very close to the spike in risk-neutral default probabilities), recedes somewhat for the following 8 months, and then starts to steadily climb from the beginning of 2010 onwards. As Table 2 shows the correlation between the risk-neutral default probability and the sovereign spread (pooled across the GIIPS) is 0.537.

FIGURE 4

Figure 4 shows scatter plots of the (bond-based) risk-neutral default probability and the (stock-based) Value Discount. The figure contains *all* 315 data points in our sample. Note that Figure 4 is analogous to Figure 2, because in both we plot graphs of VD_t versus Q_t. The scatter plots suggest that VD_t is a monotonically increasing concave function of Q_t.[19] Therefore, based on Figure 4, we expect to find $K_0 > 0$ and $0 < K_1 < 1$ when we estimate the valuation equation by maximum likelihood.

5 Empirical results

5.1 Linear regressions

Equation (4) states that the (stock-based) Value Discount in a country subject to default

[19] Note that there are few data anomalous data points close to $Q_t = 0$ in the Ireland plot. These points correspond to the August 2007-January 2009 time period. Interpreting the anomaly in terms of our model, we could say that the Irish equity market was misaligned with the Irish sovereign bond market during that period. Equities were too cheap relative to debt, and the mispricing was corrected over time.

risk is positively related to that country's (bond-based) risk-neutral default probability. In this section we present linear regressions of the Value Discount to investigate whether this relationship is present in the data. We report Driscoll-Kraay (1998) standard errors with 4 lags and clustered by country. These standard errors are robust to heteroskedasticity, autocorrelation with 4 lags within each cluster, and contemporaneous cross-sectional correlation across clusters. It is important to note that, for our purposes, the linear regressions are only a preliminary step because we cannot use them to estimate the cost of sovereign default, which is the object of our interest.

TABLE 3

Table 4 presents our linear regression results. The data are comprised of 63 months for each of the 5 GIIPS, totalling 315 data points. In Panel A we regress the Value Discount onto each of the four components of the (bond-based) risk-neutral default probability. In Column (4) we add country fixed effects and in Column (5) we add month-year fixed effects. Note that the coefficient on the sovereign spread is positive and statistically significant at 1% in all columns, in line with Equations (1) and (4) combined. The coefficient is economically significant, as a one-standard deviation (*S.D*) change in the sovereign spread is associated with changes in the Value Discount ranging from 0.35 *S.D.* (Column 4) to 0.61 *S.D.* (Column 5).

Equations (1) and (4) combined indicate that the Value Discount should be positively related to the average maturity and the risk-free rate, and negatively related to the recovery rate. Apart from the average maturity in Column (3), these three additional determinants of the risk-neutral default probability are statistically insignificant in Panel A. This lack of statistical significance could be due to lack of power to identify the relationships between the Value Discount and these additional variables because they display little variability, as shown in Table 2.

In Panel B we use the (bond-based) risk-neutral default probability instead of its four components. The coefficient on the Risk-neutral Default Probability is positive and statistically significant at 1% in all four columns, surviving the addition of country or month-year fixed effects. The coefficient ranges from 0.360 in Column (3) to 0.500 in Column (4). The coefficients are economically significant: a one *S.D.* change in the Risk-neutral Default Probability changes the Value Discount by 0.44 *S.D.* in Column (3) and 0.61 *S.D.* in Column (4).

5.2 Aggregate cost of default estimation

Equation (6) is a structural equation with two parameters linking the current Value Discount in stock prices to the bond-based risk-neutral probability of sovereign default. The parameter K_0 is the conditional cost of sovereign default, defined as a reduction in expected earnings growth rates coupled with an increase in discount rates. The parameter K_1 governs the translation from a bond-based to a stock-based risk-neutral probability of sovereign of default. We assume i.i.d. normal disturbances and estimate the parameters K_0 and K_1 by maximum likelihood. Table 4 presents our results. We report Newey-West t-statistics accounting for autocorrelation up to 4 lags in each country. Results are very similar when we vary the number of lags.

TABLE 4

Panel A of Table 4 presents our baseline result. We find that the cost of sovereign default K_0 is equal to 5.1% per year. The parameter is statistically significant at the 1% level as the t-statistics is equal to 3.94. To illustrate the economic significance of K_0, let us assume that the earnings yield EY^{REU} is equal to 8.7%, which is the average in the REU in the sample period (Table 2). Equation (4) implies that the Value Discount at default (i.e., when $Q_t = 1$) is given by $\frac{K_0}{EY^{REU}+K_0}$. Therefore, our estimate of K_0 implies that financial markets expect a $\frac{5.1\%}{8.7\%+5.1\%} = 37\%$ equity capital destruction upon sovereign default.

Panel A of Table 4 also shows that the estimate of K_1 is 0.729. Therefore, the stock-based Value Discount is a concave function of the bond-based Risk-neutral Default Probability, which is in line with the scatter plots of Figure 4. In untabulated estimations, we re-estimate the structural valuation equation (5) while forcing the parameter K_1 to be equal to one. That is, we ignore the fact that one cannot directly use a bond-based probability of sovereign default to price stocks subject to sovereign default risk because stocks and sovereign bonds can have different exposures to sovereign default risk. We find that the K_0 increases from 5.1% to 8.5% per year when we impose $K_1 = 1$. Therefore, ignoring the necessary adjustment of risk-neutral probabilities overestimates the cost of sovereign default.

The average error ε_t is very close to zero. The standard deviation of the error is 8.9% per year and we cannot reject the null hypothesis that the errors are indeed normally distributed (p-value=0.57). This implies that roughly two thirds of our fitted Value Discounts are within 8.9% of the observed Value Discounts. The correlation between fitted and observed Value Discounts is equal to 0.54.

5.2.1 Sensitivity analyses

Panel B of Table 4 reports results of several sensitivity analyses. These analyses indicate that our results are qualitatively robust to variations in our methodology. The expected equity destruction upon default is 37% in our baseline specification and ranges from 27% to 45% in our sensitivity analyses.

In Column (1) we drop the year 2006, reducing our sample from 315 to 255 data points. The cost of default estimate drops from 5.1% to 4.3% per year. However, it remains within one standard deviation of the original estimate. In Column (2) we use the median rather than the value-weighted REU industry earning yield when defining the comparable earnings yield of each GIIPS stock. The estimated cost of default increases from 5.1% to 6.7%, and remains statistically significant at the 1% level. The new estimate is not statistically different from the baseline estimate in Panel A.

In columns (3) and (4) we compute stock-level earnings yields using either one-year forward earnings forecasts or earnings forecasts for the fiscal year t+2, instead of the baseline specification in which we use the average earnings forecasts for fiscal years t, t+1, and t+2.[20] In Column (2) we find that K_0 drops from 5.1% and 4.5%, while in Column (3) we find that K_0 increases from 5.1% to 7.2%. In both cases K_0 and K_1 remain economically large and statistically significant at the 1% level.

In Columns (5) to (9) we redefine the set of comparable firms. In Columns (5) and (6) we change the industry classification. Compared to the baseline case, Column (5) uses a coarser classification (ICB Level 3, 19 industries) and Column (6) uses a finer classification (ICB Level 5, 90 industries). In both cases, the new K_0 estimates are statistically significant and within one-standard deviation of the baseline estimate in Panel A.

In Columns (7), (8), and (9) we further match stocks in the same ICB Level 4 industry based on leverage, book-to-market ratio, or size terciles.[21] The additional matching within each industry reduces the median number of comparable REU stocks for each GIIPS stock from 68 to 23. The sorting of firms into terciles is based on monthly industry breakpoints computed from the REU sample. In Column (7) we match by leverage, which is defined as total debt divided by total assets for non-financial firms, and total liabilities divided by total

[20] The one-year forward earnings forecast is an weighted average of either t and t+1, or t+1 and t+2, depending on the month of the year (and the fiscal-year end of the stock). For example, say that the current month is March and the fiscal-year end of the stock is in December. The one-year forward earnings forecast is (9/12)*Earnings Forecast for year t plus (3/12)*Earnings Forecast for year t+1.

[21] Firms with missing leverage, book-to-market ratio, and total assets were assigned to the intermediate tercile.

assets for financial firms. In Column (8) we match by book-to-market ratio. In Column (9) we match by size, defined as total assets. Each month, we use the balance sheet figures the previous fiscal year. Our K_0 and K_1 estimates remain statistically significant at the 1% level in Columns (7), (8), (9). The cost of default estimates are somewhat smaller, dropping from 5.1% in the baseline result to 3.4% in Column (7), 3.2% in Column (8), and 4.2% in Column (9).[22] Note that the standard deviation of the error term and the average error increase compared to baseline specification in Panel A. This is consistent with an increase in noise generated by the reduction of the median number of comparable REU firms from 68 to 23. For example, one fourth of the GIIPS stocks in our sample are matched to 10 or less comparable REU firms.

In untabulated results, we estimate the prospective cost of sovereign default without deleting negative earnings or truncating earnings yields. This should lead to an increase in the magnitude of measurement and specification errors. We find that the number of negative earnings forecasts (average of fiscal years t, t+1, and t+2) for Ireland goes up significantly after December 2008, especially for Irish financial firms. This has a large effect on the Irish baseline sample. For example, the value-weighted earnings yield for Ireland plunges from 14.68% per year in December 2008 to 0.04% per year in November 2009. The corresponding earnings yield of comparable stocks in November 2009 is 8.08% per year. Therefore, the Value Discount for Ireland in November 2009 is $VD = 1 - \frac{0.0808}{0.0004} = -20244\%$. This outlier, and other less dramatic Irish outliers shortly before and after November 2009, severely contaminate the sample. We deal with this issue in two different ways. First, we drop Ireland from the sample. Second, we repeat our estimations using only fiscal year t+2 earnings forecasts, rather than the average for fiscal years t, t+1, and t+2 (as we did in Column (4)). In the first case, our estimates for K_0 and K_1 are 3.1% (t-statistics=2.35) and 0.529 (t-statistics=3.62), respectively. In the second case, our estimates for K_0 and K_1 are 7.6% (t-statistics=2.49) and 1.024 (t-statistics=3.00), respectively. Therefore, we find that the results are qualitatively similar to the ones in our baseline sample. As expected, the range of estimates for the cost of default in different specifications widens considerably, and so do the standard errors of the coefficient estimates, consistent with an increase in the magnitude of measurement and specification errors.

[22] Using the average EY^{REU} in our sample (8.7% per year), the estimate of the fraction of equity destroyed upon sovereign default drops from 37% in the baseline estimation to 28%, 27%, and 33% respectively.

5.2.2 Placebo samples

We form placebo samples to further investigate whether our baseline results are driven by an imperfect match of GIIPS stocks to comparable REU stocks. For each of the GIIPS stocks in our sample, we find a placebo REU stock with similar size and book-to-market ratio, or similar size and leverage. Specifically, each month we sort REU stocks into size (total assets) quartiles. Then, we identify the corresponding REU size quartile for each of the GIIPS stocks each month. Within that quartile, we search for the REU stock with the closest leverage or book-to-market to the GIIPS stock.[23] For example, if our sample has 100 Spanish stocks in a given month, we form a placebo Spain sample containing 100 REU stocks. Each of these REU stocks belongs to the same size quartile and has either the closest leverage or book-to-market ratio to the corresponding Spanish stock.

We perform our tests on the sample of placebo stocks. If our baseline results are driven by disregarding size, leverage, and book-to-market, then the test results in the placebo sample should be similar to the test results in the treatment sample. However, we find that there is no association between Value Discounts and Risk-neutral Default Probabilities in either of the placebo samples. This indicates that our results are not driven by failing to account for cross-sectional variation in earnings yields based on size, leverage, or book-to-market.

First, we run linear regressions of the Value Discount onto Risk-neutral Default probability. In contrast to our results in Panel B of Table 3, we find that the coefficient on the Risk-neutral Default Probability is small and statistically insignificant in both placebo samples and for all specifications. These results are in Panel A of Appendix Table B.2.

Second, we perform our maximum likelihood estimation of the parameters K_0 and K_1 in both placebo samples. In contrast to our results in Panel A of Table 4, we cannot reject that K_1 is equal to zero in both placebo samples. The parameter K_0 is -1.8% and statistically significant at 5% in the size-and-leverage matched sample, and -0.2% and statistically insignificant in the size and book-to-market sample. Note that obtaining a negative K_0 and a zero K_1 is not evidence in favor of a "negative cost of default". As Panel B of Figure 2 shows, such a result arises when there is no relationship between VD_t and Q_t, but VD_t is negative on average. Additionally, note that the correlation between fitted Value Discounts and actual Value Discounts in the size-and-leverage matched sample is just 0.04, which is much smaller than the 0.54 baseline correlation reported in Panel A of Table 4.

[23] Leverage is total debt divided by total assets for non-financial firms, and total liabilities divided by total assets for financial firms. Accounting data are as of the end of the previous year.

5.2.3 Endogeneity

In this paper, a sequence of negative current shocks drives a country closer and closer to its default lower boundary. If the lower boundary is hit, countries default and give up long-term growth for immediate relief. This causes a negative, long-run regime change in the defaulting country.

In our story, high debt to GDP ratios can cause both low stock prices and low P/E ratios. High debt to GDP can cause low current corporate earnings if tax rates are high. Lower current earnings translate to low stock prices, as earnings follow a Geometric Brownian Motion. High debt to GDP ratio can also cause low P/E ratios through their impact on the likelihood of sovereign default. High debt makes immediate relief more desirable thereby increasing the likelihood of sovereign default. Default causes future earnings to grow at a slower rate as well as higher discount rates. Therefore, a high debt to GDP ratio causes low current P/E ratios.

However, what if high debt to GDP ratios affect long-run earnings growth independently of the likelihood of default? For example, Reinhart and Rogoff (2010b) argue that data suggests a causal link running from debt-to-GDP ratios above 90% to slower economic growth. If this direct causal link is quantitatively important in our case, then our methodology overstates the negative regime change caused by sovereign default.[24] Issues of endogeneity like this are notably difficult to fully address in financial economics, as it is hard to find unequivocally clean instrument variables or natural experiments. We describe below how we address this issue.

We use the May 2010 announcement of the European-wide rescue package as a quasi-natural experiment (as Claessens, Tong, and Zuccardi, 2011). On Saturday May 8 2010, European governments announced a 750 billion euro rescue package for troubled countries. The package amounted to contingent credit lines to countries in distress, which would allow them to lengthen the maturity of their debts. Importantly, the package did not contemplate debt reduction itself, and the interest rates in the contingent credit lines were significantly above the risk-free rate. Therefore, it is unlikely that any observed price reaction in stock markets was triggered by a direct effect of high debt-to-GDP ratios on growth.

We use daily data to evaluate the market reaction to the rescue package announcement. The change in sovereign spreads and (bond-based) risk-neutral default probabilities on May

[24] Note, however, that Spain's debt-to-GDP ratio in 2010 is only 60%, below the 80% ratios in Germany, France, and the U.K, and the near 100% ratio in Belgium.

10, 2010 is calculated from daily J.P. Morgan Government Bond Indices data. Spreads and risk-neutral default probabilities are defined as in our previous monthly analysis. We calculate stock returns on May 10, 2010 using daily data from Datastream ICB Level 4 Industry stock indices for all sample countries. We first compute the value-weighted stock return in each GIIPS country. Then we subtract the comparable stock return in REU countries to define the net GIIPS stock return. The calculation of the comparable stock return in REU countries is analogous to our previous analysis. That is, we first calculate the value-weighted return in each of the 39 industries for pooled REU countries on May 10, 2010. Then we multiply this vector of REU industry returns by the vector of GIIPS value-weights to find the comparable REU May 10, 2010 stock return in each of the GIIPS countries. Table 5 presents our results.

TABLE 5

The first column of Table 5 shows that bond markets reacted very positively to the European rescue package. For example, sovereign spreads on Irish and Italian bonds decreased by 123 and 175 basis points, respectively. European stock markets also reacted very positively to the rescue package announcement. For example, the return on Irish and Portuguese stock markets was 7.7% and 10.1% respectively.

Importantly, Table 5 shows that stock prices increased in GIIPS countries relative to REU countries. The last column of Table 5 shows that the GIIPS stock return net of the REU comparable return was positive for all GIIPS. The average stock return across GIIPS stocks over and above comparable REU stocks was 3.3%. To the extent that current stock earnings did not change as a result of rescue package announcement, the strong positive reaction of GIIPS stock markets relative to REU markets implies that (stock based) Value Discounts decreased on May 10, 2010. This large, positive stock market reaction to the European rescue package announcement indicates that an important fraction of the difference between earnings yields in GIIPS and REU countries is due to concerns about sovereign default, as opposed to high debt ratios directly causing a drag on future earnings growth.

We also find that the magnitude of the stock market reaction to the rescue package announcement is roughly in line with our parameter estimates. Using our baseline parameter estimates K_0=0.051 and K_1=0.729, we estimate that the model-implied average net stock market announcement return is 5.9% (t-statistic=4.30). Note that the 95% confidence interval around our point estimate (3.3% to 8.4%) includes the 3.3% observed average net announcement return. Therefore, the magnitude of the stock market reaction to the rescue package vis-a-vis the contemporaneous stock market reaction is consistent with our parameter estimates. This leads us to conclude that bond and stock market reactions to the May 2010 rescue package announcement indicate that endogeneity concerns do not seem to affect our results in a quantitatively relevant manner. [25]

5.3 Subsample cost of default estimation

In order to gain insight into the mechanisms by which sovereign defaults could be costly, we repeat our maximum likelihood estimations for subsamples of stocks. Here, rather than aggregating over all stocks in each GIIPS country, we sort stocks into two subgroups based on characteristics, and compute separate costs of default for each subgroup. For example, in estimating the cost of default for financials, we repeat our estimation in Panel A of Table 4 while removing our non-financials from the sample.

Note that removing stocks from the sample increases measurement error, even though we still end up with 63 monthly observations of the Value Discount for each of the GIIPS. If there is any measurement error in firm-level earnings yields, we lose precision when we aggregate up to the country level using a smaller number of firms. To make this point clear, think about calculating the prospective cost of sovereign debt for a single firm. The idiosyncratic factors in that firm's earnings are likely to overwhelm any macro information contained in its earnings yield and Value Discount.[26]

It is also important to note that we do not expect to find the same K_1 across different firm subgroups. Equation (5) shows that K_1 will vary across stocks in the same country if there are structural differences in their earnings processes. According to Equation (5), two types of firms will have different K_1 if their earnings have (i) different expected long-term growth (μ_X) (ii) different volatility (σ_X), (iii) different correlation with the global pricing kernel (ρ_X), and (iv) different correlation with the underlying process driving sovereign default (ρ_{XY}), for example real GDP per capita. Nonetheless, our results show that K_1 is statistically greater than zero in all firm subgroups. That is, we find a positive association between (stock-based)

[25] The model-implied net stock market announcement return takes as given the observed levels and changes in (bond-based) risk-neutral default probabilities on May 10, 2010. In performing the calculation, we also assume that current earnings in GIIPS and REU countries remain unchanged on May 10, 2010. Therefore, the net stock return for each GIIPS country can be calculated as $(1 - VD_{after}) \div (1 - VD_{before}) - 1$ and using Equation (4). We use the average of the April 2010 and May 2010 EY^{REU} in each of the GIIPS countries when calculating Equation (4). We use Stata to place a confidence interval in the point estimate through the delta-method of computing standard errors of functions of parameter estimates.

[26] The same principle applies for countries as a whole. The prospective cost of sovereign default estimated for the 5 GIIPS jointly is more reliable than separate estimates for each individual country.

Value Discounts and the (bond-based) Risk-neutral Default Probability for all types of firms we study.

5.3.1 Financials versus non-financials

First we group GIIPS stocks into financials and non-financials, based on ICB Level 2 classifications. Table B.1 in the Appendix shows that, on average in our sample period, the group of six financials comprise the following fractions of total market capitalization: Greece (42%), Ireland (25%), Italy (40%), Portugal (22%), and Spain (34%). If sovereign default is costly because it weakens the balance sheets of local banks who hold large quantities of defaulted debt, we expect to find a larger prospective cost of default for financial firms.

TABLE 6

Panel A of Table 6 shows that results are consistent with our conjecture. The estimated market-implied cost of default for financials is 7.7% per year, and is statistically significant at the 10% level. This estimate is higher than the estimate non-financials, which is 5.3% per year and statistically significant at the 5% level. In both cases the K_1 estimates are positive and statistically significant at the 5% level.

5.3.2 Non-financials subgroups

In further analyses we find the prospective cost of default for subgroups of non-financial firms. We sort non-financials into two groups with the same number of stocks based on median values of different firm-level characteristics. These characteristics are net leverage (total debt minus cash and equivalents scaled by total assets), size (total assets), and fraction of sales originating from abroad. These sorting variables are obtained from Datastream. We use net leverage, size, and the fraction of sales from abroad as of the previous fiscal year. In addition, we also subdivide non-financials into Utilities & Telecommunications and other non-financials. Panel B of Table 6 presents our results.

As explained in the previous Section, compared to the aggregate cost of default estimation in Panel A of Table 4, we lose statistical power by looking at sub-groups of firms. This occurs in spite of the fact that the total number of observations in the maximum likelihood estimation is the same (315) in both cases.

Net leverage: Firms with higher net leverage are more likely to have to tap capital markets in order to refinance their debt. In principle, if firms' current capital structure is close to their optimal levels, they will want to refinance their debt rather than substitute it by equity. Thus, if sovereign default costs operate via a credit crunch channel, we expect to find larger costs of default for firms with higher net leverage. Columns (1) and (2) confirm our conjecture. Results show that the prospective cost of default is 5.5% per year for non-financial firms with high net leverage, and 3.7% per year for firms with low net leverage. The corresponding t-statistics are 1.38 and 1.47, respectively. The K_1 estimates are positive and statistically significant at the 5% level in both high and low net leverage groups.

Size: Smaller firms are more likely to rely on local bank financing rather than other forms of financing. Thus, if sovereign default is costly because it weakens local banks balance sheets, we expect to find a larger K_0 for smaller firms. Results in Columns (3) and (4) support our conjecture. The prospective cost of default is 4.3% per year for large firms (t-statistics=2.15) and 18.7% per year (t-statistics=0.53) for small firms. The K_1 estimates are positive and statistically significant at the 5% level for both large and small firms.

Fraction of sales from abroad: Firms with a large fraction of sales originating from abroad are likely to be less subjected to local government misbehavior. Thus, if sovereign default is costly because the defaulting government loses credibility with economic agents in general, we expect to find a larger prospective cost of default for firms with lower fraction of sales from abroad. Our results confirm this conjecture. Columns (5) and (6) show that the market-implied cost of sovereign default is 1.5% per year for firms with large fraction of sales abroad and 13.6% per year for firms with small fraction of sales abroad. The K_0 estimate is statistically significant at the 1% level in the former case and at the 5% level in the latter case. In both cases the K_1 estimates are statistically significant at the 5% level.

Utility & Telecommunications versus other non-financials: Utility and Telecommunications firms tend to have their operations highly regulated by the government. Thus, if sovereign default is costly because of an overall loss of government credibility, we expect to see a larger cost of default in highly regulated industries. Columns (7) and (8) confirm this conjecture. The K_0 estimates are 24% per year for Utility & Telecommunication firms (t-statistics=2.03) and 4% (t-statistics=1.58) for other non-financial firms. The K_1 estimates are statistically significant at the 10% level. The very large K_0 estimate for Utility & Telecommunication implies a destruction of 73% of equity capital upon sovereign default (using the 8.7% average earnings yield of REU stocks in the sample period).

6 Data and Empirical Results for Emerging Markets

In this section we repeat our analysis for emerging markets (denoted EM) in the February 1995-January 2011 period. We use J.P. Morgan EMBI+ Index sovereign spread data from Datastream. EMBI+ sovereign spreads are denominated in U.S. dollars. The sample starts in 1995. Our EM sample contains countries that: (i) are part of the EMBI+ Index for at least 2 years, (ii) have a total stock market capitalization greater than $350 million at the end of 2003 (roughly the mid-point of the sample), and (iii) have data on expected recovery ratios from Markit. There are 13 countries satisfying these three conditions. Table six lists these countries along with the time period in which they are part of the EMBI+ Index, and therefore part of our sample. In total, our EM sample has 1,666 country-month observations.

TABLE 7

6.1 Methodological adjustments

A few methodological changes are needed in order to repeat our analysis for emerging markets from February/1995 to January/2011. These adjustments are described below, and in the next subsection.

Countries providing comparable stocks

There is no reason to restrict the set of comparable stocks to Europe, as emerging markets firms are not subject to the same accounting rules as European firms. Thus, here the set of comparable stocks comes from the entire developed world (denoted DEV), rather than just Europe. The DEV countries are listed in Table 7. The list is identical to Bekaert et al. (2007, 2011), only removing Italy from DEV, because it is part of the GIIPS sample.

Earnings yield calculation

The I/B/E/S coverage of emerging markets is very sparse in our sample and therefore we cannot rely on analysts' earnings forecasts to compute earnings yields. We use historical earnings instead. Our sample of historical earnings is from Datastream.[27] Specifically, we

[27] Datastream's coverage for Brazil is very poor in the February 1995 to May 1999 time period, averaging less than 10 stocks per month. Coverage jumps from 10 stocks to 237 stocks from May 1999 to June 1999. Because Brazil is a large emerging market, and, along with Mexico, has the longest presence in JP Morgan's EMBI + Index, we complement our Brazilian data set using an additional data source. We obtain monthly MV and PE time series of Brazilian stocks from Economatica and manually link Economatica stock names to Datastream identifiers. This increases our coverage for Brazil from less than 10 stocks per month in the February 1995 to May 1999 period to an average of 174 stocks per month in that period.

follow Bekaert et al. (2010) and use firm-level P/E ratios in Datastream. The earnings yield is the inverse of the P/E ratio. Datastream does not report P/E ratios for firms with negative earnings. We truncate earnings yields at 2% and 50% per year. Table 7 lists the average number of firms per country per month in our sample. On average, our sample has 1,171 EM stocks and 10,911 DEV stocks in a given month.

Datastream P/E ratios use 12-month trailing earnings updated quarterly, half-yearly, or yearly, depending on the country and the time period. The use of trailing earnings creates a mechanical autocorrelation in earnings yields, which requires us to increase the number of lags from 4 to 11 when calculating standard errors that are robust to autocorrelation.

We also need to adjust trailing P/E ratios for past inflation. This is important because some countries had very high inflation during our sample period. The following example explains the need for inflation adjustment. Suppose the current month is March 2001 and the stock price of a given Turkish firm is 1,000 Turkish liras per share. Suppose this firm has earnings per share of 100 Turkish liras in 2000. Therefore, its Datastream P/E ratio as of March 2001 is equal to 10, and its earnings yield is 10% per year. However, inflation in Turkey was 55% in 2000 and 54% in 2001. Therefore, one Turkish lira is worth much less when the stock price is quoted in March 2001 than when firm earnings were realized throughout 2000. Not adjusting for inflation severely underestimates the April/2001 earnings yield of our hypothetical Turkish firm. Thus, we must adjust earnings yields upwards in order to account for inflation. For consistency, we also apply the same type of inflation adjustment to comparable DEV stocks.

We implement the following inflation adjustment. We assume that the firm's earnings are uniformly distributed over time, and that on average there is a 9-month lag between the time when stock prices are quoted and the mid-point of the trailing earnings period. Thus, we need to account for 9 months of past inflation. Since we only have annual CPI inflation data, we assume that inflation is uniformly distributed within each year. For simplicity, we further assume that prices in a quarter are quoted at the end of the quarter. Therefore, for P/E observations in the first quarter, we consider 3 months of inflation in the current year and 6 months of inflation in the past year. For P/E observations in the second quarter, we assume 6 months of inflation in the current year and 3 months of inflation in the past year. For P/E observations in the third and fourth quarters we assume 9 months of inflation in the current year.

Let us apply the aforementioned inflation adjustment to our hypothetical Turkish stock in March 2001. It is the first quarter, so consider 6 months of 2000 inflation and 3 months of 2001 inflation. Since inflation is assumed to be uniformly distributed over time, the adjustment factor is $(1+55\%)^{\frac{6}{12}}(1+54\%)^{\frac{3}{12}} = 1.39$. Therefore, the March 2001 earnings yield of our hypothetical Turkish stock is 13.9% rather than 10% per year.

Maturity-matched risk-free rate

Our maturity-matched risk-free rate is calculated from AAA corporate bonds as opposed to U.S. Treasury bonds. U.S. Treasuries are "too expensive", as they include a convenience yield for a number of reasons (e.g., Feldhutter and Lando, 2008). To find the maturity-matched risk-free rate for each emerging market at each point in time, we linearly interpolate using two nodes. One node uses Barclays Intermediate Term AAA Corporate Bond Index and the other uses Barclays Long Term AAA Corporate Bond Index. We collect the average life and yield-to-maturity data for these indexes from Datastream. The maturity-matched risk-free rate is the (linearly interpolated) average yield in the AAA Corporate Bond Index with the same average life of the emerging market's EMBI+ Index.

Sovereign spreads

Sovereign spreads are calculated by subtracting a U.S. Treasury convenience yield from the EMBI+ stripped yield spread. The data are from Datastream. It is important to use stripped spreads instead of full (i.e., blended) spreads because, especially early in the sample, many emerging market bonds in the JP Morgan EMBI+ Index were partially collateralized by U.S. Treasuries (Claessens and Pennacchi, 1996). Further we need to subtract a U.S. Treasury convenience yield because the stripped yield in Datastream is calculated relative to the U.S. Treasury curve.

The maturity-matched convenience yield is the difference between the maturity-matched risk-free rate using Barclays AAA Corporate Bond Indexes and the maturity-matched rate of the U.S. Treasury curve.[28] We find that the average (median) difference between our preferred AAA Corporate maturity-matched risk-free rates and the Treasury maturity-matched rate is equal to 60 (50) basis points. These values are in the same order of magnitude as the Treasury convenience yields estimated by Longstaff, Mithal, and Neis (2005) and Feldhutter and Lando (2008).

FIGURE 5

[28] We use six nodes to compute the maturity-matched Treasury rate: 2, 5, 7, 10, 20, and 30 years. We use Constant Maturity Yields from the Federal Reserve's website.

Figure 5 illustrates the relation between the (stock-based) Value Discount and the (bond-based) risk-neutral probability of sovereign default. We plot these time series for Brazil. Along with Mexico and Venezuela, Brazil is one of the three countries that has been part of the EMBI+ Index since the Index's inception. The correlation between the Value Discount and Risk-neutral Default Probability for Brazil is 0.86.

6.2 Accounting for other determinants of earnings yield differences

When applying our methodology to Emerging Markets in the 1995-2011 period, one methodological adjustment merits special attention. Unlike Europe in the 2006-2011 period, it is reasonable to think that there can be other major systemic factors (in addition to sovereign default risk) driving cross-country differences in the earnings yields of otherwise comparable firms. Therefore, we must account for these potential additional factors before using our framework. In particular, we need to orthogonalize the Value Discount with respect to the effects of these potential additional factors.[29]

Bekaert, Harvey, Lundblad, and Siegel (2011) show that two factors robustly describe international differences in earnings yields. These factors are the country's Equity Openness and Investment Profile. Equity Openness is the fraction of a country's stock market that is "investable" by foreigners, using International Finance Corporations/Standard and Poor's definition and data. Investment Profile is a variable provided by The Political Risk Group. It is based on experts' assessment of the risk of (equity) expropriation and the imposition of capital or exchange controls. The maximum Investment Profile, corresponding to a country with minimal risk of expropriation or imposition of capital/exchange controls, is equal to 12. We define Investment Profile Gap as the 12 minus the Investment Profile. Bekaert et al. (2011) show that greater Equity Openness and Investment Profile tend to reduce the absolute difference between the earnings yield of EM stocks and the earnings yield of comparable DEV stocks. Panels A and B of Table 8 present summary statistics of Equity Openness, Investment Profile Gap, Value Discount, and other variables.[30]

[29] We are grateful to Stephan Siegel for pointing this out to us, and suggesting a way to address this important issue.

[30] We only have Equity Openness for 1,312 if our 1,666 country-month pairs. This is because Standard & Poor's ceased producing the data for all countries after October 2008. Furthermore, S&P did not produce the data for Colombia and Venezuela after November 2001. For a few countries, Equity Openness is not available before June 1995. We complete the sample for Equity Openness by imputing (i) October 2008 values to months after October 2008, (ii) sample mean of Colombia and Venezuela to months after November 2001, (iii) June 1995 values for months before June 1995 and countries in which the information is missing. We verify that our conclusions are not affected by completing the data in this manner.

TABLE 8

In order to use our framework and compute the prospective cost of sovereign default implied in (stock-based) Value Discounts, we first need to cleanse the potential effects of Equity Openness and Investment Profile Gap out of the Value Discount. To that end, we regress Value Discount onto these variables.[31] Panel C of Table 8 presents our results.

The results in Column (1) of Panel C show that the coefficient on Investment Profile Gap is positive and statistically significant at the 1% level. This indicates that stocks in EM countries with risk of expropriation and imposition of capital/exchange controls trade at a discount relative to the comparable DEV stocks. When we include Equity Openness in Column (2), we find that its coefficient in Equity Openness is negative and statistically insignificant.[32]

In Column (3) we investigate whether Investment Profile Gap and Value Discount are non-linearly related. We find that Investment Profile Gap Squared is statistically significant at 1%, and the R^2 of the regression in Column (3) is larger than the R^2 in Column (3). In an untabulated regression, we include both Investment Profile Gap Squared and Investment Profile Gap as explanatory variables, and find that the coefficient in Investment Profile Gap Squared remains large (drops from 5.527 in Column (3) to 4.996) whereas the coefficient in Investment Profile Gap becomes very small (drops from 0.054 in Column (1) to 0.006). These results indicate that the effect of Investment Profile Gap is better captured in quadratic rather than linear form.

In Column (4) we add Equity Openness and find that the coefficient on Investment Profile Gap Squared remains statistically significant whereas the coefficient on Equity Openness is negative and statistically insignificant. The results in Table 8 show that we need to purge the effect of Investment Profile Gap from the Value Discount, whereas no correction is needed for Equity Openness.

Based on Column (3) of Table 8, Panel C, we define an Adjusted Value Discount that is

[31] Note that Bekaert, Harvey, Lundblad, and Siegel (2011) regress the *absolute value* of differences in earnings yields onto these variables. In contrast, we are interested in VD_t which is a function of differences rather than absolute differences.

[32] In untabulated regression we find that the coefficient in Equity Openness is negative and statistically significant if we remove Investment Profile Gap. However, the economic significance of the coefficient is very small (the R^2 of the regression is just 0.02).

cleansed of the effect of Investment Profile Gap. That is, we define:

$$Adj.VD_t = VD_t - \left(5.527 \times 10^{-3}\right) \times \textit{Investment Profile Gap Squared} \tag{7}$$

Note that $Adj.VD_t$ is just the residual of the regression in Column (3) plus its intercept. Therefore, the correlation between the Adjusted Value Discount and the Investment Profile Gap Squared is equal to zero by construction.

Table 8, Panel A show that the average Adjusted Value Discount in our sample is 0.189, significantly smaller than the average (unadjusted) Value Discount, which is 0.313. Table 8, Panel B shows that the correlation of the Adjusted Value Discount with the risk-neutral default probability is 0.418, significantly smaller than the correlation of the (unadjusted) Value Discount with the default probability (0.637). Both reductions are caused by removing the effect of the Investment Profile Gap Squared on the Value Discount. The reduction in the correlation occurs because the correlations of the (unadjusted) Value Discount with the Investment Profile Gap and the Investment Profile Gap Squared are equal to 0.470 (Table 8, Panel B) and 0.485 (untabulated), respectively.

6.3 Linear regressions

We run regressions of the Adjusted Value Discount onto the risk-neutral probability of sovereign debt. These regressions are analogous to the ones reported for the GIIPS in Panel B of Table 3. Table 9 presents our results.

TABLE 9

Column (1) of Table 9 shows that the coefficient on the Risk-neutral Default Probability is positive and statistically significant at the 1% level. Column (2) shows that the coefficient remains statistically significant when we add EY^{DEV}. Columns (3) and (4) show that the statistical significance of the coefficient on the Risk-neutral Default Probability is robust to the inclusion of country or time (i.e., month/year) fixed effects. Note that the coefficient on the Risk-neutral Default Probability is economically significant in all Columns. The impact of a one standard deviation (*S.D.*) change in the Risk-neutral Default Probability in the Adjusted Value Discount ranges from 0.38 *S.D.* in Column (2) to 0.68 in Column (3).

6.4 Cost of default estimation

We estimate Equation (6) for our Emerging Market's sample. We use the Adjusted Value Discount in place of the (unadjusted) Value Discount, as discussed in the previous sections. Table 10 presents our results. We report Newey-West t-statistics accounting for autocorrelation up to 11 lags in each country.

TABLE 10

Our baseline result for Emerging Markets is in Column (1). We find that the estimate of the prospective cost of default (K_0) is equal to 4.2% per year. This estimate is statistically significant at the 1% level (t-statistics=5.42), and smaller than the one we obtained our baseline GIIPS estimation in Panel A of Table 4 (5.1%). However, the difference is not statistically significant at conventional levels. The K_1 estimate is 0.491, with t-statistics equal to 4.44.

The average error ε_t is -0.009. This average error represents close to 5% of the average Adjusted Value Discount (Table 7, Panel A). Recall that the average error in the baseline GIIPS estimation was below 0.001. The standard deviation of the error term of the Emerging Markets' estimation is 0.201, more than two times larger than the 0.089 standard deviation in the baseline GIIPS estimation. We can reject the assumption of error normality.[33]

Perhaps it is not surprising that the fit of EM estimation is worse than the fit of the GIIPS estimation. Compared to the GIIPS case, the Emerging Market estimation face additional sources of measurement error. For example, there are measurement errors because EM countries do not have the same accounting standards as DEV countries in our sample, unlike the GIIPS case in which accounting rules are homogenous. As discussed before, all European firms report their earnings according to IFRS standards since the fiscal year 2005. Moreover, data limitations prevent the use of analysts earnings forecasts for our emerging market sample. Last, but not the least, stripping out of the effect of Investment Profile Gap is indispensable but may add measurement errors.

Columns (2) to (5) of Table 10 present sensitivity analyses for the EM sample. In all Columns we obtain results that are close to our baseline result in Column (1). In Column (2) we drop the countries with less than 100 stocks per month on average (Argentina, Colombia, Egypt, Peru, and Venezuela). This could reduce measurement error in the Value Discounts,

[33] Therefore, our estimation should be interpreted as quasi-maximum likelihood.

because Value Discounts are measured with more noise for these countries (as we average across a smaller number of stocks). On the other hand, this could reduce power because the sample size drops from 1,666 to 1,112 country-month observations. In principle, the net effect in terms of model fit is unclear. We find that the K_0 and K_1 estimates in Column (2) are 4.6% per year and 0.449, respectively. Both remain statistically significant at the 1% level, and close to the baseline result. The model fit improves compared to Column (1), as the average error is closer to zero, the standard deviation of the error declines, the correlation between fitted and actual Value Discounts increase, and deviations from normality are smaller (i.e., there is an untabulated reduction in excess skewness and kurtosis).

In Columns (3) and (4) we focus on the top 5 and top 3 countries in terms of market capitalization, respectively. The top 3 countries are Brazil, Russia, and South Africa. In addition to these, the top 5 countries include Mexico and Turkey. To the extent that these countries have deeper and more developed capital markets, their market valuations should deviate less from the "efficient" valuations, and this could reduce measurement error. However, the sample size drops 1,666 country-month observations to 788 and 458 country-month observations, respectively. We find that the K_0 and K_1 estimates remain statistically significant at the 1% in both Column (3) and Column (4). These estimates are 4.1% and 0.336 for the top 5 market cap countries, and 5.2% and 0.406 for the top 3 market cap countries. Compared to Column (1), in both Column (3) and (4) the correlation between fitted and actual Value Discounts increase, average errors are closer to zero, and standard deviation of errors are smaller. We cannot reject the null hypothesis of error normality for the top 3 countries' estimation.

Finally, in Column (5) we only use the three countries that have complete time series, that is, countries that are part of the EMBI+ Index from February 1995 to January 2011. These countries are Brazil, Mexico, and Venezuela. Compared to the baseline Column (1), the sample size drops from 1,666 to 576. We find that the K_0 estimate is equal to 3.7% per year, and is statistically significant at the 1% level. The K_1 estimate is equal to 0.414, and is statistically significant at the 5% level.

Overall, we conclude that the estimates of K_0 and K_1 in our sensitivity analyses are close to the baseline estimates in all cases.

7 Conclusion

There has been little empirical evidence for the existence of sufficiently large costs of sovereign default. Such costs are necessary to explain why countries honor their foreign debt, and thus why foreign borrowing is even possible. In this paper we provide a novel empirical perspective to this debate. Importantly, we depart from measuring realized costs of default, which is challenging due to data limitations and identification issues, and rather focus on prospective long-run costs of default implied by market prices. Market prices allow us to the read the (corporate) cost of default, defined as the sum of a reduction in the average growth rate of corporate earnings and an increase in the equity discount rate following sovereign default.

Using maximum likelihood estimation of a structural valuation equation, we find that the prospective, market-implied costs of sovereign default are economically large. Financial markets assign a cost of default of 5.1% per year for the GIIPS in the January 2006 to March 2011 period. This translates to an expected destruction of 37% of the value of equity capital upon sovereign default. For Emerging Markets in the 1995-2011 period, we find a prospective cost of default equal to 4.2% per year. We further find that the prospective costs of sovereign default are larger for financial firms than for non-financial firms. Among non-financials, we find that the market-implied costs are larger for (i) firms with higher need to tap capital markets, (ii) smaller firms, (iii) firms with lower fraction of sales originating from abroad, and (iv) firms in highly regulated industries.

To the extent that debtor governments share the expectations of financial markets, or fear that these expectations may become self-fulfilling, our results explain why debtor governments sometimes resort to extreme and domestically unpopular measures to avoid defaulting on their foreign debt. Therefore, economists need not assume away debtor countries' benevolence to explain why countries repay their debts, and why foreign borrowing is possible in the first place. This view contrasts with theories in which a country honors its foreign debt because debtor governments cater to local "rentiers" whose interests are more aligned with foreign lenders than with local taxpayers (Guembel and Sussman, 2009; Krugman, 2011a and 2011b). Our results support theories in which sovereign default is costly because it causes protracted domestic banking crises (Gennaioli, Martin, and Rossi, 2011; Brutti, 2011; Basu, 2009) and results in a loss of overall government credibility (Cole and Kehoe, 1998; Sandleris, 2008).

Appendix A: Proofs

Proposition 1.

Consider riskless debt of a given vintage, paying $c > 0$ at an exponentially declining rate $m = \frac{1}{L}$. The value of this debt is

$$B_t^{riskless} = E_t[\int_t^{\infty} e^{-r(s-t)} e^{-m(s-t)} c \, ds] = \frac{c}{r+m}.$$

Let the value of GIIPS debt be B_t. By definition, the sovereign spread S_t is such that $B_t = \frac{c}{r+S_t+m}$. On the other hand, by definition of the risk-neutral default probability, we must have:

$$B_t = \frac{c}{r+m} - Q_t (1-R) \frac{c}{r+m}$$

Therefore, from the two equations for B_t we get:

$$\frac{c}{r+S_t+m} = \frac{c}{r+m} - Q_t (1-R) \frac{c}{r+m}$$

, which solving for Q_t and using $m = \frac{1}{L}$ yields the equation (1) in the text:

$$Q_t = \frac{S_t}{(1-R)\left(S_t + r + \frac{1}{L}\right)}$$

Proposition 2 (Formal Derivation).

Take Equation (5) in Andrade (2009). Consider that the acronyms EM and DEV denote GIIPS and REU respectively. Then make $\eta = 0$, $r + \lambda \rho_x \overline{\sigma_x} = \overline{d}$, $\frac{\overline{c}}{c} = R$, and $\frac{\alpha}{\beta} = K_1$ to obtain:

$$\frac{1}{EY_t^{GIIPS}} = \frac{1}{(r + \lambda \rho_x \sigma_x - \mu_x)\left(\overline{d} - \overline{\mu_x}\right)} \left(\overline{d} - \overline{\mu_x} - \left[\frac{S_t}{(1-R)(S_t + r + m)} \right]^{K_1} \left[\overline{d} - \overline{\mu_x} + \mu_x - \overline{\mu_x} \right] \right)$$

Now substitute $EY^{REU} = d - \mu_x$ and $K_0 = \left(\overline{d} - d\right) + \left(\mu_x - \overline{\mu_x}\right)$ in the equation above to get:

$$\begin{aligned} \frac{1}{EY_t^{GIIPS}} &= \frac{1}{EY^{REU}} \frac{\overline{d} - \overline{\mu_x} - \left[\frac{S_t}{(1-R)(S_t+r+m)}\right]^{K_1} K_0}{\left(\overline{d} - \overline{\mu_x}\right)} \\ &= \frac{1}{EY^{REU}} \left(1 - \left[\frac{S_t}{(1-R)(S_t + r + m)} \right]^{K_1} \frac{K_0}{\overline{d} - \overline{\mu_x}} \right) \end{aligned}$$

Note that $\overline{d} - \overline{\mu_x} = EY^{REU} + K_0$. Substituting this in the equation above gives:

$$\frac{1}{EY_t^{GIIPS}} = \frac{1}{EY^{REU}} \left(1 - \left[\frac{S_t}{(1-R)(S_t + r + m)} \right]^{K_1} \frac{K_0}{EY^{REU} + K_0} \right)$$

Re-arrange terms in the equation above to get:

$$1 - \frac{EY^{REU}}{EY_t^{GIIPS}} = \frac{K_0}{EY^{REU} + K_0} \left[\frac{S_t}{(1-R)(S_t + r + m)} \right]^{K_1}.$$

Using the equation for Q_t in Proposition 1, and the our definition $VD_t \equiv 1 - \frac{EY^{REU}}{EY_t^{GIIPS}}$, we obtain Equation (4) in the text:

$$VD_t = \frac{K_0}{EY^{REU} + K_0} Q_t^{K_1}.$$

Proposition 2 (Heuristic Derivation).

To aid intuition, let's start reviewing the role of the bond-based risk-neutral probability of default Q_t in bond pricing. Let the value of a risk-free debt be denoted by $B_t^{riskless}$. The value of risky sovereign debt is:

$$B_t = B_t^{riskless} \left[1 - (1-R) Q_t \right]$$

Now consider an equivalent stock-based rather than bond-based equation. We will find the "stock-equivalent" of each of the objects B_t, $B_t^{riskless}$, $(1-R)$, and Q_t in the bond-based equation.

First, on the left-hand side of the equation we have the price of the GIIPS stock in place of B_t. Normalizing by earnings, the left-hand side has the inverse of GIIPS earnings yield, i.e., $\frac{1}{EY_t^{GIIPS}}$. Instead of $B_t^{riskless}$, we have the price of a stock not subject to sovereign default risk, that is, the price of a comparable REU stock. Normalizing by earnings, this price is the inverse of the earnings yield, $\frac{1}{EY^{REU}}$.

Second, instead of the recovery rate upon default R, the stock-based equation has the GIIPS stock price at default divided by the comparable REU stock at default. Normalizing by earnings, the price of the GIIPS stock upon sovereign default is $\frac{1}{EY^{GIIPS}} = \frac{1}{\underline{d} - \overline{\mu_x}}$. The normalized price of the comparable REU stock is $\frac{1}{EY^{REU}} = \frac{1}{d - \mu_x}$. Therefore, we obtain the ratio $\frac{d-\mu_x}{\overline{d}-\overline{\mu_x}}$ in place of R. Note that we can write:

$$\overline{d}-\overline{\mu_x}=d-\mu_x+\left(\overline{d}-d\right)+\left(\mu_x-\overline{\mu_x}\right)=EY^{REU}+K_0$$

After some algebra, we get $\frac{K_0}{EY^{REU}+K_0}$ in the stock-based equation in place of $(1-R)$ in the bond-based equation.

Finally, we need to move from the bond-based risk-neutral default probability Q_t to a stock-based risk-neutral default probability. Andrade (2009) shows that raising Q_t to the power of K_1 (defined in Equation (5)) is the correct adjustment given the model assumptions. That is, the stock-based equation has $Q_t^{K_1}$ in place of Q_t.

Collecting what we have thus far:

$$\begin{array}{ll} \textit{Bond Equation}: & B_t=B_t^{riskless}\left[1-(1-R)\,Q_t\right] \\ \textit{Stock Equation}: & \frac{1}{EY_t^{GIIPS}}=\frac{1}{EY^{REU}}\left[1-\frac{K_0}{EY^{REU}+K_0}Q_t^{K_1}\right] \end{array}$$

Re-arranging the Stock Equation gives Equation (4) in the text:

$$1-\frac{EY^{REU}}{EY_t^{GIIPS}}=\frac{K_0}{EY_t^{REU}+K_0}Q_t^{K_1}.$$

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<u>Table 1</u> Sample Coverage for the GIIPS sample

Our sample has 5 GIIPS countries and 10 REU countries. Data are monthly and the sample period is from January 2006 to March 2011. Stocks that are both in I/B/E/S and in Datastream are included in the sample. For each country we report the time series average of the number of stocks, the market capitalization in US$ billion, and the sample coverage in terms of fraction of total market capitalization in Datastream.

Country	Group	Average number of stocks	Average Market Cap (US$ bi)	Fraction of Datastream's Mkt Cap
Greece	GIIPS	68	132	0.87
Ireland	GIIPS	36	84	0.90
Italy	GIIPS	173	699	0.91
Portugal	GIIPS	33	93	0.98
Spain	GIIPS	94	773	0.97
TOTAL	GIIPS	404	1781	0.93
Austria	REU	45	129	0.87
Belgium	REU	74	258	0.90
Denmark	REU	67	158	0.77
France	REU	346	1903	0.91
Germany	REU	372	1276	0.89
Netherlands	REU	90	605	0.91
Norway	REU	112	237	0.85
Sweden	REU	159	390	0.82
Switzerland	REU	158	920	0.85
United Kingdom	REU	961	2839	0.98
TOTAL	REU	2385	8715	0.91

Table 2 Summary Statistics for the GIIPS sample

The table reports summary statistics for our main variables. The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined in the equations below. EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, recovery ratio, risk-free rate, and average debt maturity, respectively. Data are monthly and the sample period is from January 2006 to March 2011.

$$VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}} \qquad Q = \frac{S}{(1-R)(S+r+1/L)}$$

Panel A

	EY^{GIIPS}	EY^{REU}	Value Discount	Sovereign Spread	Average Maturity	Risk-Free Rate	Recovery Rate	Risk-neutral Def. Prob.
Mean	0.094	0.087	0.058	0.011	8.434	0.035	0.395	0.098
Median	0.090	0.083	0.049	0.004	8.279	0.037	0.400	0.047
Std Dev	0.021	0.013	0.106	0.017	1.004	0.007	0.027	0.129
N	315	315	315	315	315	315	315	315

Panel B

	EY^{GIIPS}	EY^{REU}	Value Discount	Sovereign Spread	Average Maturity	Risk-Free Rate	Recovery Rate	Risk-neutral Def. Prob.
EY^{GIIPS}	1							
EY^{REU}	0.871	1						
Value Discount	0.772	0.389	1					
Sovereign Spread	0.342	0.122	0.494	1				
Average Maturity	0.100	0.162	0.026	-0.351	1			
Risk-Free Rate	-0.297	-0.167	-0.377	-0.664	0.286	1		
Recovery Rate	0.186	0.137	0.189	0.329	-0.092	-0.255	1	
Risk-neutral Def. Prob.	0.405	0.185	0.537	0.985	-0.300	-0.737	0.358	1

Table 3 Linear Regressions for the GIIPS sample

Panels A and B report the results of linear regressions of the (stock-based) Value Discount onto explanatory variables in Equation (6). The Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined in the equations below. EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, recovery ratio, risk-free rate, and average debt maturity, respectively. Data are monthly and the sample period is from January 2006 to March 2011. We report Driscoll-Kraay standard errors grouped by country and with 4 lags in parentheses below coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$\boldsymbol{VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}}} \qquad \boldsymbol{Q = \frac{S}{(1-R)(S + r + 1/L)}}$$

Panel A

	Independent Variable: Value Discount				
	(1)	(2)	(3)	(4)	(5)
Sovereign Spread	3.021 ***	2.771 ***	2.925 ***	2.197 ***	3.779 ***
	(0.569)	(0.391)	(0.516)	(0.581)	(0.861)
Average Maturity			0.017 ***	0.019	-0.003
			(0.006)	(0.013)	(0.008)
Risk-Free Rate			-0.894	-1.985	21.162
			(1.100)	(1.466)	(21.861)
Recovery Rate			-0.035	0.131	-0.216
			(0.183)	(0.183)	(0.146)
		2.789 ***	2.474 ***	2.070 ***	11.331 ***
		(0.685)	(0.693)	(0.679)	(2.913)
Constant	0.025 **	-0.214 ***	-0.286 ***		
	(0.012)	(0.058)	(0.076)		
Country Fixed Effects	No	No	No	Yes	No
Time Fixed Effects	No	No	No	No	Yes
R^2	0.24	0.35	0.38	0.59	0.53
N	315	315	315	315	315

Panel B

	Independent Variable: Value Discount			
	(1)	(2)	(3)	(4)
Risk-neutral Default Probab.	0.437 ***	0.392 ***	0.360 ***	0.500 ***
	(0.068)	(0.047)	(0.049)	(0.081)
EY^{REU}		2.507 ***	2.127 ***	11.533 ***
		(0.701)	(0.588)	(2.060)
Constant	0.015	-0.198 ***		
	(0.012)	(0.058)		
Country Fixed Effects	No	No	Yes	No
Time Fixed Effects	No	No	No	Yes
R^2	0.37	0.37	0.59	0.54
N	315	315	315	315

Table 4. Cost of Default Estimation for the GIIPS sample

Panels A and B present the results of the maximum likelihood estimation of parameters K_0 and K_1 in the Equation:

$$\boldsymbol{VD} = \frac{\mathbf{K_0}}{\boldsymbol{EY^{REU}} + \mathbf{K_0}} \mathbf{Q}^{\mathbf{K_1}} + \boldsymbol{\varepsilon}$$

The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined in the equations below. EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, the recovery ratio, the risk-free rate, and the average debt maturity, respectively. K_0 is the cost of sovereign default. K_1 is a parameter that translates the bond-based risk-neutral probability into a stock-based risk-neutral probability. Data are monthly and the sample period is from January 2006 to March 2011. Panel A has the baseline estimation. Panel B has the sensitivity analyses. Newey-West t-statistics accounting for autocorrelation up to 4 lags in each country are reported in parentheses below the coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$\boldsymbol{VD} = \mathbf{1} - \frac{\boldsymbol{EY^{REU}}}{\boldsymbol{EY^{GIIPS}}} \qquad \boldsymbol{Q} = \frac{\mathbf{S}}{(\mathbf{1}-\mathbf{R})(\mathbf{S}+\mathbf{r}+\mathbf{1}/\mathbf{L})}$$

Panel A

	Baseline
K_0 (Cost of Default)	0.051 ***
	(3.94)
K_1	0.729 ***
	(5.77)
Average ($VD-VD_{fitted}$)	0.000
Std ($VD-VD_{fitted}$)	0.089
Normality test (*p-value*)	0.57
Corr (VD_{fitted}, VD)	0.54
N	315

Panel B

	2007 to 2011	Median industry EY^{REU}	1-yr fwd Earn. Forecast	t+2 Earn. Forecast	ICB Level 3	ICB Level 5	ICB Level 4 + Leverage terciles	ICB Level 4 + BTM terciles	ICB Level 4 + Size terciles
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
K_0 (Cost of Default)	0.043 ***	0.067 ***	0.045 ***	0.072 ***	0.054 ***	0.042 ***	0.034 ***	0.032 ***	0.042 ***
	(3.93)	(5.57)	(3.69)	(5.07)	(3.93)	(3.95)	(3.93)	(3.38)	(4.00)
K_1	0.616 **	0.444 ***	0.730 ***	0.722 ***	0.757 ***	0.682 ***	0.423 ***	0.540 ***	0.658 ***
	(5.11)	(8.92)	(5.22)	(7.98)	(5.71)	(5.90)	(4.89)	(4.21)	(5.77)
Average ($VD-VD_{fitted}$)	0.002	0.006	-0.001	0.003	0.000	-0.001	0.008	0.009	0.004
Std ($VD-VD_{fitted}$)	0.091	0.083	0.094	0.079	0.091	0.076	0.100	0.097	0.088
Normality test (*p-value*)	0.58	0.02	0.16	0.36	0.42	0.01	0.06	0.04	0.49
Corr (VD_{fitted}, VD)	0.49	0.64	0.51	0.62	0.54	0.55	0.40	0.32	0.48
N	255	315	315	315	315	315	315	315	315

Table 5. Market reaction to the May 2010 rescue package announcement

The table presents one-day market reactions to the May 10, 2010 to the announcement of a rescue package for distressed European countries. Data are from daily J.P. Morgan Global Bond Indexes and daily Datastream ICB Level 4 Industry indices. The the (bond-based) Risk-neutral Default Probability Q is defined as in the equation below. Stock returns are value-weighted. The net stock return in the GIIPS countries is defined as their value-weighted stock return minus the corresponding value-weighted average of stock returns in comparable REU stocks, using GIIPS value-weights. The model-implied stock return is calculated for each GIIPS country is calculated as $[(1\text{-}VD_{after})/(1\text{-}VD_{before})] - 1$, using the VD as in the equation below, the K_0 and K_1 parameter estimates in Panel A of Table 4, and the average EY^{REU} in April and May month-ends.

$$Q = \frac{\mathbf{S}}{(\mathbf{1}-\mathbf{R})(\mathbf{S}+\mathbf{r}+\mathbf{1}/\mathbf{L})} \qquad VD = \frac{\mathbf{K_0}}{EY^{REU}+\mathbf{K_0}}\mathbf{Q}^{\mathbf{K_1}}$$

Country	Δ Spread	Δ Risk-neutral default prob.	Initial Level Risk-neutral default prob.	Stock return	Stock return net of REU comparables
Greece	-504	-0.29	0.85	0.090	0.013
Ireland	-123	-0.09	0.31	0.077	0.017
Italy	-49	-0.05	0.19	0.097	0.030
Portugal	-175	-0.13	0.36	0.101	0.044
Spain	-64	-0.06	0.19	0.128	0.061
				Average	0.033
				Model-implied average	0.058
				(t-stat)	(4.30)

<u>Table 6</u> Subsample Cost of Default Estimation for the GIIPS sample

The table reports the results of the maximum likelihood estimation of parameters K_0 and K_1 in the Equation:

$$VD = \frac{\mathbf{K_0}}{EY^{REU} + \mathbf{K_0}} \mathbf{Q}^{\mathbf{K_1}} + \boldsymbol{\varepsilon}$$

The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined in the equations below. EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, the recovery ratio, the risk-free rate, and the average debt maturity, respectively. K_0 is the cost of sovereign default. K_1 is a parameter that translates the bond-based risk-neutral probability into a stock-based risk-neutral probability. Data are monthly and the sample period is from January 2006 to March 2011. Newey-West t-statistics accounting for autocorrelation up to 4 lags in each country are reported in parentheses below the coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}} \qquad Q = \frac{\mathbf{S}}{(\mathbf{1}-\mathbf{R})(\mathbf{S}+\mathbf{r}+\mathbf{1}/\mathbf{L})}$$

<u>Panel A</u>

	Financials	Non-Financials
	(1)	(2)
K_0 (Cost of Default)	0.077 *	0.053 **
	(1.67)	(2.47)
K_1	0.588 ***	0.868 ***
	(3.11)	(3.45)
Average ($VD-VD_{fitted}$)	0.005	-0.077
Std ($VD-VD_{fitted}$)	0.187	0.182
Normality test (*p-value*)	0.00	0.00
Corr (VD_{fitted}, VD)	0.33	0.25
N	315	315

<u>Panel B</u>

	Net Leverage		Size		Fraction of Sales Abroad		Utility & Telecom	Other Non-financial
	High	Low	High	Low	High	Low		
K_0 (Cost of Default)	0.055	0.037	0.043 **	0.187	0.015 ***	0.136 **	0.240 **	0.040
	(1.38)	(1.47)	(2.15)	(0.53)	(2.64)	(2.38)	(2.03)	(1.58)
K_1	1.077 **	0.654 **	0.786 ***	1.697 **	0.274 **	0.903 ***	1.153 ***	0.963 *
	(2.24)	(2.41)	(3.12)	(2.073)	(2.09)	(5.98)	(5.89)	(1.89)
Average ($VD-VD_{fitted}$)	-0.023	-0.008	-0.003	-0.118	-0.001	-0.015	-0.025	-0.019
Std ($VD-VD_{fitted}$)	0.152	0.169	0.118	0.249	0.144	0.124	0.124	0.167
Normality test (*p-value*)	0.000	0.001	0.001	0.001	0.416	0.463	0.00	0.00
Corr (VD_{fitted}, VD)	0.40	0.35	0.42	0.42	0.23	0.64	0.64	0.34
N	315	315	315	315	315	315	260	315

<u>Table 7</u> Emerging Markets' Sample Coverage

The table reports summary statistics for our main variables for the sample of emerging countries (EMBI+) and developed countries (DEV) . Data are monthly and the sample period is from February 1995 to January 2011. For each country we report the number of months in which it is part of the sample, the sample period, the average number of stocks per month. The presence of the EM in the sample is determined by its presence in JP Morgan's EMBI+ Bond Index in Datastream. We report the average number of stocks conditional on being part of the sample.

Country	Sample	Average number of stocks	Sample Period
Argentina	EMBI+	51	Feb/95-Dec/01
Brazil	EMBI+	278	Feb/95-Jan/11
Colombia	EMBI+	34	Jun/99-Dec/06
Egypt	EMBI+	72	Jun/02-May/08
Malaysia	EMBI+	529	Feb/02-Jan/05
Mexico	EMBI+	108	Feb/95-Jan/11
Peru	EMBI+	67	Apr/97-Dec/06
Philippines	EMBI+	133	May/99-Jan/11
Poland	EMBI+	110	Aug/95-Apr/07
Russia	EMBI+	106	May/98-Jan/11
South Africa	EMBI+	277	May/02-Jan/11
Turkey	EMBI+	205	Aug/99-Jan/11
Venezuela	EMBI+	17	Feb/95-Jan/11
TOTAL	EMBI+	1171	Feb/95-Jan/11
Australia	DEV	564	Feb/95-Jan/11
Austria	DEV	74	Feb/95-Jan/11
Belgium	DEV	111	Feb/95-Jan/11
Canada	DEV	552	Feb/95-Jan/11
Denmark	DEV	167	Feb/95-Jan/11
France	DEV	623	Feb/95-Jan/11
Germany	DEV	460	Feb/95-Jan/11
Japan	DEV	2595	Feb/95-Jan/11
Netherlands	DEV	131	Feb/95-Jan/11
Norway	DEV	126	Feb/95-Jan/11
Singapore	DEV	366	Feb/95-Jan/11
Sweden	DEV	226	Feb/95-Jan/11
Switzerland	DEV	196	Feb/95-Jan/11
United Kingdom	DEV	1148	Feb/95-Jan/11
United States	DEV	3572	Feb/95-Jan/11
TOTAL	DEV	10911	Feb/95-Jan/11

Table 8 Summary Statistics for the Emerging Markets' sample

Panel A and B reports summary statistics for our main variables. Panel C has results of linear regressions of the Value Discount onto explanatory variables The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined in the equations below. The Adjusted Value Discount is defined in Equation (7).EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, recovery ratio, risk-free rate, and average debt maturity, respectively. Investment Profile Gap is 12 minus PRG's Investment Profile. Equity Openness is the fraction of domestic market cap that is investable by foreign investors. Data are monthly and the sample period is from February 1995 to January 2011. Standard errors are in parentheses below the coefficient estimates. We report Driscoll-Kraay standard errors grouped by country and with 11 lags below the coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$\boldsymbol{VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}}} \qquad \boldsymbol{Q = \frac{S}{(1 - R)(S + r + 1/L)}}$$

Panel A

	EY^{EMBI}	EY^{DEV}	Value Discount	Adj. Value Discount	Risk-neutral Def. Prob.	Investment Profile Gap	Equity Openness
Mean	0.109	0.064	0.313	0.189	0.273	4.139	0.872
Median	0.092	0.063	0.321	0.207	0.239	4.000	0.944
Std Dev	0.058	0.014	0.263	0.230	0.198	2.294	0.147
N	1666	1666	1666	1666	1666	1666	1666

Panel B

	EY^{EMBI}	EY^{DEV}	Value Discount	Adj. Value Discount	Risk-neutral Def. Prob.	Investment Profile Gap	Equity Openness
EY^{EMBI}	1						
EY^{DEV}	0.266	1					
Value Discount	0.722	-0.252	1				
Adj. Value Discount	0.493	-0.301	0.871	1			
Risk-neutral Def. Prob.	0.531	-0.210	0.637	0.418	1		
Investment Profile Gap	0.545	0.008	0.470	-0.002	0.575	1	
Equity Openness	-0.092	0.084	-0.105	-0.056	-0.191	-0.145	1

Table 8. Continued

Panel C

	Independent Variable: Value Discount			
	(1)	(2)	(3)	(4)
Investment Profile Gap	0.054 ***	0.053 ***		
	(0.005)	(0.005)		
Investment Profile Gap Squared (÷1,000)			5.527 ***	5.463 ***
			(0.475)	(0.501)
Openness		-0.068		-0.088
		(0.092)		(0.089)
Constant	0.090 *	0.152	0.189 ***	0.268 **
	(0.043)	(0.103)	(0.038)	(0.093)
R^2	0.22	0.22	0.24	0.24
N	1666	1666	1666	1666

<u>Table 9</u> Linear Regressions for the Emerging Markets' sample

The table reports the results of linear regressions of the (stock-based) Adjusted Value Discount onto explanatory variables. The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined below. The Adjusted Value Discount is defined in Equation (7). EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, recovery ratio, risk-free rate, and average debt maturity, respectively. Data are monthly and the sample period is from February 1995 to January 2011. The Value Discount is the independent variable in both panels. Standard errors are in parentheses below the coefficient estimates. We report Driscoll-Kraay standard errors grouped by country and with 11 lags below the coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$\boldsymbol{VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}}} \qquad \boldsymbol{Q = \frac{S}{(1-R)(S+r+1/L)}}$$

	Independent Variable: Adjusted Value Discount			
	(1)	(2)	(3)	(4)
Risk-neutral Default Probability	0.489 ***	0.435 ***	0.793 ***	0.759 ***
	(0.074)	(0.071)	(0.101)	(0.066)
EY^{DEV}		-3.695 **	-0.532	-3.931 **
		(1.422)	(1.922)	(1.626)
Constant	0.056 *	0.307 ***		
	(0.030)	(0.095)		
Country Fixed Effects	No	No	Yes	No
Time Fixed Effects	No	No	No	Yes
R^2	0.18	0.23	0.47	0.53
N	1666	1666	1666	1666

Table 10 **Cost of Default Estimation for the Emerging Markets' Sample**

The table reports the results of the maximum likelihood estimation of the parameters K_0 and K_1 in the Equation

$$\mathbf{Adj.VD} = \frac{\mathbf{K_0}}{\mathbf{EY^{REU}} + \mathbf{K_0}} \mathbf{Q^{K_1}} + \boldsymbol{\varepsilon}$$

The (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q are defined below. Adj. VD is the (stock-based) Adjusted Value Discount defined in Equation (6). EY^{GIIPS} is the value-weighted earnings yield in GIIPS countries, and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. S, R, r, and L are the sovereign spread, the recovery ratio, the risk-free rate, and the average debt maturity, respectively. K_1 is the parameter that translates the bond-based risk-neutral probability into a stock-based risk-neutral probability. The sample has Emerging Markets in the Feb/1995-Jan/2011 period. Panel A has the baseline estimation. Panel B has sensitivity analyses. Newey-West t-statistics accounting for autocorrelation up to 4 lags in each country are reported in parentheses below the coefficient estimates. ***, **, * denote significance at the 1%, 5% and 10% respectively.

$$\boldsymbol{VD = 1 - \frac{EY^{REU}}{EY^{GIIPS}}} \qquad \boldsymbol{Q = \frac{S}{(1-R)(S+r+1/L)}}$$

	All EMBI+	At least 100 stocks (avg)	Top 5 Mkt Cap	Top 3 Mkt Cap	Complete time series only
	(1)	(2)	(3)	(4)	(5)
K_0 (Cost of Default)	0.042 ***	0.046 ***	0.041 ***	0.052 ***	0.037 ***
	(5.42)	(4.13)	(4.46)	(3.67)	(4.43)
K_1	0.491 ***	0.449 ***	0.336 ***	0.406 ***	0.414 **
	(4.44)	(3.88)	(3.27)	(2.87)	(2.39)
Average ($VD-VD_{fitted}$)	-0.009	-0.005	-0.004	-0.002	-0.007
Std ($VD-VD_{fitted}$)	0.201	0.185	0.180	0.185	0.172
Normality test (*p-value*)	0.00	0.00	0.00	0.13	0.00
Corr (VD_{fitted}, VD)	0.50	0.52	0.52	0.54	0.55
N	1666	1112	788	458	576

Appendix B

<u>Table B.1</u> Industry Coverage for the GIIPS sample

The table show how our I/B/E/S - Datastream sample coverage compares to all stocks in Datastream. We report the time series average of the market capitalization weights of each of 39 industries. The industry definition is based on ICB level 4 classification. Data are monthly and the sample period is from January 2006 to March 2011.

	GREECE		IRELAND		ITALY		PORTUGAL		SPAIN		REST OF EUROPE	
Industry (Level 4)	Datastream	Sample	Datastream	Sample	Datastream	Sample	Datastream	Sample	Datastream	Sample	Datastream	Sample
Oil & Gas Producers	4.02	4.64	3.86	3.88	15.83	16.44	11.26	11.39	6.54	6.77	8.94	8.43
Oil Equipment, Services & Distribution					1.92	2.10					0.97	0.72
Chemicals	0.65	0.07			0.15	0.06	0.06	0.00	0.15	0.13	3.19	3.39
Forestry & Paper				-5.57			3.94	4.01	0.27	0.28	0.15	0.10
Industrial Metals & Mining	2.50	2.54			0.05	0.05	0.05	0.02	0.85	0.87	1.40	1.48
Mining	0.25	0.29	0.72	0.55	0.01	0.00					3.33	3.61
Construction & Materials	5.41	5.37	23.67	26.31	2.48	1.82	8.78	8.79	7.43	7.61	2.53	2.53
Aerospace & Defense					1.30	1.43					1.17	1.28
General Industrials	1.62	1.45	2.08	2.22	0.47	0.46	0.43	0.40	0.08	0.08	1.55	1.67
Electronic & Electrical Equipment	0.07	0.00			0.67	0.66	0.01	0.00			0.88	0.91
Industrial Engineering	1.25	1.17			0.56	0.50			1.35	1.37	2.79	2.73
Industrial Transportation	0.60	0.63			3.03	3.22	6.56	6.49	3.21	2.67	1.84	1.34
Support Services	0.17	0.02	4.72	5.23	0.11	0.06	0.02	0.00	0.43	0.35	1.79	1.87
Automobiles & Parts					3.53	3.55	0.31	0.00	0.10	0.10	2.52	2.72
Beverages	7.01	8.09	2.18	2.16	0.38	0.00	0.15	0.14	0.10	0.00	2.32	2.39
Food Producers	2.54	0.73	9.49	10.46	0.78	0.00	0.09	0.00	1.01	0.80	4.62	4.21
Household Goods & Home Construction	1.03	0.83	0.59	0.54	0.39	0.40	0.02	0.00	0.07	0.03	0.98	1.04
Leisure Goods	0.93	1.04			0.03	0.02					0.46	0.49
Personal Goods	1.31	0.76			3.18	3.39			0.03	0.03	2.61	2.70
Tobacco	0.19	0.01							0.85	0.85	1.08	1.18
Health Care Equipment & Services	0.97	0.99	1.77	1.59	0.27	0.28			0.09	0.07	1.20	1.23
Pharmaceuticals & Biotechnology	0.88	0.86	6.40	4.06	0.41	0.44	0.02	0.00	1.04	1.07	7.57	6.85
Food & Drug Retailers	0.44	0.00	1.33	1.47	0.08	0.00	8.85	9.05			1.94	1.96
General Retailers	1.27	1.08			0.47	0.50	0.38	0.38	4.47	4.63	1.73	1.83
Media	0.75	0.27	1.46	1.66	2.58	2.67	4.18	4.28	1.63	1.67	2.53	2.54
Travel & Leisure	10.32	10.49	12.84	13.94	1.31	1.29	0.49	0.25	1.03	1.03	1.64	1.70
Fixed Line Telecommunications	6.62	7.60	0.34	0.36	5.28	4.36	12.39	12.66	14.01	14.45	2.07	2.20
Mobile Telecommunications	2.44	2.53			0.07	0.07	1.34	1.37	0.93	0.83	2.85	3.12
Electricity	4.47	5.14			9.73	10.68	17.91	18.28	15.03	15.33	2.65	2.67
Gas, Water & Multiutilities	0.91	1.06			4.27	4.57			3.46	3.48	3.98	4.13
Banks	35.23	37.21	23.81	20.34	27.36	28.09	22.07	22.02	27.80	28.33	12.56	13.03
Nonlife Insurance	0.35	0.21	0.89	1.01	7.79	8.12	0.04	0.00	1.55	1.60	3.41	3.54
Life Insurance			3.14	3.61	1.73	1.87					2.33	2.49
Real Estate Investment & Services	0.98	0.69	0.13	0.10	0.89	0.75	0.04	0.00	2.78	1.75	0.95	0.75
Real Estate Investment Trusts	0.51	0.54									1.34	1.35
Financial Services	3.01	3.05	0.29	0.27	2.32	1.63	0.19	0.17	2.35	2.39	2.63	2.16
Software & Computer Services	0.75	0.23	0.29	0.24	0.30	0.29	0.40	0.28	0.46	0.47	1.78	1.83
Technology Hardware & Equipment	0.51	0.40			0.25	0.21			0.14	0.15	1.33	1.39
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100

Appendix B.

Table B.2. Placebo GIIPS samples

The table reports results of linear regressions and maximum likelihood estimation of a placebo sample created for each GIIPS. At each point in time, each firm in the GIIPS sample is matched to a REU firm with similar size and net leverage or similar size and book-to-market ratio. We repeat the tests in Table 3 and Table 4 using the placebo sample. Panel A has linear regressions of the Value Discount (comparable to Table 3 Panel A) and Panel B has the maximum likelihood estimation of the cost of sovereign default (comparable to Table 4 Panel B). Below coefficient estimates, we report Driscoll-Kraay standard errors grouped by country and with 4 lags in Panel A and Newey-West t-statistics grouped by country and with 4 lags in Panel B. ***, **, * denote significance at the 1%, 5% and 10% respectively.

Panel A

	Independent Variable: Value Discount							
	Placebo sample matched on Size and Leverage				Placebo sample matched on Size and BTM			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
EY^{REU}		-1.957	-2.651	-4.985 *		0.435	0.791	-8.882 **
		(2.649)	(2.832)	(2.056)		(0.996)	(0.957)	(2.407)
Risk-neutral Default Probab.	-0.310	-0.264	-0.151	-0.168	0.082	0.071	0.054	-0.124
	(0.229)	(0.236)	(0.235)	(0.343)	(0.118)	(0.117)	(0.089)	(0.227)
Constant	-0.110 **	0.059			-0.072 **			
	(0.035)	(0.211)			(0.017)			
Country Fixed Effects	No	No	Yes	No	No	Yes	No	No
Time Fixed Effects	No	No	No	Yes	No	No	Yes	Yes
R^2	0.03	0.04	0.14	0.40	0.01	0.01	0.29	0.19
N	315	315	315	315	315	315	315	315

Panel B

	Placebo samples matched on:	
	Size and Leverage	Size and BTM
	(1)	(2)
K_0 (Cost of Default)	-0.018 ***	-0.002
	(2.79)	(-0.87)
K_1	0.229	0.000
	(1.56)	(0.00)
Average ($VD-VD_{fitted}$)	-0.015	-0.037
Std ($VD-VD_{fitted}$)	0.241	0.140
Normality test (*p-value*)	0.000	0.097
Corr (VD_{fitted}, VD)	0.03	0.09
N	315	315

Figure 1.

This figure shows Argentina's real GDP per capita (1993 prices) and net barter terms of trade index from 1998 to 2007. The net barter terms of trade Index is calculated as the ratio of the export prices index to the import prices index, normalized to 100 in the base year of 2000. Argentina's sovereign default took place in early January 2002.

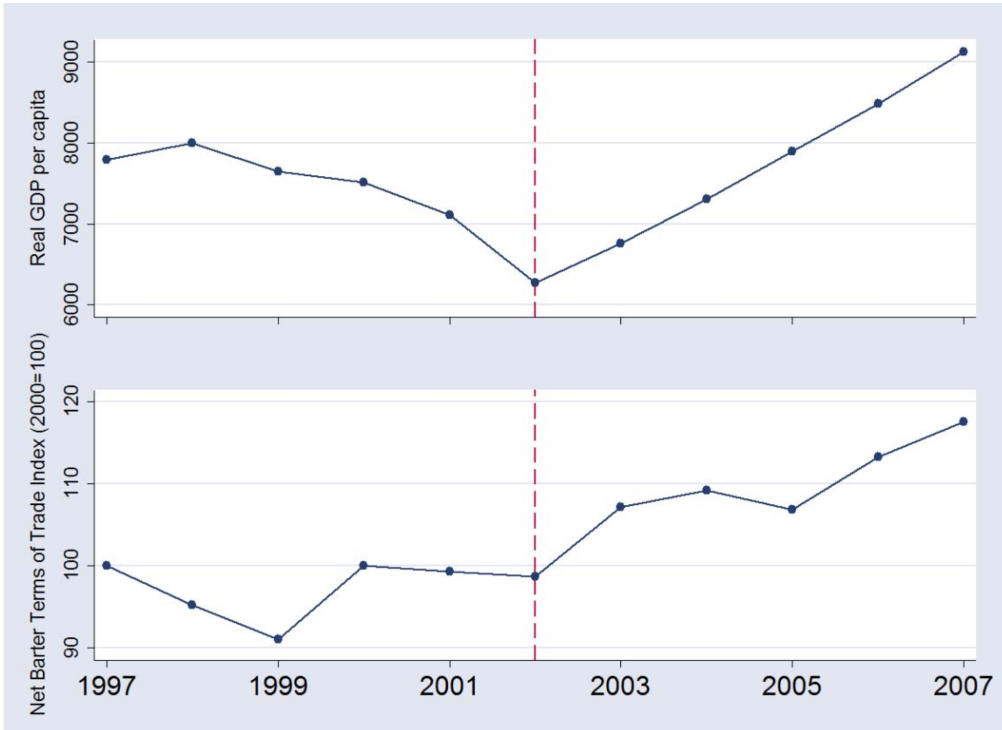

Figure 2.

This picture illustrates the effect of changing model parameters. The x-axis has the Risk-Neutral Default Probability and y-axis has the Value Discount. In both panels, EY^{REU} is fixed at 0.08. The left panel fixes K_1=0.75 and varies K_0. The right panel fixes K_0=0.04 and varies K_1. The equation connecting the (stock-based) Value Discount VD and the (bond-based) Risk-neutral Default Probability Q is $VD = \frac{K_0}{EY^{REU}+K_0} Q^{K_1}$.

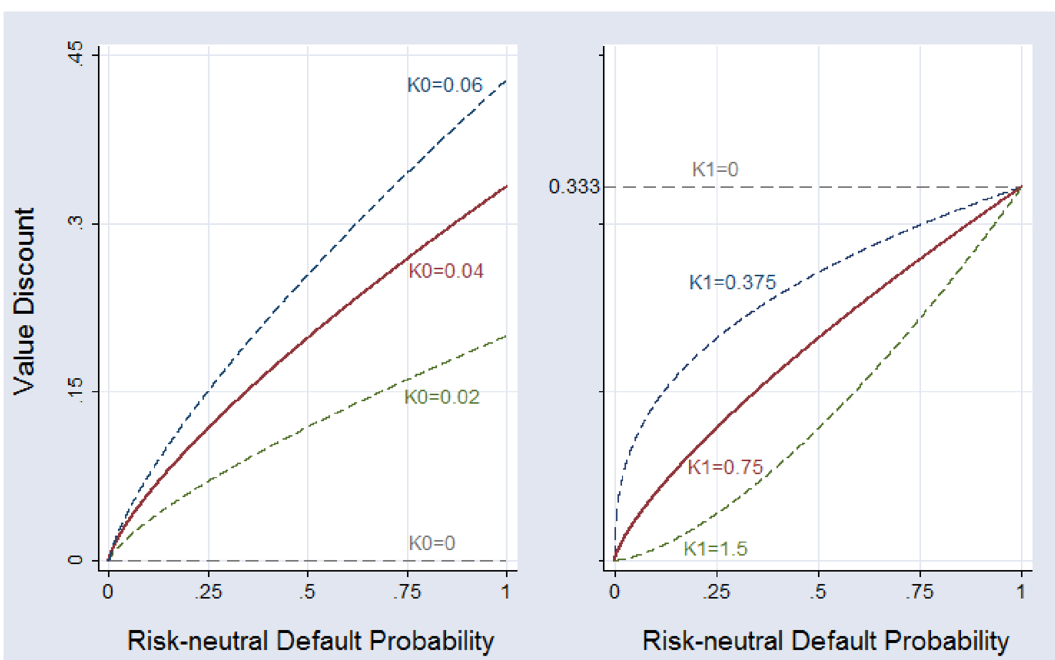

Figure 3.

The first panel shows the time series of GIIPS sovereign spreads from Jan/2006 to Mar/2011. The second panel shows the time series of the (bond-based) Risk-neutral Default Probability. The third panel shows the time series of the average GIIPS Value Discount. For each GIIPS country and each month, the Value Discount is defined $VD=1-EY^{REU}/EY^{GIIPS}$, where EY^{GIIPS} is the value-weighted earnings yield in the GIIPS country and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms. The Average Value Discount is the arithmetic average of Value Discounts of the GIIPS.

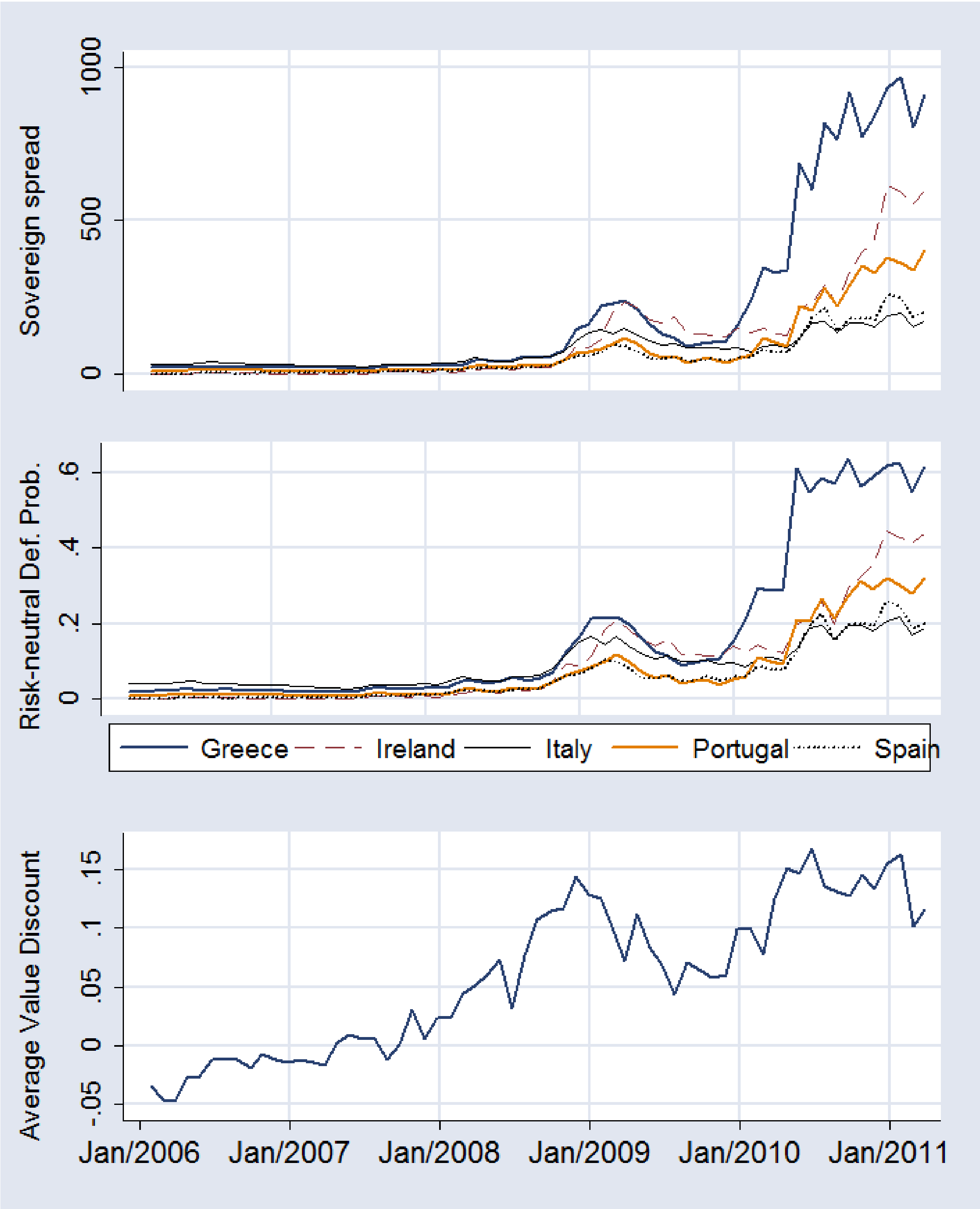

Figure 4.

This picture plots the (stock-based) Value Discount in the y-axis versus the (bond-based) Risk-neutral Default Probability in the x-axis. Data are for the GIIPS countries from Jan/2006 to Mar/2011. For each GIIPS country and each month, the Value Discount is defined $VD=1-EY^{REU}/EY^{GIIPS}$, where EY^{GIIPS} is the value-weighted earnings yield in the GIIPS country and EY^{REU} the corresponding value-weighted earnings yield (using GIIPS weights) of comparable REU firms.

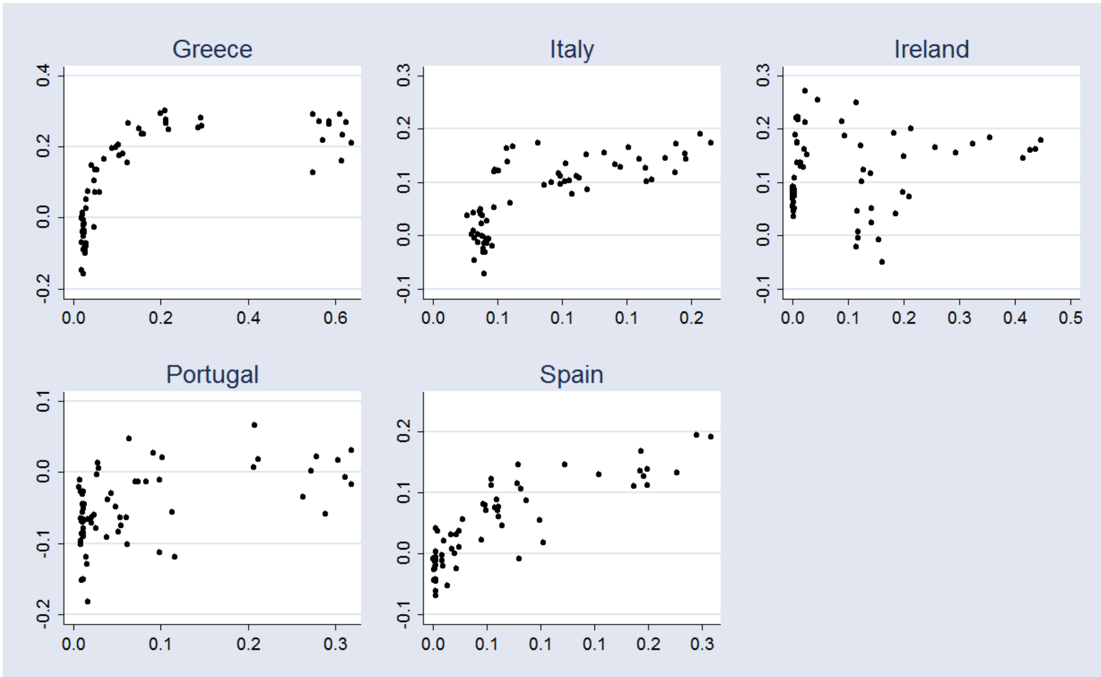

Figure 5.

This picture plots the time series of the (stock-based) Value Discount and the (bond-based) Risk-neutral Default Probability for Brazil. The sample period is Feb/1995 to Jan/2011. The Value Discount is defined as $VD=1-EY^{DEV}/EY^{EM}$, where EY^{EM} is the value-weighted earnings yield in the emerging market and EY^{DEV} the corresponding value-weighted earnings yield (using EM weights) of comparable DEV firms.