Persistent Gaps, Volatility Types and Default Traps

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Abstract

We show that cross-country differences in the underlying volatility and persistence of macroeconomic shocks help explain two historical regularities in sovereign borrowing: the existence of "vicious" circles of borrowing-and-default ("default traps"), as well as the fact that recalcitrant sovereigns typically face higher interest spreads on future loans rather than outright market exclusion. We do so in a simple model where output persistence is coupled with asymmetric information between borrowers and lenders about the borrower's output process, implying that a decision to default reveals valuable information to lenders about the borrower's future output path. Using a broad cross-country database spanning over a century, we provide econometric evidence corroborating the model's main predictions - namely, that countries with higher output persistence and conditional volatility of transient shocks face higher spreads and thus fall into default traps more easily, whereas higher volatility of permanent output tends to dampen these effects.

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1 Introduction

Two main stylized facts permeate the history of sovereign borrowing. The first is serial default. Lindert and Morton (1989) find that countries that defaulted over the 1820-1929 period were, on average, 69 percent more likely to default in the 1930s, and that those that incurred arrears and concessionary schedulings during 1940-79 were 70 percent more likely to default in the 1980s. While these estimates are not conditioned on countries' fundamentals, evidence provided by Reinhart, Rogoff and Savastano (2003) indicates that serial default is only loosely related to countries' indebtedness levels and other fundamentals. They show that such serial defaulters have lower credit ratings and face higher spreads at relatively low indebtedness levels – a phenomenon they call "debt intolerance". The experience of such debt-intolerant countries – which embark upon a "vicious circle" of borrowing, defaulting and being penalized with higher interest rates – stands in sharp contrast with that of countries that manage to undergo a "virtuous circle" of borrowing and repayment with declining sovereign spreads.

A second notable empirical regularity is that default rarely entails permanent exclusion from international capital markets but mainly a re-pricing of country risk (higher spreads), at least for sometime. This regularity is at odds with much of the theoretical literature: in early models (notably Eaton and Gersovitz, 1981) it is the threat of permanent exclusion from capital markets which is crucial to sustain sovereign lending; later models allowed for this exclusion to be temporary but with random re-entry rules which are not price-dependent (Aguiar and Gopinath, 2005; Arellano, 2006).[1] In practice, default is often "punished" not through outright denial of credit or fixed re-entry rules but a worsening of the terms on which the country can

[1] Earlier work had already noted, however, that punishment through market exclusion is problematic, particularly when lenders are heterogenous and coordination is non-trivially costly (Kletzer, 1984). Later work has examined the circumstances under which equilibrium with default risk is shaped by post-default debt renegotiation and market exclusion becomes an inefficient punishment (Cohen, 1991; Yue, 2005). Bulow and Rogoff (1989) further pointed out that exclusion alone is not a sufficient condition for international lending if borrowers retain the ability to invest in international assets. More recently, Kletzer and Wright (2000) provide a qualified reinstatement of the original Eaton and Gersovitz exclusion-based result, relying on a "cheater of the cheater" game-theoretical argument.

borrow again.[2] Provided that borrowing needs are not too price elastic, the sovereign will continue to tap the market – absolute exclusion representing only the limiting case in which lenders' "capture technology" is so weak that country spreads may become prohibitively large for any borrowing to take place.

This paper argues that two structural features which are typically found in emerging markets help explain both stylized facts. These structural features are that output shocks are not only typically large, thus producing high cyclical variability about trend growth, but also highly persistent.

That output volatility is generally high among emerging markets is a well-documented phenomenon (see, for instance, Kose et al., 2006). Recent work has related such volatility to a number of long-lasting structural features, ranging from domestic institutions (Acemoglu et al., 2004), commodity specialization (Blattman et al., 2006) to imperfections in international capital markets that limit these countries' ability to issue domestic-currency denominated sovereign debt, thus rendering them more vulnerable to currency fluctuations (Eichengreen et al., 2003).

What has received less attention in the literature, however, is the fact that such output volatility is often coupled with considerable persistence of output shocks. For a given dispersion of shocks (conditional output volatility), higher persistence implies that associated output fluctuations will be larger;[3] so, the same unconditional output volatility may be generated by different combinations of persistence and dispersion of shocks. Yet, as we

[2]In fact, not only is permanent exclusion quite rare, but even temporary loss of market access tends to be relatively short-lived: recent estimates using micro data on international loans and bond issuance put it at 2.5 years for the post-1980 period (Gelos et al., 2004). While there is some debate about whether recalcitrant borrowers are consistently punished with higher spreads (Eichengreen and Portes, 1986; Ozler, 1993), broader historical data that we present in this paper and have examined further in a companion paper (Catão, Fostel and Kapur, 2007) overwhelmingly indicates that bond yields typically do shoot up in the wake default events and remain higher than average (albeit declining) for several years after those events. This is also consistent with evidence provided in Flandreau and Zumer, (2004) on the behavior of spreads during the pre-WW I period.

[3]To see this, let $y_{i,t} = \rho y_{i,t-1} + \omega_{i,t}$ where $y_{i,t}(y_{i,t-1})$ is output of country i in period t (and $t-1$), ρ is the persistent parameter and ω is an iid shock. Then we have that the unconditional output volatility is $\sigma_{y_{i,t}} = \frac{\sigma_{\omega_{i,t}}}{\sqrt{1-\rho^2}}$.

show below, it is important to disentangle the effects of these distinct parameters on sovereign risk. On a broader analytical level, such a separation is important as well because there are distinctive macroeconomic mechanisms behind shock persistence in emerging-market economies. One is the presence of short-run supply-side inelasticities which make primary commodity price shocks long-lasting; to the extent that primary commodities remain key export items for many such countries, sizeable persistence in output and terms-of-trade is not surprising.[4] Second, various frictions, political as well as economic, make fiscal policy more procyclical in these countries than others.[5] In a recession, a contractionary fiscal stance tends to delay recovery, which exacerbates shock persistence. Third, financial and institutional frictions in emerging markets typically magnify the sensitivity of domestic credit to loan collateral values. As a result, the credit-transmission mechanism can induce more prolonged spirals of output contraction or expansion, including painful episodes of debt deflation. Insofar as such frictions are often coupled with protracted balance-sheet adjustments stemming from currency-denomination mismatches (see, e.g., Calvo, 1998; Mendoza, 2005), they also help explain higher shock persistence in those economies.

This begs the question as to whether, and to which extent, output has indeed been typically more volatile and persistent among defaulters and serial defaulters. Tables 1 and 2 provide suggestive evidence. Using data spanning the century-and-quarter period from dawn of international bond financing in the 1870s through 2004, the Tables report the standard deviation as well as the first autoregressive coefficient of HP-filter de-trended output for each country over the three main sub-periods delimited by the World Wars. As

[4]See Cashin et al. (2000) and references therein for empirical evidence on the persistence of commodity price shocks. Mendoza (1995) finds that terms of trade variations typically account for up to one-half of business cycle fluctuations in developing countries.

[5]Gavin and Perrotti (1997) and Kaminsky et al. (2004) provide empirical evidence. Talvi and Vegh (2005) examine the role of political frictions in creating such procylicality. Eichengreen, Hausmann and Panizza (2005) explain greater fiscal procyclicality in developing countries in terms of the incompleteness of international financial markets. As this incompleteness limits long-term external borrowing in these countries' own currency, when bad shocks hit (which typically entail a currency depreciation or devaluation), the cost of public borrowing rise accordingly; this in turn forces these countries to undergo contractionary fiscal adjustment or at least limits the scope for counter-cyclical fiscal policies. Guidotti et al. (2005) provide empirical evidence consistent with this theoretical story, in that more "dollarized" countries tend to display slower recoveries following capital account shocks ("sudden stops").

is immediately apparent from group medians, defaulting countries typically display higher volatility and persistence than non-defaulting countries on average. Further, these cross-countries differences appear to be typically even higher between serial defaulters and non-defaulters, and are consistently observed for certain countries over the entire 1870-2004 period. The postulated relationship also appears to be robust to potential reverse causality emanating from the effects of defaults on the volatility and persistence of output shocks: when we eliminate from the sample all default events and their immediate aftermaths, defaulters continue to display greater output volatility and shock persistence relative to their more virtuous peers.

We lay below a simple model to examine the effects of volatility and persistence of output shocks on sovereign risk. The main novelty relative to previous studies is to combine these two "structural" features of output growth with asymmetric information between borrowers and lenders about the nature of output shocks. In a companion paper (Catão, Fostel and Kapur, 2007), we establish how such asymmetry of information ensures an equilibrium pricing mechanism characterized by a "default premium" which is absent in the symmetric information benchmark. This equilibrium can account for the two stylized facts described above as follows. Once sovereign borrowers are better informed about the output shock than lenders, the borrower's action (default vs repayment) can be highly informative: default triggers a discrete shift in expectations about the future repayment flows so that lenders tend to "assume the worst" about the future output path. Such pessimism, combined with lenders' need to (at least) break-even period by period, implies that fresh borrowing is sustainable only at much higher interest spreads. The difference between the prices that the borrower faces after repayment or default can be viewed as a "default premium". Ex-ante such a "default premium" constitutes a deterrent mechanism that induces countries to pay even in the absence of output penalties featuring elsewhere (e.g., Sachs and Cohen, 1985; Obstfeld and Rogoff, 1996; Alfaro and Kanuzck, 2005). Expost, however, the attendant rise in spreads associated with such a "default premium" increases the cost of future borrowing. Provided that borrowing needs are not overly elastic to the hike in spreads, the ratio of debt service to (expected) output will rise, thereby raising the cost of future repayments, all else constant. Thus, a sufficiently large negative shock combined with some output persistence and asymmetric information between borrowers and lenders about the nature of the shock, tends to create "default traps".

In this paper we study how this default trap mechanism is exacerbated (or tempered) by changes in output persistence and volatility. Since output volatility and persistence tend to be structural (and hence slowly-evolving) macroeconomic features that vary from country to country, the mechanism just described entails clear-cut testable propositions about sovereign bond pricing on a cross-country basis. Three main theoretical results are derived in this connection.

First, countries that display higher underlying persistence of output shocks face higher sovereign spreads, all else constant. This occurs irrespective of whether the country has defaulted or not in the past; a previous history of default further exacerbates this effect. In other words, higher persistence increases country risk both before and after default relative to baseline. This helps explain why certain countries may face systematically higher spreads than others at lower debt ratios and even after after controling for other fundamentals.

Second, countries with higher volatility of the temporary component of output tend to face higher spreads including those with a clean credit history.

Third, and tempering the preceding results, we find that higher volatility of the persistent component of the output shock dampens the "default premium" – that is, the difference in borrowing rates between default and non-default states after the realization of a given shock. The intuition is that, under asymmetric information, default by a high volatility country is more "excusable", to use Van Huyck and Grossman's (1988) jargon: that is, it generates a less pessimistic outlook for the borrower's future output path relative to a less volatile economy that also defaults; so, the default premium does not rise as much in the former case. This result, which follows mainly from asymmetric information, is to the best our knowledge new in the literature.

These theoretical findings relate to previous studies. Aguiar and Gopinath (2006) also study the effect of output persistence on default risk. They develop an infinite-horizon model where sovereign borrowing is motivated by consumption-smoothing and default triggers a temporary exclusion from financial markets. While they also find that greater output persistence tends to raise default risk, the underlying mechanism differ. They rely on the conventional penalty of exclusion with exogenously given re-entry probabilities to deter default. In contrast, our main deterrent is an *endogenous pricing mechanism* (default premium). Further, while their analysis focuses on shocks to trend, our model shows that persistent cyclical shocks as well as shocks to trend both can greatly affect default risk in the presence of asymmetric information.

Several other studies have examined the role of volatility in default risk. Our first result regarding the volatility of temporary shocks mirrors that of Aguiar and Gopinath (2006), Arellano (2006), Catão and Kapur (2006), where higher output volatility is shown to raise spreads. In contrast, we also find here that higher trend volatility lowers the default premium, a result not found in these studies. As such, this paper's findings build some bridge between the Eaton and Gersovitz (1981) story - where volatility is negatively related to default risk - and the results of more recent work.

The other main contribution of this paper is to provide empirical evidence for the theoretical results that we derive. We do so by constructing a long and broad cross-country database spanning the first globalization era in the 1870s - when international financial integration and sovereign bond financing began to climb to unprecedented historical levels – to 2004. This database is not only longer relative to previous historical studies on sovereign risk (e.g. Obstfeld and Taylor, 2003) but also has better output data for some countries and encompasses a wider set of variables (See Appendix 2). We use this database to provide econometric evidence on the effects of conditional volatility and persistence of output shocks on sovereign risk. The results indicate that countries with more volatile and persistent output shocks are likely to face higher ex-ante interest spreads and thus more likely to be caught into default traps. Consistent with our theoretical findings, we also find that, conditional upon actual default, the default premia of countries with historically higher output volatility tend to be lower than less volatile countries, all else constant. We show that these empirical results are robust to a host of controls.

The plan of the paper is as follows. Section 2 presents the model, comparative statics and a brief discussion of the main assumptions. Section 3 reports the econometric results. Section 4 concludes. Appendix 1 presents the proofs to the theoretical propositions, and Appendix 2 describes the data.

2 Theory

2.1 Model

A sovereign borrower issues bonds in international capital markets to finance investment in long-term projects. We can think of these as physical infrastructure and/or human capital development (e.g. education and health). We develop our argument in the simplest setting, which involves three periods, $t = 0, 1$, and 2. The project's investment requirements, I_0 in period 0 and I_1 in period 1, are exogenously given.[6] To finance this requirement, the sovereign issues one-period bonds in $t = 0$ and $t = 1$. In periods 1 and 2, the sovereign decide whether or not to redeem previously issued bonds. Bonds are held by competitive-risk neutral lenders and the issue price of bonds is determined endogenously in each period, based on the perceived likelihood of sovereign default.

In our model, the likelihood of default depends on the sovereign's indebtedness relative to its stochastic output. There are two sources of output uncertainty: a persistent and a transient shock. Specifically, output in $t = 1, 2$ is given by

$$\tilde{Y_1} = \bar{Y_1} + \tilde{\epsilon_1} + \tilde{\omega_1} \tag{1}$$

$$\tilde{Y_2} = \bar{Y_2} + \rho\tilde{\epsilon_1} + \tilde{\omega_2} \tag{2}$$

where $\bar{Y_t}$, the path of expected output, allows for secular growth. ω_t denotes transient or temporary shocks: these are i.i.d., with mean 0 and standard deviation σ_ω. Random variable ϵ_1 is a persistent shock, with mean 0 and standard deviation σ_ϵ. The parameter $\rho \in (0, 1)$ measures the persistence of the shock from period 1 to period 2. Let $\Phi(\epsilon)$ denote the distribution of persistent shocks and $\phi(\epsilon)$ the associated density function.

The model builds on informational asymmetry between the sovereign borrower and lenders. We assume that, while $\bar{Y_1}, \bar{Y_2}$, ρ and the distribution of shocks are common knowledge, only the sovereign observes the magnitude of

[6]We discuss below the implications of relaxing this assumption.

its period-1 shock directly. Bondholders do not,[7] but make an inference about its distribution by observing the sovereign's repayment decision in period 1. These updated beliefs are used to calculate future probability of default.

The sequence of events is as follows. At time $t = 0$, the sovereign issues one-period bonds to meet its initial investment requirement I_0. The issue price of these bonds is determined endogenously: it reflects expected future default risk. At time $t = 1$, the sovereign observes its output and chooses between default, d, or repayment, r. On observing the sovereign's repayment choice in period 1, bondholders update their beliefs about the sovereign's future output using Bayes' rule. The sovereign then issues new bonds in period 1 to finance its period-1 investment requirement I_1, at a price which reflects perceived future default risk. In the final period, the sovereign chooses whether or not to repay its debt.

The bond market is competitive, with risk-neutral lenders who are willing to subscribe to bonds at any price that, given their beliefs, allows them to break-even. For modeling simplicity we treat the mass of lenders as a single lender who chooses a price that, given the perceived default risk, just allowing it to break even. As the risk of default depends on future output and indebtedness, so does the price of bonds.

Let p_0 be the market-clearing price in period 0 of a bond with unit face value in period 1. To meet the investment requirement I_0, the sovereign must issue D_1 bonds where:

$$p_0 D_1 = I_0. \tag{3}$$

The implied yield on these bonds is $i_0 = (D_1/I_0) - 1$.

[7]Informational asymmetry is common in many models of debt. In the present context, it could be argued that publicly-available information on a country's output and/or the sovereign income is subject to statistical inaccuracies, and in the short run at least, vulnerable to deliberate obfuscation. Other forms of informational asymmetry in sovereign markets have been studied by Kletzer (1984), Atkeson (1991), Calvo and Mendoza (2000), Alfaro and Kanczuk (2005), Fostel (2005) and Catão, Fostel and Kapur (2007). Clearly, in a multi-period context there is greater scope for learning, hence doing away with some of this asymmetry. Yet, a longer time horizon also increases the likelihood of structural changes in the underlying dynamics of the output process which makes learning more difficult or protracted. In a nutshell, the mechanism described above is operative in practice to the extent that learning is never complete.

We assume that in the event of default, bondholders can enforce partial recovery cD_1; here $c < 1$ is the recovery rate and hence $1 - c$ is the "haircut" inflicted on bondholders. If the sovereign is expected to default in $t = 1$ with probability π_1, the expected return to bond holders is $[\pi_1 c + (1 - \pi_1)]D_1$. For a risk-neutral lender to break even, we require

$$[\pi_1 c + (1 - \pi_1)]D_1 = R_f I_0, \tag{4}$$

where R_f is the exogenously-given gross risk-free interest rate. Combining the last two equations the market-clearing price of bonds is:

$$p_0 = \frac{1 - \pi_1(1 - c)}{R_f} \tag{5}$$

which indicates that the issue price of bonds is decreasing in the anticipated probability of default. Note that $p_0 \in [c/R_f, 1/R_f]$ so the bond price is positive as long as $c > 0$.

Likewise, bonds issued in period 1 must meet investment requirement $p_1 D_2 = I_1$. As the payment history $h \in \{r, d\}$ in period 1 affects the probability of future default, it affects the issue price p_1^h and the issuance D_2^h. Hence, lender's break-even condition yields a period-1 price as:

$$p_1^h = \frac{1 - \pi_2^h(1 - c)}{R_f} \tag{6}$$

where π_2^h is the history-contingent probability of default in the final period.

Given our choice of a finite-horizon framework, partial capture provides insufficient deterrence against default in the final period. In the absence of other penalties, in period 2 the borrower will default with probability one. To avoid the trivialities associated with this case, we assume that default in the final period is also punished with sanctions that cause the sovereign to lose a fraction s of its current output $\tilde{Y}_2$.[8] If so, repayment will be rational in the final period if and only if the cost of sanctions exceeds any direct gain from reneging on repayments.

[8]As in Sachs and Cohen (1985) and Obstfeld and Rogoff (1996) we assume that bondholders do not appropriate any benefit from these sanctions. Alternatively we might interpret these as endogenous loss of output due to disruptions following default, as in Cohen (1992), Calvo (2000).

We model the interaction between the borrower and lenders as a game. A strategy for the sovereign borrower involves the following elements: bond issuance D_1 in period 0, repayment choice $h \in \{r, d\}$ followed by history-contingent bond issuance D_2^h in period 1, and, finally, the repayment choice in period 2. For simplicity, we assume that the sovereign's utility function is linear in payoffs. When making its period-1 choice, the sovereign maximizes $E(\tilde{y}_1 + \beta \tilde{y}_2)$, where $\tilde{y}_t$ denote its output net of any (voluntary or enforced) repayments and $\beta \leq 1$ is a discount factor. With this linear specification, the sovereign cares only about expected future payoffs. If so, the decision to default or repay in period 1 does not depend on the transient component of the shock, ω_1, as this does not affect expected future payoff, $E(\tilde{y}_2)$.[9]

A strategy for the lender involves prices (p_0, p_1^r, p_1^d) that allow it to break even in each period for every history. Alternatively, we can represent these prices in terms of the bond yields (i_0, i_1^r, i_1^d) that capture the risk spreads needed to break even. We say that the default premium is positive if default lowers the issue price of new bonds relative to the repayment scenario, that is, if $p_1^d < p_1^r$. Or equivalently, if $i_1^d > i_1^r$.

Finally, since the lender does not observe the realization of shocks directly, we need to specify the beliefs based on the commonly-known prior distribution of shocks and on the borrower's observed choice.

In a companion paper, Catão, Fostel and Kapur (2007), we prove the existence of a Perfect Bayesian Equilibrium for this model. There, we also show how asymmetric information ensures an equilibrium pricing mechanism in contrast to the symmetric information benchmark. In the rest of this section we will study how the key parameters, persistence and volatility, affect the price mechanism present in that equilibrium. However, before moving to the comparative statics, let us briefly describe the equilibrium.

The borrower's optimal strategy in each period has a cut-off property. It will repay in period 1 if and only if the realization of the persistent shock is above some threshold, e_1^*. In the second period it will repay only if the debt to output ratio do not exceed a value which depends on output losses

[9] We discuss below the consequences of non-linear utilities specifications, in particular the effect of risk aversion. A linear specification allows us to get closed form solutions that are very tractable for the purpose of comparative statics which is the goal of this paper.

and haircuts associated to default. The lender, on the other hand, charges a price for bonds such that the expected return equals the opportunity cost of funds. The key property of the equilibrium is that there is a positive default premium, this is, $p_1^r - p_1^d > 0$. Hence, the price charged after a repayment history is always higher than the price charged after a default history.

Obviously, the expected return depends on lender's beliefs, which in period 1 depend on the borrower's observed repayment choice. Given the borrower's repayment strategy, default signals that the realization of the persistent shock must have been below the threshold (that is, in the lower tail of the distribution). Thus, in period 1, after observing default, lender's beliefs are given by

$$\gamma(\epsilon_1|e_1^*, d) = \begin{cases} \frac{\phi(\epsilon_1)}{\Phi(e_1^*)} & \epsilon_1 < e_1^* \\ 0 & \epsilon_1 \geq e_1^* \end{cases}$$

If instead, lenders observe repayment

$$\gamma(\epsilon_1|e_1^*, r) = \begin{cases} \frac{\phi(\epsilon_1)}{1-\Phi(e_1^*)} & \epsilon_1 \geq e_1^* \\ 0 & \epsilon_1 < e_1^* \end{cases}$$

In words, given the borrower's strategy, default in period 1 creates a more pessimistic outlook for future output, translating into lower prices (higher spread) for further bond issues. The positive default premium captures the increase in future borrowing costs that follow from default (relative to repayment). Default triggers an increase in borrowing costs that affects future borrower's payoffs. The continuation payoff for the borrower following default, call it V_2^d, is lower than the continuation payoff following repayment, V_2^r. The difference between these value functions measures the anticipated future loss from default, in terms of the higher cost of financing the current investment requirement. On the other hand, the immediate gain from default is the avoided repayment, which in net terms equals $(1-c)D_1$. At e_1^*, the present value of future loss from default is just balanced by the immediate gain from default:

$$\beta(V_2^r(e_1^*) - V_2^d(e_1^*)) = (1-c)D_1(e_1^*) \tag{7}$$

As shown in Catão, Fostel and Kapur (2007), that the borrower repays for realizations above this threshold follows from the fact that the future gain from repayment is decreasing whereas the immediate gains from default is increasing in the chosen value of the threshold. To understand the intuition, note that for very low values of e_1^*, bondholders consider default in period 1 very unlikely. But if this unlikely event actually occurs, the bondholders expectations about future output levels face a large downward correction (given persistence), translating into a wide divergence between V_2^r and V_2^d. For high values of e_1^*, the ex-ante probability of default is very high, and hence actual default in period one will not trigger big ex-post corrections. On the other hand, the immediate gain from default in period 1, given by $(1-c)D_1 = (1-c)(I_1/p_0)$ is increasing, since p_0 is a decreasing function of the probability of default, and hence of e_1^*. At the equilibrium repayment threshold e_1^*, the gain from repayment is just matched by the direct gain from default. The determination of this threshold is depicted in Figure 1.

The equilibrium just discussed rationalizes the two stylized facts mentioned before. First, it gives an ex-ante endogenous mechanism, through the positive default premium, that punishes default without the need of exogenous exclusion rules. Second, this pricing mechanism allows the possibility of default traps. An adverse shock in period 1, if it triggers default, can make bond issuance more expensive, increasing the probability of future default. All things equal, a previous defaulter will need good luck in the period 2 shock (ω_2) not to default again, and thus be able to get out of the *default trap.*

2.2 Comparative Statics

Next, we move towards the goal of the present paper: to consider how the default trap mechanism just described varies with key parameters - the persistence and volatility of shocks.

As discussed above, the equilibrium mechanism relies on two key relative prices: the spread and the default premium. The country's sovereign spread is defined as the difference between the interest rate faced by the country and the "world" riskless interest rate: $r - r_f$. On the other hand, the default premium is defined as the interest rate faced by the borrower after default minus the interest rate faced after repayment: $r_1^d - r_1^r$ (or equivalently $p_1^r - p_1^d$). The following propositions study how these two relative prices- the sovereign spread and the default premium- are affected by changes in persistence and shock's volatility.[10]

Proposition 1: Persistence and Default Traps.

An increase in the persistence of output shocks has the following effects:

1. *Increases the probability of default at period 1 and hence decreases the price at time 0.*
   That is, $\triangle\rho$ implies $\triangle\pi_1$ and ∇p_0.

2. *Increases the default premium. That is, $\triangle\rho$ implies $\triangle(p_1^r - p_1^d)$.*

Consider the impact of an increase in the persistence parameter ρ observable by all agents. Given the borrower's strategy, higher ρ will translate into higher default premium. This is because greater persistence implies that future output shocks are more closely related to current shocks, so that the informational value of default is greater. Hence, the impact on future financing costs will be more severe. For a given e_1^*, the gain from repayment now exceeds the gain from default. If so, the borrower's strategy e_1^* is no longer optimal. To restore the balance between the gain from repayment and default, the threshold needs to increase to a new higher value (call it e_1^{**}), as shown in Figure 1. Note that this new equilibrium is associated with a higher probability of default in period 1 and hence a higher spread at the initial period.

In short, higher persistence exacerbates the default trap mechanism. Note that this result of higher probability of default *ex ante* may seem counterintuitive, since one would expect that a higher default premium would deter default. However the greater deterrence against default, in equilibrium, can support debt transactions that carry greater risk of default.

[10] All the following results are stated in terms of prices. Of course, that has a direct translation into interest rates and spreads (which are going to be the variables used in the empirical estimations) as shown above. So a decrease in price corresponds to an increase in spreads (given that the risk-free interest rate is fixed).

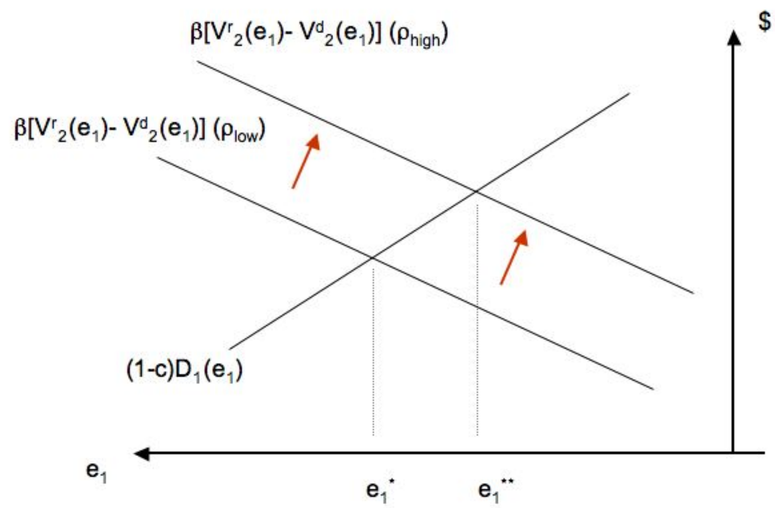

Figure 1: Default Traps and Persistence.

The impact of variations in the volatility of shocks is more subtle. Proposition 2 and 3 explore these effects.

Proposition 2: Transient Volatility and Default Traps.

An increase in the transient shock' volatility results in a decrease in the issue price of bonds, i.e. if $\triangle\sigma_{\omega_2}$ *then* ∇p_1.

The intuition behind this proposition is as follows. Given that the debt repayment function that lenders face is a step function (recall that lenders recover cD upon default, where $c < 1$), they lose more when output is low than what they gain when output is high.[11] Hence, an increase in the variance of temporary shocks will lower the price enough to account for this.[12]

[11] A similar result obtains under different repayment functions provided that they display some concavity. See, e.g. Catão and Kapur, 2006.

[12] This effect is obviously reinforced by risk aversion, as discussed below.

This result is consistent with other studies on the impact of volatility on default risk as Aguiar and Gopinath (2006), Arellano (2006) and Catão and Kapur (2006). What has not been emphasized before is that, under asymmetric information, volatility has a dampening effect on risk, as the following proposition states.

Proposition 3: Permanent Volatility and Default Traps.

Assume that the persistent shock is distributed uniformly. An increase in the volatility of the persistent shock has the following effects:

1. *Decreases the price at time 1. That is,* $\triangle\sigma_{\epsilon_1}$ *implies* ∇p_1^h *for* $h = r, d$.
2. *Decreases the default premium. That is,* $\triangle\sigma_{\epsilon_1}$ *implies* $\nabla(p_1^r - p_1^d)$.

High volatility of the persistent shock will reduce the informational content of any action in period 1. This is because the more volatile output is, the higher the range of output realizations that make default optimal. In other words, borrowers have the same number of signals, default and repayment, to convey information about a wider set of outcomes. Once lenders know this, default will not trigger as pessimistic expectations about the future as in the less volatile case. To use the jargon of Grossman and Van Huyck (1998) there is more "excusability" in default. So, while p^r and p^d will both decrease (implying that the country' spread will rise), p^d will decrease less. That is, the default premium will shrink.

Propositions 2 and 3 together help to reconcile very different views on the effect of volatility on sovereign risk. Proposition 3, is not only novel to the best of our knowledge, but also builds a bridge between the Eaton and Gersovitz' s (1981) story (in which volatility has a positive effect on default risk) and the findings of the recent studies cited above.

Summing up the results in this section, default traps are exacerbated by output persistence and volatility of the transient component, since they increase default risk (through spreads and default premium). However, when the precision of persistent shock decreases, the mechanism is weaker, since it lowers the default premium.

2.3 Discussion

For both fixing ideas as well as better relate theory and data, it is important to discuss the role of the main assumptions in our model.

1. *Asymmetric information.*

   Asymmetric information is key for our mechanism since it yields a positive default premium in equilibrium which works as an endogenous deterrence mechanism. As proved in our companion paper, this premium disappears when the informational noise is zero: prices are a direct function of the shock (observable by all) and hence are completely inelastic to the borrower's action. As a consequence, in equilibrium, the borrower always default in period 1 in the absence of output losses or other related default penalties.

   Moreover, informational noise plays two other key roles: on the one hand, it amplifies the effect of persistence on sovereign risk; on the other, it dampens some of the positive effect of volatility on country spreads by depressing the default premium, as discussed above.

2. *Risk aversion.*

   For simplicity of exposition our model assumes that the borrower's utility function is linear. With a linear specification, the sovereign cares only about expected payoff, so all default is strategic. In particular, this ignores the possibility of "involuntary" default: for instance, a large negative but albeit transitory shock, combined with low intertemporal elasticity of substitution, could raise the marginal utility of current consumption to the point where default becomes optimal in period 1. Likewise, if for whatever reason there are limits to the borrower's capacity to repay in times of crises, negative shocks – even temporary ones – can trigger a "involunatry default". Thus the borrower's repayment choice may depend not just on the persistent shock but also on temporary shock. This introduces the possibility that volatility in the *temporary* component of output shocks can trigger a vicious circle of credit events leading to serial default. Given asymmetry of information between borrowers and lenders, even when default is triggered by inability to pay in the face of adverse temporary shocks, this may be misconstrued as arising due to adverse persistent shocks. If so, this misperception will lead lenders to raise interest spreads in the subsequent period. Such higher spreads will then widen the range of output realizations in the subsequent period for which the borrower default. So, a combination of "bad luck" and asymmetric information can thus induce serial default over and above the volatility of the persistent component of output.[13] Overall, risk aversion thus tend to strengthen rather than weaken our theoretical results.

3. *Endogenous output and borrowing.*

   While period-2 output is vulnerable to exogenous shocks, the model overlooks the possibility that default itself may cause endogenous loss of output.[14] If circumstances following default weakens access to trade credit or causes other disruption, we may well have the case that expected output in period 2, $\bar{Y_2}$, depend on the repayment decision in the previous period. Specifically, this introduces the possibility that $\bar{Y_2^d} < \bar{Y_2^r}$. In this scenario, the default premium is likely to be higher still. So, the *ex-ante* deterrence mechanism described in this paper will be even stronger. By the same token, however, this mechanism will also have an adverse *ex-post* effect on creditworthiness: if, notwithstanding this deterrent effect, the sovereign does default following the shock realization in $t = 1$, this will in turn lower the cost of defaulting in the subsequent period, as the debt burden relative to output will be higher in the second period.

[13]Clearly in those circumstances, the borrower would have an obvious incentive to prove to the lender that the output shock was temporary rather than permanent. But as lenders internalize such incentives, they will likely require a third party or some form of objective monitoring of output realizations which will entail verification costs. Whether such monitoring scheme can be implemented and how costly it would be, will then determine the extent to which this mechanism is operative in practice. For further discussion of this point as well of other implications of risk aversion is a similar setting, see Catão, Fostel and Kapur (2007)

[14]Cohen (1992) and Calvo (2000) suggest that this is the case in practice. Obsfeld and Rogoff (1996) provide a theoretical model in which lower-than-envisaged output growth is related to under-investment due to imperfect monitoring by lenders of the use of borrowed funds.

Further, while the risk free world rate R_f was held constant for expositional purposes in the preceding two sub-sections, it is straighforward to see that a negative output elasticity to interest shocks, once combined with output persistence, can amplify the role of a much-documented trigger of "sudden stops" in sovereign borrowing and business cycles in emerging markets – namely, fluctuations in the international (risk-free) interest rate (see, e.g., Calvo, Leiderman, and Reinhart, 1993; Catão, 2006 and Uribe and Yue, 2006). For any given I_0 , as the risk-free R_f rises in period 1, so will D_1 all else constant (see equation (6)). If $\bar{Y_1}$ is a negative function of R_f and $\bar{Y_2} = (1+g)\bar{Y_1}$, where g is the expected secular growth rate of output, then both the likelihood of default in period 1 as well as that serial default will increase along the lines discussed above. Empirical results reported below provide some support for this external interest rate channel as a determinant of sovereign risk.

A final assumption that is important to discuss is the one of fixed borrowing needs. Clearly, to the extent that countries have alternative borrowing sources and/or can temporarily abstain from borrowing, some of the hike in spreads following a default will be dampened by lower loan demand. In other words, instead of having the post-shock adjustment falling entirely on prices, quantities will adjust too. This case is discussed in a related setting in Fostel (2005), where bond prices and quantities adjust to adverse exogenous shocks (in her model to US High Yield sector) and to feedbacks from endogenous margins requirements. Her model simulations show that emerging market bond prices typically rise and borrowing falls some, but the drop is differentiated: richer countries (which supposedly have greater access to alternative borrowing sources) cut down borrowing further to signal their type, whereas others countries cannot afford to do so and hence do not cut borrowing by as much. What share of the adjustment falls on prices rather than on quantities is ultimately an empirical matter of relative elasticities. Yet, for the purpose of our model's main predictions on country spreads and default traps, note that what is important is whether the D/Y ratio will rise/fall after default/repayment. If borrowing is endogenous and falls with bond prices in period 1, but output is also endogenous and falls further with default, D/Y may well end up rising as much as (or possibly even more than) in the baseline model:

I_1 will fall as p_1 rises, but since $D_1 = p_1 I_1$, D_1 may not fall at all; meanwhile Y_2 may drop considerably if default related output losses are substantial, so D_1/Y_2 may hike up.

4. *Shock to trend or shock to cycle.*

   Finally, since our model is a 3-period model, until now we did not need to take a stand about the nature of the persistent shock. Is ϵ a shock to cycle (ultimately mean revertible) or a shock to trend (which will therefore alter the level of output permanently), and what does our model explain in each of these cases? This question has a clear bearing on one's empirical strategy for testing of the comparative statics described in Section 2.2.

   Assume first that the persistent shock amounts to a shock to trend. In this case, where a negative shock entails a permanent reduction in future levels of trend output, a default today will help explain a default many years into the future. Following a negative shock today that is accompanied by default, investors will revise down their trend output predictions and see debt servicing costs rising relative to expected output many years down the line. As the sovereign is thus seen to be more risky, sovereign spreads will have to rise so as to allow lenders to break-even ex-ante. As debt servicing costs rise, so will the cost of future repayments, leading to default traps.

   On the other hand, if the cyclical component is broadly defined as sufficiently long (as often the case for some emerging markets - see Aiolfi et al. 2006), ϵ can be interpreted as a persistent but still cyclical, mean-reversible shock. In this case, the described mechanism can still explain default traps for two reasons. If investors seek to break even period by period, a country with higher persistence of cyclical shocks will always face a higher spread; when the same negative shock hits all countries with the same borrowing needs relative to output, those paying higher spreads and hence higher debt servicing costs will be more prone to default. So, differences in cyclical persistence help explain why certain countries are more prone to fall prey of default traps. At a basic intuitive level, this is not surprising: countries more prone to long deep reasons will tend to have a harder time in repaying if lenders are not long-sighted enough. This has clear cross-sectional testable implications which we examine below. A second reason has to do with investors' gradual learning about the persistence properties of a country's output process. In practice, investors do not know ρ but learn it. In this case, an Argentine default in 1983, for instance, will indicate to investors that Argentina is a high persistence country and thus will have to face higher spreads on a permanent basis. If so, future debt servicing costs will rise notwithstanding the fact that output eventually returns to trend. This may lead to default traps through the same mechanism just described.

3 Empirics

In this section we empirically test the four main implications that follow from the above theoretical set-up, namely

1. *Hypothesis 1:* Countries that display higher underlying persistence of output shocks face higher sovereign spreads (or equivalently lower prices of their discount bonds), all else constant. This follows from proposition 1.

2. *Hypothesis 2:* Countries with higher conditional volatility of output gaps (i.e. those that are more prone to larger shocks) will tend to face higher spreads. This follows directly from the first part of proposition 2.

3. *Hypothesis 3:* Conditional upon previous default, we expect countries to face a positive "default premium". Further, their spreads will be higher (relative to those countries that did not default at that same point in time) than other defaulting countries with lower shock persistence. This follows from the second part of proposition 1.

4. *Hypothesis 4:* To the extent that excessive volatility decreases the informational content of default, the default premium should be negatively related to volatility. This follows from proposition 3.

As these hypotheses have both cross-sectional and time series implications, an important requirement for their assessment is the existence of relatively long data series on sovereign spreads on a broad cross-country basis, which also encompasses a number of default events. A long and cross-sectionally large dataset will allow for more robust inferences about the response of spreads and repayment decisions to the evolution of persistence and the variance of shocks over time. In this vein, a main contribution of this paper consists of constructing such a long database, which allows us to overcome the limitations of the short time-series data series on sovereign bond spreads available for the post-1990 period, and to incorporate also pre-war data to gauge such relationships.[15] Our sample starts from the early globalization years of the 1870s through the eve of World War II, covering 33 countries for this period. For the post-1990 period, the coverage extends to 60 countries plus two additional variables about which pre-WWII information is scarce (debt maturity and denomination) and that we use as additional controls in the later sub-sample.

Our theoretical model suggests a parsimonious empirical specification for the determinants of default risk consisting of five variables: an external "risk-free" interest rate, the ratio of debt to GDP, an indicator of openness to capture the costs of defaults in terms of associated trade losses (consistent with Rose's (2002) empirical results), and measures of volatility and persistence of output shocks.

The distinct interpretations of our theoretical set up clearly call for distinct estimation approaches for volatility and persistence parameters. Should we interpret ϵ as a trend shock, a natural trend-cycle decomposition approach is the classical method proposed by Beveridge and Nelson (1981). It consists of modelling output as an ARIMA (p,1,q), where p and q can be chosen by usual likelihood-based criteria. In this case, we can define the "trend gap" as:

[15] In the post-war period, a consistent series on emerging market sovereign bond indices (EMBIs) is only available from 1994 onwards and, even then, suffers from a sample selection bias in the first few years. This is because the countries issuing internationally traded bonds (Bradies) were the ones with tarnished recent history of sovereign default. It was not until later in the 1990s when a more diversified group of sovereign emerging markets began issuing widely traded bonds in international capital markets that comprise the currently available EMBI series. Unlike its pre-war counterpart used in this paper, this post-1990 series does not encompass the whole gamut of developing and developed countries.

$$\triangle z_t - \mu = [(1 + \theta_1 + \theta_2 + ... + \theta_q)/(1 - \phi_1 - \phi_2 - ... - \phi_p)] \cdot \epsilon_t,$$

where $\triangle z$ stands for overall trend growth, μ represents its deterministic component (drift), ϵ is i.i.d. $(0, \sigma^2)$, and ρ =$[(1 + \theta_1 + \theta_2 + ... + \theta_q)/(1 - \phi_1 - \phi_2 - ... - \phi_p)]$ is a standard measure of persistence. Clearly, if $\rho = 0$, then the trend is purely deterministic (expanding at a constant rate μ), and the "trend gap" vanishes. In this case, default relays no information on the future output path, so the postulated mechanism in the model is no longer operative. The theoretically interesting and more realistic case is thus that where $\rho \neq 0$, as will be seen below. Note that since in the Beveridge-Nelson decomposition (BN henceforth) ϵ is both a shock to trend and a shock to the purely transient component of output, there is just one single source of shock in this context.[16]

Alternatively, suppose that the trend is deterministic (or nearly deterministic) but the cyclical component displays considerable persistence. In this case, a standard widely-used measure of stochastic persistence is the slope coefficient of a regression of detrended real GDP - the so-called "output gap", as obtained by say the standard HP-filter method - on its first-order lag.[17] In this case, stochastic volatility can then be gauged by the standard deviations of the respective regression residuals. To allow for gradually evolving changes in volatility and persistence, we compute both measures recursively over a 10-year or 20-year rolling window, consistent with what is also typically done in the business cycle literature (Mendoza, 1995; Williamson et al., 2006; Aiolfi et al., 2006)).[18] Similar rolling window measures are employed

[16] As can be seen from the above equation, how much the shock ϵ is attributed to the trend vs. to the transient component in the BN decomposition depends on the persistence parameter ρ. In terms of our model, this would be equivalent to assuming that instead of two output shocks, there is just one shock but investors make inferences about ρ.Working with the combination of two shocks and the assumption of common knowledge about ρ (as we did) facilitates the theoretical exposition and understanding of the model's comparative statics. But these are two equivalent modeling choices to get to the same results, so the empirical strategy based on the BN decomposition is entirely consistent with our theoretical approach.

[17] As standard, we set the HP-filter smoothing factor to 100 with annual data. This yields considerable smoothness in trend growth in the long annual series for the various countries in our sample.

[18] To avoid throwing away information on pre-1890s defaults in our sample, we use a 10-year rolling volatility window in the pre-WWI sub-sample and then a 20-year window in the interwar and post-WWII sub-samples.

for the real GDP instrument discussed below.

Starting with the pre-WWII evidence and the HP-filter measure of cyclical persistence, column (1) of Table 3 reports the pooled OLS regressions of the country spread as the left-hand side variable, defined as the interest rate on the respective sovereign bond relative to the benchmark foreign interest rate of similar maturity (the UK consol for the pre-WII period and the US long bond rate later - see Appendix 2). As such, these regressions allow us to test empirically hypotheses 1 and 2 above. The reported t-ratios are corrected for heterocedasticity (using the standard White estimator) and for country-specific first-order auto-correlation, with the right-hand side variables entering the regression with a one-year lag so as to mitigate endogeneity biases.[19] As in Obstfeld and Taylor (2003), we drop from all regressions observations corresponding to spreads above 1,000 basis points so as to eliminate non-traded bonds and bonds of countries in default. As typical in country spread regressions, the R-square is relatively low reflecting the fact that spreads are known to be sensitive to news and uncorrelated shocks. Yet, all the estimated coefficients yield signs that are consistent with those of the theoretical model and are statistically significant at 5 percent, including the debt-to-GDP variable which was not found to be significant by Obstfeld and Taylor (2003) in their pre-WWI regressions.[20] The respective point estimates show that a 1 percentage point increase in conditional volatility ("$\sigma_{\epsilon,t}$") implies a 15.2 basis point increase in sovereign spreads, while a 10 percentage point increase in persistence (i.e., as "ρ" moves from, say, 0.5 to 0.6) raised spreads by 4 basis points, all else constant. These effects may appear small by today's standards, but were not so in the pre-WWI context when the cross-country dispersion of spreads was much tighter.[21]

[19]The external interest rate could be thought of as exogenous for all but two countries in our sample – the US and the UK. So, one could plausible enter i* without lags but it turns out that lagging i* of one year dominates the specification with contemporaneous i*.

[20]Apparent reasons for this discrepancy are that in their regressions Obstfeld and Taylor (2003) do not control for the volatility and persistence effects considered here, plus the fact that our sample has wider country coverage and uses GDP indicators for four Latin American countries (Argentina, Brazil, Chile, and Mexico) that are deemed to be more reliable than the Maddison figures used in their study. See the Appendix for details.

[21]Furthermore, cross-country spread dispersion declined dramatically during the period as capital markets became more internationally integrated. By the eve of WWI, the cross-country standard deviation of spreads was down to 91 basis points. See Flandreau and

In light of the potential criticism that our output shock volatility and persistence measures may be (weakly) endogenous to spreads, the second column of Table 3 replaces the output gap-based indicators with an instrument. The latter is constructed by regressing the output gap of each country on its terms of trade, the world interest rate, and an indicator of world output growth.[22] To the extent that all these three variables are exogenous to individual country spread, any remaining endogeneity bias is eliminated. The results of this instrumental variable regression clearly indicate the the previous results were robust: all coefficients retain a similar order of magnitude of the regressions in column and are statistically significant at 1%.

Columns (3) to (8) of Table 3 introduce a variety of fixed effects as well as other controls to the baseline model regression which capture nevertheless key aspects of our model. We start with fixed effects associated with differences between developed countries and less developed ones (a "periphery" dummy, "Dper"), the same control featuring in Obtsfeld and Taylor (2003) spread regressions. The rationale is to capture a host of structural characteristics not ammemable to easy measurement, such as quality of institutions and degrees of financial development. To the extent that quality of institutions and financial maturity are also proxies for the degree of information asymmetries between borrower and lenders in our model, we should expect this catch-all variable to be significantly related to spreads. As the dummy takes the value of 1 for "peripheral" countries and zero otherwise, the positive sign of the estimated coefficient in column (3) of Table 3 conforms to our theoretical priors. Its main effect on the other estimated coefficients is to detract from the significance of export/GDP ratio in explaining spreads – which is hardly surprising given that the two variables bear considerable multicolinearity.[23] The other fixed effect control, also considered in Obstfeld and Taylor (2003), is whether the country formally belonged to the British empire - inter alia a catch-all proxy for assurances of greater investors' legal protection and arguably preferential access to British markets. In the

Zumer (2004, chapter I), for a discussion of these trends.

[22]These estimate of world output growth was constructed as a weighted average of real GDP in eight countries (Australia, Canada, France, Germany, Italy, UK and the US) in 1990 dollars, as provided in Maddison (2003). In these instrumental regression we allowed for up to one lag of each independent variable.

[23]This is because, in the context of the pre-WWI international division of labor, international trade was a main driving force of GDP growth in the peripheral economies which thus tend to display high openness coefficients.

context of our model, this dummy variable ("Demp") can thus be thought of as a potential increase in the recovery rate parameter c, which will tend to lower spreads. Accordingly, the results reported in columns (4) to (8) of Table 3 indicate that this dummy takes on the expected negative sign and is highly significant statistically. Its main effect is to reduce the coefficients of the volatility and persistence variables, though without rendering them insignificant.

Exchange rate regimes are often perceived to be related to macroeconomic risk, so it seems important to examine whether our hypotheses regarding the roles of volatility and shock persistence on sovereign spreads stand up to such a control variable. In the pre-WWII era, the main dichotomy is that between countries that were on the gold standard and those that were not, so a dummy ("Gold") taking on the unity value (and zero otherwise) was introduced in the regressions. The results reported in column (5) are consistent with the findings of Bordo and Rockoff (1996) as well as Obstfeld and Taylor (2003): membership of the gold standard shaved off some 60 basis points in country spreads, consistent with the view of gold standard membership as a good housekeeping seal of approval. Interestingly, both the size and the statistical significance of the persistence variables shrink after the introduction of this exchange rate regime control, though remaining statistically significant at 10%. This is not surprising in light of well-known theoretical reasons to expect that fixed exchange rate regimes tend to exacerbate shock persistence by both fostering balance sheet mismatches and/or slowing the relative price adjustment process.

Another important set of non-fixed effect controls include the respective country's default history, which in turn gauges how much of the "default premium" (or its converse in case of repayment) percolates into the country spread relative to the world (risk-free) interest rate. In other words, by including default history in the regression we are testing to which extent the borrower's action (default vs. repay) help explain the evolution of spreads over and above the information contained in the previous history of shocks (as captured by σ, ϵ and ρ) as well in other fundamentals included in the regressions. According to our model, this variable should be expected to be positively correlated with current spreads and quite significant statistically. This is because repayments and defaults entail new information about the country's output process in addition to what is entailed by its history of output realizations (which are captured by σ_{ϵ_1} and ρ). In other words, if a country defaults, this implies that the mean of its output distribution should shift to left of e^* (relative to its previous output history), so investors become more pessimistic about its future capacity to repay and thus average spreads should adjust upwards, all else constant. The way the indicator "Def. history" is constructed captures this time-dependence as it is defined as the number of years in default relative since the beginning of the sample; as such, this extra-kick effect from the default premium on spreads decays over time.[24] Table 3 shows that this variable is highly statistically significant and takes on the correct positive. Thus, as predicted by the model, previous credit history matters over and above the actual history of output realizations. As before and consistent with the summary statistics of Tables 1 and 2, this result is robust to the exclusion of default aftermath observations from the sample (or to the use of instruments for real GDP) so as to minimize the potentially negative feedback of default on output.

The remainder controls in the regressions are the ratio of foreign currency-denominated external debt to total debt (a proxy for "original sin" considerations), and terms of trade shock which, if large enough, may prompt a country into default along the lines of capacity to pay arguments.[25] Neither of these variables undermine the statistical significance of our volatility and persistence proxies, nor default risk although they do weight down on the estimated size of the persistence coefficient. This, again, is not surprising since currency mismatches are found to exacerbate the severity of debt and financial crises thus making shocks more persistent (IADB, 2006). Likewise, as persistence is a very slowly moving indicator and bound to be highly correlated with default history if our model is correct, one would expect considerable colinearity between default history and persistence. Overall, though, the results are very consistent with the model's theoretical priors and provide significant support for the hipotheses laid out above.

Table 4 reports a similar set of regressions using the Beveridge-Nelson (BN) measure of the "trend gap". While the fit improves considerably in these regressions relative to Table 3, this is mostly due to fewer observa-

[24]A similarly constructed indicator is used in Reinhart et al (2003).

[25]This latter variable is computed as the residual of HP-detrended terms of trade on its first order lag.

tions.[26] But more importantly, all the relevant coefficients have the correct sign and are significantly throughout. Regarding the magnitude of the effects, while the coefficient on the volatility variable is broadly similar using the HP output gap or the BN trend gap, persistence effects are often twice as large on HP gap measure. This suggests that cyclical persistence does a better job in explaining sovereign risk relative to the view that attributes much of the stochastic output variations to trend shocks.

Turning to the inter-war period, we follow Obstfeld and Taylor (2003) in focusing on the post-1924 years, thereby dropping from the sample the early post-WWI spell - when war dislocations, hyperinflations, and Britain's delay in re-joining gold had far-reaching effects on international bond issuance. As result, while the country coverage is essentially the same, the number of observations is less than half of the pre-WWI sample in Table 3. As before, we start by reporting regression estimates for the HP-gap measures in Table 5. As is typically the case with inter-war regressions, the fit of the model is much poorer than its pre-WWI counterpart and the international risk free rate is no longer statistically significant at coventional levels, though it retains its expected theoretical sign. However, the volatility and persistence indicators remain both significant at 5% in the baseline model of column (1), with the significance of the volatility indicator dropping in some alternative specifications. Further, the effect of persistence on spreads is now much larger: an 10 percentage point increase in persistence leads to 20 basis point increase in spreads (as opposed to 4 bps in the pre-WWI sample). Instrumenting both variables out as in column (2) dampens the respective coefficients, but variables remain significant at close to 5%. This appears to be partly related to the fact that, as most economies in our sample became closer to international trade and financial linkages, our set of instruments (terms of trade, the world interest rate, and world GDP growth) bore a weaker correlation with GDP in each country; that is, we no longer have such good instruments as in the pre-WWI period. Columns (3) to (8) in Table 5 reports the results for the same set of controls as in the pre-WWI regressions (see Table 3). The main

[26] Because the computation of the Beveridge-Nelson decomposition is far more data intensive than HP-filter measures, we often had to broaden our estimation window beyond 20 years to ensure convergence, depending on the curvature of the likelihood function of the various country specific regression. As a result, the 1870-1913 sample becomes a lot smaller in these regressions. Results ot Table 3 regressions using this smaller sample are available from the authors upon request.

quantitative difference is that now the debt/GDP ratio regains statistical significance only after some controls are added, whereas our volatility variable looses it. Persistence remains significant thoughout at 5% . These inferences are broadly the same with the BN trend gap measures, as reported in Table 6. As with the pre-WWI period, the main difference is that the effect of persistence on sovereign spreads is stronger when HP gap measure is used relative to the BN measure.

Tables 7 and 8 report the results of a similar specification and controls for the 1994-2005 period. As noted above, despite the wider country coverage, the number of observations in these regressions is considerably lower than the various pre-WWII regressions due to the lack of spread data for many emerging markets until later in the 1990s/early 2000s. This means that the cross-sectional dimmension of these regressions dominate the time-series dimmension. Partly reflecting that, the fit is higher overall and considerably so for the baseline model of column (1) in both tables, where the basic model accounts for about half of variations in country spreads. Once again, the persistence variable ? is economically and statistically significant throughout, whereas volatility is significant in nearly all of them. A main difference with the pre-war regressions is the inclusion of regional dummies (given that these regressions encompass the more homogenous group of emerging markets), of which only the dummy for Asia is significant in the majority of cases.[27] Interestingly, neither exchange rate regimes, nor debt maturity or currency composition stand out as significant in explaining spread variations. Yet, and consistent with first-generation currency crisis models and related empirical evidence on twin crisis (Kaminsky and Reinhart, 1998), international reserve coverage (as a share of broad money, M2) does matter. Similar inferences obtain with the BN decomposition, reported in Table 8 - a main difference being again the weaker and less precisely estimated (semi)elasticity of spreads to the persistence parameter ρ, compared with the HP-filter gap specification of Table 7.

A final and important set of predictions in our model regarding both persistence and volatility pertains to their effects on the "default premium" – as stated in hypotheses 3 and 4 above. We measure such a premium as the

[27]This is likely because of Asian crisis governments in the late 1990s did not formally go into default with the exception of Indonesia's debt renegotiation but the havoc in these countries clearly weighed down on spreads.

difference in spreads between a country that defaults and others that do not in any given year, controlling of course for differences in fundamentals between the defaulter(s) and the non-defaulters. Our model indicates that the default premium should rise on persistence, whereas a rise in volatility may temper some of this effect since higher volatility implies that default in t=1 is less informative on the country's future prospects. The various regression results reported in Tables 9 and 10 indicate that these predictions find broad support in the data. In both set of regressions, the dependent variable is simply the interest rate on the defaulter's bond in the year following the default announcement minus the cross-sectional average of interest rates paid by all other countries that were not in default in the same year. Clearly, the default premium rises on persistence as the model predicts, while being negatively affected by the volatility of output or trend gap - consistent with the view that higher volatility makes the act of defaulting less informative about a country's future output. This result holds once the various additional controls akin to our model are contemplated -default/repayment history in particular. So, once again, this result is consistent with the model's prediction that both underlying output moments and repayment history matter for actual sovereign bond pricing. Overall, the default trap pricing mechanism postulated in our model thus appears to be broadly consistent with the evidence from long-run macroeconomic data.

4 Conclusion

History tells us that sovereign creditworthiness displays persistence: countries that default once are more likely to do so again, face higher spreads as a result, which in turn tends to lower future default costs. This paper has sought to rationalize how differences in underlying persistence and volatility of output shocks help explain why certain countries are more prone to fall prey to such "default traps". We study the effects of these parameters on sovereign bond pricing in a model combining three key ingredients that have featured in previous models either separately or in pairs but not all together - namely, the volatility and persistence of output shocks, as well as asymmetric information between borrowers and lenders about the extent of shock persistence. While the first two factors alone can make default optimal for a range of output realizations, asymmetric information amplifies this spread mechanism in our model: a default decision signals that the country was likely hit by a large negative output shock which will persist, thus raising future debt-to-output ratios above the expected baseline. As competitive lenders seek to break even and the sovereign continues to tap the market given its financing needs, this gives rise to a positive "default premium". By increasing country spreads further, and hence the borrower's debt burden relative to output, this mechanism makes future default more likely; in other words, it creates "default traps".

In this setting, higher shock persistence and greater volatility of transient shocks exacerbate this spread mechanism. Hence default traps are more likely to bite in countries with such charateristics in their growth profile. In contrast, our model also indicates that higher volatility in the persistent or trend component of output tends to lower the default premium, thus dampening this default trap mechanism. This dual effect of volatility on sovereign risk had not been contemplated in previous work and has some interesting practical implications, as discussed below.

To the extent that these three parameters display significant cross-country differences (due to institutions, commodity specialization, etc.), and as these differences are structural and hence slowly-evolving, they should translate into distinct sovereign bond pricing and hence distinct credit histories. Using an unprecedentally comprehensive database spanning 135 years and up to 62 countries, we have shown that countries which faced higher spreads are typically the ones displaying higher conditional volatility and persistence of output gaps - such effects being statistically and economically significant over and above a variety of controls. Likewise consistent with the model is the result that the default premium tends to be damped by the volatility of the permanent or trend component of output. These inferences are also robust to detrending methods: whether one measures persistence as shocks to trend (thus creating a "trend gap") or shocks to cyclical output (thus creating an output gap which may persist for several years but is ultimately mean revertible), the postulated spread mechanism finds broad support in the data.

Our results add to the literature in three ways. First, by helping explain default traps and its converse (virtuous circles in borrowing and repayment) our model also helps rationalizes "debt intolerance" phenomenon documented in Reinhart et al. (2003): that is, how a sizeable group of countries face much higher spreads and more stringent borrowing constraints than others with far higher debt to income ratios. Rather than the standard causality running from higher debt ratios to higher credit risk along a steady upward sloping supply curve (see Sachs, 1984; Sachs and Cohen, 1985), our findings suggest that it is the perceived riskiness of some countries – as determined by intrisically high volatility and persistence of output shocks – which shifts the investors' supply curve inwards limiting the borrower from taking or "tolerating" as much debt. Thus, the combination of higher volatility and shock persistence helps account for both default traps and debt intolerance.

Second, our results reinforce the empirical evidence from previous studies showing that underlying output volatility tends to increase default risk and hence increase spreads. Unlike previous studies, however, we have shown that, conditional upon default, volatility tends to dampen the default premium. To the best of our knowledge, this subtle effect of conditional output volatility on country spreads has not been developed in the literature.

A third contribution of this paper to the empirical literature is to highlight the previously neglected role of historical output volatility and persistence indicators in country spread regressions. Clearly, the volatility and persistence indicators in our model and regressions are, in a deeper sense, catch-all variables that stem from underlying economic mechanisms which can be quite complex in practice. For analytical purposes of singling out the issue at hand, we chose in the paper to take them as exogenous. But insofar as both indicators are readily observed by agents, then there is also a case to study their effects as if they were indeed parameters actually taken into account by investors.

Finally, some practical implications follow from this paper's results. Plainly, they highlight the importance of reforming institutions and changing policy frameworks that typically make many emerging markets slower in recovering from large negative shocks. At the same time, our findings also suggest that countries with higher underlying dispersion of temporary shocks are more vulnerable to sheer "bad luck": given that these are countries with a wider region of output realizations over which they cannot pay, and that a default may be misperceived by lenders as strategic and due to a highly persistent shock, default traps can be more easily activated. If so, unless an improvement in fundamentals dramatically narrows the variance of output shocks, it may take more than improvements in fundamentals to escape from a default trap: once investors are imperfectly informed about how persistent is the shock and the sovereign's borrowing needs remain high, good luck in output realizations may turn out to be just as important.

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6 Appendix 1: Proofs of Propositions.

6.1 Proof of Proposition 1

For fixed e_1^*, higher ρ increases the informational value of default. To see why, note that with greater persistence, observed default in period 1 leads to greater pessimism about future returns to bondholders, (and hence a higher π_2^d) so required D_2^d is increasing in ρ. On the other hand, observed repayment suggests a more optimistic outlook for future repayments (and hence a lower π_2^r), justifying a lower D_2^r. Thus, for fixed e_1^*, a higher value of ρ is associated with a greater default premium and hence a higher $\beta[V_2^r(\epsilon_1, e_1) - V_2^d(\epsilon_1, e_1)]$. So at e_1^* the gain from repayment is higher than the gain from default. Given that the gain from default, given by $(1-c)D_1(e_1^*)$, is increasing in e_1^*, in order to restore equilibrium, the value of e_1^* must rise. This in turn, implies that the probability of default in period 1 rises as well and the price at $t = 0$ falls.

6.2 Proof of Proposition 2

Let ω_2^* be the threshold such that above it the borrower repays and let $G(\omega_2)$ the distribution function. By the lender's breaking even condition we have that, $\int^{\omega_2^*} cD_1 dG(\omega_2) + \int_{\omega_2^*} D_1 dG(\omega_2) = R_f I_1$. Hence, $(1 - G(\omega_2^*)(1 - c))D_1 = R_f I_1.(*)$ Now, suppose that $\omega_2^* < 0$ (for a related assumption see Eaton and Gersovitz (1995)). To capture an increase in volatility, consider H a distribution defined as a mean preserving spread of the distribution G. In particular, $H(\omega_2) > G(\omega_2)$ for all $\omega_2 < 0$. Then, since $\omega_2^* < 0$, we have that $(1 - H(\omega_2^*)(1 - c)) < (1 - G(\omega_2^*)(1 - c))$. Hence, from (*) we have that the required debt issuance under distribution H is larger than the debt issuance under G, $D_2^H > D_2^G$. Therefore, the associated equilibrium price with H needs to be smaller.

6.3 Proof of Proposition 3

First we prove that an increase in volatility of the permanent shock will decrease the p_0. We assume uniform distribution and without loss of generality that $\bar{Y_1} = 0$ and $\omega_1 = 0$. Now suppose the volatility of the ϵ_1 shock increases so that ϵ_1 is uniform $[-\alpha\epsilon, \alpha\epsilon], \alpha > 1$. Lender's break even condition implies that $\frac{\epsilon-\epsilon^*}{2\epsilon}.D_1 + \frac{\epsilon^*+\epsilon}{2\epsilon}.cD_1 = R_f$ and $\frac{\alpha\epsilon-\epsilon^*}{2\alpha\epsilon}.kD_1 + \frac{\epsilon^*+\alpha\epsilon}{2\alpha\epsilon}.ckD_1 = R_f$ have to hold in equilibrium. Doing some algebra we can get that $k = \frac{\alpha(A-B)}{\alpha A-B}$, where $A = (1+c)\epsilon$ and $B = \epsilon^*(1-c)$. The derivative $k'(\alpha) = \frac{(A-B)(\alpha A-B)-\alpha(A-B).A}{(\alpha A-B)^2}$. Hence the sign of the derivative of k with respect to α will be positive provided that $\epsilon^* < 0$. This proves that an increase in α induces a decrease in the price. The second step is to prove that this induces a decrease in the premium as well. Note that from equation (5) an increase in α also induces an increase in the probability of default. This must mean, therefore, that in equilibrium there must be an increase of e_1^*. In Catão, Fostel and Kapur (2007) we proved that the default premium is decreasing in e_1^*, hence, this induces a decrease in the premium as wanted. The decrease in the price follows directly from the increase in the probability of default caused by the increase in e_1^*.

7 Appendix 2: Data Construction and Sources.

7.1 Pre-World War II data.

Our pre-WWII sample spans 32 countries: Australia, India, Japan, and New Zealand in Asia; Egypt in Africa; Argentina, Brazil, Chile, Mexico, Peru, Venezuela, Uruguay in Latin America; Canada and the US in North America; Austria (including the Austro-Hungarian Empire before 1914), Belgium, Denmark, Finland, France, Germany, Greece, Hungary (after WWI), Italy, Netherlands, Norway, Portugal, Spain, Russia, Serbia, Sweden, United Kingdom, and Turkey.

1. *Sovereign Bond Yields and Spreads:*

   Bond yields on long-maturity sterling denominated bonds were taken from Obstfeld and Taylor (2003) for all countries except for Peru, Venezuela, Hungary, and Yugoslavia. Pre-WWI data for Peru and Venezuela are from Kelly, Trish, 1998, "Ability and Willingness to Pay in the Age of Pax Britannica, 1890-1914," *Explorations in Economic History*, 35, 1998: 31-58, and were kindly provided by the author. Interwar data for all four countries were compiled from the League of Nations, *Statistical Yearbook*, Geneva, several issues. Country spreads calculated as the difference between the respective countrys bond yields and the yield on UK consols, the latter taken from Holmer, Sidney and Richard Sillas, 1996, *A History of Interest Rates*, Rutgers. From the latter source also comes our two measures of the short-term world interest rate, i^*, used in the regressions (The UK discount rate on short-term commercial paper) which we deflated by the UK wholesale price index provided in Mitchell, Brian, 2005, *International Historical Statistics: Europe*, London.

2. *GDP:*

   Real GDP data are from Maddison, Angus (2003), *The World Economy: Historical Statistics*, Paris, except in the following cases:

Argentina, Brazil, Chile and Mexico: from Aiolfi, Catão, and Timmermann (2006), who present a variety of robustness tests to show that their estimates are superior to those provided by Maddison.

Greece: new estimates kindly provided by George Kostelenos, based on his earlier research (*Money and Output in Modern Greece, 1858-1938*, Athens, 1995).

Russia: the net national product estimate from Paul Gregory, *Russian National Income, 1885-1913* (Cambridge: Cambridge University Press, 1983), Table 3.1, pp. 567, ("variant 1").

Spain: Prados de la Escosura, Leandro 2003, *El Progreso Economico de España, 1850-2000* (Madrid: Fundacin BBVA), Table A. 9.1 and A.13.5, pp. 517-22 and 681-82.

Venezuela: Baptista, Asdrbal, 1997, *Bases Cuantitativas de la Economia Venezolana, 1830-1995*, Caracas.

Nominal GDP from Obsfeld and Taylor (2003) except for the above countries (which are provided in the respective sources), as well as for New Zealand (which is from Rankin, Keith, 1992, New Zealand's Gross National Product, Review of Income and Wealth, 38(1), pp.49-6, Table 4, p.60/61), and for Hungary and Yugoslavia which are taken from Mitchell, Brian, 2003, *International Historical Statistics: Europe*, New York.

3. *Public Debt:*

Argentina, Brazil, Chile and Mexico: from Aiolfi, Catão, and Timmermann (2006).

Peru and Venezuela: Kelly (1998) and League of Nations, op. cit., several issues.

Greece: Lazaretou, Sophia, 1993, "Monetary and Fiscal Policies in Greece: 1833-1914, *Journal of European Economic History*, vol.22, no.2.

Venezuela: Baptista, Asdrbal, 1997, *Bases Cuantitativas de la Economia Venezolana, 1830-1995*, Caracas.

All other countries from Obstfeld and Taylor (2003), Flandreau, M. and F. Zulmer, 2004, *The Making of Global Finance, 1880-1913*, Paris, and the League of Nations, op. cit., several issues. The last two sources provide a breakdown between domestic and foreign currency debt.

4. *Foreign Trade:*

   Export values from Brian Mitchells *International Historical Statistics: The Americas, Asia and Oceania, and Europe*, London.

   Terms of Trade from Blattman, Chris, Jason Hwang, and Jeffrey Williamson, 2006, "How do Trade and Financial Integration affect the Relationship between Growth and Volatility", Journal of International Economics, 69, pp 176-202, kindly provided by the authors. The exceptions are the series for Argentina, Brazil, Chile and Mexico which were taken from Aiolfi, Catão, and Timmermann (2006).

7.2 Post-World War II data.

Our post-WWII includes all countries of the pre-WWII sample except for Serbia, and adds the following 29 countries: Bostswana, Gabon, Jordan, Morocco, Oman, South Africa; China, Indonesia, Korea, Malaysia, Pakistan, Philipines, Singapore, Thailand; Bolivia, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Jamaica, Panama, Paraguay; Bulgaria, Czech Republic, Poland, Romania; Iceland, and Switzerland.

1. *Sovereign Bond Yields and Spreads:*

   JP Morgan Emerging Market Bond Index (EMBI). Our measure of the world "risk-free interest rate, i^*, is the 3-month US TB rate taken from IMFs International Financial Statistics (IFS) and deflated by the US WPI provided in the same source.

2. *GDP:*

   IFS.

3. *Public Debt and other Fiscal Data:*

   Luis A.V. Catão and Marco E. Terrones, 2005, "Fiscal Deficits and Inflation, *Journal of Monetary Economics*, 52, pp. 529554. Updated through 2005 using data from the IFS, IMFs World Economic Outlook (WEO), and the World Banks Global Development database (GDD).

4. *Foreign Trade, International Reserves, Real Exchange Rates, and Monetary Agregates:*

   IFS, WEO, and GDD.

Table 1: Real GDP Volatility and Persistence and Countries' Repayment Records, 1870-1939
(in deviations from HP trend, group medians)

1870-1913

		Incl. defaults		**Exc. defaults**	
	Def. Freq.	Std. Dev.	AR(1)	Std. Dev.	AR(1)
Latin America	**1.4**	**0.057**	**0.662**	**0.056**	**0.659**
Asia	**0.0**	**0.040**	**0.133**	**0.040**	**0.134**
Non-def Europe	**0.0**	**0.027**	**0.458**	**0.027**	**0.458**
Def. Europe	**1.2**	**0.037**	**0.302**	**0.036**	**0.379**
North America	**0.0**	**0.041**	**0.396**	**0.041**	**0.396**
Developing	**1.0**	**0.046**	**0.443**	**0.045**	**0.455**
Developed	**0.0**	**0.042**	**0.318**	**0.041**	**0.318**
Defaulters	**1.3**	**0.046**	**0.479**	**0.045**	**0.437**
Serial Defaulters	**2.0**	**0.064**	**0.593**	**0.064**	**0.528**
Non-defaulters	**0.0**	**0.037**	**0.350**	**0.037**	**0.350**

1919-1939

		Incl. defaults		**Exc. defaults**	
	Def. Freq.	Std. Dev.	AR(1)	Std. Dev.	AR(1)
Latin America	**0.7**	**0.091**	**0.582**	**0.056**	**0.554**
Asia	**0.0**	**0.052**	**0.550**	**0.052**	**0.550**
Non-def Europe	**0.0**	**0.057**	**0.522**	**0.057**	**0.514**
Def. Europe	**0.7**	**0.075**	**0.519**	**0.059**	**0.380**
North America	**0.0**	**0.099**	**0.764**	**0.099**	**0.764**
Developing	**1.0**	**0.075**	**0.582**	**0.053**	**0.554**
Developed	**0.0**	**0.069**	**0.534**	**0.072**	**0.508**
Defaulters	**0.6**	**0.088**	**0.562**	**0.057**	**0.534**
Serial Defaulters	**0.7**	**0.091**	**0.647**	**0.065**	**0.604**
Non-defaulters	**0.0**	**0.057**	**0.571**	**0.056**	**0.571**

Table 2. Real GDP Volatility and Persistence and Countries' Repayment Records, 1960-2004
(in deviations from HP trend, group medians)

		Incl. Defaults		Excl. Defaults	
	Def. Freq.	Std. Dev.	AR(1)	Std. Dev.	AR(1)
Latin America	**1.00**	**0.041**	**0.619**	**0.037**	**0.619**
Asia def	**1.00**	**0.029**	**0.577**	**0.024**	**0.653**
Asia non-def	**0.00**	**0.043**	**0.504**	**0.043**	**0.504**
Africa def	**1.00**	**0.037**	**0.526**	**0.039**	**0.619**
Africa non-def	**0.00**	**0.057**	**0.511**	**0.057**	**0.511**
EEU def	**1.00**	**0.059**	**0.758**	**0.055**	**0.768**
EEU non-def	**0.00**	**0.024**	**0.600**	**0.024**	**0.600**
Developing	**1.00**	**0.042**	**0.622**	**0.038**	**0.653**
Developed	**0.00**	**0.021**	**0.592**	**0.021**	**0.592**
Defaulters	**1.00**	**0.044**	**0.620**	**0.038**	**0.619**
Serial Defaulters	**1.19**	**0.042**	**0.623**	**0.038**	**0.672**
Non-defaulters	**0.00**	**0.024**	**0.605**	**0.024**	**0.605**

Table 3. Determinants of Sovereign Spreads: 1870-1913 1/

(HP-filter measures of the output gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ir*	0.013	0.011	0.013	0.014	0.013	0.014	0.014	0.013
	(2.41)**	(2.62)***	(2.42)**	(2.12)**	(2.18)**	(2.15)**	(2.11)**	(2.16)**
Debt/GDP	0.01	0.015	0.009	0.007	0.008	0.007	0.007	0.008
	(12.88)***	(22.17)***	(8.48)***	(7.19)***	(8.10)***	(8.32)***	(8.22)***	(10.36)***
X/GDP	-0.005	-0.011	0.002	-0.001	0.003	0.005	0.005	-0.003
	(-2.02)**	(-8.09)***	(0.66)	(-0.32)	(1.77)*	(2.69)***	(2.67)***	(-1.00)
std_ε_t	0.152		0.111	0.099	0.13	0.145	0.146	0.12
	(9.73)***		(7.40)***	(5.66)***	(8.13)***	(8.36)***	(8.42)***	(7.22)***
ρ_t	0.004		0.004	0.002	0.001	0.002	0.002	0.003
	(5.66)***		(5.06)***	(2.91)***	(1.69)*	(2.07)**	(2.02)**	(2.97)***
std_ins(ε_t)		0.18						
		(5.57)***						
$\rho_{t\ (vins)}$		0.004						
		(4.12)***						
Dper			0.02	0.025	0.022	0.019	0.019	0.014
			(11.15)***	(10.25)***	(11.42)***	(10.88)***	(10.85)***	(5.93)***
Demp				-0.023	-0.019	-0.015	-0.015	-0.017
				(-11.22)***	(-11.14)***	(-10.95)***	(-10.80)***	(-11.00)***
Gold					-0.006	-0.006	-0.006	-0.006
					(-9.69)***	(-11.2)***	(-11.12)***	(-10.66)***
Def. history						0.041	0.042	0.038
						(8.77)***	(8.64)***	(8.74)***
Ext. Debt/Total Debt								0.005
								(3.11)***
TOT shock							0.0	
							(0.27)	
Observations	619	598	619	619	619	619	619	588
R-squared	0.24	0.23	0.26	0.31	0.36	0.37	0.37	0.31

1/ Robust t-ratios in parentheses. Dependent variable is the respective country's interest rate on long-term bonds minus the UK consol interest rate. A constant is included in all regressions. All explanatory variables except for TOT shock enter the regression one period lagged, as discussed in the main text.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 4. Determinants of Sovereign Spreads: 1870-1913 1/
(Beveridge-Nelson measures of the trend gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ir*	0.004	0.004	0.004	0.002	0.003	0.002	0.002	
	(0.72)	(0.58)	(0.63)	(0.3)	(0.36)	(0.31)	(0.34)	
Debt/GDP	0.014	0.015	0.014	0.013	0.013	0.013	0.013	0.014
	(11.52)***	(11.62)***	(9.01)***	(9.95)***	(9.45)***	(9.41)***	(9.16)***	(9.04)***
X/GDP	-0.012	-0.018	-0.022	-0.016	-0.017	-0.017	-0.019	-0.02
	(-3.20)***	(-4.00)***	(-4.20)***	(-3.84)***	(-3.72)***	(-3.71)***	(-3.59)***	(-3.81)**
std_ε_t	0.159	0.117	0.106	0.119	0.132	0.13	0.128	0.127
	(6.20)***	(4.34)***	(4.08)***	(4.77)***	(5.44)***	(5.31)***	(4.95)***	(4.96)**
ρ_t	0.002	0.002	0.001	0.001	0.001	0.001	0.001	0.001
	(5.58)***	(4.17)***	(2.96)***	(3.06)***	(2.52)**	(2.60)**	(2.98)***	(2.95)***
Dper		0.014	0.019	0.016	0.014	0.014	0.006	0.006
		(10.31)***	(9.82)***	(11.74)***	(11.89)***	(11.91)***	(3.12)***	(2.91)***
Demp			-0.02	-0.015	-0.014	-0.014	-0.018	-0.018
			(-11.02)***	(-12.49)***	(-12.51)**	(-12.29)**	(-11.10)***	(-10.45)***
Gold				-0.01	-0.008	-0.008	-0.009	-0.009
				(-9.61)***	(-9.01)**	(-9.00)**	(-9.46)***	(-9.21)***
Def. history					0.03	0.03	0.031	0.032
					(10.01)***	(10.05)***	(8.98)***	(8.41)***
Ext. Debt/Total Debt							0.01	0.011
							(4.06)***	(4.10)***
TOT shock						0.003		
						(1.39)		
Observations	424	424	424	424	424	424	413	413
R-squared	0.39	0.39	0.42	0.48	0.46	0.47	0.46	0.46

1/ Robust t-ratios in parentheses. Dependent variable is the respective country's interest rate on long-term bonds minus the UK consol interest rate. A constant is included in all regressions. All explanatory variables except for TOT shock enter the regression one period lagged, as discussed in the main text.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5. Determinants of Sovereign Spreads: 1925-1939 1/
(HP-filter measures of the output gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ir*	0.005 (0.53)	0.005 (0.66)	0.005 (0.64)	0.005 (0.57)	0.006 (0.80)	0.008 (1.08)	0.01 (1.35)	
Debt/GDP	0.004 (1.54)	0.001 (0.23)	0.003 (0.68)	0.004 (1.18)	0.004 (1.24)	0.009 (5.64)***	0.009 (4.58)***	0.008 (5.67)***
X/GDP	-0.057 (4.61)***	-0.051 (-3.97)***	-0.052 (4.77)***	-0.045 (3.53)***	-0.042 (3.94)***	-0.028 (3.84)***	-0.026 (3.01)***	-0.03 (4.48)***
std_ε_t	0.333 (3.93)***		0.503 (4.47)***	0.329 (3.01)***	0.205 (2.25)**	0.083 (1.51)	0.119 (1.75)*	0.085 (1.55)
ρ_t	0.02 (3.89)***		0.022 (4.09)***	0.018 (3.38)***	0.017 (3.51)***	0.01 (2.14)**	0.01 (2.29)**	0.009 (2.08)**
std_ins(ω_t)		0.168 (2.95)**						
$\rho_{t\ (vins)}$		0.007 (1.81)*						
Dperiphery			0.018 (5.43)***	0.028 (5.57)***	0.029 (6.06)***	0.015 (3.04)***	0.015 (2.97)***	0.015 (3.09)**
Dempire				-0.027 (5.00)***	-0.025 (4.33)***	-0.017 (3.22)***	-0.016 (3.15)***	-0.017 (3.27)***
Gold					-0.007 (5.01)***	-0.007 (6.46)***	-0.007 (6.31)***	-0.007 (6.92)**
Def. history						0.08 (4.29)***	0.079 (4.59)***	0.079 (4.30)***
Ext. Debt/Total Debt								
TOT shock							0.001 (0.51)	
Observations	305	305	305	305	305	305	295	305
R-squared	0.12	0.11	0.19	0.23	0.33	0.52	0.53	0.52

1/ Robust t-ratio in parenthesis. Dependent variable is the respective country's interest rate on long-term bonds minus the UK consol interest rate. A constant is included in all regressions. All explanatory variables except for TOT shock enter the regression one period lagged, as discussed in the main text.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6. Determinants of Sovereign Spreads: 1925-1939 1/
(Beveridge-Nelson measures of the trend gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ir*	0.004	0.005	0.004	0.005	0.005	0.007	0.016	
	(0.45)	(0.53)	(0.43)	(0.71)	(0.88)	(1.15)	(1.95)*	
Debt/GDP	0.002	0.003	0.008	0.006	0.01	0.01	0.036	0.01
	(0.78)	(0.76)	(2.29)**	(2.40)**	(6.06)***	(5.09)***	(7.82)***	(6.10)***
X/GDP	-0.053	-0.05	-0.048	-0.043	-0.037	-0.038	-0.029	-0.038
	(-4.43)***	(-3.71)***	(-3.93)***	(-5.01)***	(-5.41)***	(-4.54)***	(-1.16)	(-5.82)***
std_ε_t	0.084	0.384	0.309	0.272	0.128	0.149	0.18	0.128
	(1.67)*	(3.78)***	(2.57)**	(2.99)***	(2.55)**	(2.37)**	(1.36)	(2.57)**
ρ_t	0.015	0.004	0.004	0.004	0.002	0.002	0.004	0.002
	(2.12)**	(3.03)**	(3.32)**	(2.98)**	(2.12)**	(2.01)**	(2.34)**	(2.06)**
Dperiphery		0.021	0.029	0.026	0.014	0.015	0.021	0.014
		(4.69)**	(5.24)**	(6.17)**	(3.13)**	(3.02)**	(1.26)	(3.13)***
Dempire			-0.031	-0.027	-0.02	-0.021	-0.007	-0.02
			(-4.72)***	(-4.97)***	(-3.92)***	(-3.84)***	(-0.81)	(-3.93)***
Gold				-0.008	-0.007	-0.007	-0.007	-0.007
				(-5.25)**	(-6.67)**	(-6.53)**	(-4.87)***	(-7.04)***
Def. history					0.079	0.077	0.104	0.079
					(4.24)***	(4.42)***	(9.85)***	(4.23)***
Ext. Debt/Total Debt							-0.019	
							(-1.67)*	
TOT shock						0.001		
						(0.49)		
Observations	302	302	302	302	302	292	100	302
R-squared	0.12	0.17	0.28	0.41	0.56	0.53	0.56	0.56

1/ Robust t-ratios in parentheses. Dependent variable is the respective country's interest rate on long-term bonds minus the UK consol interest rate. A constant is included in all regressions. All explanatory variables except for TOT shock enter the regression one period lagged, as discussed in the main text.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 7. Determinants of Sovereign Spreads, 1994-2005 1/
(HP-filter measures of the output gap)

	(1)	(2)	(3)	(4)	(7)	(5)	(6)	(8)	(9)
ir*	0.217	0.210	0.215	0.207	0.205	0.210	0.218	0.222	0.180
	(1.57)	(1.51)	(1.51)	(1.53)	(1.54)	(1.57)	(1.54)	(1.53)	(1.31)
Debt/GDP	0.124	0.123	0.125	0.125	0.134	0.126	0.124	0.126	0.105
	(3.98)**	(3.82)**	(4.10)**	(5.12)**	(6.22)**	(4.22)**	(4.24)**	(3.85)**	(3.63)**
X/GDP	-0.157	-0.152	-0.156	-0.156	-0.158	-0.149	-0.149	-0.158	-0.162
	(4.85)***	(4.71)***	(5.23)***	(4.48)***	(5.06)***	(5.10)***	(4.07)***	(5.18)***	(4.81)***
std_ε_t	1.118	1.163	1.643	1.554	1.584	1.455	1.689	1.600	1.795
	(1.61)	(1.63)	(2.37)**	(2.08)**	(2.19)**	(2.03)**	(2.58)***	(2.27)**	(2.81)***
ρ_t	0.054	0.053	0.046	0.048	0.050	0.049	0.047	0.055	0.047
	(3.17)***	(3.01)***	(2.80)***	(3.74)***	(3.51)***	(3.56)***	(3.04)***	(3.07)***	(3.49)***
Def. history		0.043	0.077	0.067	0.069	0.074	0.089	0.083	0.062
		(1.59)	(2.71)***	(2.54)**	(2.42)**	(2.37)**	(2.98)***	(2.86)***	(2.20)**
DAsia			0.023	0.025	0.027	0.018	0.026	0.019	0.012
			(1.90)*	(1.98)**	(2.09)**	(1.45)	(2.13)**	(1.53)	(0.97)
FX regime				0.003					
				(0.72)					
REER misalignment					0.018				
					(0.48)				
TOT shock						-0.070			
						(-1.42)			
Ext. Debt/Total Debt							-0.014		
							(-0.56)		
% Short-term Debt								0.000	
								(-0.75)	
Reserves/M2									-0.094
									(-3.29)***
Observations	177	177	177	177	177	177	177	171	177
Number of countries	26	26	26	26	26	26	26	25	26
R-squared	0.45	0.5	0.51	0.51	0.51	0.51	0.51	0.52	0.53

1/ Robust t-statistics in parentheses. Dependent variable is the respective country's spread on long-term bonds relative to the US instrument the US instrument of similar maturity (JP Morgan's EMBI index). A constant is included in all regressions. All explanatory are lagged one-year with the exception of terms of trade shock, as discussed in the text.

Table 8. Determinants of Sovereign Spreads, 1994-2005 1/

(Beveridge-Nelson measures of the trend gap)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ir*	0.223	0.218	0.225	0.218	0.224	0.200	0.221	0.209	0.200
	(1.65)	(1.58)	(1.69)*	(1.66)*	(1.69)*	(1.61)*	(1.58)	(1.53)	(1.53)
Debt/GDP	0.124	0.124	0.122	0.120	0.134	0.131	0.133	0.135	0.106
	(4.24)***	(4.27)***	(4.58)***	(5.11)***	(6.54)***	(3.85)***	(5.12)***	(4.31)***	(4.02)***
X/GDP	-0.125	-0.117	-0.122	-0.117	-0.127	-0.124	-0.121	-0.126	-0.117
	(-3.94)***	(-3.74)**	(-4.58)**	(-4.28)**	(-4.96)**	(-3.91)**	(-4.12)**	(-3.92)**	(-4.28)**
std_ε_t	1.028	0.989	1.244	1.242	1.275	0.950	1.242	1.200	1.354
	(1.79)*	(1.70)*	(2.03)**	(1.89)*	(2.02)**	(1.49)	(1.93)*	(1.71)*	(2.11)**
ρ_t	0.005	0.006	0.010	0.011	0.010	0.010	0.012	0.010	0.010
	(1.05)	(1.15)	(1.58)	(1.70)*	(1.47)	(1.66)*	(1.91)*	(1.58)	(1.50)*
Def. history		0.035	0.080	0.079	0.070	0.071	0.072	0.072	0.063
		(1.31)	(2.47)**	(2.51)**	(2.20)**	(1.83*)	(1.90)*	(2.04)**	(1.69)*
DAsia			0.033	0.037	0.041	0.038	0.042	0.022	0.024
			(1.99)*	(2.22)*	(2.22)*	(2.16)*	(2.25)*	(1.14)	(1.10)
FX regime				0.003					
				(0.77)					
REER misalignment					0.029				
					(0.76)				
TOT shock						-0.074			
						(-1.42)			
Ext. Debt/Total Debt							-0.013		
							(0.46)		
% Short-term Debt								0.000	
								(0.31)	
Reserves/M2									-0.074
									(-2.74)**
Observations	173	173	173	173	173	173	173	167	173
Number of countries	26	26	26	26	26	26	26	25	26
R-squared	0.45	0.5	0.51	0.51	0.51	0.51	0.51	0.52	0.53

1/ Robust t-statistics in parentheses. Dependent variable is the respective country's spread on long-term bonds relative to the US instrument of similar maturity (JP Morgan's EMBI index). A constant is included in all regressions. All explanatory are lagged one-year with the exception of terms of trade shock, as discussed in the main text.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 9. Determinants of the Default Premium, 1870-1939 1/
(HP-filter measures of the output gap)

	(1)	(2)	(3)	(4)	(5)	(6)
ir*	0.237	0.277	0.303	0.091	0.106	0.109
	(1.20)	(1.35)	(1.44)	(0.80)	(0.87)	(1.09)
Debt/GDP	-0.029	-0.014	0.006	0.079	0.102	0.091
	(1.11)	(0.59)	(0.32)	(3.53)***	(3.45)**	(3.60)**
X/GDP	-0.004	-0.003	-0.003	-0.009	-0.056	0.069
	(-0.86)	(-0.79)	(-0.76)	(-3.34)**	(-0.38)	(-0.44)
std_gap_t	-1.046	-1.271	-1.483	-1.659	-1.654	-1.765
	(-1.71)*	(-1.89)*	(-1.98)**	(-2.27)**	(-2.25)**	(-2.27)**
ρ_t	0.125	0.163	0.262	0.171	0.169	0.083
	(1.66)*	(1.84)*	(2.36)**	(2.51)**	(2.52)**	(1.68)*
Dperiphery		-0.072	-0.112	-0.218	-0.244	-0.283
		(-2.30)**	(-2.76)**	(-3.14)***	(-3.03)***	(-2.79)***
Gold			0.104	-0.035	-0.034	-0.051
			(-1.98)**	(-0.84)	(-0.63)	(-1.54)
Def. history				0.402	0.447	0.395
				(2.56)**	(2.53)**	(2.67)***
TOT shock					-0.288	-0.258
					(-2.17)**	(-2.11)**
Ext. Debt/Total Debt						0.133
						(1.76)*
Observations	66	66	66	66	63	74
R-squared	0.15	0.17	0.19	0.35	0.40	0.41

1/ Robust t statistics in parentheses. In all regressions, the dependent variable is the difference between the spread of a country in default and the mean spread of all other countries not in default in that year.

* significant at 10%; ** significant at 5%; *** significant at 1%

Table 10. Determinants of the Default Premium, 1870-1939 1/

(Beveridge-Nelson measures of the trend gap)

	(1)	(2)	(3)	(4)	(5)	(6)
ir*	0.397	0.482	0.474	0.287	0.311	0.31
	(1.50)	(1.60)	(1.58)	(1.97)**	(2.13)**	(2.06)**
Debt/GDP	-0.058	-0.05	-0.04	0.06	0.078	0.078
	(-1.43)	(-1.40)	(-1.25)	(3.82)***	(4.24)***	(4.21)***
X/GDP	-0.328	-0.18	-0.341	0.831	0.802	0.806
	(-1.80)*	(-0.86)	(-1.11)	(-1.77)*	(-1.74)*	(-1.79)*
std_gap_t	-0.989	-1.224	-1.23	-1.776	-1.772	-1.771
	(-1.75)*	(-1.79)*	(-1.79)*	(-2.53)**	(-2.55)**	(-2.53)**
ρ_t	0.105	0.144	0.166	0.146	0.15	0.15
	(1.68)*	(1.75)*	(1.74)*	(2.21)**	(2.26)**	(2.23)**
Dperiphery		-0.103	-0.133	-0.309	-0.335	-0.333
		(-1.69)*	(-1.67)*	(-2.64)***	(2.81)***	(2.52)***
Gold			0.08	-0.283	-0.269	-0.271
			(1.05)	(2.26)**	(2.16)**	(2.23)**
Def. history				0.678	0.694	0.697
				(2.60)***	(2.66)***	(2.77)***
TOT shock					-0.215	-0.215
					(-2.35)**	(-2.33)**
Ext. Debt/Total Debt						-0.005
						(-0.08)
Observations	64	64	64	64	64	64
R-squared	0.24	0.26	0.27	0.49	0.53	0.53

1/ Robust t statistics in parentheses. In all regressions, the dependent variable is the difference between the spread of a country in default and the mean spread of all other countries not in default in that year.

* significant at 10%; ** significant at 5%; *** significant at 1%