The Importance of Sovereign Reference Rates for Corporate Debt Issuance: Mind the Gap

Sjoerd van Bekkum, Bruce D. Grundy and Patrick Verwijmeren

February 7, 2019

Abstract

We show that sovereign bond reference rates are theoretically and empirically important determinants of corporate bond issuance and maturity. By providing reference rates, government issues complement corporate issues. Government and corporate bond issues are also substitutes and corporations issue more long-term bonds when sovereign alternatives are in short supply. The substitution weakens when sovereign bonds fail to provide high-quality reference rates and we conclude that reference rates are a prerequisite for gap-filling behavior in an international sample. Introductions and suspensions of sovereign bond issues that change the maximum reference rate precede similar changes in the maximum maturity of corporate issues.

Van Bekkum (vanbekkum@ese.eur.nl) is with the Erasmus School of Economics, Erasmus University Rotterdam. Grundy (bruceg@unimelb.edu.au) is with the Faculty of Business and Economics, University of Melbourne. Verwijmeren (verwijmeren@ese.eur.nl) is with the Erasmus School of Economics, Erasmus University Rotterdam, and the Faculty of Business and Economics, University of Melbourne. We thank Effie Benmelech, Antje Berndt, Doug Diamond, Andrea Eisfeldt, Mark Flannery, Mark Grinblatt, Zhiguo He, David Musto, Mary Pieterse-Bloem, Dimitri Vayanos and seminar participants at the Australian National University, University Technology Sydney, and the Doug Diamond 65th Birthday Conference for valuable comments. We thank Dan Li and Matthijs Pauli for excellent research assistance.

The government bond market prices 'risk-free' debt across a maturity spectrum .... A dependable yield curve is built on having sufficient depth in tranches across the maturity spectrum to provide reliable prices. It is with regard to longer maturities, however, that the contribution of the (Government Securities) market will be most acutely missed if the market was to be extinguished. ... it [is] a particularly valuable pricing discovery tool (benchmark) for other instruments.

Industry response to a 2002 Treasury proposal to retire all Australian government debt

1. Introduction

Prior research shows that corporations supply relatively safe securities to investors when sovereign alternatives are in short supply. Such "gap filling" has been documented in US markets by Greenwood, Hanson and Stein (2010), Graham, Leary and Roberts (2014, 2015), and Badoer and James (2016). Lugo and Piccillo (2016) documents that gap filling occurs in Euro-zone countries. Demirci, Huang and Sialm (2017) demonstrates a negative relation between government debt and corporate leverage in 40 countries. In short, corporate and sovereign bonds of a given maturity can be substitutes. However, when long-maturity sovereign bonds are scarce and fail to provide a reference rate for long-maturity corporate issues, investors will have difficulty in valuing and hedging long-maturity corporate bonds and firms will face high underwriting costs if they do issue long-maturity bonds. We extend the model developed in Greenwood, Hansen and Stein (2010) and Krishnamurthy and Vissing-Jorgensen (2012) to the choice of debt maturity when the sovereign bond market does not provide high-quality reference rates. When there is investor demand for long-maturity corporate bonds but no long-maturity sovereign bonds to provide a benchmark, corporations face a challenge in filling the gap and may instead choose to mind the gap.

Absent a liquid market in long-term bonds, corporations must determine the amount of long-term debt to issue without a clear price signal as to the strength of preferred-habitat investor demand. Corporate issuers hire risk-averse underwriters who charge a fee to cover the difference between a bond's issue price and its expected post-issue market price plus a reward for bearing the associated risk. The payoff from long-term corporate debt issues is chosen to minimize the sum of the total of the expected cost of repaying both short- and long-term bonds and the cost of deviating from the target bond maturity structure. Since underwriting fees reduce the net amount raised by issuing long-term bonds, raising any given amount of debt capital will require issuing more short- and/or long-term bonds.

The model's main prediction is the reference rate hypothesis, namely that the optimal amount of long-term debt capital raised is lower when uncertainty about the strength of preferred-habitat investor demand is higher. Uncertainty about the price at which long-term bonds can be sold increases as the quality of the reference rates provided by the sovereign market declines, in which case corporations become less willing to borrow long-term. To empirically investigate this prediction, we use a data set of 14 countries' sovereign and corporate bond issues between 1991 and 2017, and explicitly allow for the possibility of *not* issuing bonds that would otherwise fall into particular country-year-maturity bins. Examining bond issues rather than the maturities of outstanding bonds allows us to observe the incremental response in corporate issuance behavior at various points along the maturity spectrum. In line with the reference rate hypothesis, we document that firms rarely issue bonds with maturities longer than that of their home country's sovereign bonds.

There are three reasons why we conclude that a reference rate effect is an important determinant of the maturity of corporate bond issues and that the observed link between sovereign and corporate bond maturity is not purely an endogenous reflection of either differences in countries' political risks and institutional environments or differences in preferred habitat investor demand across countries and time. First, both corporations and financial authorities from various countries state directly that benchmarking is an important motivation for altering the available maturities of sovereign bonds. A 2009 report of the Central Bank of Malaysia and the Securities Commission Malaysia gave as a specific objective of the choice of the maturity of sovereign issues the development of reference rates.[1] When Singapore introduced 30-year sovereign bonds, the Bank of International Settlements noted the importance of sovereign reference rates for the

[1] "*The Government is committed to continuously issue 3-year, 5-year, and 10-year MGS [Malaysian Government Securities] as benchmark securities as part of its efforts to develop the benchmark yield curve. … . In addition, 15-year and 20-year MGS have also been issued to lengthen the benchmark yield curve*."

development of the corporate bond market.[2] A Bank for International Settlements study, Brooke et al. (2001), notes that "*Larger governments in the euro area have been particularly active in adapting their maturity profiles to demand, in an effort to establish their securities as benchmark instruments at different points along the yield curve.*" It is natural for policy makers to focus on how the maturity of sovereign debt affects corporate debt maturity since debt maturity affects corporate behavior in the event of credit and liquidity shocks (Diamond, 1991).[3]

Second, our analysis of an international data set of 48,085 corporate bond issues and 31,474 sovereign bond issues from 14 countries over a 27-year period with granular observations on the bonds' maturities documents strong evidence of both gap filling in general (in both an international context and with a finer partition of maturity bins than examined in prior studies) and a reduction in gap filling when sovereign bonds fail to provide a high-quality reference rate. While an omitted common driver may explain our observation that corporate issuance of bonds of a given maturity is low when sovereign issuance at that maturity is also low, we verify that our results hold after including firm-year fixed effects and stress that it is the willingness of corporations to fill gaps when sovereign bond issuance is low but still high enough to provide a useful benchmark that points to the importance of reference rates. The percentage of all corporate issues in a given country and year that fall in a country-year-maturity bin is significantly positively related to whether the sovereign yield curve provides a benchmark either directly or indirectly via interpolation.

Third, we observe via a quasi-natural experiment that the introduction of sovereign bonds that increase the tenor of reference rates precedes the issuance of corporate debt of the new longer maturity. Conversely, the suspension of sovereign bonds in a certain maturity segment is followed by a suspension of corporate bonds in that same segment. The observed relative timing of changes in the maturities of sovereign and corporate bonds is unlikely in the absence of a reference rate

[2] "… *with the improvement of liquidity to the market, the provision of a robust government yield curve was possible, thus stimulating the growth of the domestic corporate debt market which was able to price off the benchmark curve.*" See https://www.bis.org/publ/bppdf/bispap67w.pdf

[3] Almeida, Campello, Laranjeira, and Weisbenner (2011) show that the maturity structure of corporate debt had important causal effects on investment cuts in the 2007-2008 financial crisis.

effect as a common omitted variable driving the maturity changes of both corporate and sovereign bonds would not imply leader-follower behavior unless sovereigns react faster than corporations.

Our investigation of reference rates has broad implications for the sovereign's role in well-functioning capital markets. Following a formal review of the Australian Commonwealth Government Securities Market in 2002 that considered industry, regulator and academic submissions, the Australian government decided not to retire all its long-term debt. The government chose instead to create a sovereign wealth fund and retain the long-term sovereign bond market. Ricardian equivalence implies that a sovereign wealth fund effectively financed via long-term sovereign debt simply nets to zero and has no implications for consumer welfare. But, like other irrelevance theorems, Ricardian equivalence presumes the absence of information asymmetries. When sovereign bonds provide valuable pricing guides for corporations considering undertaking long-term debt-financed investments, government debt and government assets do not simply offset. Rather, the debt component of the combination provides reference rates useful in pricing long-term payoffs. Reference rates can guide long-term investment decisions as well as facilitate their financing, thereby enhancing consumer and investor welfare.

The paper is organized as follows. Section 2 describes related literature and models the corporate debt maturity decision in the absence of a reference rate. Section 3 describes our international dataset of corporate and sovereign bond issues. Section 4 documents both gap filling and a reference rate effect in our data set that covers 14 countries and spans 27 years. Section 5 documents that gap-filling behavior is stronger when sovereign bonds provide a more precise benchmark. Section 6 investigates a quasi-natural experiment and documents the effects of extensions and reductions in the maximum tenor of sovereign reference rates on the maturity of corporate bond issues. Section 7 concludes.

2. Reference Rates and the Corporate Choice of Debt Maturity

A large literature investigates the determinants of the maturity of corporate bonds. When it is costly to issue debt, Flannery (1986) shows that a separating equilibrium can exist in which firm quality and debt maturity are linked. Good firms can prefer to bear the additional transactions costs of rolling over (short-term) bonds in order to separate from lower-valued bad firms and bad firms can prefer to issue long-term bonds and bear only one round of transactions costs even though it means revealing their type. Diamond (1991, 1993) considers a setting in which firms have private information about their future credit ratings and develops a model in which borrowers with good private information trade off the incentive to issue short-term debt against the inefficient liquidation incentives of lenders and conclude that borrowers with high credit ratings and borrowers with low credit ratings will both issue short-term debt, while other borrowers will prefer long-term debt. Stohs and Mauer (1996) document such an empirical relation in US data. Guedes and Opler (1996) also model inefficient liquidation and conclude that although risky firms have an incentive not to issue short-term debt, they are screened out of the long-term debt market because of their incentive to undertake asset substitution. Barclay and Smith (1995) report that firms with larger information asymmetries are more likely to issue short-term debt. Myers (1977) observes that firms whose assets are primarily growth opportunities will be averse to borrowing so as not to distort their investment incentives, while firms with assets-in-place face less of a debt overhang problem. Assets-in-place can serve as collateral and maturity matching will tie the maturity of corporate debt to the duration of the issuer's assets. Badoer and James (2016) is motivated by insurance companies' desire to invest in long-term bonds since the bonds' payoffs will match the maturity of insurers' long-dated liabilities.

There are a number of empirical investigations of cross-country differences in the maturity of corporate bonds. Demirgüç-Kunt and Maksimovic (1999) and Fan, Titman and Twite (2012) conclude that governments have a role in facilitating the issuance of long-term debt by reducing corruption and strengthening investor protection laws. Almeida, Cunha, Ferreira and Restrepo (2017) document a credit rating channel through which sovereign downgrades reduce both investment and bond issues in a country while increasing the yield on corporate debt. This suggests that sovereign and corporate bond maturity may be linked through political risk.

Our contribution to the literature on corporate bond maturity is to study the role of reference rates in well-functioning capital markets. A study by Dittmar and Yuan (2008) examines the pricing of 98 dollar-denominated sovereign bonds and 239 dollar-denominated corporate bonds in eight emerging markets and concludes that adding more sovereign bonds to the set of emerging market bonds increases the average annual Sharpe ratio by approximately 54%. It further concludes that dollar-denominated sovereign bonds play a role in price-discovery in that one-fifth of the information in corporate yield spreads measured relative to US treasury rates is traced to innovations in sovereign yield spreads and that the issuance of dollar-denominated sovereign bonds lowers corporate yield spreads and bid-ask spreads.

We model a firm's choice of debt maturity when the issuance of long-term sovereign bonds has two effects. First, corporations and the sovereign act as substitute suppliers to preferred-habitat investors and gap filling is the natural result. Second, the quality of the price signal provided by the reference rate yield on long-term sovereign bonds is affected by the liquidity of the sovereign bond market. Via this second channel, sovereign bond issues that improve the quality of the sovereign reference rate complement the issuance of corporate bonds.

2.1 Model intuition

When pricing corporate debt and calculating credit spreads, it is customary to use the yield on a sovereign debt security of the same maturity and currency as a reference rate (Duffie and Singleton, 2003). The sovereign yield curve contains information about expectations of the macroeconomy and future monetary policy decisions. Data providers such as Bloomberg routinely provide sovereign bond yield curves as benchmark rates. The benchmark status of sovereign debt comes about for a number of reasons listed in Brooke et al. (2001) as "*First, governments in most of the industrial countries are perceived to be the most creditworthy of borrowers; their securities are ... essentially free of the risk of default. Second, the large amount of government debt outstanding and the fungibility of issues facilitate trading. Therefore, government paper, especially the most recently issued ... tends to be more liquid ... . Third, owing to their large borrowing needs and long life, governments are able to offer a wider range of maturities than* *many other borrowers.*"[4] We incorporate the utility of a reference rate into our model by assuming that the cost of underwriting a corporate bond is lower when a sovereign bond provides a reference rate at the corporate bond's maturity.

Our model extends Greenwood, Hansen and Stein (2010) (GHS) by assuming that preferred-habitat investor demand for long-term bonds is uncertain. As in GHS, a low level of long-term sovereign bonds issuance leads to low long-term interest rates and an incentive for corporate issuers to fill the gap. But when long-term sovereign bonds are so scarce they fail to provide high-quality benchmarks, corporations will be less willing to issue long-term bonds given the associated high underwriting fees. Thus, rather than corporate long-term issuance being simply negatively related to the value of long-term sovereign bonds outstanding, our model predicts that the relation between the corporate and sovereign bond markets also involves a positive relation between corporate bond issuance and the quality of the signal provided by the traded prices of long-term sovereign bonds.

2.2 A model of the effect of reference rates on corporate bond maturity

At time 0 corporations and the sovereign issue short-term bonds maturing at time 1 and may also issue long-term bonds maturing at time 2. Short-term bonds issued by corporations at time 0 are rolled over at time 1. Firms wish to raise debt capital of C at time 0 with effective repayment at time 2. Preferred-habitat investors have a specific demand for long-term bonds maturing at time 2.[5] The modelling proceeds in two steps. Subsection 2.2.1 sets out a simplified version of the GHS (2010) gap-filling model. Subsection 2.2.2 introduces uncertainty about the strength of preferred-habitat demand and shows that a reduction in the size of the sovereign bond market not only creates a force for corporations to fill the gap, but also a second force to mind a

---

[4] Brooke et al. (2001) also discusses why the swap market does not provide an alternate source of benchmark rates. Trading in interest rate swaps is concentrated in very short maturities and the market becomes illiquid beyond five years. Further, swaps are not free of counterparty credit risk and this risk is heightened in times of market stress. Finally, swaps are administratively burdensome and relatively expensive to process.

[5] Greenwood and Vayanos (2010) demonstrate the important role played by preferred-habitat investors in the pricing of long-term bonds through an analysis of the effect on yields of the 2004 UK Pensions Act. Of the 14 countries in our dataset, the UK has the longest maximum tenor of its sovereign yield curve at 50 years. The UK also has the longest average and median maturity for its corporate bonds at 13.9 years and 10.0 years, respectively.

gap when its width must be estimated without high quality signals coming from the sovereign market.

2.2.1 Non-stochastic preferred-habitat investor demand for long-term bonds

In the GHS (2010) model of gap filling, the time 0 preferred-habitat investor demand for time 2 payoffs is L and the sovereign supplies long-term bonds worth G at time 0. Corporations determine the amount that their long-term bonds will pay at time 2. This payoff is denoted by H. Equating the supply and demand for long-term bonds gives

$$HP + G = L, \tag{1}$$

where P is the time 0 price of a dollar to be received at time 2. The time 0 price of a dollar at time 2 adjusts such that corporations are willing to fill any gap between preferred-habitat investor demand and the amount of sovereign long-term bonds issued.

The equilibrium value of P will be such that the fraction of corporate debt that is long-term minimizes the total time 2 expected cost of issuing corporate debt: The expected time 2 repayment of the firm's short- and long-term debt plus the cost of deviating from the corporation's target maturity structure, z. Assume that the time 2 cost of deviating from the target maturity structure is given by $\theta C\left(\frac{HP}{C}-z\right)^2 \Big/ 2$. The θ parameter is a measure of the cost of deviating from the target debt maturity structure. The total cost of debt financing is

$$H + (C - HP)(1+r_1)(1+E\{\tilde{r}_2\}) + \theta C\left(\frac{HP}{C}-z\right)^2 \Big/ 2.$$

The cost-minimizing level of H, H^*, solves the first-order condition

$$1 - P\left((1+r_1)(1+E\{\tilde{r}_2\}) - \theta\left(\frac{HP}{C}-z\right)\right) = 0. \tag{2}$$

Substituting (1) into (2) gives the time 0 market clearing price of a dollar at time 2 as

$$P = \frac{1}{(1+r_1)(1+E\{\tilde{r}_2\}) - \theta\left(\frac{L-G}{C}-z\right)}.$$

The "gap" is the difference between preferred-habitat demand for long-term bonds and the sovereign bonds issued, i.e., $L - G$. When the gap is equal to the corporate target amount of long-term corporate debt, zC, the expectations hypothesis holds. When the gap exceeds (is less than) the target, corporations are willing to issue more (less) than their target amount of long-term bonds provided the long-term interest rate, P^{-1}, is less than (greater than) the compounded expected short rate.

2.2.2 Stochastic preferred-habitat investor demand for long-term bonds

We extend the GHS model by recognizing that preferred-habitat investor demand for long-term bonds, L, is stochastic and that sovereign bond yields can provide a signal of the price at which long-term corporate bonds will trade post-issue. Equating the supply and demand for long-term bonds gives

$$P = \frac{L - G}{H}.$$

Let T denote the traded price of a sovereign bond paying one dollar at time 2 and assume that T is a noisy signal of P. The quality of long-term sovereign bond prices as signals of the post-issue price at which long-term corporate bonds will trade is decreasing in the noise. When sovereign bonds provide a less than perfect signal, corporations hire underwriters to guarantee the amount to be raised. Underwriters buy the bonds at their issue price of D and bear the risk associated with reselling them at their equilibrium price HP. Underwriters have mean-variance utility with risk tolerance of γ^U. The underwriters charge a fee, denoted by $F(H;T)$, that covers both the expected difference between the issue price and the expected resale price of the bonds and a reward for bearing the risk associated with the resale price. Underwriter wealth, W, is then

$$W = F(H;T) + HP - D.$$

Underwriter expected utility, $E\{U(W|T)\}$, is

$$\begin{aligned} E\{U(W|T)\} &= E\{W|T\} - \frac{Var\{W|T\}}{2\gamma^U} \\ &= F(H;T) - D + HE\{P|T\} - \frac{H^2 Var\{P|T\}}{2\gamma^U}. \end{aligned}$$

Consistent with the price discovery role of sovereign bonds examined in Dittmar and Yuan (2008), reference rates are of higher quality when $Var\{P|T\}$ is lower.

Competitive underwriters will set the fee such that

$$F(H;T) = D - HE\{P|T\} + \frac{H^2 Var\{P|T\}}{2\gamma^U}.$$

For a given difference between the issue price and expected value of the corporate bonds, the fee is higher when uncertainty about the bonds' resale value is higher. The amount raised net of the underwriting fee is

$$\begin{aligned} V(H;T) &\equiv D - F(H;T) \\ &= HE\{P|T\} - \frac{H^2 Var\{P|T\}}{2\gamma^U}, \end{aligned}$$

and the total time 2 expected cost of debt financing is

$$H + \big(C - V(H;T)\big)(1+r_1)\big(1+E\{\tilde{r}_2\}\big) + \theta C\left(\frac{V(H;T)}{C} - z\right)^2 \Big/ 2. \tag{3}$$

Corporations act as price-takers and treat $E\{P|T\}$ and $Var\{P|T\}$ as unaffected by their choice of how much long-term debt to issue. The cost-minimizing level of *H*, H^*, solves the first-order condition (*FOC*).

$$1 + \left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\left(-(1+r_1)\big(1+E\{\tilde{r}_2\}\big) + \theta\left(\frac{V(H^*;T)}{C} - z\right)\right) = 0. \tag{4}$$

The following Lemma establishes that $\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*} > 0$ and the *FOC* then implies that

$$-(1+r_1)\big(1+E\{\tilde{r}_2\}\big) + \theta\left(\frac{V(H^*;T)}{C} - z\right) < 0. \tag{5}$$

Lemma: $\frac{\partial V(H;T)}{\partial H} > 0$ *at the cost minimizing level of H.*

The proof proceeds by contradiction. Let $H^{**} > 0$ denote the solution for the optimal long-term bond payoff and suppose that $\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^{**}} < 0$. Since $V(H;T)$ is a quadratic in *H* with the properties that $\frac{\partial V^2(H;T)}{\partial H^2} < 0$, $V(H;T)\big|_{H=0} = 0$ and $\frac{\partial V(H;T)}{\partial H}\bigg|_{H=0} > 0$, there exists a value H such that $0 < H < H^{**}$ and $V(H;T) = V(H^{**};T)$. The first component of the total cost of debt financing as set out in (3) is lower at a payoff level of H rather than H^{**}. Both the second and third components of the total cost of debt financing depend on H only through $V(H;T)$ and therefore take on the same values at payoff levels of H and H^{**}. Considering all three components, we see that the purported solution cannot minimize the cost of debt-financing and the lemma is established by contradiction. ■

Our interest is in the relation between H^* and the quality of the price signal provided by the sovereign bond market, in particular in the partial of H^* with respect to $Var\{P|T\}$ holding constant the expectation $E\{P|T\}$.

$$\frac{\partial H^*}{\partial Var\{P|T\}} = -\frac{\partial FOC \big/ \partial Var\{P|T\}\big|_{H=H^*}}{\partial FOC \big/ \partial H\big|_{H=H^*}} \tag{6}$$

A necessary condition for H^* to minimize the total expected cost in (3) is that the second-order condition be satisfied; i.e., that the denominator of the right-hand-side of (6) is positive. The denominator is

$$\frac{\partial FOC}{\partial H}\bigg|_{H=H^*} = \frac{\partial^2 V(H;T)}{\partial H^2}\bigg|_{H=H^*}\left(-(1+r_1)(1+E\{\tilde{r}_2\}) + \theta\left(\frac{V(H^*;T)}{C} - z\right)\right) + \frac{\theta}{C}\left(\frac{\partial V(H;T)}{\partial H}\right)^2\bigg|_{H=H^*}.$$

Since $\frac{\partial^2 V(H;T)}{\partial H^2}\big|_{H=H^*} = -\frac{Var\{P|T\}}{\gamma^U}$, the above relation can be rewritten as

$$\frac{\partial FOC}{\partial H}\bigg|_{H=H^*} = \left(-\frac{Var\{P|T\}}{\gamma^U}\right)\left(-(1+r_1)(1+E\{\tilde{r}_2\}) + \theta\left(\frac{V(H^*;T)}{C} - z\right)\right) + \frac{\theta}{C}\left(\frac{\partial V(H;T)}{\partial H}\right)^2\bigg|_{H=H^*}.$$

Recalling the inequality in (5), it follows that $\left.\frac{\partial FOC}{\partial H}\right|_{H=H^*} > 0$ and the second-order condition for a minimum is satisfied. Thus, we have shown that the denominator of the right-hand-side of (6) is positive.

It follows that when the numerator of (6) is positive, a decrease in the quality of the signal will be associated with a decline in the optimal payoff from long-term corporate bonds. The numerator of (6) is

$$\left.\frac{\partial^2 V(H;T)}{\partial H \partial Var\{P|T\}}\right|_{H=H^*}\left(-(1+r_1)(1+E\{\tilde{r}_2\})+\theta\left(\frac{V(H^*;T)}{C}-z\right)\right)+\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\frac{\theta}{C}\left.\frac{\partial V(H;T)}{\partial Var\{P|T\}}\right|_{H=H^*}.$$

Substituting for the cross-partial and the partial with respect to $Var\{P|T\}$, the numerator equals

$$\left(-\frac{H^*}{\gamma^U}\right)\left(-(1+r_1)(1+E\{\tilde{r}_2\})+\theta\left(\frac{V(H^*;T)}{C}-z\right)\right)+\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\frac{\theta}{C}\left(-\frac{H^{*2}}{2\gamma^U}\right)$$
$$=\left(-\frac{H^*}{\gamma^U}\right)\left(-(1+r_1)(1+E\{\tilde{r}_2\})+\theta\left(\frac{V(H^*;T)}{C}-z\right)+\frac{\theta}{C}\frac{H^*}{2}\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\right).$$

Thus, the numerator of (6) is positive *iff*

$$-(1+r_1)(1+E\{\tilde{r}_2\})+\theta\left(\frac{V(H^*;T)}{C}-z\right)+\frac{\theta}{C}\frac{H^*}{2}\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}<0\ ;$$

i.e., from (4) *iff*

$$-\frac{1}{\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}}+\frac{\theta}{C}\frac{H^*}{2}\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}=\frac{1}{\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}}\left(-1+\frac{\theta}{C}\frac{H^*}{2}\left(\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\right)^2\right)<0;$$

i.e., *iff*

$$\frac{\theta}{C}\frac{H^*}{2}\left(\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}\right)^2<1. \tag{7}$$

Given that $\frac{\partial V^2(H;T)}{\partial H^2}<0$, $V(H;T)|_{H=0}=0$, $\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=0}>0$, and $\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}>0$, the partial $\left.\frac{\partial V(H;T)}{\partial H}\right|_{H=H^*}<\frac{V(H^*;T)}{H^*}$. Thus, the left-hand-side of the inequality in (7) is less than

$$\frac{\theta}{C}\frac{H^*}{2}\left(\frac{V\left(H^*;T\right)}{H^*}\right)^2 = \frac{\theta}{2}\frac{V\left(H^*;T\right)}{C}\left(\frac{V\left(H^*;T\right)}{H^*}\right). \tag{8}$$

Given $V\left(H^*;T\right) < C$ (i.e., firms issue both short- and long-term bonds) and $V\left(H^*;T\right) < H^*$ (i.e., interest rates are non-negative), it follows that the left-hand-side of (7) is less than $\frac{\theta}{2}$. Thus, a sufficient condition for the left-hand-side of (7) to be less than one, and hence for the optimal payoff from corporate long-term bonds to be increasing in the quality of the sovereign bond benchmark, is that the cost of deviating from the target debt maturity structure parameter, namely θ, be less than two.

Satisfaction of the inequality $\theta < 2$ is not a necessary condition for long-term bond financing to be increasing in the quality of the benchmark. From expression in (8) and the fact that $V\left(H^*;T\right) < H^*$, the left-hand-side of the inequality in (7) is less than $\frac{\theta}{2}\frac{V\left(H^*;T\right)}{C}$. To approximate the ratio $\frac{V\left(H^*;T\right)}{C}$ in our two-period model of debt maturity, we need first to determine the appropriate maturity cutoff that defines whether a bond is short-term or long-term. Panel A of Table 3 reports that in many countries a significant fraction of corporate issues appear in each of the different maturity ranges along the 30-year spectrum. While much of the debt-maturity literature has followed the accounting convention of defining long-term as greater than one year, only a small fraction of corporate bond issues have maturities of one year or less. The empirical analyses of Barclay and Smith (1995), Barclay, Marx, and Smith (2003), and Johnson (2003) consider a less extreme categorization and designate bonds with maturities beyond three years as long-term. Johnson (2003) reports that for the average non-financial firm, the value of bonds with greater than three years to maturity is about half of the total value of their bonds. Approximating $\frac{V\left(H^*;T\right)}{C}$ as 0.5, it follows that the left-hand side of (7) is less than $\frac{\theta}{2}\times 0.5$. Thus, the left-hand side of the equality in (7) will be less than one provided θ is less than four. In turn, long-term bond financing will be increasing in the quality of the benchmark provided θ is less than four. Values of θ greater than four are very high. For θ equal to four, a firm with a ratio of long-term debt to total debt that exceeds its target by 0.2 would incur a cost that exceeds more than eight percent of the value of its debt.

Thus, we conclude that in the absence of very high costs of deviating from their target debt maturity structures, firms will be more willing to issue long-term bonds when sovereign bonds provide higher quality reference rates. To investigate the simultaneous existence of gap filling and the reference rate effect, we turn now to an examination of an international data set of corporate and sovereign bonds.

3. Data

We assemble an international sample of bonds from three sources: Thomson One Banker's corporate bond issues, Bloomberg's historical sovereign yield curves, and Bloomberg's history of sovereign bond issues. Our sample starts in 1991, when international sovereign yield curve data starts to become widely available and ends in 2017. We examine bond issues from a set of countries for which the total number of corporate bond issues constitutes at least one percent of the total over the sample period. Thus, we examine issues from Australia, Brazil, Canada, France, Germany, India, Japan, Malaysia, Mexico, the Netherlands, South Korea, Thailand, the United Kingdom, and the United States; i.e., from a set of countries with capital markets at different stages of development during the sample period.[6]

The sovereign bond sample is created from the set of all bond issues from 1991 through 2017 that have a BICS Classification of "Sovereign" in Bloomberg and are issued domestically by the countries in our sample.[7] We remove coupon strips and bonds not issued by the national government. From the Thomson One Banker data on corporate bond issues we delete foreign bonds and issues by financials and utilities, hybrid securities such as convertible bonds, perpetual bond issues, and 100-year bond issues. The gap-filling and reference rate hypotheses cannot fully

---

[6] Although China meets the one percent threshold, Chinese bond issues are not included because of the opaqueness of the distinction between its corporate and government sectors. Guatemalan bond issues also just meet the one percent threshold but are not included because only two of the 1,106 issues have maturities of more than 10 years.

[7] As shown in Panel B of Table 1, the sample period is shorter for Brazil, South Korea and Thailand.

explain the choice of corporate bond maturity if machismo affects the maturity choice and it is for this reason that extreme-maturity corporate bonds are deleted from the sample.[8]

Table 1 defines the variables used in the paper's analysis. Panel A of Table 2 summarizes the number and maturity of the corporate bond issues in each country. The average maturity of all newly-issued corporate bonds in our sample is 7.8 years. The average of the 14 country-specific mean maturities is 7.3 years and the median maturity of all newly-issued corporate bonds is six years. There is substantial variation across countries in the average and median maturities. The average ranges from 3.2 years for South Korean firms to 13.9 years for UK firms. The median ranges from three years for Mexican firms to ten years for UK firms.

[please insert Table 2]

Panel B1 of Table 2 summarizes by country the number and maturity of the sovereign bond sample. Most sovereign debt issues are short-dated and the average (median) maturity in the total sample is five years (one year). Substantial variation in the average and median maturities exists across countries. The average ranges from 1.8 years in Thailand to 8.3 years in Japan and the median ranges from a fifth of a year in Thailand and the UK to five years in Japan.

A benchmark rate for a given maturity can be provided by newly-issued sovereign bonds of the desired maturity or previously-issued sovereign bonds with the requisite remaining maturity. We obtain countries' sovereign yield curves from Bloomberg on the last trading day of each calendar year. The curves consist of the yield-to-maturity on bonds of different tenors. The set of tenors varies across countries and over time. Panel B2 of Table 2 summarizes by country the tenors of the Bloomberg sovereign yield curves. Bloomberg's yield curves report the current yield on the issue that corresponds to the tenor based on closeness of remaining maturity, liquidity/market consensus, recentness of the auction, or on a list provided by local financial authorities (and sometimes altered by Bloomberg). Thus, if a country issues bonds regularly, the benchmark rate at a given tenor will be close to the yield on a newly-issued "reference" bond of that tenor. When

[8] The choice of a bond's maturity can also reflect a bit of craic. Rather than a commemorative stamp, the Irish government issued €100,000,000 of 100-year government bonds in 2016, to be repaid during the bicentenary of the Easter Rising. For further discussion of machismo and other unrelated reasons for issuing ultra-long-term bonds, see: http://www.nytimes.com/1997/03/22/your-money/with-century-bonds-100-years-of-low-yield.html.

bonds are issued less frequently, the benchmark can be based on government securities with a remaining time to maturity close to the tenor of interest, which means that a six-year bond that was issued two years ago can be used in determining the benchmark yield at the 4-year tenor point. The maximum tenor in Panel B2 of Table 2 can equal the maximum sovereign bond maturity, but it can also be shorter than the maximum sovereign bond maturity since bonds can only serve as a reference if they are sufficiently liquid.

4. The Empirical Link between Reference Rates and Corporate Bond Issuance

4.1 The maturity spectrum

We examine the distribution of the maturities of the bonds issued by corporations in our set of countries by calculating the percentage of issues with maturities at the time of issue that fall in the following set of bins: [0,3), [3,6), [6,9), [9,12), [12,15), [15,20), [20,25), [25,30), and [30,…). Since these bins may or may not have a sovereign bond issue, we explicitly allow for the absence of a benchmark (in line with our model).

[please insert Figure 1]

Figure 1 depicts the distribution of corporate bond issuance across maturities. Most bonds are relatively short-lived, with over 30 percent of issues having a 3- to 6-year maturity. Bond issues with maturities beyond 10 years are relatively infrequent, although bond issues of 30 or more years to maturity occur more frequently than issues in the [12,15), [15,20), [20,25) and [25,30) year bins.

[please insert Figure 2]

The maturity distribution of sovereign bond issues is shown in Figure 2. The distribution is strongly right-skewed, with the modal bin being the shortest maturity [0,3) year bin. At the longer-term spectrum, sovereigns are more likely to issue 5-, 10-, 20- and 30-year bonds than bonds with maturities of between five and 10 years, between 10 and 20 years, or between 20 and 30 years. Figure 3 depicts the availability of yield curve benchmarks across maturities. Benchmarks with tenors of 10, 15, 20 and 30 years are more common than benchmarks with, for example, 12- or 25-year tenors.

[please insert Figure 3]

Table 3 reports details of the distribution of maturities of bond issues in each country. Panel A of Table 3 reports the distribution for corporate issues and Panel B reports the distribution for sovereign issues.

[please insert Table 3]

4.2 Relation between maximum maturity of corporate and sovereign bonds

If the existence of a sovereign bond reference rate is important when a firm is selecting the maturity of its corporate debt, then corporate bond issues with maturities beyond that of the maximum tenor of the sovereign's yield curve benchmarks will be rare. For each country we examine the maximum maturity of corporate bond issues in a given year and the maximum-maturity of the reference rate that year. The maximum-maturity of the reference rate in a given year is the larger of (i) the maximum maturity of the sovereign bonds issued that year and (ii) the maximum tenor of the yield curve in the year prior to the corporate issue. The right-most column of Panel A of Table 3 shows that corporate bond issues with maturities in excess of the maximum-maturity of the reference rate are extremely rare. Less than one percent of all corporate issues have a maturity greater than the maximum-maturity of the reference rate. In contrast to the situation with corporate issues, the right-most column of Panel B of Table 3 shows that it is not uncommon for a sovereign issue to mature after the latest-maturing corporate bond issued in the same year. In fact, on average 9% of sovereign issues mature after the maturity of all corporate bonds issued in the same country-year.

Table 4 shows the correlations between the maximum corporate, sovereign, and yield curve maturities. For each country-year, we obtain the maturity of the longest-maturity corporate debt issue, the longest available tenor of the sovereign yield curve, and the longest initial maturity of that year's sovereign bond issues. The correlation between the maximum maturity of a country's corporate issues in a given year and the maximum maturity of that country's sovereign issues in the same year is significantly positive and equal to 0.26. The correlation between the maximum maturity of a country's corporate issues in a given year and the maximum tenor of that country's sovereign yield curve that year is 0.27. The correlations are less than one because the maximum maturity of corporate issues in a given country-year bin is often less than (rather than greater than) the maximum maturity of sovereign issues in that country-year bin.

[please insert Table 4]

Table 5 presents means and standard deviations across maturity bins of the principal dependent and explanatory variables. We investigate the determinants of two measures of corporate bond issuance, namely an indicator termed *Any Corporate Issue* and a *% Corporate Issues* variable. The *Any Corporate Issue* indicator is equal to 1 if the number of corporate issues in a country-year-maturity bin exceeds zero and is equal to 0 otherwise. The *% Corporate Issues* variable is equal to the number of corporate issues in a country-year-maturity bin expressed as a percentage of the total number of corporate issues in that country-year.

The explanatory variables used in our analysis of corporate bond issuance are a number of measures that can proxy for both the existence and quality of a benchmark rate and for the size of the sovereign bond market. The *Yield Curve Benchmark Exists* variable is an indicator equal to 1 if a corporate issue's maturity falls in the same maturity bin as the tenor of a benchmark rate on the sovereign's yield curve. *Interpolatable Maturity* is an indicator equal to 1 if the corporate issue's maturity bin is smaller than or equal to the maximum tenor on that country-year's sovereign yield curve. *Same-Maturity Sov' Bond Issue* is an indicator equal to 1 if there exists a sovereign bond issue in the country-year-maturity bin. *Same-Maturity Sov' Bond Outstanding* is an indicator equal to 1 if there exists an outstanding sovereign bond in the country-year-maturity bin. *ln*(*USD Same-Maturity Sov' Bond Issues*) is the total log-transformed, US dollar-denominated amount of government bond issues in the country-year-maturity bin, corrected for taps and re-openings and converted into U.S. dollars using the end-of-year exchange rate taken from Bloomberg. The correction for taps and re-openings is necessary because Bloomberg includes all taps and re-openings as part of each bond's issued amount. We treat each tap as a new issue. For instance, if a 10-year bond is issued for an amount of €10 in 1999 and tapped in a 2000 reopening for €5, we add an amount of €10 to 10-year issues in 1999 and an amount of €5 to 9-year issues in 2000. *% Same-Maturity Sov' Bond Issues* is the total amount of sovereign bond issues in a country-year-maturity bin scaled by the total amount of sovereign bonds issued in the corresponding country-year. This measure compares issuance in a bin against issuance in all other bins, in the spirit of the GHS gap-filling hypothesis.

The fourth and third last rows of Table 5 report high correlations between the means over the country-year-maturity bins of the principal independent variables, namely *Any Corporate Issue* and *% Corporate Issues*, and the key explanatory variables. Both *Any Corporate Issue* and *% Corporate Issues* have correlations of 0.69 or higher with the presence of a benchmark on the yield curve as measured by the indicator *Yield Curve Benchmark Exists* and with the presence of a contemporaneous sovereign bond issue of comparable maturity as measured by the indicator *Same-Maturity Sov' Bond Issue*. The final two rows report that the correlations between the country-year-maturity bin values of the principal independent variables and the explanatory variables are in every case positive and significant.

[please insert Table 5]

4.3 Logit and Tobit analysis

Relation (9) expresses the odds of a corporate bond issue in a country-year-maturity bin as dependent on a set of explanatory variables chosen to proxy for the determinants of the reference rate and gap-filling hypotheses.[9]

$$\begin{aligned} &\textit{log odds}(\textit{Any Corporate Issue}) = \alpha + \beta_1 \textit{Yield Curve Benchmark Exists} + \beta_2 \textit{Interpolatable Maturity} \\ &+ \beta_3 \textit{Same-Maturity Sov' Bond Issue} + \beta_4 \textit{Any Sov' Bond Outstanding} \\ &+ \beta_5 \textit{ln}(\textit{USD Same-Maturity Sov' Bond Issues}) + \beta_6 \textit{\% Same-Maturity Sov' Bond Issues} \\ &+ \theta \textit{Has Sov' Bond Rating} + \textit{time and/or country-related controls.} \end{aligned} \tag{9}$$

If sovereign bonds are to provide a benchmark, they must do so before the corporate bond is issued. Therefore, we link the variable *Any Corporate Issue* in year t to benchmarking variables observed in year $t - 1$. Similarly, our specifications assume that corporations react to observed gaps. To the extent the explanatory variables on the beta coefficients are measures of the quality of the reference rate provided by sovereign bonds in a country-year-maturity bin, the reference rate hypothesis predicts that the estimated betas will be positive. Table 6 presents the results of relation (9). Bond ratings are measured as bin-level averages of the highest of the Fitch, Moody's

[9] By analyzing bond issuance, rather than either the fraction of existing debt in a bin or the average maturity of existing debt, our results are not impacted by compositional issues. For instance, an increase in the fraction or the average maturity may come from an increase in long-term debt or from a decrease in short-term debt. Footnote 13 of GHS (2010) describes a further compositional issue arising from differences in the bond maturity structure of private and public corporations and changes from private to public ownership through time.

and Standard & Poor's ratings of sovereign bonds after conversion into a scale from 1 (unrated) to 17 (AAA-rated). The rating level of unrated bonds is set at the lowest possible level of 1 for the purpose of the empirical exercise. Time fixed effects cover 5-year periods, as in Badoer and James (2016). Standard errors are clustered at the country level.[10] The pseudo-R^2 values reported throughout the paper's tables are the McKelvey/Zavoina measures recommended in Veall and Zimmermann (1994).

[please insert Table 6]

The coefficients on the *Yield Curve Benchmark Exists* and *Interpolatable Maturity* variables indicate a significant link between corporate issuance and the availability of yield curve benchmarks. The exponential of the reported coefficients gives the estimated factor by which the odds of a corporate issue in a particular country-maturity bin increase when the associated explanatory variable increases by 1 unit. Based on the coefficients reported in column (4), we estimate that the odds of a corporate bond issue in a particular maturity bin increase significantly, by a factor of 4.05, when the corporate's maturity is smaller than or equal to the maximum maturity on that country-year's sovereign yield curve. In such a case, the yield curve provides a benchmark, either directly or via interpolation. The odds increase by a further significant factor of 5.9 if the yield curve provides a direct benchmark because the bond's maturity falls in the same country-year-maturity bin as the tenor of a benchmark rate on the sovereign's yield curve.

The coefficient on the *Same-Maturity Sov' Bond Issue* variable is significantly positive once country effects are controlled for. Not only can a newly-issued sovereign bond provide a benchmark, previously-issued sovereigns also provide benchmarks and a value of one for the *Same-Maturity Sov' Bond Outstanding* indicator is associated with a significant increase in the likelihood of a corporate issue in the same country-year-maturity bin. The significant estimated coefficient on *ln*(*USD Same-Maturity Sov' Bond Issues*) implies that having a critical mass of sovereign debt in a country-year-maturity bin is strongly positively related to the probability of corporate issuance in that bin, which is consistent with the volume of same-maturity sovereign

[10] Standard errors tend to be similar or smaller when we or cluster in the time or tenor dimensions or double-cluster in the country-year dimension. We choose to be conservative in our choice of standard errors.

issues being a measure of whether the sovereign issues have sufficient mass to create an effective benchmark.

The results of the logit regression are in line with the hypothesis that corporations are more likely to issue bonds of a maturity for which sovereign bonds provide a reference rate. Importantly, this result is found when we control for institutional and political differences between countries by means of country fixed effects, and 5-year fixed effects that capture time-varying changes common to all countries (such as the global interest rate environment).[11] Furthermore, country × 5-year fixed effects capture general, time-varying institutional and policy factors that can affect the shape of the yield curve in a country and thereby affect the incentive for both corporates and sovereigns to issue long-term bonds.[12]

To the extent the explanatory variables are proxies for the absence of a gap, the gap-filling hypothesis predicts that the estimated betas will be negative. The single negative estimated coefficient in columns (1) to (4) of Table 6 is that on the *% Same-Maturity Sov' Bond Issues* variable. The negative coefficient is consistent with this variable being the most clearly linked to the value of sovereign bonds and thereby providing the cleanest proxy for the absence of a gap. In contrast, it is most difficult to interpret the *Interpolatable Maturity* variable as a proxy for a gap. Rather, its natural interpretation is that of a measure of the existence of a reference rate and the estimated coefficient on this variable is significantly positive. The fact that, other than for the *% Same-Maturity Sov' Bond Issues* variable, all the estimated beta coefficients are significantly positive is strong evidence that there is a reference rate effect and further that for most the explanatory variables the reference rate effects more than offsets any gap filling that might otherwise be associated with the explanatory variable.

Columns 5 through 7 report that the link between the existence of sovereign reference rates and corporate bond maturity choice, as captured by the significant coefficient on the *Yield Curve Benchmark Exists* variable, holds for each of the Americas, Europe and the Asia-Pacific region. Interestingly, reference rates may be a more important determinant of the corporate maturity

[11] The 5-year time periods begin in 1991. The final time period covers 2016 and 2017 only.

[12] For instance, Greenwood and Vissing-Jorgensen (2018) document the effect of UK regulatory changes on preferred-habitat investor demand for long-term bonds.

choice in the Asia-Pacific region than in the Americas. Note that the vast majority of American observations are from the US and Canada.

Gap filling appears strongest in the Americas. The negative coefficient on the % *Same-Maturity Sov' Bond Issues* measure is consistent with gap filling. When relative sovereign bond issuance in a country-year-maturity bin is particularly low, the negative estimated coefficient on % *Same-Maturity Sov' Bond Issues* predicts a high probability of a gap-filling corporate issue in that bin. Section 5 further explores gap filling controlling for the quality of the reference rates provided by sovereign bonds. That corporations are more willing to fill gaps when sovereign bonds provide more precise reference rates provides further evidence of the reference rate effect.

In Table 7 we report a Tobit analysis of the link between an alternate continuous measure of corporate bond issuance in a given year, namely the *% Corporate Issues* variable, and the explanatory variables of the reference rate and gap-filling hypothesis as observed in the prior year. *% Corporate Issues* is the proportion of corporate bonds issued that fall in a particular country-year-maturity bin. The conclusions from the Tobit analysis reinforce those from the logit analysis. The percentage of all corporate issues in a given country and year that fall in a particular country-year-maturity bin is significantly positively related to whether the yield curve provides a benchmark for bonds in that bin directly and whether it is does so indirectly via interpolation. The percentage is also positively related to the quality of the benchmark as proxied by the existence and total size of sovereign bond issues and the existence of outstanding sovereign bonds in the same country-year-maturity bin. Again, there is simultaneous evidence of gap filling in that the larger the proportion of all sovereign issues in a country-year that fall into a country-year-maturity bin, the smaller the proportion of all corporate bonds issued in that country-year that fall into the country-year-maturity bin. Mirroring the logit analysis of the *Any Corporate Issue* variable, the strongest evidence of gap filling is found in the data from the Americas.

[please insert Table 7]

5. Gap Filling given a Reference Rate

Our exploration of gap filling differs from that of other studies in that we consider a more granular maturity structure. Extant studies consider the effect of changes in the supply of sovereign bonds with maturities of greater than one-year (GHS, 2010; Graham, Leary and Roberts, 2014;

Graham, Leary and Roberts, 2015; Lugo and Piccillo, 2016; Demirci, Huang, and Sialm, 2017) or of greater than twenty-years (Badoer and James, 2016).[13] More importantly, we condition on the existence of a high-quality reference rate. The model developed in Section 2 shows that in the absence of a high-quality reference rate, it can be optimal to issue fewer corporate bonds. Gap filling would imply the opposite result, with the incentive to issue long-term corporate bonds greatest when the supply of sovereign bonds is smallest. We therefore explore gap filling conditional on the existence of a high-quality reference rate. We expect to find stronger evidence of gap filling in a conditioned sample than in an unconditioned sample of bond issues.

We condition on both a value of one for the indicator variable *Yield Curve Benchmark Exists* for the country-year-maturity bin in the preceding year and a requirement that the size of the sovereign bond issues in that particular bin (the *ln*(*USD Same-Maturity Sov' Bond Issues*) measure for that particular bin) exceeds the 1991-2017 median (in end-of-year USD) of all sovereign bond issues in country-year-maturity bins. These twin criteria increase the likelihood that sufficient sovereign bonds are being issued in that country-year-maturity bin for the benchmark yield to be accurately measured. When the twin conditions are satisfied, we deem the benchmark reference rate to be of high-quality.

In Panels A and B of Table 8, the explanatory variable *% Same-Maturity Sov' Bond Issues* is observed in the year prior to the observation of the dependent variable, which is either the *Any Corporate Issue* measure or the *% Corporate Issues* measure. When the % *Same-Maturity Sov' Bond Issues* for a particular country-year-maturity bin is relatively low but high enough for the quality of the benchmark to still be high, the issuance of corporate bonds in the same country-year-maturity bin can fill the gap. Panel A does not condition on there being a high-quality reference rate. Panel B applies the conditioning. The difference in the results in Panels A and B is striking. Without conditioning the sample, we appear to have the opposite of gap filling: In the absence of a high-quality reference rate, corporations do not rush to fill the gap and the coefficient on *% Same-*

[13] Most studies of gap filling examine US data, but Demirci, Huang and Sialm (2017) examines data from 40 countries and Lugo and Piccillo (2016) documents that corporations in the Eurozone respond to shocks in the supply of long-term government debt both in their home countries and in other Eurozone countries. Eidam (2017) documents that sovereigns within the Eurozone issue debt to fill gaps left by other sovereigns in the zone.

Maturity Sov' Bond is significantly positive for both the *Any Corporate Issue* and the *% Corporate Issues* measures. This is consistent with the reference rate hypothesis but not with gap filling.

The results in Panel B of Table 8 are more like those in Tables 6 and 7. In Tables 6 and 7 the coefficient on *% Same-Maturity Sov' Bond* is negative, and significantly so in Table 6. The full sample analyses in Tables 6 and Tables 7 differ from the full sample analysis in Panel A of Table 8 in that Tables 6 and 7 include sovereign bond supply measures as explanatory variables. These sovereign bond supply measures provide a partial control for the quality of the reference rate. Panel B of Table 8 applies the control directly through its conditioning. After conditioning the sample on the existence of a high-quality reference rate, we see clear evidence of gap filling: The coefficient on the *% Same-Maturity Sov' Bond Issues* measure is significantly negative in the conditioned sample.

[please insert Table 8]

If the percentage of sovereign issues of a particular maturity was always a constant, the fact that percentage happened to be larger or smaller than for other maturities would not necessarily imply the existence of a gap to be filled. Recognizing this, we consider an alternate measure of the gap in a country-maturity bin, namely the percentage of same-maturity sovereign bond issues in the country-year bin in excess of the 1991-2017 average of the percentage for the country-maturity bin. We term this deviation from the normal percentage as *Excessive % Same-Maturity Sov' Bond Issues*. Panel C considers the conditioned sample and reports that sovereign issuance in a particular country-year-maturity bin has a more negative and a more significant effect on corporate bond issuance when sovereign bond issuance is excessive.

Finally, we apply the approach in Table V of GHS (2010) to our conditioned sample. Relation (10) links corporate issuance to changes in sovereign issuance over the preceding k years: k = 1, 2, 3 and 4.

$$\%\ Corporate\ Issues^{k}_{ijt} = a + b\Delta_k \%\ Same\ Maturity\ Sov'\ Bond\ Issues_{ijt} + \varepsilon_{ijt}, \qquad (10)$$

where the subscript *ijt* denotes the country-maturity-year dimension. The results of a Tobit analysis are reported in Panel D of Table 8. As in Table V of GHS, the estimated b coefficient of relation (10) is negative, and significantly so for $k \geq 1$. The similarity of the evidence in favor of gap filling in Panel D of Table 8 and Table V of GHS is striking in that the two analyses are quite distinct.

GHS only consider US data and whether maturity is more or less than a year. We consider a more granular measure of bond maturity, analyze data from 14 countries, and condition on the existence of a high-quality reference rate. Conditional on the existence of a high-quality reference rate, Panel D documents that gap filling exists in the full sample and not just in the Americas.

6. Introductions and Suspensions

Investor demand may be a common driver of the maximum maturity of both sovereign and corporate debt. If a country is seen as politically unstable, then lenders will be less willing to lend long-term to its government because of the risk of default and/or hyperinflation. Investors in companies in that country will face a similar lack of certainty regarding property rights and will be similarly unwilling to buy long-term corporate bonds. Our inclusion of country- and time-fixed effects in the analyses of the preceding sections is a partial cure for the problem of endogeneity. In this section we use a quasi-natural experiment to demonstrate that the existence of reference rates has a role in determining corporate bond maturities that is distinct from the effect of a common factor driving sovereign and corporate maturities.

We address endogeneity directly by investigating the impact on the maturity of corporate bond issues of a country introducing or suspending long-maturity sovereign debt. We search Bloomberg's sovereign bond database to identify newly-introduced and newly-suspended conventional sovereign bonds. Since the goal is to examine how the issuance of corporate bonds with comparable maturity is affected by a change in the available set of sovereign bonds, we do not consider introductions or suspensions of inflation-linked sovereign bond issues. Such bonds do not provide a benchmark for corporate issues. Whenever possible, we use internet and newspaper sources to verify the introductions and suspensions we identify from our database search.[14]

For an event to be qualified as a bond introduction or suspension, we require the event to occur in an active corporate bond market in that there are at least 5 corporate issues in that country in the year of the event. Furthermore, in order to be classified as an introduction event, the government needs to extend the maturity of earlier issues by at least 5 years and into a new maturity

[14] The results reported in this Section are effectively unchanged if we exclude the four introductions/suspensions without such corroborating evidence.

bin. Since infrequent issues are both introductions and suspensions, a suspension event requires that bonds of the suspended maturity had been previously issued at least once every other year and then not issued for at least four years.[15] In this part of the analysis, we treat bonds with maturities of greater than 29 years but less than 31 years to be 30-year bonds. As shown in Table 9, we identify a set of 10 introductions and 2 suspensions between 1994 and 2016 with the events dispersed across the three regions.

[please insert Table 9]

The reference rate hypothesis states that introductions of sovereign bonds with longer maturities than previously issued will facilitate corporate issues of bonds with similarly increased maturities, but does not state that the sovereign introductions are the cause of these corporate issues. Demand for whole-of-life annuity products may lead insurers to lengthen the maturity of the bonds included in their preferred habitat. It may be that sovereigns issue at the new longer maturity before corporations do, not because sovereign debt-management offices are more attuned to insurers' demands, but because corporations lobby the sovereign to introduce longer-maturity bonds in order to provide a reference rate to which they can benchmark their own subsequent issues. Such a narrative would be in line with the reference rate hypothesis. Several of the internet and newspaper sources used to corroborate our identification of introductions state that setting a benchmark at a longer point on the maturity curve was the reason for the long-term sovereign issue. Bloomberg's commentary on the 2013 Malaysian issue of 30-year sovereign bonds notes that "Malaysia sold its first 30-year bonds, its longest maturity, as the Southeast Asian nation seeks to set a new benchmark for the local debt market." An OECD publication on the 2008 introduction of 30-year sovereign bonds in Thailand states that the goal was a "Government bond yield curve that can effectively be a reference rate for private sector bond issuance."

Panel A of Figure 4 shows that for introductions, corporate issues in the maturity bin of the introduced sovereign occur in the year *after* the new sovereign maturity is launched. The figure plots the annual averages in the years both before and after the introduction of the *% Corporate Issues* variable for corporate issues in the bin of the introduced sovereign maturity. The averaging

[15] For example, the Netherlands issues a 30-year bond every 4 to 5 years. We do not consider this activity to be either an introduction or a suspension.

is done across the 10 introductions. The introduction year is denoted as year zero and the figure plots the corporate issues variable for the preceding and following three years.

In the years after a new long-term sovereign bond is introduced, corporate issues in the new maturity bin increase dramatically. If an omitted variable was driving the increase in the maturity of both sovereign and corporate bonds and there was no reference rate effect, then corporate issuance could also be elevated in the years prior to and contemporaneously with the sovereign introduction. Absent a reference rate effect, introductions would be as likely to follow as to precede new issues of longer-term corporate bonds. This is not what we observe: In the years prior to the sovereign introduction, corporate long-term issuance remains rare. It then peaks in the year after the sovereign bond introduction.

Panel B of Figure 4 considers the two suspensions in the sample: France in 1994 and the US in 2001. The pattern in Panel B might be explained by either a common driver of sovereign and corporate bond maturity and/or by a reference rate effect. The *% Sov' Issues* measure for the suspended bin is declining in the years before the suspension and the *% Corporate Issues* measure is also declining during those same years.

Absent both a common driver and a reference rate effect, gap filling would predict that corporate issues in the suspended bin should have increased once the gap yawned large. We observe that instead corporate issues decline dramatically in the two and three years after the suspension. Note that Section 2.2 predicts that, all else equal, there is less likelihood of a corporate issue in the absence of a benchmark. The model does not predict that there will never be corporate issues in the absence of a benchmark. If corporations are familiar with financing via 30-year bonds and there are near-30-year corporate and sovereign bonds still trading in the year after suspension, then a near-reference rate remains available in the year after suspension. Thus, it is not surprising that the effect of sovereign suspensions on corporate issuance is not as immediate as that of introductions.

[please insert Figure 4]

Panel B of Figure 4 appears inconsistent with the conclusion on gap filling drawn in Badoer and James (2016). Badoer and James (2016) examines quarterly corporate issuance between 1987 and 2009, a period that encompasses the 2001 suspension of issues of 30-year US sovereign bonds.

By comparing issuance during the 1987-2001 and 2002-2009 periods, the researchers conclude that “consistent with gap filling, ... the elimination of 30-year Treasury bonds is associated with an increase in the proportion of long-term bonds with maturities of 30 years or more”. The measures examined in Badoer and James (2016) are measures of corporate issuance of bonds with maturities of 30-plus years relative to corporate issuance of bonds with maturities of 20-plus years. The number and proceeds of long-term corporate issues may in fact decline after a suspension, but the Badoer-James proportion will increase if the number of issues with maturities of at least 20 but less than 30 years declines by more than the number of 30-plus year issues declines.

It should also be noted that the 2002-2009 post-suspension period examined in Badoer and James (2016) includes the years following the February 9, 2006 reintroduction of 30-year US sovereigns. Figure 5 investigates the apparent inconsistency between Panel B of Figure 4 and the gap-filling conclusion in Badoer and James (2016). Panel A of Figure 5 depicts corporate issuance in the years surrounding the 2001 US sovereign suspension. Panel B shows that the post-suspension spike in the Badoer-James measure of the proceeds of corporate issues with maturities greater than or equal to 30 years is strongly influenced by a change in the number of corporate issues with maturities in the [20, 30) range. During the four years 1997 to 2000 inclusive, there were 298 corporate issues in the [20, 30) range, but only 27 such issues in 2002. In the four years that precede the 2001 suspension year, the Badoer-James measure of the number of corporate issues with maturities greater than or equal to 30 years relative to the number of corporate issues with maturities greater than or equal to 20 years is 73.0%. In the year immediately after the suspension, corporate issues in the [20, 30) year range dried up and for that year the Badoer-James measure came to exceed 95%. Over the four-year post-suspension period of 2002-2005, the Badoer-James measure of the proceeds of 30-plus year issues of 72.3% was slightly less than it was over the four years prior to the suspension. Measured relative to the proceeds of all bond issues, the proportion accounted for issues with maturities of 30-plus years declined from 8.9% in 1998-2001 to 6.2% in 2002-2005. Panel B also illustrates the growth in 30-plus-year US corporate issues after the reintroduction of a 30-year US reference rate in 2006. This period of growth is included in the post-suspension period examined in Table IX of Badoer and James (2016).

Table 10 undertakes the Figure 4 analysis of corporate issuance before and after long-term sovereign introductions and suspensions using a regression analysis. For bonds in maturity bins of

20 or more years, we report a Tobit analysis of the relation between the *% Corporate Issues* measure and a set of indicator variables that reflect whether there was an introduction or suspension in year *k* relative to the year in which *% Corporate Issues* is observed, $k = -3, \ldots, +3$. The indicator equals +1 for introductions, −1 for suspensions, and zero otherwise. The analysis controls for the slope of the country-specific term structure, the global average credit spread, the country-specific level of inflation, and country and time fixed effects. Introductions (suspensions) of long-dated sovereign bonds lead to significant increases (decreases) in the issuance of similarly long-dated corporate bonds in subsequent years. The contemporaneous effect is insignificant. Absent a reference rate effect, introductions (suspensions) would be as likely to follow as to precede new issues of longer-term corporate bonds. However, introductions (suspensions) of long-dated sovereign bonds do not follow increases (decreases) in the issuance of similar corporate bonds.

[please insert Table 10]

7. Conclusion

Studies on gap filling have demonstrated that a gap between investor demand and sovereign bond issuance at a particular maturity provides an opportunity for corporations to issue bonds at that maturity. We show that in addition to being a substitute for corporate bonds, sovereign bonds provide reference rates that facilitate the issuance of corporate bonds. Our reference rate hypothesis is developed in an extension of the GHS (2010) gap-filling model in which preferred-habitat investor demand is stochastic and corporations employ risk-averse intermediaries to underwrite corporate bond issues. Underwriting fees are increasing in the risk borne by the underwriter and that risk is higher when sovereign bonds fail to provide reference rates that give an accurate signal as to the strength of preferred-habitat investor demand. As a result, the cost of issuing long-term corporate bonds is higher when sovereign bonds fail to provide high-quality reference rates.

Our examination of an international dataset over the period 1991 – 2017 shows that there is less gap filling when sovereign bonds fail to provide high-quality reference rates. The willingness of corporations to fill gaps when sovereign bond issuance is low but still high enough to provide a useful benchmark points to the importance of reference rates. We also investigate a quasi-natural experiment provided by introductions and suspensions of sovereign bonds that alter the tenor of reference rates. We document that increases in the maximum maturity of sovereign bonds precede increases in corporate bond issuance at the new maximum sovereign maturity and that decreases in the maximum maturity of sovereign bonds precede decreases in corporate bond issuance at the old maximum sovereign maturity. The relative timing of sovereign and corporate bond maturity changes is consistent with the corporate bond maturity change being driven by a reference rate effect that is quite distinct from the effect of a common omitted variable that may underlie a change in maximum maturity of sovereign and corporate bonds. Market observers' statements surrounding the introductions of longer-maturity sovereign bonds emphasize the importance of the reference rate effect.

Our results are of interest to policy makers as extending the maturity structure of financing has been posited as central to financial development: "*Long-term finance may contribute to faster growth, greater welfare, shared prosperity, and enduring stability in two important ways: by reducing rollover risks for borrowers, thereby lengthening the horizon of investments and improving performance, and by increasing the availability of long-term financial instruments, thereby allowing households and firms to address their lifecycle challenges*" (Global Financial Development Report 2015/2016, World Bank). Our finding that reference rates provided by sovereign bonds facilitate the issuance of long-term corporate bonds is consistent with the policy-maker view that capital market development can enhance consumer and investor welfare. Like other irrelevance theorems, Ricardian equivalence presumes the absence of information asymmetries. When sovereign bonds provide valuable pricing guides for corporations considering undertaking long-term debt-financed investments, government debt and government assets do not simply offset. Rather, the traded prices of government bonds provide reference rates useful in pricing long-term payoffs. Reference rates can guide long-term investment decisions as well as facilitate their financing, and thereby enhance consumer and investor welfare.

References

Almeida, Heitor, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner, 2011, Corporate debt maturity and the real effects of the 2007 credit crisis, *Critical Finance Review* 1, 3-58.

Almeida, Heitor, Igor Cunha, Miguel A. Ferreira, and Felipe Restrepo, 2017, The real effects of credit ratings: The sovereign ceiling channel, *Journal of Finance* 72(1), 249-290.

Badoer, Dominique C., and Christopher M. James, 2016, The determinants of long-term corporate debt issuances, *Journal of Finance* 71(1), 457-495.

Barclay, Michael J., and Clifford W. Smith Jr., 1995, The maturity structure of corporate debt, *Journal of Finance* 50, 609-631.

Barclay, Michael J., Leslie M. Marx, and Clifford W. Smith Jr., 2003, The joint determination of leverage and maturity, *Journal of Corporate Finance* (2), 149-167

Brooke, M., M. J. Fleming, K. Koyama, M. Lagana, O. Mastroeni, E.M. Remolona, W. Schulte, R. Violi, P.D. Wooldridge, and T. Yonatani, 2001, The changing shape of fixed income markets: A collection of studies by central bank economists, Bank of International Settlements Papers Series No 5.

Central Bank of Malaysia & Securities Commission Malaysia, 2009, Malaysian Debt Securities and Sukuk Market - A Guide for Issuers and Investors.

Commonwealth Government Securities Market Industry Working Group, 2002, Submission on the Review of the Commonwealth Government Securities Market. https://ebtreview.treasury.gov.au/content/subs/040.pdf

Demirci, Irem, Jennifer Huang, and Clemens Sialm, 2017, Government debt and corporate leverage: International evidence, *Journal of Financial Economics*, forthcoming.

Demirgüç-Kunt, Asli, and Vojislav Maksimovic, 1999, Institutions, financial markets, and firm debt maturity, *Journal of Financial Economics* 54(3), 295-336.

Diamond, Douglas W., 1991, Debt maturity structure and liquidity risk, *Quarterly Journal of Economics* 106, 709–737.

Diamond, Douglas W., 1993, Seniority and maturity of debt contracts, *Journal of Financial Economics* 33, 341-368.

Dittmar, Robert F., and Kathy Yuan, 2008, Do sovereign bonds benefit corporate bonds in emerging markets? *Review of Financial Studies* 21(5), 1983-2014.

Duffie, Darrell, and Kenneth J. Singleton, 2003, *Credit Risk: Pricing, Measurement, and Management*, Princeton University Press.

Eidam, Frederik, 2017, Gap-filling debt maturity choice in the government bond market: Evidence from the ECB's 3-year LTRO, University of Mannheim Working Paper.

Fan, Joseph P.H., Sheridan Titman, and Garry Twite, 2012, An international comparison of capital structure and debt maturity choices, *Journal of Financial and Quantitative Analysis* 47, 23-56.

Flannery, Mark J., 1986, Asymmetric information and risky debt maturity choice, *Journal of Finance* 41, 19-37.

Graham, John R., Mark T. Leary, and Michael R. Roberts, 2014, How does government borrowing affect corporate financing and investment? NBER Working Paper No. 20581.

Graham, John R., Mark Leary, and Michael Roberts, 2015, A century of capital structure: The leveraging of corporate America, *Journal of Financial Economics* 118, 658-683.

Greenwood, Robin, Samuel Hanson, and Jeremy C. Stein, 2010, A gap-filling theory of corporate debt maturity choice, *Journal of Finance* 65, 993-1028.

Greenwood, Robin, and Dimitri Vayanos, 2010, Price pressure in the government bond market, *American Economic Review: Papers and Proceedings* 100, 585-590.

Greenwood, Robin, and Annette Vissing-Jorgensen, 2018, The impact of pensions and insurance on global yield curves, Harvard Business School Working Paper 18-109.

Guedes, Jose, and Tim C. Opler, 1996, The determinants of the maturity of corporate debt issues, *Journal of Finance* 51, 1809–1833.

Johnson, Shane A., 2003, Debt maturity and the effects of growth opportunities and liquidity risk on leverage, Review of Financial Studies 16(1), 209-236

Krishnamurthy, Arvind, and Annette Vissing-Jorgensen, 2012, The aggregate demand for Treasury debt, *Journal of Political Economy* 120, 233-267.

Lugo, Stefano, and Giulia Piccillo, 2016, The relationship between corporate and government debt maturity in Europe, Utrecht University Working Paper.

Myers, Stewart C., 1977, Determinants of corporate borrowing, *Journal of Financial Economics* 5, 147-175.

Stohs, Mark Hoven, and David C. Mauer, 1996, The determinants of corporate debt maturity structure, *Journal of Business* 69, 279-312.

Veall, Michael R., and Klaus F. Zimmermann,, 1994, Goodness of Fit measures in the Tobit model, *Oxford Bulletin of Economics and Statistics* 56(4), 485-499.

Table 1: Variable definitions

Variable name	Source	Definition
Corporate bond characteristics		
Any Corporate Issue	Thomson One Banker	Indicator equal to 1 if the number of corporate issues in a country-year-maturity bin is larger than zero, and 0 otherwise.
% Corporate Issues	Thomson One Banker	Number of corporate issues in a country-year-maturity bin as a % of the total number of corporate issues in that country-year.
Yield curve characteristics		
Yield Curve Benchmark Exists	Bloomberg	Indicator equal to 1 if an issue's maturity corresponds to the tenor of a benchmark rate on the sovereign yield curve, and 0 otherwise.
Interpolatable Maturity	Bloomberg	Indicator equal to 1 if the corporate issue's maturity bin is smaller than or equal to the maximum maturity on that country-year's sovereign yield curve, and 0 otherwise.
Sovereign bond characteristics		
Same-Maturity Sov' Bond Issue	Bloomberg	Indicator equal to 1 if there is a sovereign bond issue in the country-year-maturity bin, and 0 otherwise.
Same-Maturity Sovereign Bond Outstanding	Bloomberg	Indicator equal to 1 if there exists a sovereign bond in a country-year-maturity bin, and 0 otherwise.
ln(*USD Same-Maturity Sov' Bond Issues*)	Bloomberg	Log of 1 + USD amount of sovereign bond issues in the country-year-maturity bin in millions with all conversions into USD based on the end-of-year exchange rate.
% Same-Maturity Sov' Bond Issues	Bloomberg	The total amount of sovereign bond issues in a country-year-maturity bin scaled by the total amount of sovereign-issued debt in the corresponding country-year.
Sov' Bond Rating	Bloomberg	Bin-level average across bonds in a country-year-maturity bin of the highest of the Fitch, Moody's and Standard & Poor's ratings of sovereign bonds after conversion into a scale from 1 (unrated) to 17 (AAA-rated).
Has Sov' Bonds with Rating	Bloomberg	Indicator equal to 1 if a sovereign bond issue in the country-year-maturity bin exists and has a rating from Fitch, Moody's, or Standard & Poor's, and 0 otherwise.
Excessive % Same Maturity Sov' Bond Issues	Bloomberg	*% Same-Maturity Sov' Bond Issues* in excess of the average of the *% Same-Maturity Sov' Bond Issues* for the country-maturity bin during the 1991-2017 period.
Maturity Change (τ), $\tau = t, \ldots, t-3$.	Bloomberg, Internet searches	Indicator equal to 1 if a long-maturity sovereign bond is introduced in year (τ); −1 if a long-maturity sovereign bond is suspended in year (τ); and 0 otherwise.

Table 1: Variable definitions (continued)

Variable name	Source	Definition
Credit Spread	Bloomberg	The global average BBB-minus-AAA credit spread on 30-year corporate bonds in a year.
Term Spread	Bloomberg	The average 10-year-minus-1-year sovereign term spread in a country-year.
Inflation	Worldbank	Inflation as reflected in each country's end-of-year consumer price index.

Table 2: Descriptive statistics on bond maturity

This Table shows summary statistics for bonds issued between 1991 and 2017. Panel A presents maturity statistics obtained from Thomson One Banker for corporate bond issues after excluding foreign currency bonds and issues by financials and utilities, hybrid securities such as convertible bonds, perpetual bond issues, and 100-year bond issues. The countries included have distinct corporate and government sectors and are responsible for more than 1 percent of the total number of corporate bond issues since 1991. Panel B.1 presents maturity statistics for all domestic currency sovereign bond issues in those countries. The data is obtained from Bloomberg and includes tap issues and reopenings after the initial offering, and excludes coupon strips and bonds not issued by the national government. Panel B.2 presents statistics for the tenors of the Bloomberg sovereign yield curves for the same set of countries.

Panel A: Corporate bonds

Country	#Obs	Average maturity	Median maturity	Maximum maturity
Australia	283	7.7	6.0	60.0
Brazil	1,303	4.8	4.9	25.0
Canada	1,137	11.6	7.2	60.3
France	1,318	7.2	7.0	35.0
Germany	628	7.4	6.0	99.0
India	1,299	5.3	5.0	60.0
Japan	6,072	7.1	6.0	60.0
Malaysia	1,436	8.1	6.0	50.0
Mexico	574	4.3	3.0	52.0
Netherlands	629	5.9	5.0	30.0
South Korea	8,789	3.2	3.0	50.0
Thailand	1,130	5.1	4.6	30.0
UK	673	13.9	10.0	50.0
US	22,814	10.0	8.5	95.4
Total	48,085	7.8	6.0	99.0

Panel B: Sovereign bonds and sovereign yield curve tenors

	B1: Sovereign bonds					B2: Sovereign yield curve tenors			
	Start year	#Obs	Average maturity	Median maturity	Maximum maturity	Start year	Max. tenor	Min. # benchmarks in given year	Max. # benchmarks in given year
Australia	1991	718	4.4	0.5	30.4	1991	30	8	15
Brazil	1994	987	3.6	1.4	40.7	2007	10	5	7
Canada	1991	1,524	3.2	0.5	50.6	1991	30	8	13
France	1991	2,258	5.7	1.0	50.2	1991	50	12	14
Germany	1991	1,562	4.5	2.1	32.5	1991	30	9	14
India	1991	4,215	5.8	1.0	40.0	1998	30	8	16
Japan	1991	5,545	8.3	5.0	40.3	1991	40	11	14
Malaysia	1991	1,605	1.9	0.5	30.0	1999	30	4	8
Mexico	1991	2,727	2.1	1.0	30.9	2001	30	5	14
Netherlands	1991	713	6.7	2.3	32.9	1991	30	11	14
South Korea	1994	589	5.1	3.0	49.9	1998	30	3	7
Thailand	1998	2,078	1.8	0.2	50.6	2000	30	6	14
UK	1991	3,774	5.3	0.2	55.1	1991	50	10	14
US	1991	3,179	4.4	2.0	30.5	1991	30	5	13
Total	1991	31,474	5.0	1.0	55.1				

Table 3: Distribution of maturities of corporate and sovereign bonds

This Table summarizes the maturity distribution by country of corporate bond issues (Panel A) and sovereign bond issues (Panel B) by presenting the fraction of issues between 1991 and 2017 that occur in the maturity bins. The right-most column of Panel A tabulates the percentage of corporate issues in each country with maturities that exceed in the year of issue the maximum reference maturity by more than one year. The maximum reference maturity is the maximum of (i) the maximum maturity of sovereign bonds issued in the year of the corporate bond issue and (ii) the maximum tenor of the yield curve in the year prior to the corporate bond issue. The right-most column of Panel B tabulates the percentage of sovereign issues in each country with maturities that exceed in the year of issue the maximum corporate maturity by more than one year.

Panel A: Corporate bonds

	% with maturity ∈ [0-3) years	% with maturity ∈ [3-10) years	% with maturity ∈ [10-30) years	% with maturity ∈[30-100) years	% with maturity > maximum reference maturity + 1 year
Australia	4.6%	67.1%	27.6%	0.7%	3.5%
Brazil	26.6%	66.5%	6.9%	0.0%	0.0%
Canada	6.9%	47.4%	30.5%	15.1%	4.3%
France	8.0%	67.8%	23.5%	0.6%	0.0%
Germany	11.1%	65.4%	21.5%	1.9%	1.4%
India	21.9%	62.4%	15.3%	0.3%	0.3%
Japan	1.2%	75.0%	23.2%	0.6%	0.1%
Malaysia	11.0%	56.7%	31.3%	1.0%	3.3%
Mexico	35.9%	55.4%	8.0%	0.7%	0.0%
Netherlands	24.5%	54.5%	20.7%	0.3%	0.0%
South Korea	37.8%	59.6%	2.3%	0.3%	0.1%
Thailand	11.6%	75.8%	12.4%	0.2%	0.0%
UK	4.2%	32.2%	52.5%	11.1%	0.9%
US	6.4%	46.1%	39.7%	7.8%	1.3%
Total	13.4%	55.3%	26.9%	4.5%	0.9%

Panel B: Sovereign bonds

Country	% with maturity ∈ [0-3) years	% with maturity ∈[3-10) years	% with maturity ∈[10-30) years	% with maturity ∈[30-100) years	% with maturity > maximum corporate maturity + 1 year
Australia	63.2%	16.9%	19.1%	0.3%	9.0%
Brazil	67.0%	24.6%	5.7%	1.8%	14.4%
Canada	74.3%	6.9%	6.7%	3.0%	0.9%
France	58.4%	21.6%	15.5%	3.7%	8.3%
Germany	55.9%	34.4%	7.4%	1.7%	2.7%
India	61.5%	14.7%	20.6%	0.9%	9.4%
Japan	41.8%	25.8%	29.4%	1.9%	2.1%
Malaysia	84.4%	9.1%	5.4%	0.1%	1.2%
Mexico	81.1%	16.6%	1.6%	0.2%	4.0%
Netherlands	49.8%	19.9%	24.0%	2.3%	14.6%
South Korea	42.2%	46.5%	9.0%	1.9%	6.4%
Thailand	84.5%	9.2%	5.2%	0.5%	5.5%
UK	72.7%	8.6%	12.1%	5.8%	3.7%
US	58.0%	33.0%	5.9%	1.4%	0.0%
Total	63.1%	19.4%	13.9%	2.0%	9.0%

Table 4: Correlations between maximum maturities

This Table presents correlations calculated across the 313 country-year observations of the maximum maturity of corporate bond issues, the maximum maturity of sovereign bond issues, and the maximum tenor of the yield curve. *** indicates significance at the 1% level.

	Maximum maturity of corporate bond issues	Maximum tenor of yield curve benchmark
Maximum tenor of yield curve benchmark	0.268***	1
Maximum maturity of sovereign bond issues	0.258***	0.273***

Table 5: Characteristics of reference rate variables for corporate bonds in alternate maturity bins

The Table reports the mean and standard deviation across countries and years of each reference rate-related variable for each maturity bin. Variable definitions are given in Table 1. *, **, and *** indicate significance at the 10% level, 5% level, and 1% level, respectively. The *Interpolatable Maturity* indicator is equal to 1 if the corporate issue's maturity bin is smaller than or equal to the maximum maturity on that country-year's sovereign yield curve and hence for the [30,...) bin the indicator is 0 by definition. The final rows report correlations between measures of corporate bond issuance and proxies for the quality of reference rates and gap filling.

	Any Corporate Issue	*% Corporate Issues*	*Yield Curve Benchmark Exists*	*Interpolatable Maturity*	*Same-Maturity Sov' Bond Issue*	*Same-Maturity Sov' Bond Outstanding*	*ln(USD Same-Maturity Sov' Bond Issues)*	*% Same-Maturity Sov' Bond Issues*
[00,03)	0.76	0.11	1.00	1.00	0.92	0.96	3.99	0.50
	(0.42)	(0.14)	(-)	(-)	(0.28)	(0.19)	(2.45)	(0.31)
[03,06)	0.97	0.38	1.00	0.99	0.93	1.00	2.92	0.18
	(0.17)	(0.21)	(-)	(0.08)	(0.25)	(-)	(1.79)	(0.2)
[06,09)	0.92	0.20	0.88	0.99	0.64	1.00	0.78	0.03
	(0.27)	(0.14)	(0.33)	(0.11)	(0.48)	(-)	(1.42)	(0.08)
[09,12)	0.90	0.19	0.99	0.89	0.96	0.96	2.78	0.16
	(0.3)	(0.15)	(0.11)	(0.31)	(0.2)	(0.20)	(1.85)	(0.17)
[12,15)	0.51	0.03	0.10	0.88	0.41	0.89	0.43	0.03
	(0.5)	(0.05)	(0.3)	(0.33)	(0.49)	(0.31)	(1.03)	(0.11)
[15,20)	0.55	0.03	0.64	0.78	0.55	0.91	0.86	0.02
	(0.5)	(0.04)	(0.48)	(0.42)	(0.5)	(0.29)	(1.49)	(0.05)
[20,25)	0.40	0.02	0.70	0.60	0.41	0.72	0.68	0.02
	(0.49)	(0.07)	(0.46)	(0.49)	(0.49)	(0.45)	(1.23)	(0.06)
[25,30)	0.26	0.01	0.12	0.55	0.51	0.73	0.74	0.01
	(0.44)	(0.03)	(0.33)	(0.50)	(0.5)	(0.44)	(1.46)	(0.05)
[30,...)	0.36	0.03	0.55	0	0.47	0.35	1.03	0.03
	(0.48)	(0.07)	(0.50)	(-)	(0.5)	(0.48)	(1.53)	(0.08)
All Maturities	0.63	0.11	0.66	0.74	0.64	0.84	1.58	0.11
	(0.48)	(0.17)	(0.47)	(0.44)	(0.48)	(0.37)	(2.03)	(0.21)
ρ in means with Any Corporate Issue			0.79**	0.74**	0.82***	0.75**	0.63*	0.47
ρ in means with % Corporate Issues			0.69**	0.55	0.77**	0.55	0.59*	0.35
ρ in bins with Any Corporate Issue			0.38***	0.37***	0.30***	0.31***	0.33***	0.18***
ρ in bins with *% Corporate Issues*			0.37***	0.30***	0.27***	0.24***	0.23***	0.16***

Table 6: Logit analysis of maturity bin choice for corporate issuers

This Table presents a logit analysis of corporate bond issues in 14 countries during the period 1991-2017. The dependent variable, *Any Corporate Issue*, is an indicator equal to 1 if the number of corporate issues in a country-year-maturity bin is larger than 0, and zero otherwise. All explanatory variables are defined in Table 1. The explanatory variables are observed in the year prior to the observation of the dependent variable. The set of countries and country-years covered are given in Table 1. The bond maturity bins are described in Figure 1. Heteroskedasticity-consistent standard errors clustered at the country level are reported in parentheses. *, **, and *** indicate significance at the 10% level, 5% level, and 1% level, respectively.

	Any Corporate Issue$_{t+1}$						
	(1)	(2)	(3)	(4)	Americas (5)	Europe (6)	Asia-Pacific (7)
Yield Curve Benchmark Exists	1.130***	1.650***	1.698***	1.775***	1.495***	1.184***	2.473***
	(0.206)	(0.251)	(0.245)	(0.271)	(0.440)	(0.367)	(0.482)
Interpolatable Maturity	1.009***	1.113***	1.245***	1.400***	0.799	1.595**	1.550***
	(0.202)	(0.236)	(0.265)	(0.331)	(0.693)	(0.744)	(0.322)
Same-Maturity Sov' Bond Issue	0.354	0.628**	0.684**	0.735*	-0.220	1.666***	0.256
	(0.384)	(0.308)	(0.328)	(0.388)	(0.140)	(0.566)	(0.495)
Same-Maturity Sov' Bond Outstanding	0.705***	1.099***	0.870***	0.881***	-0.667	0.566	1.441***
	(0.203)	(0.283)	(0.309)	(0.332)	(1.174)	(0.635)	(0.395)
ln(*USD Same-Maturity Sov' Bond Issues*)	0.345***	0.284***	0.226***	0.257***	0.679***	0.243**	0.103**
	(0.097)	(0.076)	(0.083)	(0.085)	(0.163)	(0.115)	(0.051)
% Same-Maturity Sov' Bond Issues	-1.368***	-1.230***	-0.813*	-1.058**	-3.162**	-1.299***	-0.367
	(0.521)	(0.385)	(0.415)	(0.432)	(1.262)	(0.320)	(0.574)
Sov' Bond Rating	0.008	0.019	0.011	0.008	0.081	-0.083***	0.020
	(0.036)	(0.030)	(0.034)	(0.041)	(0.091)	(0.013)	(0.044)
Has Sov' Bonds with Rating	-0.319	-0.431	-0.530*	-0.543*	-0.225	0.012	-0.943***
	(0.244)	(0.307)	(0.289)	(0.314)	(0.850)	(0.302)	(0.263)
Observations	2,691	2,691	2,691	2,691	684	918	1,089
Country FE	N	Y	Y	N	N	N	N
5-year FE	N	N	Y	N	N	N	N
Country×5-Year FE	N	N	N	Y	Y	Y	Y
McKelvey/Zavoina Pseudo-R^2	0.339	0.605	0.621	0.565	0.575	0.516	0.618

Table 7: Determinants of the maturity structure of corporate bond issues

This Table presents a Tobit analysis of corporate bond issues in 14 countries during the period 1991-2017 analogous to the logit analysis reported in Table 6. The dependent variable is *% Corporate Issues*: the number of corporate issues in a country-year-maturity bin relative to the total number of corporate issues in a country-year. *, **, and *** indicate significance at the 10% level, 5% level, and 1% level, respectively.

	% Corporate Issues$_{t+1}$						
	(1)	(2)	(3)	(4)	Americas (5)	Europe (6)	Asia-Pacific (7)
Yield Curve Benchmark	0.157***	0.170***	0.171***	0.175***	0.132***	0.150***	0.222***
Exists	(0.026)	(0.028)	(0.028)	(0.028)	(0.035)	(0.053)	(0.041)
Interpolatable Maturity	0.106***	0.112***	0.112***	0.125***	0.130	0.120*	0.158***
	(0.025)	(0.028)	(0.029)	(0.030)	(0.083)	(0.066)	(0.024)
Same-Maturity Sov'	0.098***	0.104***	0.101***	0.104***	0.016	0.193***	0.056
Bond Issue	(0.032)	(0.036)	(0.037)	(0.040)	(0.014)	(0.070)	(0.070)
Same-Maturity	0.081***	0.098***	0.101***	0.095**	-0.082	0.126*	0.139***
Sov' Bond Outstanding	(0.026)	(0.035)	(0.035)	(0.037)	(0.112)	(0.071)	(0.036)
ln(*USD Same-Maturity*	0.009*	0.012*	0.013**	0.014**	0.034***	0.008**	0.010
Sov' Bond Issues)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)	(0.004)	(0.009)
% Same-Maturity Sov'	-0.072	-0.107*	-0.118**	-0.131**	-0.239***	-0.111	-0.108
Bond Issues	(0.070)	(0.060)	(0.058)	(0.058)	(0.035)	(0.074)	(0.148)
Sov' Bond Rating	-0.002	-0.002	-0.002	-0.002	0.001	-0.007***	-0.004
	(0.003)	(0.003)	(0.004)	(0.004)	(0.009)	(0.001)	(0.006)
Has Sov' Bonds with	-0.040*	-0.043	-0.039	-0.030	-0.016	0.006	-0.061
Rating	(0.022)	(0.028)	(0.029)	(0.031)	(0.053)	(0.020)	(0.051)
Observations	2,691	2,691	2,691	2,691	684	918	1,089
Country FE	N	Y	Y	N	N	N	N
5-year FE	N	N	Y	N	N	N	N
Country×5-Year FE	N	N	N	Y	Y	Y	Y
McKelvey/Zavoina Pseudo-R^2	0.438	0.461	0.463	0.470	0.330	0.499	0.499

Table 8: The importance of gap filling in the presence of a high-quality reference rate

This Table presents logit and Tobit analyses of corporate bond issues for 14 countries during the period 1991-2017. In Panels A to C, the dependent variables are *Any Corporate Issue* and *% Corporate Issues*. All explanatory variables are defined in Table 1. In Panels B to D the sample is conditioned such that it contains only country-year-maturity observations for which both a sovereign yield curve benchmark exists and there are sovereign bond issues in the country-year-maturity bin that in size exceed the 1991-2017 median (in end-of-year USD) of all sovereign bond issues in that bin. Panel D reports Tobit regression results of *% Corporate Issues* against *Same-Maturity Sov' Bond Issues (%)* (in *k*-th differences), with $k = 1, \dots, 4$. The right-most column of Panel D reports the McKelvey/Zavoina R^2 of the relation reported in column (2). Heteroskedasticity-consistent standard errors are clustered at the country level and reported in parentheses. *, **, and *** indicate significance at the 10% level, 5% level, and 1% level, respectively.

Panel A: Unconditioned sample and the gap measured by *% Same-Maturity Bond Issues*

	Any Corporate Issue $_{t+1}$ logit		*% Corporate Issues* $_{t+1}$ Tobit	
	(1)	(2)	(3)	(4)
% Same-Maturity Sov' Bond Issues	2.685***	3.300***	0.227***	0.233***
	(0.705)	(0.810)	(0.080)	(0.081)
Sov' Bond Rating	0.006	0.013	0.001	0.001
	(0.034)	(0.033)	(0.003)	(0.003)
Has Sov' Bonds with Rating	0.392	0.067	0.019	0.009
	(0.356)	(0.298)	(0.029)	(0.034)
Observations	2,691	2,691	2,691	2,691
Country×5-Year FE	N	Y	N	Y
McKelvey/Zavoina Pseudo-R^2	0.104	0.363	0.090	0.128

Panel B: Conditioned sample and the gap measured by *% Same-Maturity Bond Issues*

	Any Corporate Issue $_{t+1}$ *logit*		*% Corporate Issues* $_{t+1}$ *Tobit*	
	(1)	(2)	(3)	(4)
% Same-Maturity Sov' Bond Issues	-1.523***	-2.813**	-0.184***	-0.269***
	(0.585)	(1.319)	(0.064)	(0.059)
Sov' Bond Rating	0.077	0.061	-0.006	-0.007
	(0.067)	(0.079)	(0.006)	(0.006)
Has Sov' Bonds with Rating	-0.475	-0.385	-0.019	-0.023
	(0.412)	(0.687)	(0.039)	(0.038)
Observations	624	624	624	624
Country×5-Year FE	N	Y	N	Y
McKelvey/Zavoina Pseudo-R^2	0.053	0.255	0.083	0.361

Panel C: Conditioned sample and the gap measured by *Excessive % Same-Maturity Bond Issues*

	Any Corporate Issue $_{t+1}$ logit (1)	(2)	*% Corporate Issues* $_{t+1}$ Tobit (3)	(4)
Excessive % Same-Maturity Sov' Bond Issues	-3.093***	-3.949	-0.271***	-0.377***
	(1.144)	(3.387)	(0.058)	(0.088)
Sov' Bond Rating	0.110**	0.114	-0.002	-0.001
	(0.052)	(0.072)	(0.005)	(0.005)
Has Sov' Bonds with Rating	-0.607	-0.408	-0.026	-0.024
	(0.419)	(0.644)	(0.038)	(0.040)
Observations	624	624	624	624
Country×5-Year FE	N	Y	N	Y
McKelvey/Zavoina Pseudo-R^2	0.079	0.251	0.058	0.362

Panel D: Greenwood-Hanson-Stein (2010) type analysis of the conditioned sample.

	% Corporate Issues Tobit (1)	(2)	# Obs.	Column (2) Pseudo-R^2
Δ_k*% Same-Maturity Sov' Bond Issues, k=1*	–0.112	–0.141*	643	0.354
	(0.0688)	(0.075)		
Δ_k *% Same-Maturity Sov' Bond Issues, k=2*	–0.154***	–0.179***	637	0.345
	(0.047)	(0.054)		
Δ_k *% Same-Maturity Sov' Bond Issues, k=3*	–0.192***	–0.199***	625	0.359
	(0.046)	(0.046)		
Δ_k *% Same-Maturity Sov' Bond Issues, k=4*	–0.168***	–0.176***	614	0.327
	(0.051)	(0.050)		
Country×5-Year FE	N	Y		

Table 9: Sovereign debt maturity extensions and suspensions

This Table reports changes in the issuance of sovereign bonds for the countries in our sample period that extend or suspend the maximum maturity of sovereign debt issues. Changes are identified based on Bloomberg's sovereign bond issuance data and an internet search for corroborating documents or newspaper announcements. We determine the year when the extending bond was first issued or suspended ("Issue Year"), and its approximate "rounded" maturity in which, say, maturities from 19 years to 21 years are referred to as 20-year maturities. To be classified as an introduction, the sovereign's maturity must be extended by at least 5 years relative to earlier issues. To be classified as a suspension, the government must halt for at least 4 years the issuance of a bond that had previously been issued at least every second year and that had the longest-maturity at the time of the halt. The requirement that the bond be frequently issued prior to the halt is imposed because infrequent issues are both introductions and suspensions. We do not classify issues from 1991-1993 since we are unable to compare to earlier years. We ignore sovereign bond introductions made during severe economic crises that likely prevent corporates from following the sovereign (Brazil in 2001-2002 and Japan in 1999) and in years with less than 5 corporate bond issues across all maturities (Mexico in any year between 2000-2009, Malaysia in 1998).

Country	Issue Year	Maturity	Event	Relevant quote from source	Corroborating source
Australia	2016	30Y	Introduction	Australia's decision to extend its bond curve out to 30 years for the first time means the highest interest-rate available from a major developed sovereign market is about to get even more appealing.	Bloomberg News
France	1994	30Y	Suspension	-	-
France	1998	30Y	Introduction	[T]he government will therefore enrich its range of long-term bonds in the first half of 1998 with a new 2029 bond, set to become the 30-year euro-denominated benchmark	Agence France Tresor, 1998, Press release, January 9
Germany	1994	30Y	Introduction	-	-
India	2015*	30Y	Introduction	[N]ew 30-year government bond will act as a benchmark for pricing debt.	Indian credit rating agency India Ratings and Research (Ind-Ra)
Malaysia	2013	30Y	Introduction	Malaysia sold its first 30-year bonds, its longest maturity, as the Southeast Asian nation seeks to set a new benchmark for the local debt market.	Bloomberg News
South Korea	2006	20Y	Introduction	-	
South Korea	2012	30Y	Introduction	A longer maturity is required for KTBs (Korean Treasury Bonds) to minimize the risks associated with expenses for rollover of KTBs and funding expenses and to distribute the burden of redemptions.	Ministry of Strategy and Finance South Korea
Thailand	2001	20Y	Introduction	-	-
Thailand	2008	30Y	Introduction	Goal: Government Bond Yield Curve that can effectively provide a reference rate for private sector bond issuance	OECD

United Kingdom	1997	30Y	Introduction	Two new conventional stocks were created: a five year benchmark (…) and a long benchmark (6% Treasury 2028)	Bank of England
United States	2001	30Y	Suspension	Maintaining the issuance levels of 30-year bonds would be unnecessary and expensive to taxpayers.	U.S. Department of the Treasury, 2001, Press release, October 31
United States	2006	30Y	Introduction	(…) Treasury has large financing needs going forward (forecasted deficits), (..) there is unprecedented demand for longer-dated securities, but (..) the average maturity of the debt outstanding was near its lowest level in twenty years.	U.S. Department of the Treasury, 2006, Press release, January 31

* India introduced a 30-year bond issue as early as 2002, which technically allowed for a 30-year point on Bloomberg's sovereign yield curve. However, this point could not be used effectively as a benchmark until 2015 due to insufficient liquidity; e.g., in 2007 only 10% of all bonds of more than 3-year maturity traded on more than 200 days. Consequently, the Indian 30-year tenor appears and disappears repeatedly in Bloomberg. The 2015 introduction of a 30-year sovereign bond made newspaper headlines and proved to be liquid. Our results are qualitatively unchanged if we use the year 2002 rather than 2015 as the year of the introduction of a 30-year sovereign bond in India.

Table 10: Quasi-natural experiment involving extensions and suspensions of sovereign debt maturity

This Table presents Tobit analyses of corporate bond issues following introductions and suspensions of long-term sovereign bonds. The introductions and suspensions are reported in Table 9. The sample is limited to maturity bins of 20 or more years. The dependent variable is *% Corporate Issues*: the number of corporate issues in a country-year-maturity bin relative to the total number of corporate issues in a country-year. The key independent variables are the indicators *Maturity Change* ($t + k$), $k = -3, \ldots, +3$, which depend on whether there was an introduction or suspension k years prior to or after the year t observation of *% Corporate Issues*. The indicators are equal +1 for introductions, −1 for suspensions, and 0 otherwise. Heteroskedasticity-consistent standard errors are clustered at the country level and reported in parentheses. *, **, and *** indicate significance at the 10% level, 5% level, and 1% level, respectively.

	% Corporate Issues			
	(1)	(2)	(3)	(4)
Maturity Change (t + 3)				-0.034
				(0.043)
Maturity Change (t + 2)			-0.007	-0.005
			(0.026)	(0.028)
Maturity Change (t + 1)	-0.060	-0.052	-0.051	-0.048
	(0.043)	(0.040)	(0.041)	(0.044)
Maturity Change (t)	-0.042	-0.039	-0.031	-0.025
	(0.027)	(0.026)	(0.024)	(0.022)
Maturity Change (t – 1)	0.055**	0.055**	0.068***	0.073***
	(0.025)	(0.022)	(0.022)	(0.024)
Maturity Change (t – 2)			0.051**	0.056*
			(0.026)	(0.029)
Maturity Change (t – 3)				0.010
				(0.035)
Credit Spread		0.009	0.011*	0.011*
		(0.006)	(0.006)	(0.006)
Term Spread		0.004	0.003	0.002
		(0.003)	(0.003)	(0.003)
Inflation		-0.007	-0.008	-0.007
		(0.005)	(0.006)	(0.006)
Observations	858	762	711	642
Country FE	Y	Y	Y	Y
5-Year FE	Y	Y	Y	Y
McKelvey/Zavoina Pseudo-R^2	0.517	0.549	0.544	0.533

Figure 1: Fraction of corporate bonds, per maturity bin

This figure plots the distribution of corporate bond issuance across maturities for bonds issued between 1991 and 2017. Maturity statistics are obtained from Thomson One Banker.

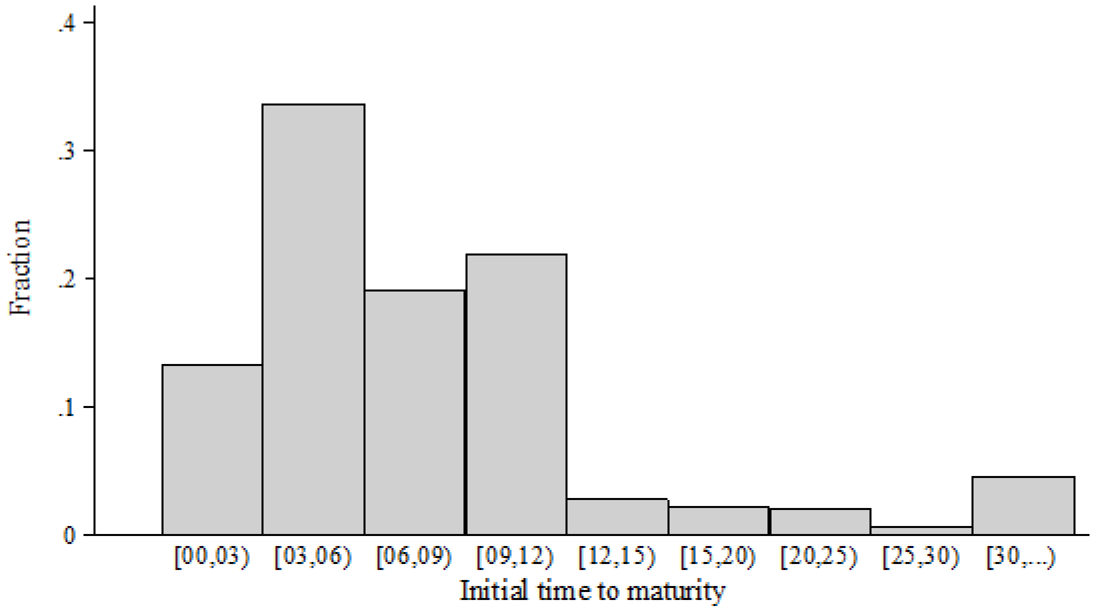


Figure 2: Fraction of sovereign bonds, per maturity bin

This figure plots the distribution of domestic currency sovereign bond issuance across maturities for bonds issued between 1991 and 2017. Maturity statistics are obtained from Bloomberg.

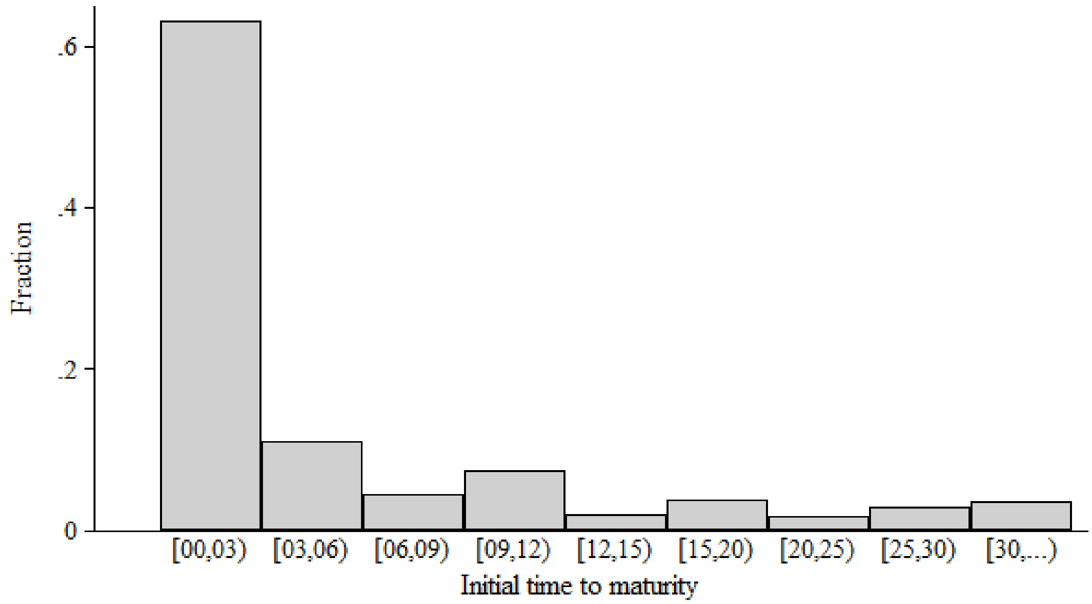


Figure 3: Fraction of available benchmarks, per maturity bin

This figure plots the availability of yield curve benchmarks across maturities for the period 1991 – 2017. The statistics are obtained from Bloomberg.

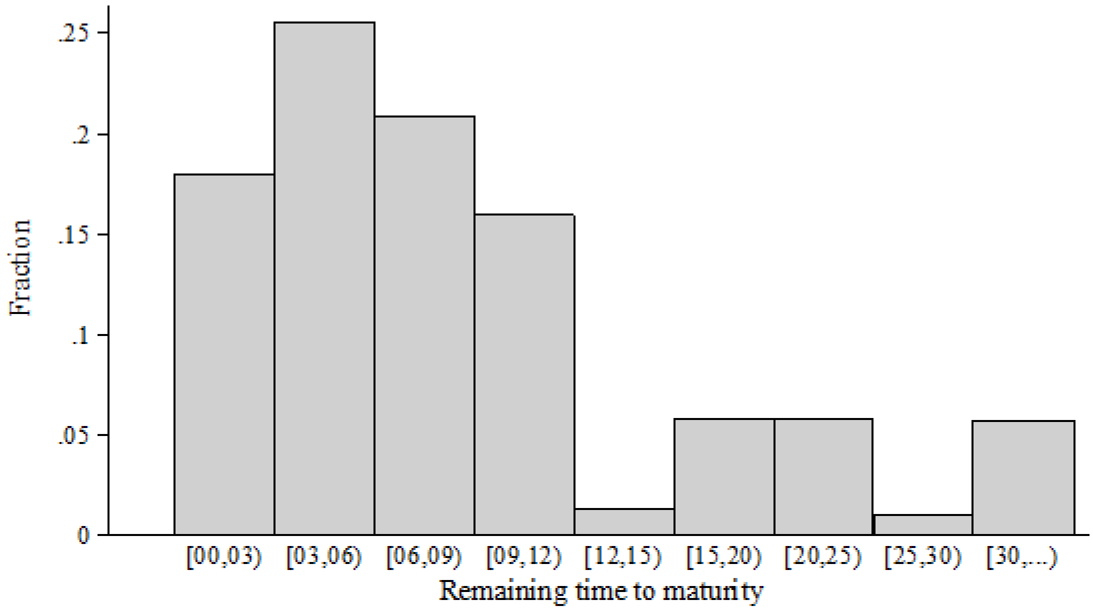
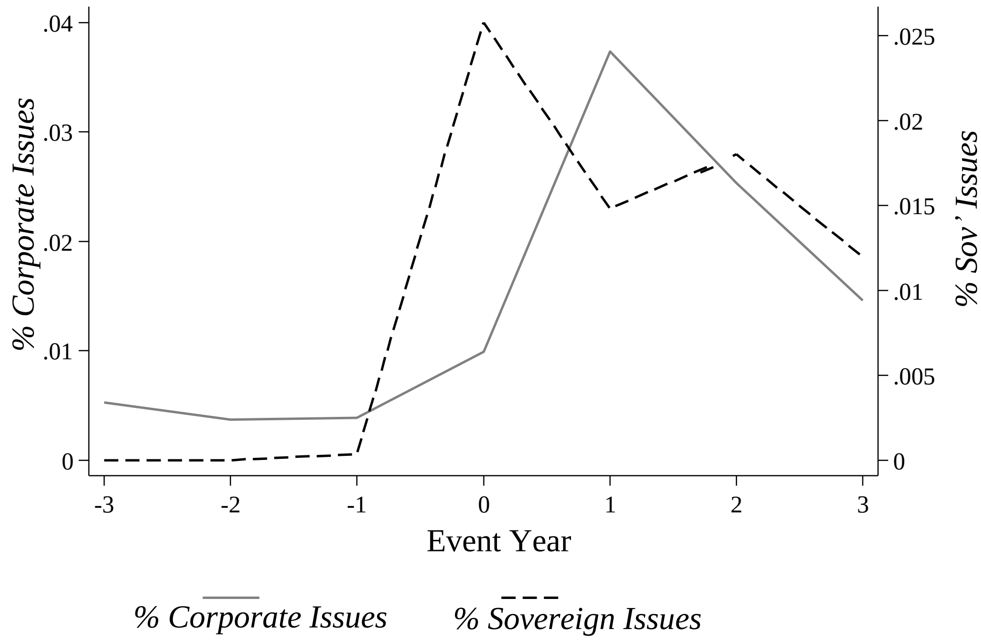


Figure 4: Corporate issuance before/after sovereign debt maturity extension/suspension

This figure plots the average across introducing countries of the *% Corporate Issues* and *% Sov' Issues* measure of the percentage of all corporate and sovereign issues respectively in a country-year that fall in the newly introduced (Panel A) and suspended (Panel B) maturity bin for years −3 to +3 relative to the year of introduction/suspension. Year 0 is the year of the sovereign introduction/suspension.

Panel A: Corporate issuance around introductions of longer maturity sovereign bonds



Panel B: Corporate issuance around suspensions of longer maturity sovereign bonds

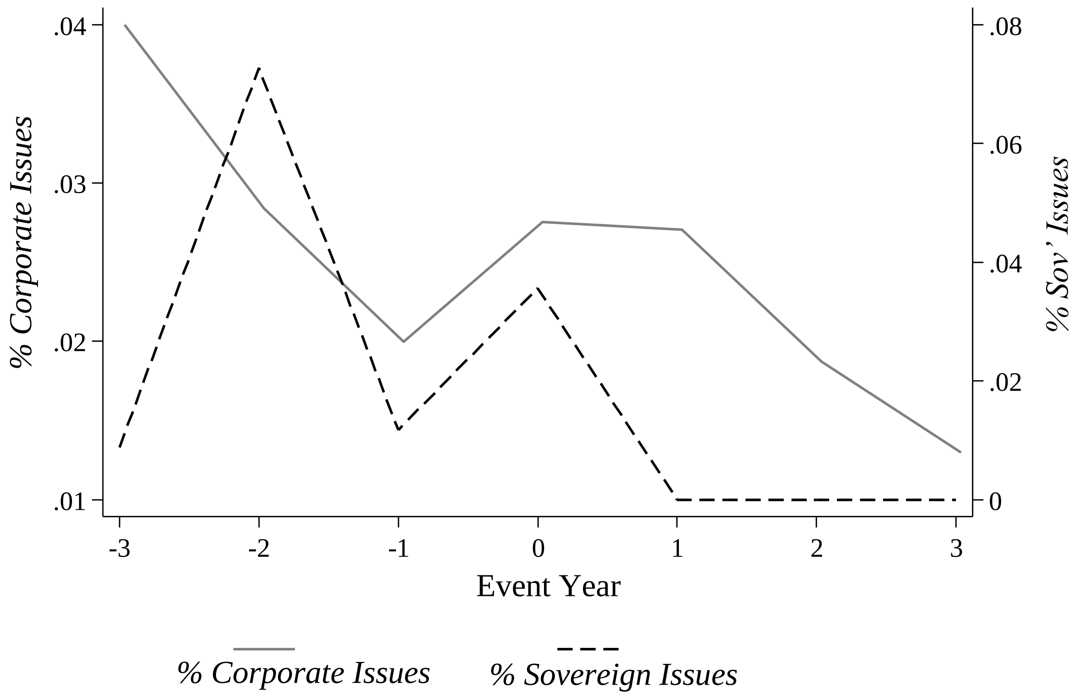
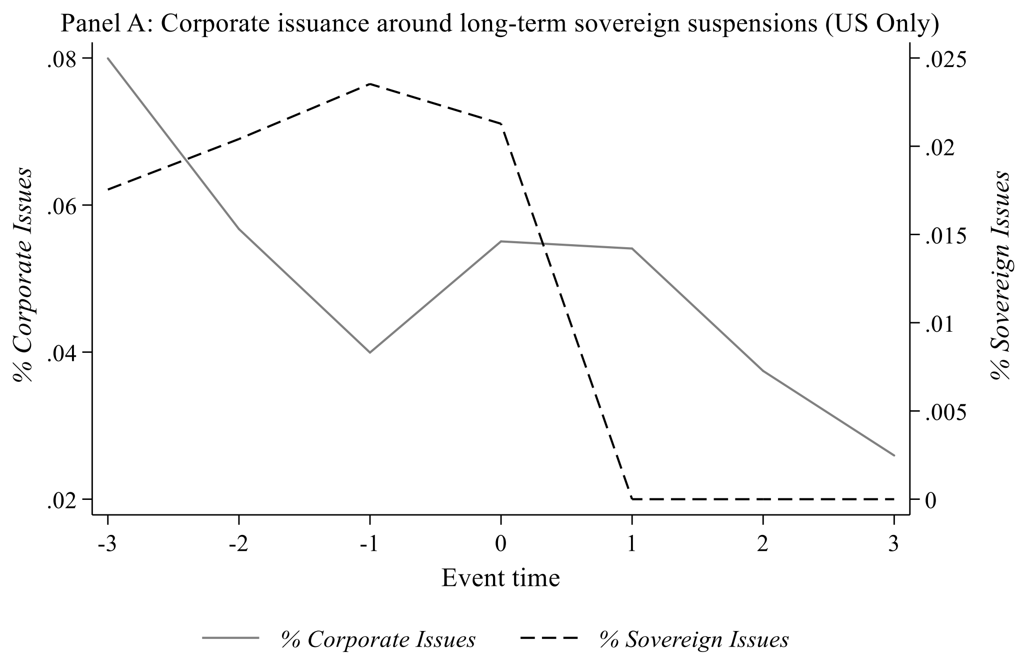
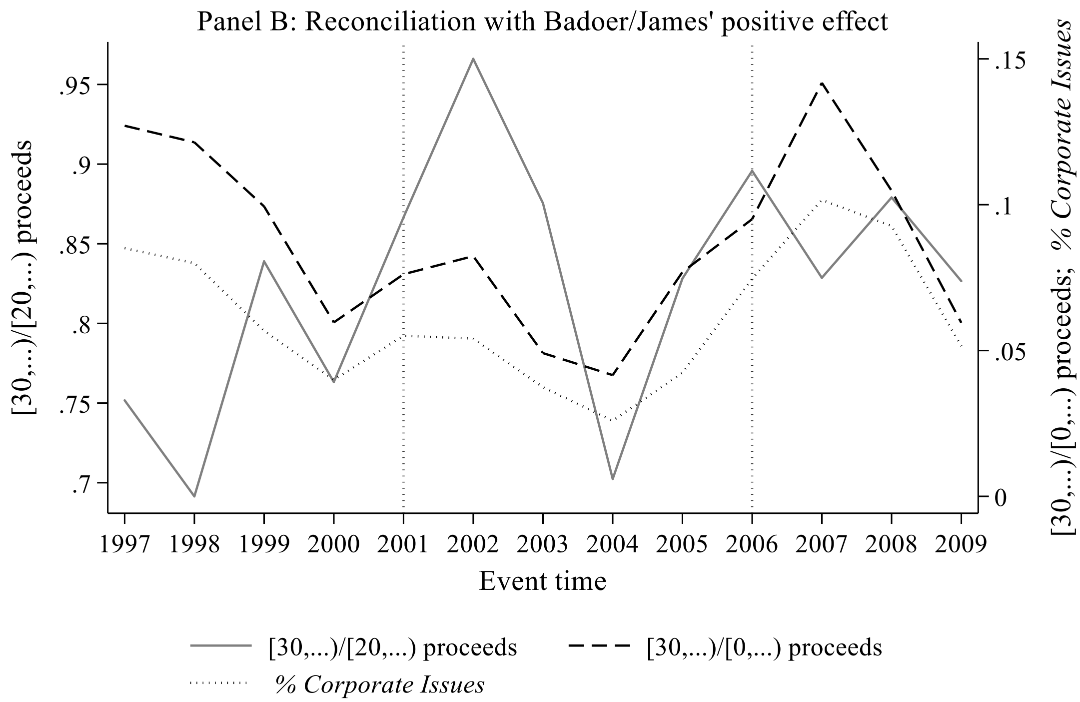


Figure 5: US Corporate issuance and the 2001 suspension of 30-year US sovereign bonds

Panel A plots the annual averages of the number of US corporate issues in the [30,…) bin in a given year as a percent of the number of all US corporate issues that year and the analogous average percentages for US sovereign bond issues. Panel A examines the seven years centered on the 2001 suspension. For the period 1997-2009, Panel B plots the annual averages of the proceeds of all US corporate issues in the [30,…) bin in a given year as a percent of the proceeds of all corporate issues that year. Panel B also plots the annual averages of the proceeds of all US corporate issues in the [30,…) bin in a given year as a percent of the proceeds of all corporate issues that year that have maturities of 20 years or more. In addition, Panel B plots annual averages of the number of US corporate issues in the [30,…) bin in a given year as a percent of the number of all corporate issues in that year.




Panel B: Reconciliation with Badoer/James' positive effect
[30,...)/[20,...) proceeds
.95
.9
.85
.8
.75
.7
[30,...)/[0,...) proceeds; % Corporate Issues
.15
.1
.05
0
1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009
Event time
[30,...)/[20,...) proceeds
[30,...)/[0,...) proceeds
% Corporate Issues