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The Importance of Sovereign Bond Benchmarks for Corporate Debt Issuance: Mind the Gap

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Abstract

Sovereign bond benchmarks are important determinants of corporate bond issuance and maturity. We show that by providing benchmark rates, long-maturity government issues complement the issuance of similar-maturity corporate issues. Government and corporate bond issues are also substitutes and more long-term corporate bonds are issued when sovereign alternatives are in short supply. However, the substitution weakens when sovereign bonds fail to provide a precise benchmark. Sovereign debt and its maturity play an important role in capital market development with sovereign bond issues that increase a country's maximum maturity preceding increases in the maximum maturity of corporate issues.

JEL classification: G12, G15, G18, G32, H63

Keywords: Corporate bond issuance, Sovereign bond issuance, Bond maturity, Sovereign benchmark, Reference rates

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"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

How does corporate debt issuance depend on sovereign debt issuance? In this paper we highlight the complementary nature of sovereign and corporate debt. The yield on a sovereign bond of the same maturity and currency can be used as a benchmark by corporate bond issuers. In the absence of a sovereign bond benchmark, investors will have difficulty in valuing and hedging long-maturity corporate bonds and corporations must determine the amount of long-term debt to issue without a clear price signal of the strength of preferred-habitat investor demand. We characterize the relation between the quality of the benchmark provided by sovereign bonds and corporations' willingness to issue long-maturity bonds as the sovereign benchmark hypothesis.

Corporate and sovereign bonds can also be substitutes. Corporations supply relatively safe securities to investors when sovereign alternatives are in short supply, behavior which is known as "gap filling" (Greenwood, Hanson and Stein, 2010). We argue that the existence of a sovereign bond benchmark can be a prerequisite for such gap filling. Without such a benchmark, corporations face a challenge in filling the gap and may choose to issue less long-term debt, and possibly forgo issuance entirely; i.e., to *mind* the gap.

To empirically investigate the importance of sovereign bond benchmarks and our prediction of reduced gap filling in the absence of a precise sovereign bond benchmark, we examine 48,085 corporate bond issues and 31,474 sovereign bond issues with granular observations on the bonds' maturities. The data come from 14 countries between 1991 and 2017. Examining bond issues rather than the maturities of outstanding bonds allows us to observe the response of corporate issuance to sovereign issuance at points along the maturity spectrum. The

sovereign yield curve contains information about expectations of the macroeconomy and future monetary policy decisions unclouded by default risk. Data providers such as Bloomberg routinely provide sovereign bond yield curves as benchmark rates. The benchmark status of sovereign debt is discussed in a Bank for International Settlements study, Brooke et al. (2001): "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."[1]

There are five reasons we conclude that the relation between sovereign and corporate bond maturities reflects a benchmark effect and is not purely an endogenous reflection of differences in countries' political risks and institutional environments, or differences in preferred-habitat investor demand across countries and time. First, we estimate that the odds of a corporate bond issue in a particular maturity bin increase significantly, by a factor of four, if the corporate's maturity is smaller than or equal to the maximum tenor of 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 almost six 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. We also document that it is rare for firms to issue bonds with maturities longer than that of their home country's sovereign bonds.

Second, both corporations and financial authorities state directly that benchmarking is an important motivation for altering the available maturities of sovereign bonds. A 2009 report of the

[1] Theoretically, Dunne, Moore, and Portes (2007) model the relation between benchmark status and price discovery. Duffie, Dworczak, and Zhu (2017) model improved matching in OTC markets when securities are priced relative to a benchmark. Remolona and Yetman (2020) investigate attempts by governments of countries with less-developed capital markets to designate particular issues as benchmark bonds and to foster their liquidity. Brooke et al. (2001) 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.

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 bond benchmarks.[2] When Singapore introduced 30-year sovereign bonds, the Bank of International Settlements noted the importance of sovereign bond benchmarks for the development of the corporate bond market.[3] Brooke et al. (2001) notes that "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).[4] The financial sector's resistance to the Australian proposal to retire sovereign debt, quoted at the beginning of this paper, also highlights the economic importance of sovereign bond benchmarks.

Third, we document 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 precise benchmark. Since 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 include country-time fixed effects and show that corporations are willing to fill gaps when sovereign bond issuance is low but still high enough to provide a useful benchmark.

Fourth, we present results from quasi-natural experiments that examine 13 different events across 9 countries, spans 20 years, and exploits the relative timing of changes in the maturities of sovereign and corporate bonds. We find that the introduction of sovereign bonds that increase the maximum benchmark tenor precedes the issuance of corporate debt of the new longer maturity. Conversely, the suspension of long-term sovereign bonds tends to be followed by a suspension of

[2] "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."

[3] "… 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

[4] 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.

corporate bonds of the same maturity. On average, the effect of sovereign bond introductions and suspensions is largest in the year immediately following the events, when long-term corporate bond issuance changes by around one standard deviation. The effect continues into the subsequent year but is absent in the years preceding the events.

Our fifth reason for concluding that the relation between sovereign and corporate bond maturities reflects a benchmark effect follows from the observation that quantitative easing introduces large preprogrammed purchases into the sovereign bond market by central banks with objectives quite distinct from those of the typical investor in safe bonds. As a result, the quality of sovereign yields as pricing guides for corporate issuers can be reduced. Consistent with this possibility, we find that quantitative easing is associated with a significant reduction in corporations' preference for issuing bonds with maturities that match the tenors at which the Bloomberg yield curve had previously provided precise benchmark rates; i.e., that the strength of the sovereign benchmark effect declines as the quality of the benchmark declines.

Collectively, our findings show that the relation between sovereign and corporate bond maturities is consistent with the sovereign benchmark hypothesis. It is important to recognize that the hypothesis does not claim that sovereign introductions are the seminal cause of corporate issues with longer maturities than in the past. It may be that sovereigns issue at the new longer maturity before corporations do because corporations lobby the sovereign to introduce longer-maturity bonds in order to provide a benchmark from which they can then key off their own subsequent issues. Our observation is that sovereign bond benchmarks play an important role in facilitating corporate bond issuance.

Our investigation of sovereign bond benchmarks has broad implications for the sovereign's role in a well-functioning capital market. The formal review of the Australian Commonwealth Government Securities Market in 2002 considered industry, regulator and academic submissions. The outcome of the review was that the Australian government decided not to retire all its long-term debt. The government chose instead to retain the long-term sovereign bond market and use the capital that might have retired the national debt to instead create a sovereign wealth fund. Ricardian equivalence might imply 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 benchmark rates useful in pricing long-term payoffs. Sovereign bond benchmarks 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 reviews the literature on debt maturity. Section 3 describes our international dataset of corporate and sovereign bond issues and Section 4 documents both gap filling and the benchmark effect. Section 5 documents that gap-filling behavior is stronger when sovereign bonds provide a more precise benchmark. Section 6 uses a set of quasi-natural experiments to document the effect of extensions and reductions in the maximum tenor of sovereign bonds on the maturity of corporate bond issues. Section 7 documents the diminution in the strength of the benchmark effect in periods during which quantitative easing lowers the quality of the benchmark provided by sovereign bonds. Section 8 concludes.

2. The Determinants of Corporate 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 this 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. He concludes 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 can be 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 a smaller debt overhang problem. Assets-in-place can serve as collateral and maturity matching can tie the maturity of an issuer's debt to the duration of its assets.

Several empirical studies investigate 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. Dittmar and Yuan (2008) conclude that dollar-denominated sovereign bonds in emerging markets provide reference rates that facilitate price-discovery since one-fifth of the information in corporate yield spreads measured relative to US treasury rates can be traced to innovations in sovereign yield spreads and that the issuance of dollar-denominated sovereign bonds in emerging markets lowers both corporate yield spreads and bid-ask spreads. Flannery, Hong and Wang (2020) find that the 2017 issuance of $2 billion of five- and ten-year Chinese sovereign bonds denominated in USD led to a decline in the yield spread on similar-maturity Chinese corporate bonds denominated in USD. The Flannery, Hong and Wang's (2020) focus on prices of Chinese bonds complements our results on the quantities of bonds of varying maturities in 14 countries.

Our study empirically examines the simultaneous roles that long-term sovereign bonds play as substitutes for long-term corporate bonds issues in the portfolios of preferred-habitat investors and as providers of benchmark rates. The substitutability of sovereign and corporate bonds results in gap-filling behavior as modelled in Greenwood, Hanson and Stein (2010). Empirically, gap-filling behavior has been documented in US markets by Greenwood, Hanson and Stein (2010), Graham, Leary and Roberts (2014, 2015), and Badoer and James (2016) and in Euro-zone countries by Lugo and Piccillo (2016). Demirci, Huang and Sialm (2019) demonstrate a negative relation between government debt and corporate leverage in 40 countries. By providing benchmarks, long-term sovereign bonds are not simply replacements for corporate bonds. Rather, a liquid market in sovereign bonds can encourage the issuance of long-term corporate bonds. For example, corporations may be more willing to issue long-term bonds when a large long-term

sovereign bond market provides accurate price signals to underwriters and, as a result, underwriting risk and underwriting fees are lower than they would otherwise be. A link between sovereign bond benchmarks and underwriting fees is modelled in Appendix A. Preferred-habitat investor demand for long-term corporate bonds can be higher if the existence of similar-maturity sovereign bonds makes it easier to price and hedge corporate bonds.[5] The following section describes the international data set we use to investigate both "gap minding" associated with the benchmark effect (the complementarity of corporate and sovereign bonds) and "gap filling" (the substitutability of corporate and sovereign bonds).

3. Data

Our international sample of bonds is assembled from multiple sources. For corporate bond issuance, we use Thomson Reuters SDC Platinum (through Thomson One Banker), which is standard in the literature. The bond issues are from the 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.[6] We delete foreign currency bonds and issues by financials and utilities, hybrid securities such as convertible bonds, perpetual bond issues, and 100-year bond issues.[7] Sovereign bond issuance is obtained from Bloomberg's Professional Services and based on the set of domestic currency bond

[5] Greenwood and Vayanos (2010) demonstrate the important role played by preferred-habitat investors in the long-term bond market through an analysis of the effect of the 2004 UK Pensions Act on long-term yields in the UK.

[6] Given our focus on issuance decisions, Chinese bond issues are not included because of the opaqueness of the distinction between the Chinese corporate and sovereign sectors. Guatemalan bond issues 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. Our results are robust to including these two countries.

[7] The gap-filling and sovereign benchmark hypotheses cannot fully explain the choice of bond maturity when machismo affects the maturity choice and it is for this reason that extreme-maturity bonds are deleted from the sample. 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.

issues with a BICS Classification of "Sovereign".[8] We remove coupon strips and bonds not issued by the national government. As Bloomberg also provides comprehensive historical information on international yield curves, we are able to construct an international panel of sovereign yield curves. The sample starts in 1991 when international sovereign yield curve data become widely available and ends in 2017.[9]

Appendix B defines the variables used in the paper's analysis. Panel A of Table 1 summarizes the number and maturity of the corporate bond issues in each country. The average (median) maturity of all newly-issued corporate bonds in our sample is 7.8 years (six years) and the average of the 14 country-specific mean maturities is 7.3 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 and South Korean firms to ten years for UK firms. Panel B1 of Table 1 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). As with corporate bonds, there is substantial variation across countries in the average and median maturities of sovereign bonds. The average ranges from 1.8 years in Thailand to 8.3 years in Japan and the median ranges from 0.2 of a year in Thailand and the UK to five years in Japan. The maximum maturity of sovereign bonds exceeds 30 years for all the sample countries, but for many countries such long-term bonds were only first issued toward the end of the sample period.

[please insert Table 1]

A benchmark rate for a given maturity can be provided by newly-issued sovereign bonds of the desired maturity or by 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 1 summarizes by country the

[8] We have verified that Bloomberg's cross-country fixed income coverage is more comprehensive than coverage in other data sources, such as Datastream. We have also confirmed that the number of "regular" US Treasury bonds and notes issues in Bloomberg (1,072) is almost identical to the number of "regular" issues in CRSP's US Treasury database (1,061).

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

tenors of the Bloomberg sovereign yield curves. Bloomberg's yield curves report the 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 of issues provided by local financial authorities (and sometimes altered by Bloomberg). 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 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 1 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 benchmark if they are sufficiently liquid.

4. The Empirical Link between Sovereign Bond Benchmarks 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,…). 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.[10] 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 1]

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. Figure 3

[10] While much of the debt-maturity literature has followed the accounting convention of delineating short- versus long-term bonds as those with maturities below versus above one year, only a small fraction of corporate bond issues have a maturity of one year or less. The empirical analyses of debt maturity in Barclay and Smith (1995), Barclay, Marx and Smith (2003), and Johnson (2003) use three years as the cut-off between long- and short-term debt.

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 Figures 2 and 3]

If the existence of a sovereign bond benchmark 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. To investigate this prediction, we examine for each country the maximum maturity of corporate bond issues in a given year and the maximum benchmark maturity that year. The maximum benchmark maturity in a given year is taken as 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. Panel C of Table 1 shows that corporate bond issues with maturities in excess of the maximum benchmark maturity are rare. Less than one percent of all corporate issues have a maturity greater than the maximum benchmark maturity. In contrast to the situation with corporate issues, Panel C also 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 maximum maturity of all corporate bonds issued in the same country-year.

4.2 Variable definitions

This section presents a variety of measures that intuitively capture the benchmarking role of sovereign bonds and sovereign yield curves. All variables are summarized in Appendix B. In our regression analysis, we consider two measures of corporate bond issuance as dependent variables, namely an indicator *Any Corporate Issue* and a variable *% Corporate Issues*. The *Any Corporate Issue* indicator equals 1 if the number of corporate issues in a country-year-maturity bin exceeds zero and is 0 otherwise. The *% Corporate Issues* variable is equal to the number of corporate issues in a country-year-maturity bin as a percentage of the total of all corporate issues in that country-year. As explanatory variables we consider a number of measures that proxy for the precision of the benchmark. *Precise Yield Curve Benchmark* 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 Yield Curve 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. *New Sov' Issue* is an indicator equal to 1 if there exists a newly-issued sovereign bond in the country-year-maturity bin. *Vintage Sov' Bond* is an indicator equal to 1 if there exists an outstanding sovereign bond in the country-year-maturity bin. *Sov' Issuance Activity* is the log-transformed amount of government bond issues (in millions) in the country-year-maturity bin converted into U.S. dollars using the end-of-year exchange rate taken from Bloomberg.[11]

The measure *% New Sov' Issue* 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. If a high percentage implies that there is a small gap at that maturity, corporations will be less likely to issue into that bin.

[please insert Table 2]

Table 2 presents means and standard deviations of the principal dependent and explanatory variables investigated. The third and fourth rows of Table 2 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* are correlated at the 1% level with the presence of a precise or interpolated yield curve benchmark and with the presence of a contemporaneous sovereign bond issue of comparable maturity, the presence of a previously-issued sovereign bond whose remaining maturity is comparable, the volume of new sovereign bond issuance of comparable maturity, and the percentage of all sovereign bond issuance that has comparable maturity. In the next sections, we investigate whether the sovereign benchmark hypothesis can partially explain these correlations.

4.3 Regression Analysis

[11] We treat a tap of an existing issue 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 recognize a €10 issue of 10-year bonds in 1999 and a €5 issue of 9-year bonds in 2000.

Our investigation of the issuance of corporate bonds considers a granular maturity structure with maturity bins that may or may not be empty across country-years. This is important as the notion of short- versus long-term maturity varies across countries. In contrast, extant studies on gap filling consider maturities of greater or less than one year (Greenwood, Hanson and Stein, 2010; Graham, Leary and Roberts, 2014; Graham, Leary and Roberts, 2015; Lugo and Piccillo, 2016; Demirci, Huang and Sialm, 2019) or greater or less than twenty years (Badoer and James, 2016).[12] An investigation of the effect of high quality benchmarks on corporate bond issuance requires a more refined categorization of bond maturity. Our choice of nine maturity bins allows us to better determine whether yields on comparable maturity sovereign bonds provide benchmarks for corporations considering issuing bonds of a specific maturity. Relation (1) 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 sovereign benchmark and gap-filling hypotheses.

$$\begin{aligned} Corporate\ Issuance_{ij,t+1} &= \alpha + \beta_1 Precise\ Yield\ \ Curve\ Benchmark_{ij,t} \\ &+ \beta_2 Interpolatable\ Yield\ \ Curve\ Benchmark_{ij,t} + \beta_3 New\ Sov'\ Issue_{ij,t} \\ &+ \beta_4 Vintage\ Sov'\ Bond_{ij,t} + \beta_5 Sov'\ Issuance\ Activity_{ij,t} \\ &+ \beta_6 \%\ New\ Sov'\ Issuance_{ij,t} + \theta Sov'\ Bond\ Rating_{ij,t} + c_{i,\tau}, \end{aligned} \tag{1}$$

where the subscript *ij,t* denotes the country-maturity-year dimension. To the extent the explanatory variables are measures of the quality of the benchmark provided by sovereign bonds in a country-year-maturity bin, the sovereign benchmark hypothesis predicts that the estimated beta coefficients will be positive. Bond rating control variables are measured as bin-level averages of the highest of the Fitch, Moody's and Standard & Poor's ratings of the sovereign after conversion into a scale from 1 (unrated) to 17 (AAA-rated) with the rating level of unrated sovereign bonds set at the lowest possible level of 1. Country-time fixed effects are captured by $c_{i,\tau}$ where τ refers to 5-year

[12] Most studies of gap filling examine US data. Demirci, Huang and Sialm (2019) examine data from 40 countries and Lugo and Piccillo (2016) document 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.

periods.[13] The explanatory variables are observed in the year prior to the observation of the dependent variable.

The dependent variable, *Corporate Issuance*, is measured by either the indicator variable *Any Corporate Issue* or the continuous variable *% Corporate Issues*. As maturity bins may or may not contain an outstanding corporate bond issue, we use the standard logit and Tobit estimators, respectively, as our 20-year sample period alleviates concerns about the use of nonlinear estimators in panel data.[14] Standard errors are clustered at the country level to account for serial correlation.[15] The pseudo-R^2 values reported throughout the paper's tables are the McKelvey/Zavoina measure recommended in Veall and Zimmermann (1994). If sovereign bonds are to provide a benchmark, they must do so before the corporate bond is issued. Therefore, we link the dependent variable in year $t + 1$ to benchmarking variables observed in year t.

Unobservables with a similar influence on both corporate and sovereign bond issuance are likely to exist. For instance, investor demand may be a common driver of the maximum maturity of both sovereign and corporate debt. If a country is politically unstable, then lenders will be less willing to lend long-term to the government because of the risk of default and/or hyperinflation. Investors in that country will face a similar lack of certainty regarding property rights and will be similarly unwilling to buy long-term corporate bonds. As a second example, suppose demand for whole-of-life annuity products increases. Insurers may lengthen the maturity of corporate and sovereign bonds in their preferred habitat. The (potentially time-varying) differences between countries are reflected in the country-time fixed effects $c_{i\tau}$. We address endogeneity concerns more directly in Sections 6 and 7.

[please insert Table 3]

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

[14] Specifically, the incidental parameters problem of biased coefficient estimates arises when the number of time periods is small. However, in a panel consisting of only 8 years, this bias is already substantially reduced (Green, 2004, p.697).

[15] Standard errors tend to be similar or smaller when we cluster in the time or tenor dimensions or double-cluster in the country-year dimension. Hence our choice of standard error clustering is conservative.

Columns 1-3 of Table 3 report regression estimates of the relation (1) as applied to the *Any Corporate Issue* measure. The three regressions differ in the explanatory variables examined. Column (1) reports the result when the yield curve measures of the quality of the sovereign benchmark are used as explanatory variables. Column (2) uses sovereign bond market measures of the quality of the sovereign benchmark as explanatory variables. Column (3) uses both the yield curve measures and the sovereign bond market measures as well as the *% New Sov' Issue* variable.

The coefficients on the *Precise Yield Curve Benchmark* and the *Interpolatable Yield Curve Maturity* variables in Columns 1 and 3 indicate a significant positive 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 coefficient on *Interpolatable Yield Curve Maturity* in Column 3, we estimate that the odds of a corporate bond issue in a maturity bin increase significantly, by a factor of 4.1, when the corporate's maturity is smaller than or equal to the maximum tenor of 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.

Columns 2 and 3 report significant positive coefficients on all three sovereign bond market measures of the quality of the sovereign benchmark, namely the *New Sov' Issue* and *Vintage Sov' Bond* indicator measures and the *Sov' Issuance Activity* variable. New or previously issued sovereign debt in a country-year-maturity bin and a critical mass of sovereign debt in a country-year-maturity bin are incrementally all strongly positively related to the probability of corporate issuance into that bin.

In summary, the results of the logit regressions in Columns 1, 2 and 3 are consistent with the hypothesis that corporations are more likely to issue bonds with a maturity for which sovereign bonds provide a precise benchmark. Importantly, this result is found when we control for institutional and political differences between countries by means of country-time fixed effects. Country-time fixed effects will also captures time-varying changes common to all countries (such as the global interest rate environment) and 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 corporations and sovereigns to issue long-term bonds.[16]

The *% New Sov' Issue* variable is the monetary amount of issuance in a bin relative to the total monetary amount of issuance across all bins. A high percentage may mean a small gap at that maturity, in which case gap filling suggests that corporations will be less likely to issue into that maturity bin. In contrast to the positive coefficients on the yield curve and sovereign bond market measures of the quality of the sovereign benchmark, the estimated coefficient on *% New Sov' Issue,* is significantly negative. To the extent *% new Sov' Issue* is an inverse measure of the gap in a maturity bin, gap filling appears to coexist with the benchmark effect when we control for the other yield curve and sovereign bond market measures of the quality of the sovereign benchmark.

Columns 4-6 of Table 3 report a Tobit analysis of the link between a continuous measure of corporate bond issuance in a given year, the *% Corporate Issues* variable, and explanatory variables observed in the prior year. The conclusion from the Tobit analysis reinforces that from the logit analysis. The percentage of all corporate issues in a given country-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 indirectly via interpolation. The percentage is also positively related to the quality of the benchmark as proxied by the existence of sovereign bond issues in the same country-year-maturity bin, by the existence of outstanding sovereign bonds in the same country-year-maturity bin, and by the total volume of sovereign bond issues in the same country-year-maturity bin. The effects are of sizeable economic magnitude. For instance, the coefficients in Column 6 indicate that the availability of a direct (indirect) yield curve benchmark increases the latent, uncensored percentage of similar-maturity corporate issues by about 18% (13%), and the availability of new (existing) government bond issues increase this percentage by 10% (10%). Again, there is 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.[17]

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

[17] In untabulated analysis, we scale *% New Sov' Issue* by GDP rather than by the total monetary amount of sovereign issuance across all bins. This alternative scaling does not alter our conclusions.

Our results are robust to splitting the sample into different subsamples. In Table 4, we estimate the Tobit specification per region. Columns 1 through 3 report that the link between the existence of sovereign benchmarks and corporate bond maturity choice, as captured by the significant coefficient on the *Precise Yield Curve Benchmark* variable, is present in each of the Americas, Europe, and the Asia-Pacific region.[18] Interestingly, sovereign bond benchmarks may be a more important determinant of the corporate maturity choice in the Asia-Pacific region, where the coefficient on the *Precise Yield Curve Benchmark* variable is highest. Gap filling as proxied by the negative coefficient on the % *New Sov' Issue* measure appears strongest in the Americas. The majority of the observations in the Americas are from the US.

In Columns 4 and 5 of Table 4 we split the sample to distinguish more-developed bond markets from less-developed bond markets. Countries included in Column 4 (5) are those with an above-median (below-median) ratio of corporate bond issuance to GDP as reported in the Worldbank's data catalog for the countries in our sample. Column 6 presents *p*-values of Wald tests of the differences in the coefficients between the samples. The results indicate that sovereign bond benchmarks are particularly important in countries with below-median ratios of corporate bond issuance to GDP in that the coefficients on the *Interpolatable Yield Curve Maturity* and the *New Sov' Issue* indicators are significantly greater in that subsample. In the following section, we examine the implications of variation in the availability and precision of sovereign bond benchmarks for gap-filling behavior.

[please insert Table 4]

5. Gap Filling given a Sovereign Bond Benchmark

In the absence of a precise sovereign bond benchmark, it may be that few corporate bonds would be issued even given a large gap. We therefore explore gap filling conditional on the existence of a precise benchmark. 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 *Precise Yield Curve Benchmark* for the country-year-maturity bin in the preceding year and a requirement that the size of the sovereign bond issues in that bin

[18] The conclusions reached from Table 4 are similar to those obtained from a logit analysis of the *Any Corporate Issue* indicator variable using the same set of explanatory variables.

exceeds the median across time of the sovereign's bond issues in that maturity bin (with size measured in end-of-year USD). 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 describe the benchmark as "precise".

Table 5 examines how the size of the gap in a country-year-maturity bin as proxied by the *% New Sov' Issue* variable for that bin affects both the decision to issue a corporate bond in the country-year-maturity bin and the fraction of all corporate issues that occur in that bin, as well as whether that effect varies with the existence of a precise sovereign bond benchmark. Panel A does not condition on there being a precise benchmark. Panel B applies the conditioning. The difference in the results in columns (1) and (2) of Panels A and B is striking. Without conditioning, we appear to have the opposite of gap filling: In the absence of a precise benchmark, corporations do not appear to rush to fill a gap and the coefficient on *% New Sov' Issue* variable is significantly positive in column (1) of Panel A for the *Any Corporate Issue* measure and in column (2) of Panel A for the *% Corporate Issues* measure. This suggests that the existence of a precise sovereign bond benchmark can be a prerequisite for gap filling. Panel B of Table 5 controls for the benchmark quality directly by conditioning the sample on the existence of a precise sovereign bond benchmark. In columns (1) and (2) of Panel B we see clear evidence of gap filling: The coefficients on the *Any Corporate Issue* measure and on the *% New Sov' Issuance* measure are significantly negative in the conditioned sample.

[please insert Table 5]

If the percentage of all sovereign issues that occur in a country-maturity bin was constant through time, the fact the percentage was smaller in some bins than in other bins for the same country 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 sovereign bond issues in a country-year-maturity 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 % New Sov' Issuance*. Columns 3 and 4 of Panel B considers the conditioned sample and reports that sovereign issuance in a particular country-year-maturity bin has a more negative effect on corporate bond issuance when sovereign bond issuance is more excessive relative to the

norm for the bin rather than, as in columns (1) and (2) of Panel B, merely larger than in other country-year-maturity bins.

Finally, to directly compare our results to those in Greenwood, Hanson and Stein (GHS, 2010), we apply the approach in Table V of GHS to our conditioned sample. Relation (2) describes four different regressions, each of which links corporate issuance in a country-year-maturity bin to changes in sovereign issuance over the preceding k years, where k = 1, 2, 3 and 4.

$$\%\ Corporate\ Issues_{ij,t} = \alpha + \lambda\,\Delta_k \%\ New\ Sov'\ Issuance_{ij,t} + \varepsilon_{ij,t}\,. \qquad (2)$$

The explanatory variables in the separate regressions are the k'th difference of the $\%\ New\ Sov'\ Issuance_{ij,t}$ variable. The results of a Tobit analysis of (2) are reported in Panel C of Table 5. As in Table V of GHS, the estimated λ coefficient of relation (2) is negative, and significantly so for $k > 1$. The evidence in favor of gap filling in both Panel C of Table 5 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 granular measure of bond maturity, analyze data from 14 countries, and condition on the existence of a precise benchmark.

6. Introductions and Suspensions

The results in Tables 3, 4 and 5 suggest that the gap-filling and sovereign benchmark hypotheses coexist. To clearly distinguish the two forces, we examine the effect of introductions of sovereign bonds with longer maturities than previously issued and the suspension of issues of the longest maturity sovereign bonds. In the absence of long-maturity sovereign bonds the gap at the long end looms large and the pricing signal is extinguished. The gap-filling hypothesis absent a benchmark effect predicts that corporations will rush to fill the gap. The sovereign benchmark hypothesis predicts that corporations will step back from the yawning chasm. We use a set of quasi-natural experiments to examine whether sovereign bond benchmarks have a role in determining corporate bond maturities that is distinct from the effect of any common factor driving both sovereign and corporate maturities. In the spirit of Badoer and James (2016), who design a quasi-natural experiment of new corporate debt issues around the 2001 suspension of 30-year U.S. Treasury bonds, we consider the experiment for a large set of introductions and suspensions of long-maturity sovereign debt in many countries and time periods. We present narrative, graphical,

and statistical evidence on individual introductions and individual suspensions as well as the average effect of introductions and suspensions.

We use Bloomberg's sovereign bond database to identify newly-introduced and newly-suspended sovereign bonds denominated in the domestic currency. Since our goal is to examine how the issuance of corporate bonds of a given maturity is affected by a change in the maturity of the available set of sovereign bonds, we do not consider introductions or suspensions of inflation-linked sovereign bond issues as such bonds do not provide a benchmark for conventional corporate bonds. We use internet and newspaper sources to confirm the introductions and suspensions we identify from Bloomberg.

For an introduction or suspension to be included in our analysis, we require the event to occur in a country with an active corporate bond market that year in that there are at least five corporate issues in that country in the year of the event. Further, in order to be classified as an introduction event, the government needs to extend the maturity of earlier issues by at least five years and into a new maturity bin.[19] 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.[20] We do not include the Brazilian sovereign bond introductions in 2001-2002 and the Japanese introduction in 1999 because the countries were experiencing economic crises at the time that would likely affect corporate bond issuance decisions. Throughout this section we describe bonds with maturities of greater than 29 (19) years but less than 31 (21) years as 30-year (20-year) bonds. As shown in Table 6, we examine a set of 10 introductions and 2 suspensions between 1994 and 2016 with the events dispersed across the three regions.[21,22]

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[19] An extension by at least five years takes the bond into a new maturity bond unless the extension is in the [30,…) bin.

[20] For example, the Netherlands issues a 30-year bond every 4 to 5 years. We do not consider this to be either an introduction or a suspension. We do not investigate introductions or suspensions prior to 1994 since we are unable to compare to earlier years.

[21] The introduction of a 30-year French sovereign bond in the first half of 1998 preceded the January 1, 1999 adoption of the Euro. Hence the 30-year German bonds that did exist in 1998 did not provide a high-quality benchmark for French corporations considering issuing long-term bonds in 1998.

[22] 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

[please insert Table 6]

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. For instance, 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." The 2008 introduction of 30-year sovereign bonds in Thailand was described by the OECD as having as its goal a "Government bond yield curve that can effectively be a reference rate for private sector bond issuance." Table 6 shows that for most introductions, benchmarking is mentioned in the announcements by the local financial authorities. Thus, benchmarking seems to be important to the audience of these authorities and the authorities themselves.

Table 7 shows corporate issuance per event before, during, and after introductions and suspensions. For most countries, corporate issue of long-term bonds increases dramatically in the years after a new long-term sovereign bond is introduced. If an omitted variable was driving the increase in the maturity of both sovereign and corporate bonds and there was no benchmark effect, then corporate issuance could also be elevated in the years prior to and contemporaneously with the sovereign introduction. This is not what we observe. In the years prior to the sovereign introduction, corporate issuance of similarly long-term bonds is rare. In contrast, after the introduction the equal-weighted mean across the nine introducing countries of the *% Corporate Issues* measure for the newly introduced bin increases from an annual average over the three years prior to the introduction of 0.56% to an annual average of 4.59% over the three years after the introduction. An untabulated *t*-test shows that collectively across countries, the difference in corporate issuance before and after sovereign introductions is significant at the 2% level.

The evidence around sovereign suspensions is not as strong. There is no long-term corporate issuance by French companies in the seven years centered on the year of the French

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.

suspension of long-term sovereign issuance. There is a decrease in, but not elimination of, long-term US corporate issuance following the US suspension. We analyze the US suspension in more detail in Appendix C. The continued issuance of corporate bonds following the suspension of long-term US sovereign bonds is not necessarily surprising. When corporations are familiar with financing via 30-year bonds and there are near-30-year corporate and sovereign bonds still trading after the sovereign suspension, then a near-benchmark rate remains available for some time. Hence, the impact of sovereign suspensions is arguably less immediate than it is for introductions.

[please insert Table 7]

We aggregate the evidence from Table 7 in Figure 4, which plots the cross-country average sovereign and corporate bond issuance in the three years before and after introductions and suspensions. The introduction/suspension year is denoted as year 0. The vertical bars indicate 1.68 standard deviations around each year's average. Panel A shows that introductions meaningfully change the maturity structure of sovereign debt, with ongoing issuance in the newly introduced bin. Panel A plots the average *% Sovereign Issues* variable for the newly introduced bin in the years surrounding the introduction year. The standard deviation is calculated across the nine introducing countries. Panel B focuses on corporate issuance. It plots the annual averages of the *% Corporate Issues* variable in the newly introduced bin during the same years. The results highlight that long-term corporate issues increase when long-term sovereign bonds are introduced, and the increase occurs *after* the new sovereign maturity is launched; i.e., long-term corporate bond issuance follows the introduction of long-term sovereign bonds.

Panel C of Figure 4 considers the two suspensions in the sample, namely the suspension of 30-year bond issuance by France in 1994 and by the US in 2001. Corporate issuance substantially declines two and three years after the suspension.[23] As mentioned, it is not surprising that the effect of sovereign suspensions on corporate issuance is not as immediate as that of introductions. However, we also see that 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

[23] Since France had no issues of similarly long-term corporate bonds during any of the seven years around 1994, the average *% Corporate Issues* measure in Panel C is simply one half the value of the measure for the US.

same years. Thus, the pattern in Panel C might be explained by either a common driver of sovereign and corporate bond maturity and/or by a benchmark effect, and the evidence on suspensions is less clear cut than that on introductions.

[please insert Figure 4]

Table 8 analyses corporate issuance before and after long-term sovereign introductions and suspensions after controlling for observed and unobserved differences between countries. For the set of bond issues with maturities 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 the *% Corporate Issues* measure is observed, $k = -3, \ldots, +3$. The indicator equals +1 for introductions, –1 for suspensions, and zero otherwise. The analysis controls for the global average credit spread, the slope of the country-specific term structure, 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. Absent a benchmark effect, introductions (suspensions) would be as likely to follow as to precede new issues of longer-term corporate bonds. However, Table 8 shows that introductions (suspensions) of long-dated sovereign bonds do not follow increases (decreases) in the issuance of similarly long-dated corporate bonds. On average, latent corporate issuance increases (decreases) by 5.5 to 7.3 percentage points in the year after the introduction (suspension). The (unreported) sample-wide standard deviation of the *% Corporate Issues* measure for the [20,…)-year maturity bin is 6.1%, indicating that the effect is economically meaningful. Furthermore, the effect lingers on two years after the event but there is no effect in the three years prior to the event. The results in Table 8 are in line with the importance of a benchmark effect. Unless sovereigns react faster than corporations, a common omitted variable driving the maturity changes of both corporate and sovereign bonds will not imply the leader-follower behavior we observe.

[please insert Table 8]

7. The Implications of QE for Corporate Bond Maturity

The economic conditions that induce a sovereign to print money (QE) have implications for corporate investment and capital raising. Large-scale central bank purchases of sovereign bonds create a gap between investor demand for long-term bonds and their supply and thus one natural effect of quantitative easing will be increased issuance of long-term bonds by corporations. Foley-Fisher, Ramcharan and Yu (2016) conclude that the 2011-2012 QE program in the US induced gap filling and relaxed financial constraints on firms reliant on long-term debt financing. Giambona, Matta, Peydro and Wang (2020) observe that the QE-induced gap between investor demand for long-term safe bonds and the available supply led "companies with access to the bond market to increase capital expenditures by issuing 'safe' corporate bonds". A second effect of QE arises from the fact that central banks whose objective functions are quite distinct from that of typical investors in safe bonds become large participants in the market for sovereign bonds. As a result, the quality of sovereign yields as pricing guides for corporate issuers will be reduced.

The effects of QE on gap filling and on the quality of sovereign bond benchmarks provided by sovereign bonds are difficult to empirically investigate because data is not available on sovereign bond issuance net of central bank purchase. Still, two clear predictions can be investigated. First, all else equal, gap filling implies that corporate bond issuance will increase during QE. Second, the reduction in the quality of pricing information at maturities that previously provided precise benchmarks will reduce corporations' relative desire to issue at those particular maturities. These two predictions are modelled in relation (3).

$$\begin{aligned} Corporate\ Issuance_{ij,t+1} &= \alpha + \phi_1 QE_{i,t} + \phi_2 Precise\ Yield\ \ Curve\ Benchmark_{ij,t} \\ &+ \phi_3 QE_{i,t} \times Precise\ Yield\ \ Curve\ Benchmark_{ij,t} + \theta Sov'\ Bond\ Rating_{ij,t} + c_{i,\tau}. \end{aligned} \tag{3}$$

$QE_{i,t}$ is an indicator equal to 1 in years in which a country had a QE program. QE-induced gap filling implies that ϕ_1 will be positive. The sovereign benchmark hypothesis implies that ϕ_2 will be positive, but a QE-induced reduction in the relative precision of benchmarks at the tenors on the Bloomberg yield curve implies that the ϕ_3 coefficient on the interaction term will be negative. The results of estimating relation (3) for the two measures of *Corporate Issuance*, namely *Any Corporate Issue* and *% Corporate Issues*, are reported in Table 9.

[please insert Table 9]

The *QE* indicator is 1 in the UK from 2009 on; in the US between 2011 and 2014; in Japan from 2013 on; and in Germany, France, and the Netherlands from 2015 on. Table 9 separately investigates the full 1991-2017 period (columns (1) and (4)) and the 2007-2017 subperiod containing the years in which QE took place (columns (2) and (5)). Consistent with the simultaneous existence of gap-filling and benchmark effects, the estimates of both ϕ_1 and ϕ_2 are significantly positive in all four regressions. The novel element of Table 9 is the interaction of *QE* with the precision of sovereign bond benchmarks. The estimate of the coefficient on the interaction term, ϕ_3, is significantly negative. This is consistent with the benchmark effect being weaker when benchmarks become less precise.[24]

Columns (3) and (6) focus on the six countries in our sample that experienced quantitative easing at some time; i.e., on Germany, France, the Netherlands, UK, US, and Japan. Focusing on only these countries again shows that corporate issuance is higher in country-years in which the central bank acts to reduce the supply of sovereign bonds. Further, when QE causes yield curve benchmarks to become less precise, issuance at maturities previously associated with precise benchmarks loses some of its allure. The estimated negative coefficient on the interaction term is never larger in absolute value than the estimated coefficient on the *Precise Yield Curve Benchmark* indicator and so the indicator is positively associated with corporate bond issuance. Still, this positive effect is significantly weaker during periods of QE.

8. Conclusion

In addition to being a substitute for corporate bonds, sovereign bonds are a complement to corporate bonds in that sovereign bond benchmarks facilitate the issuance of corporate bonds. We show that the availability of sovereign bond benchmarks is an important determinant of whether

[24] We have investigated an augmented version of relation (1) that adds a QE indicator and a multitude of QE interaction terms to the set of explanatory variables. Without country-year-maturity bin data on sovereign bond issuance net of central bank purchases, we do not know how well our country-year-maturity bin data on sovereign bond issuance reflects the net issuance data that determines the quality of the sovereign bond benchmark in a bin. The *Precise Yield Curve Benchmark* indicator does not suffer from this weakness. Still, the untabulated results of our investigation of the expanded relation (1) are consistent with the results for (3). For both measures of corporate issuance and both the full 1991-2017 sample period and the 2007-2017 subperiod, the estimated coefficient on *QE* is positive (consistent with gap filling) and the estimated coefficients on the interaction terms are either significantly negative (consistent with lower quality for benchmark rates) or insignificant.

gap filling occurs. When sovereign bonds cannot be used as precise benchmarks, gaps may not be filled.

Our examination of a granular, international dataset of corporate and sovereign bond issuance over the 1991–2017 period shows that corporations' willingness to issue corporate bonds of a given maturity depends on the existence and quality of the corresponding sovereign bond benchmark. We also investigate quasi-natural experiments provided by introductions and suspensions of sovereign bonds that alter the tenor of sovereign bond benchmarks. The alterations occur in nine countries over a 23-year period. 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 importance of a benchmark effect that is quite distinct from the effect of a common omitted variable driving changes in the maturities of both sovereign and corporate bonds. The statements of market participants and financial authorities at the time of the introduction of longer-maturity sovereign bonds further emphasize the importance of sovereign bond benchmarks for corporate bond issuance. An additional reason for concluding that the relation between sovereign and corporate bond maturities reflects a benchmark effect follows from the reduction in the quality of sovereign yields as pricing guides during periods of quantitative easing. This quality reduction is associated with a reduction in corporate bond issuance at maturities that would have been associated with precise benchmarks in the absence of QE.

Since extending the maturity structure of financing has been posited as central to financial development, our results can be of interest to policy makers: "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, p.1). Our finding that sovereign bonds facilitate the issuance of long-term corporate bonds indicates that capital market development can enhance long-term financing. Since sovereign bonds provide benchmark rates useful in pricing long-term

payoffs, sovereign bond benchmarks can guide long-term investment decisions as well as facilitate their financing thereby enhancing consumer and investor welfare.

Appendix A: A Link between Sovereign Bond Benchmarks and Underwriting Fees

This appendix shows that corporations may be more willing to issue long-term bonds when the long-term sovereign bond market provides accurate price signals to underwriters and, as a result, underwriting risk and underwriting fees are low. The corporate sector's willingness to issue long-term bonds is decreasing in the underwriting fee that must be paid. The underwriting fee will be high when the uncertainty surrounding a bond's value is high. Uncertainty will be high when the benchmark rates provided by the traded price of sovereign bonds, denoted by *T*, are noisy signals of the strength of preferred-habitat demand and hence noisy measures of the post-issue market price of a long-term bond. Let *P* denote the post-issue market price of a zero-coupon long-term bond paying one dollar at its maturity. The size of the underwriting fee is a determinant of corporations' desire to issue long-term bonds. Let *H* denote the total payoff from the long-term bond. Underwriters have mean-variance utility with risk tolerance of $\gamma^U$and agree in return for their fee to buy the new issue for its expected value of $HE\{\tilde{P}|T\}$ and to bear the risk associated with reselling the bonds for $H\tilde{P}$. Underwriter wealth, denoted by *W*, is then given by

$$\widetilde{W} = H\tilde{P} - HE\{\tilde{P}|T\} + F(H;T),$$

where $F(H;T)$ denotes the underwriting fee. Competitive underwriters will set the fee such that underwriter expected utility, $E\{U(\widetilde{W}|T)\}$, is zero. Hence

$$E\{U(\widetilde{W}|T)\} = E\{\widetilde{W}|T\} - \frac{Var\{\widetilde{W}|T\}}{2\gamma^U} = F(H;T) - \frac{H^2 Var\{\tilde{P}|T\}}{2\gamma^U} = 0.$$

Consistent with the price discovery role of sovereign bonds, benchmark rates are more precise when $Var\{\tilde{P}|T\}$ is lower. When the sovereign bond market is less liquid and as a result provides a less accurate signal of the value of long-term bonds, $Var\{\tilde{P}|T\}$ is high. In turn, underwriting fees are high and the corporate desire to issue long-term bonds will be lower; i.e., corporations may prefer to mind the gap when it is large.

Appendix B: 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		
Precise Yield Curve Benchmark	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 Yield Curve Benchmark	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		
New Sov' Issue	Bloomberg	Indicator equal to 1 if there is a sovereign bond issue in the country-year-maturity bin, and 0 otherwise.
Vintage Sov' Bond	Bloomberg	Indicator equal to 1 if there is a previously issued sovereign bond in a country-year-maturity bin, and 0 otherwise.
Sov' Issuance Activity	Bloomberg	Natural 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).
% New Sov' Issuance	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).
Excessive % New Sov' Issuance	Bloomberg	*% New Sov' Issuance* in excess of the average of the *% New Sov' Issuance* 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.

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.
QE		Indicator equal to 1 if a program of quantitative easing existed in a country-year.

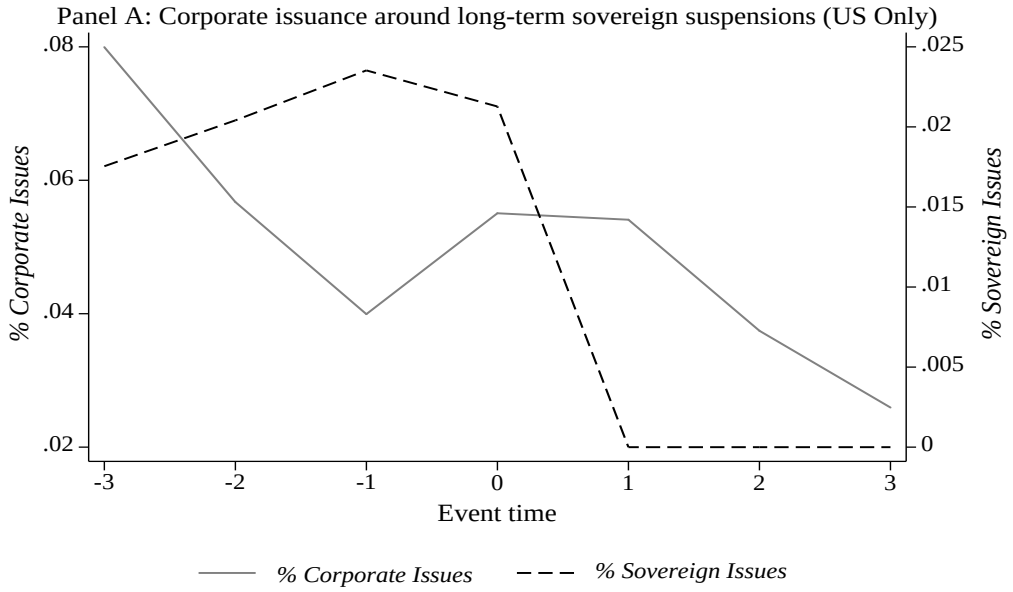
Appendix C: Additional Evidence on the 2001 US Suspension of 30-Year Sovereign Bonds

Badoer and James (2016) examine quarterly corporate issuance over a period that encompasses the 2001 suspension of issues of 30-year US sovereign bonds. By comparing issuance during the 1998-2001 and 2002-2005 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 proportion examined by Badoer and James (2016) is the fraction of corporate issues with maturities of 20-plus years that have maturities of 30 years or more. This fraction may rise even though the number of issues with maturities of 30 years or more declines. In particular, the fraction will rise whenever the decline in the number of issues in the [20,30) year range measured relative to the number of pre-suspension issues in the [20,30) year range is greater than the decline in the number of issues in the [30,…) range relative to the number of pre-suspension issues in that more narrow range of maturities.

Figure C.1 investigates the apparent inconsistency between Panel C of Figure 4 in this paper and the gap-filling conclusion in Badoer and James (2016). Panel A of Figure C.1 depicts corporate issuance in the years surrounding the 2001 US sovereign suspension. Panel B of Figure C.1 shows the post-suspension spike in the Badoer-James measure (solid line), the numerator of the Badoer-James measure (long-dashed line), and the denominator of the measure (short-dash line). The Badoer-James measure is strongly influenced by a change in the number of corporate issues with maturities in the [20, 30) range. During the four years 1998 to 2001 inclusive, there were 157 corporate issues in the [20, 30) range, but only 5 such issues in 2002. In the four years up to and including the 2001 suspension year, the proceeds of corporate issues with maturities greater than or equal to 30 years relative to the proceeds of corporate issues with maturities greater than or equal to 20 years is 63.6%. In the year immediately after the suspension, corporate issues in the [20, 30) year range dried up and in that year the Badoer-James measure came to exceed 89.1%. Measured relative to the proceeds of all bond issues, the proportion accounted for by issues with maturities of 30-plus years declined from 8.9% in 1998-2001 to 6.2% in 2002-2005.

Figure C1: 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 for the years around the 2001 suspension. Panel B plots the annual averages of the proceeds of all US corporate issues in the [30,…) bin and of all issues in the [20,30) bin as a percent of the proceeds of all corporate issues in the year as well as 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 US corporate issues that year with maturities of 20 years or more.



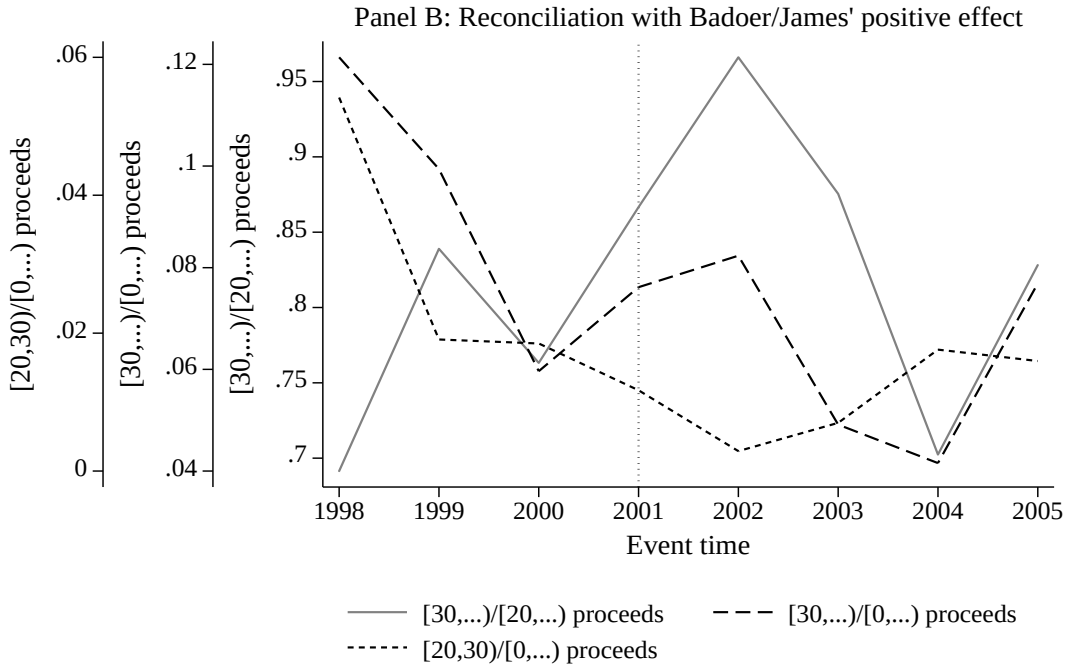


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Table 1: Descriptive statistics on bond maturity

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 C tabulates the percentage of corporate issues in each country with maturities that exceed in the year of issue the maximum benchmark maturity by more than one year. The maximum benchmark 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. Panel C also 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

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			
			Maturity					# benchmarks in given year	
	Start year	# Obs	Aver	Median	Max	Start year	Max. tenor	Min	Max
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				

Panel C: Issues exceeding the maximum maturity

	% of corporate issues with maturity > maximum benchmark maturity	% of sovereign issues with maturity > maximum maturity of corporate issues in the same country-year
Australia	3.5%	9.0%
Brazil	0.0%	14.4%
Canada	4.3%	0.9%
France	0.0%	8.3%
Germany	1.4%	2.7%
India	0.3%	9.4%
Japan	0.1%	2.1%
Malaysia	3.3%	1.2%
Mexico	0.0%	4.0%
Netherlands	0.0%	14.6%
South Korea	0.1%	6.4%
Thailand	0.0%	5.5%
UK	0.9%	3.7%
US	1.3%	0.0%
Total	0.9%	9.0%

Table 2: Characteristics of sovereign benchmark variables for corporate bonds in alternate maturity bins

The Table reports the mean and standard deviation across countries and years of each sovereign benchmark variable. Variable definitions are given in Appendix B. *** indicates significance at the 1% level. The *Interpolatable Yield Curve 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 sovereign bond benchmarks and gap filling.

Any Corporate Issue	*% Corporate Issues*	*Precise Yield Curve Benchmark*	*Interpolatable Yield Curve Maturity*	*New Sov' Issue*	*Vintage Sov' Bond*	*Sov' Issuance Activity*	*% New Sov' Issue*
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		0.38***	0.37***	0.30***	0.31***	0.33***	0.18***
ρ in means with % Corporate Issues		0.37***	0.30***	0.27***	0.24***	0.23***	0.16***

Table 3: Sovereign bond benchmarks and the maturity bin choice of corporate issuers

This Table presents logit and Tobit analyses of corporate bond issues in 14 countries during the period 1991-2017 in columns (1) to (3) and columns (4) to (6), respectively. The dependent variable in the logit analysis, *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. The dependent variable in the Tobit analysis is *% Corporate Issues*: the number of corporate issues in a country-year-maturity bin relative to the total number of corporate issues in the country-year. All explanatory variables are defined in Appendix B. The explanatory variables are observed in the year prior to the observation of the dependent variable. 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%, 5%, and 1% levels.

	Any Corporate Issue			*% Corporate Issues*		
	(1)	(2)	(3)	(4)	(5)	(6)
Precise Yield Curve Maturity	2.108***		1.775***	0.215***		0.175***
	(0.243)		(0.271)	(0.030)		(0.028)
Interpolatable Yield Curve Maturity	1.945***		1.400***	0.182***		0.125***
	(0.390)		(0.331)	(0.035)		(0.030)
New Sov' Issue		0.639***	0.735*		0.107***	0.104***
		(0.153)	(0.388)		(0.022)	(0.040)
Vintage Sov' Bond		1.728***	0.881***		0.195***	0.095**
		(0.274)	(0.332)		(0.036)	(0.037)
Sov' Issuance Activity		0.330***	0.257***		0.019**	0.014**
		(0.071)	(0.085)		(0.007)	(0.007)
% New Sov' Issuance			–0.058**			–0.131**
			(0.432)			(0.058)
Sov' Bond Rating			0.008			–0.002
			(0.041)			(0.004)
Observations	2,691	2,691	2,691	2,691	2,691	2,691
Country×5-Year FE	Y	Y	Y	Y	Y	Y
McKelvey/Zavoina Pseudo-R^2	0.527	0.446	0.563	0.436	0.344	0.470

Table 4: Robustness: Sovereign bond benchmarks and corporate maturity bin choice for different subsamples

This Table presents a Tobit analysis of corporate bond issues during the period 1991-2017, split based on geographical location (Columns 1-3) or the corporate bond issuance to GDP ratio (Columns 4-5). Column 6 reports *p*-values of tests of the equality of the corresponding coefficients in Columns 4 and 5. The dependent variable is *% Corporate Issues*; i.e., the number of corporate issues in a country-year-maturity bin relative to the total number of corporate issues in a country-year. All explanatory variables are defined in Appendix B and observed in the year prior to the observation of the dependent variable. 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.

	(1)	(2)	(3)	(4)	(5)	(6)
	Americas	*Europe*	*Asia-Pacific*	*Corp. Issuance Relative to GDP*		
				High	*Low*	
Precise Yield Curve Benchmark	0.132***	0.150***	0.222***	0.148***	0.219***	0.122
	(0.035)	(0.053)	(0.041)	(0.036)	(0.032)	
Interpolatable Yield Curve Maturity	0.130	0.120*	0.158***	0.091**	0.190***	0.014
	(0.083)	(0.066)	(0.024)	(0.039)	(0.015)	
New Sov' Issue	0.016	0.193***	0.056	0.053	0.210***	0.020
	(0.014)	(0.070)	(0.070)	(0.042)	(0.056)	
Vintage Sov' Bond	−0.082	0.126*	0.139***	0.107**	0.089*	0.779
	(0.112)	(0.071)	(0.036)	(0.050)	(0.045)	
Sov' Issuance Activity	0.034***	0.008**	0.010	0.013	0.008	0.681
	(0.007)	(0.004)	(0.009)	(0.009)	(0.006)	
% New Sov' Issuance	−0.239***	−0.111	−0.108	−0.123	−0.136	0.910
	(0.035)	(0.074)	(0.148)	(0.078)	(0.091)	
Sov' Bond Rating	0.001	−0.007***	−0.004	−0.002	−0.008*	0.338
	(0.009)	(0.001)	(0.006)	(0.005)	(0.005)	
Observations	684	918	1,089	1,494	1,233	
Country×5-Year FE	Y	Y	Y	Y	Y	
McKelvey and Zavoina Pseudo-R^2	0.330	0.499	0.499	0.401	0.534	

Table 5: The importance of gap filling in the presence of a precise sovereign bond benchmark

This Table presents logit and Tobit analyses of corporate bond issues for 14 countries during the period 1991-2017. In Panels A and B, the dependent variables are *Any Corporate Issue* and *% Corporate Issues*. All explanatory variables are defined in Appendix B and observed in the year prior to the observation of the dependent variable. Panels B and C examine a conditioned sample that contains only country-year-maturity observations for which both a precise 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 C reports Tobit regressions of *% Corporate Issues* on *k*-th differences in the *New Sov' Issuance (%)* measure with $k = 1, \ldots, 4$. The right-most column of Panel C 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

	Any Corporate Issue	*% Corporate Issues*
	(1)	(2)
% New Sov' Issuance	3.300***	0.233***
	(0.810)	(0.081)
Sov' Bond Rating	0.013	0.001
	(0.033)	(0.003)
Observations	2,691	2,691
Country×5-Year FE	Y	Y
McKelvey/Zavoina Pseudo-R^2	0.363	0.128

Panel B: Conditioned sample

	Any Corporate Issue	*% Corporate Issues*	*Any Corporate Issue*	*% Corporate Issues*
	(1)	(2)	(3)	(4)
% New Sov' Issuance	–2.813**	–0.269***		
	(1.319)	(0.059)		
Excessive % New Sov' Issuance			–3.186**	–0.303***
			(1.388)	(0.071)
Sov' Bond Rating	0.061	–0.007	0.099**	–0.003
	(0.079)	(0.006)	(0.051)	(0.005)
Observations	624	624	624	624
5-Year FE	N	N	Y	Y
Country×5-Year FE	Y	Y	N	N
McKelvey/Zavoina Pseudo-R^2	0.298	0.361	0.119	0.080

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

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

Table 6: Narrative evidence on benchmarking around extensions and suspensions of sovereign debt maturity

This Table reports instances where countries in our sample period 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 with, say, maturities from 19 years to 21 years 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 and into another maturity bin. 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 was the longest-maturity bond 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.

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. Dep. of Treasury, Press release, October 31, 2001
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. Dep. of Treasury, Press release, January 31, 2006

Table 7: Country-specific evidence on the corporate response to the introduction and suspension of long-term sovereign bonds

This table reports averages of the *% Corporate Issues* variable for the newly introduced/suspended bin for periods surrounding sovereign bond introductions and suspensions as detailed in Table 6. For each country, the three columns report the annual average in percentage points of the *% Corporate Issues* measure for the introduced/suspended bin during the three years preceding, the year of, and the three years following the event, respectively. Year *t* is the year of the introduction or suspension event.

	Annual Average of *% Corporate Issues*		
	–3 to –1	year 0	+1 to +3
Introductions			
Australia	0.0	0.0	15.9
France	0.0	0.0	2.3
Germany	0.0	0.0	0.0
India	0.9	0.0	1.1
Malaysia	0.0	0.0	4.5
South Korea	0.0	0.0	0.5
Thailand	0.6	0.0	1.1
United Kingdom	0.0	3.4	7.7
United States	3.5	7.5	8.2
Suspensions			
France	0.0	0.0	0.0
United States	5.9	5.5	3.9

Table 8: Cross-country evidence on benchmarking around extensions and suspensions of long-maturity sovereign bonds

Tobit analyses of corporate bond issues following introductions and suspensions of long-term sovereign bonds. The introductions and suspensions are reported in Table 6. The sample is limited to maturity bins of 20 or more years. The dependent variable *% Corporate Issues* is 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 observation of the *% Corporate Issues* measure. The indicators are equal to +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$_t$			
	(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

Table 9: Quantitative easing and corporate bond issuance

This table reports logit and Tobit analyses of the relation between corporate issues and quantitative easing. The dependent variable in the logit analysis, *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. The dependent variable in the Tobit analysis is *% Corporate Issues*, the number of corporate issues in a country-year-maturity bin relative to the total number of corporate issues in the country-year. The *QE* indicator is 1 from 2009 on in the UK; between 2010 and 2014 in the US; from 2013 on in Japan; and from 2015 on in the EU countries Germany, France, and the Netherlands. Explanatory variables in addition to QE are defined in Appendix B. Explanatory variables are observed in the year prior to the observation of the dependent variable. Heteroskedasticity-consistent standard errors are clustered at the country level and reported in parentheses. *PYCB* denotes the *Precise Yield Curve Benchmark* indicator. Columns (1) and (4) examine the 1991-2017 period. Columns (2) and (5) focus on 2007 and later. Columns (3) and (6) focus on 2007 and later and consider only the set of countries for which *QE* = 1 in some year. ** and *** indicate significance at the 5% and 1% levels, respectively.

	Any Corporate Issue			*% Corporate Issues*		
	1991-2017	2007-2017	UK US JP EU 2007-2017	1991-2017	2007-2017	UK US JP EU 2007-2017
	(1)	(2)	(3)	(4)	(5)	(6)
QE	1.348***	1.528***	1.340***	0.160***	0.155***	0.110***
	(0.466)	(0.486)	(0.247)	(0.040)	(0.041)	(0.034)
Precise Yield Curve Benchmark (*PYCB*)	2.376***	2.461***	2.133***	0.265***	0.257***	0.201***
	(0.219)	(0.388)	(0.737)	(0.039)	(0.037)	(0.046)
QE × PYCB	–1.657**	–1.715**	–1.427**	–0.192***	–0.184***	–0.130***
	(0.803)	(0.797)	(0.569)	(0.053)	(0.053)	(0.043)
Sov' Bond Rating	0.011	0.026	0.005	0.000	0.000	0.001
	(0.014)	(0.023)	(0.021)	(0.001)	(0.002)	(0.002)
Observations	2,691	1,251	540	2,691	1,251	540
Country × 5-Year FE	Y	Y	Y	Y	Y	Y
McKelvey and Zavoina Pseudo-R^2	0.521	0.525	0.523	0.365	0.353	0.274

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.

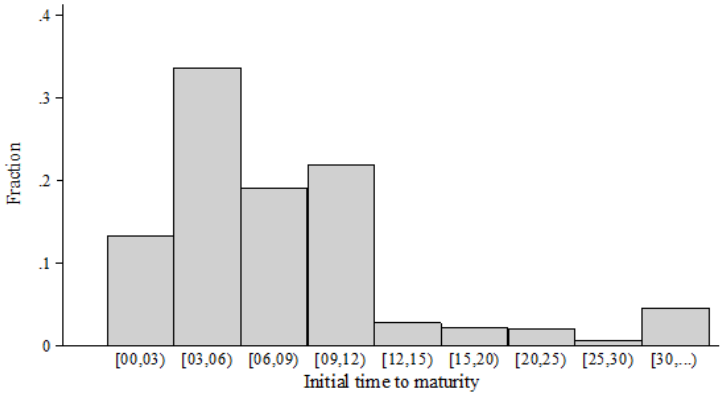


Figure 2: Fraction of sovereign bonds, per maturity bin
This figure plots the distribution of domestic currency sovereign bond issuance across maturities for bonds issued between 1991 and 2017. Maturity statistics are obtained from Bloomberg.

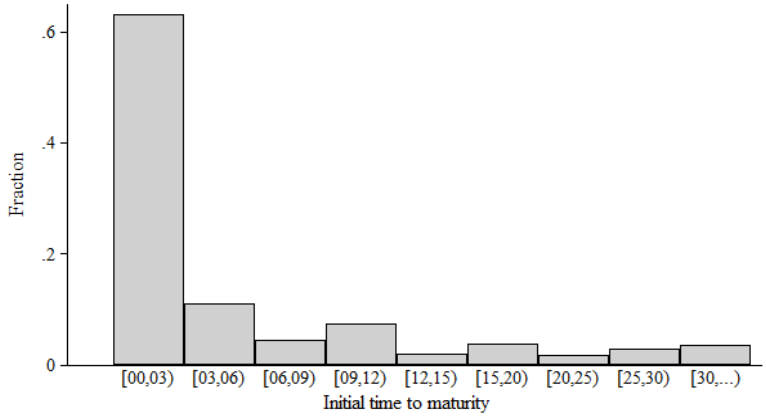


Figure 3: Fraction of available benchmarks, per maturity bin
This figure plots the availability of yield curve benchmarks across maturities for the period 1991 – 2017. The statistics are obtained from Bloomberg

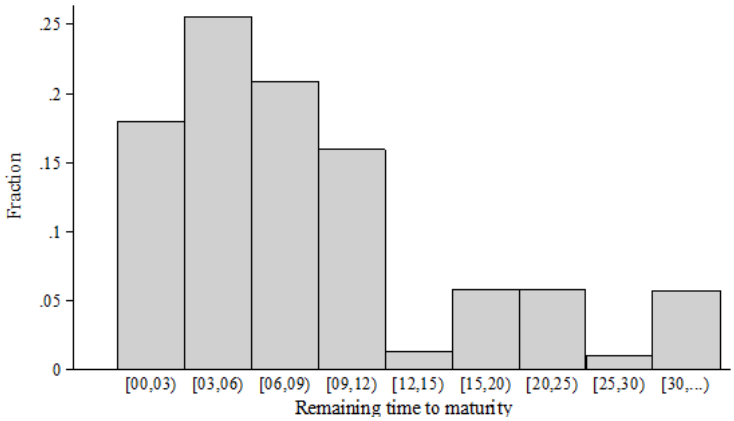
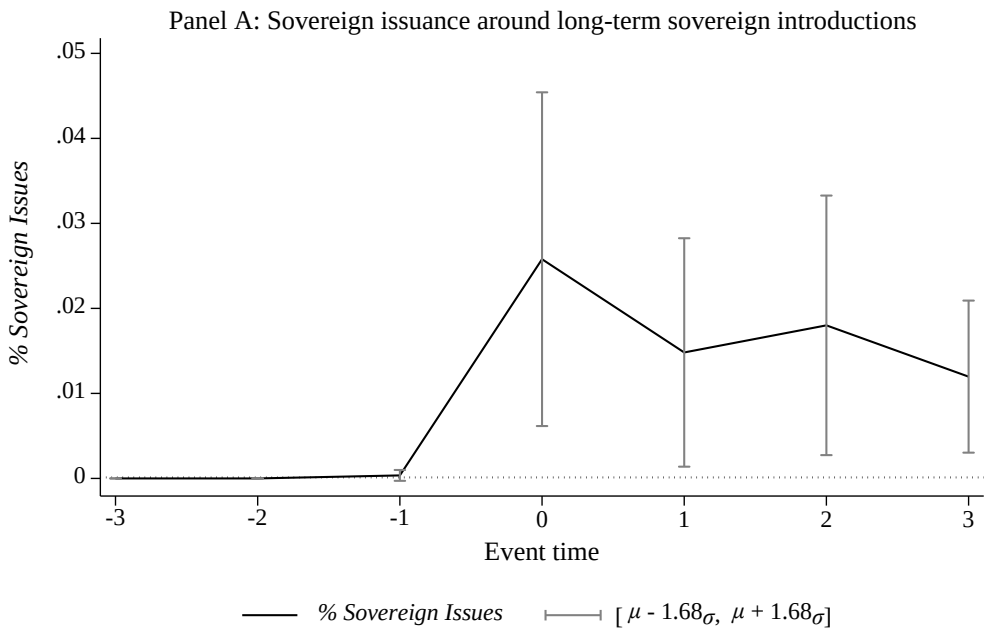
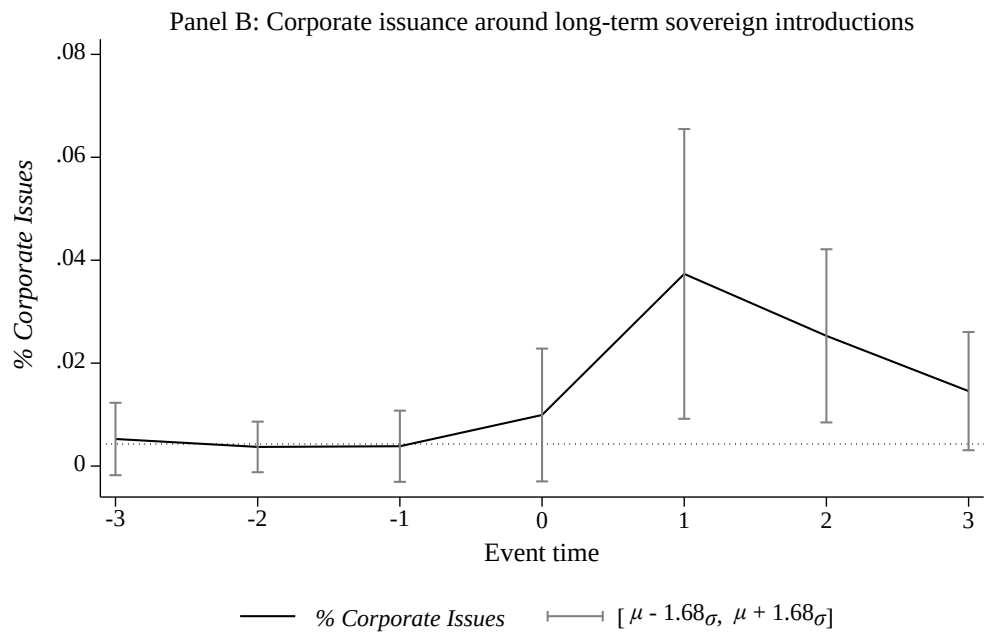


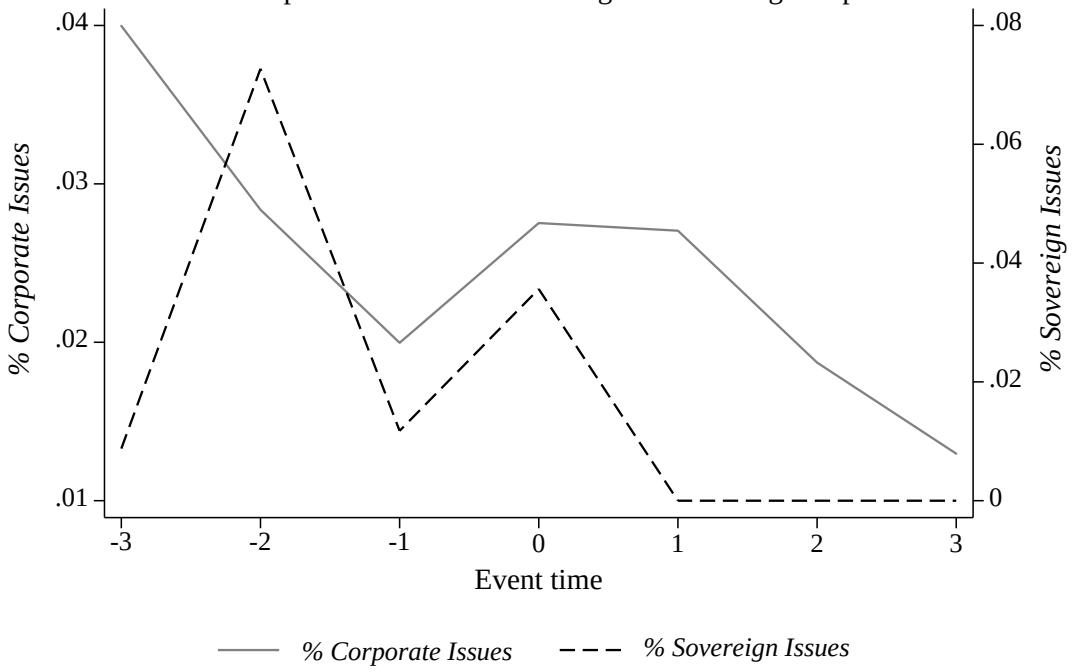
Figure 4: Corporate issuance before/after sovereign debt maturity extension/suspension

This figure plots average *% Sov' Issues* (Panel A) and average *% Corporate Issues* (Panel B) for the newly introduced bin during the years –3 to +3 relative to the year 0 introduction of the long-maturity sovereign listed in Table 6. Panel C plots average *% Corporate Issues* and average *% Sov' Issues* around sovereign suspensions. Averages for the newly introduced/suspended maturity bin are calculated across country-years.





Panel C: Corporate issuance around long-term sovereign suspensions



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