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Abstract

The risk-taking effects of low interest rates, now prevailing in many advanced countries, "search-for-yield," can be hard to analyze due to both a paucity of data and challenges in identification. Unique, security-level data on portfolio investment into the United States allow us to overcome both problems. Analyzing holdings of investors from 36 countries in close to 15,000 unique U.S. corporate bonds between 2003 and 2016, we show that declining home-country interest rates lead investors to shift their portfolios toward riskier U.S. corporate bonds, consistent with "search-for-yield". We estimate even stronger effects when home interest rates reach a low level, suggesting that risk-taking further accelerates.

JEL Classification: F21, F34, G11, G20

Keywords: low interest rates, risk-taking, search for yield, portfolio choice, corporate debt, Unites States

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1 Introduction

Over the last decade since the Great Financial Crisis (GFC), interest rates in many advanced economies have been at historic lows, especially on safe assets. Although low interest rates help support economic recovery, persistently low rates have also raised concerns about incentives for increased risk-taking by households, banks, and other investors. Specifically, investors could seek to offset the lower returns on safer assets through "search-for-yield": through either risk-increasing portfolio shifts or greater risk-taking on new investments. As discussed in more detail below, the majority of empirical papers on risk-taking related to interest rates have either focused on the effects on bank lending and bank loan portfolios or on mutual fund flows to broad asset categories (see Dell'Ariccia and Marquez, 2013, and Adrian and Liang, 2016, for analytical and literature reviews). Empirical research on the effects of interest rates on investors' portfolios is limited (Domanski, Shin, and Shushko (2017), Choi and Kronlund (2017), di Maggio and Kacperczyk (2017)). This is in part because the necessary detailed data to detect risks taken in investment decisions are often unavailable. Analysis is also challenging because of difficulties in identification. Importantly, interest rates depend on macroeconomic conditions, which also determine the relative riskiness of various borrowers as well as their demand for external financing. In addition, spreads and other funding conditions for individual borrowers are affected by investors' risk-return preferences, which also depend on macroeconomic and general financial conditions, including interest rates. Here, we use unique security-level data on foreign investors' holdings of U.S. corporate bonds and a large variety in movements in these foreign investors' home interest rates to analyze risk-taking in response to changes in investors' home interest rates. This approach allows us to detect risks taken in investment decisions and helps us overcome the identification challenges outlined above.

More specifically, we empirically examine how interest rates affect risk-taking in investors' asset portfolios by analyzing the extent to which overseas investors shift the composition of their U.S. corporate bond holdings response to changes in their home interest rates. We use detailed security-level data on holdings of U.S. corporate bonds by private investors from 36 foreign countries for the period 2003 - 2016 and analyze how portfolio allocations and purchases of newly-issued U.S. corporate bonds relate to changes in investors' home interest rate. The data are from the U.S. Treasury International Capital annual surveys on cross-border portfolio investment in the United States. Given the mandatory reporting, the data we use are comprehensive, i.e., they capture countries' entire portfolios of U.S. corporate bonds at the individual security level. In contrast, the existing literature on the

effects of interest rates on portfolio investment focuses on particular types of investors. These granular data allow us to gauge changes in portfolio risk using security-level characteristics for a broad spectrum of borrowers. Together with the significant heterogeneity in movements in investor-country interest rates, it provides for a unique way of analyzing risk-taking. An important pitfall of a single-country study is the possibility that assets' relative riskiness and (safe) interest rates are driven by macroeconomic and financial conditions that also affect the saving and investment behavior of investors. In contrast, we have a cross-section of countries in which interest rates are not directly influenced by the economic and financial conditions that determine the riskiness of U.S. corporate bond issuers. And since the foreign investments into the United States represent a small share of the total external financing of issuers, they are unlikely to drive issuers' overall financing conditions or riskiness. As such, it allows us to overcome concerns about reverse causality and omitted variables.

We find evidence consistent with search-for-yield, in that the more the interest rate in the investors' home country declines, the more investors allocate their holdings towards corporate bonds with higher yields and wider spreads. We find these effects for both existing and newly-issued bonds, i.e., net purchases of bonds with higher yields and wider spreads increase in both the secondary and the primary market. In addition, in many specifications, we find that declining home-country interest rates lead investors to invest more in bonds with longer durations, a second dimension of risk-taking that appears to accompany the increased credit risk in foreign investors' U.S. portfolios. We show that these search-for-yield effects cannot be attributed to other country characteristics that could be correlated with interest rates, such as bank CDS premiums or expected earnings growth in the corporate sector. Our findings are also robust to controlling for the liquidity of the individual security in secondary markets, different choices for the countries' home interest rate, exclusions of a number of countries from the sample, as well as variations in econometric approaches, including weighted regression, clustering of errors, winsorizing, and differential use of fixed effects.

The effects we document are economically important. Consider a 215 basis-point decline in the home interest rate, which is the difference between the net declines in 1-year German and Japanese sovereign yields from 2003 to 2016. We estimate a shift towards riskier securities that implies a pick-up of yield of between 15 and 33 basis points, but with an associated decline in credit quality of 0.1-0.5 rating notches. In many specifications, we also find an increase in portfolio duration of 0.1 to 0.2 years. Estimated effects are generally larger for shifts within investment-grade bond categories, which comprise a large part of our sample.

We also find larger search-for-yield effects for the sub-periods that exclude the 2008-2009 GFC and 2010-2012 European debt crisis, when many investors from major countries engaged in a "flight home" or a search for safety.[1] Furthermore, we find evidence that "low for long" leads to more risk-taking, with effects about two and a half times greater at low levels of the home interest rate.

Our work relates to two main strands in the literature: that on (low) interest rates and risk-taking by banks and other institutional investors, and that on the role of interest rates for capital flows and international portfolio choices. We contribute to both these literatures in two main ways. First, we document a search-for-yield behavior in investors' portfolios. Only a few empirical papers have been able to document convincingly search-for-yield in response to low interest rates. The majority of papers on risk-taking related to the level of interest rates have focused on bank loan portfolios; research on the effects of interest rates on investors' general portfolio composition is limited and focuses on particular types of investors. In contrast, we draw on granular portfolio choices within an important asset class by a very broad set of investors. Also, to our knowledge, no previous paper has studied responses in cross-border securities investment at a granular level, along the lines we do. Second, much of the evidence using data from a single country has challenges in identifying casual relationships. Is a low interest rate a reflection of a subdued economic and financial environment with related shifts in saving and investment behavior and possibly greater corporate-sector credit risk; or does a low interest rate lead to more risk-taking in lending and investment decisions? Using data on capital inflows to the United States from a cross-section of countries with a wide variety of changes in home interest rates, yet with their investment still representing a modest fraction of outstanding U.S. securities, we can overcome many of the identification challenges plaguing other studies. Finally, our findings also have important policy implications in that they suggest that low interest rates can lead to more risky investments overseas.

The paper proceeds as follows. In section 2 we review the related literature. In section 3 we provide an overview of our security-level dataset and other data sources we use. Section 4 presents a number of stylized facts and summary statistics. In section 5 we outline our empirical methodology and in section 6 we present the empirical results on how the riskiness of countries' portfolios varies in response to changes in home interest rates. Section 7 presents robustness tests. Section 8 concludes and discusses possible policy implications of search-for-yield.

[1] See, for example, Giannetti and Laeven (2012); and De Haas and Van Horen (2012, 2013).

2 Related Literature

Our work relates to two main strands in the literature: analyses on (low) interest rates and risk-taking by banks and other institutional investors, and on capital flows and international portfolio choices. The possibility of search-for-yield by banks (and other investors) has been long recognized in theoretical models (e.g., Fishburn and Porter, 1976). Traditional portfolio allocation models predict that a decrease in interest rates will increase risk-taking as it induces a portfolio reallocation from safe assets towards riskier securities. With fixed costs of operating a financial institution and costs to reporting low or negative nominal net income, incentives to shift into assets with higher expected returns could become even stronger when rates on safer assets are very low or even negative.

Most of the theoretical and empirical literature exploring the effect of low or declining interest rates on risk-taking has focused on banks. As a number of studies have documented, low interest rates can put downward pressure on banks' net interest margins.[2] Consistent with banks seeking to offset these negative financial performance effects, empirical analyses have often found that lower interest rates increase banks' risk-taking.[3] Several empirical studies have found that banks tend to make riskier loans and lower their lending standards when rates are lower (e.g., Ioannidou, Ongena, and Peydro (2009) using data on Bolivia and Maddaloni and Peydro (2011) using data for euro countries). Other recent papers have documented indirect evidence of bank risk-taking in the context of low interest rates (e.g., Altunbas, Gambacorta, and Marques-Ibanez (2014) and Kandrac and Schlusche (2016)).

In addition, there is evidence that when interest rates are at low levels, bank profitability is under more pressure.[4] As such, a prolonged low interest rate could further affect risk-taking

[2]See, for example Covas, Rezende, and Voitech (2015), Borio, Gambacorta, and Hofmann (2017), and Claessens, Coleman, and Donnelly (2017).

[3]Even though many models suggest that low (or lower) interest rates can increase incentives for (excessive) risk-taking, some recent papers argue that these incentives depend not just on interest rates but also on the banks' capitalization and franchise value. Given asymmetric information, bank creditors (and depositors) cannot price risk at the margin, which can lead banks to take excessive risks in general. In this context, Dell'Ariccia, Laeven, and Marquez (2014) show that, as a decline in interest rates reduces these agency problems, risk-taking is less likely, at least for less-capitalized banks that are more susceptible to agency problems.

[4]Using recent data for a sample of 108 relatively large international banks, many from Europe, Japan, and the United States, Borio, Gambacorta and Hofmann (2015) find non-linear relationships between the level of interest rates and the slope of the yield curve and bank net interest margins and profitability, with effects stronger at lower levels of interest rates and with an unusually flat term structure. For a larger sample, Claessens, Coleman and Donnelly (2017) also find that low interest rates reduce bank profitability more. Many other studies do not address offsetting effects of low interest rates, including valuation gains on securities held or improvements in the credit quality of loans as borrowers' debt service is lower.

given declines in banks' profitability and related capitalization. In practice, the risk-taking effects of low interest rates seem to vary not only by bank capitalization, but also by country circumstances. For example, Dell'Ariccia, Laeven and Suarez (2017), using U.S. data, find that the effects of low interest rates are lower for the least capitalized banks. In contrast, Jimenez et al (2014), using data on Spanish banks, find the least capitalized banks to react the most, that is, take more risk when monetary policy eases.[5]

The theoretical literature linking low interest rates to search-for-yield for other investors generally applies similar arguments to those used for banks. In a traditional portfolio choice model, e.g., with mean-variance utility, risk-taking incentives for bond investors are typically not affected by a common downward shift in the distributions of all asset returns. However, as a number of papers have pointed out and along the same lines as the bank risk-shifting channel, there could be a search-for-yield effect for financial intermediaries with long-term liabilities and shorter-term assets, such as life insurance companies and pension funds.[6] These intermediaries may switch to riskier assets with higher expected yields when lower interest rates compress their margins and challenge their ability to meet their obligations with lower yielding assets, with this effect more pronounced for lower-capitalized institutions. Models of how life insurers invest in bonds, such as Domanski, Shin, and Sushko (2017), emphasize how prospects for low asset returns can encourage these investors to have de facto target rates of return, particularly when facing costs from (tighter) prudential regulation, including from increased mismatches between liabilities and assets, and greater insolvency risk.

Some recent papers have also shown that search-for-yield can be reconciled with preferences different from mean-variance. For example, Hanson and Stein (2015) show that reaching-for-yield can occur when some investors distinguish between the income and capital gain components of asset returns, with "yield-oriented" investors willing to accept a lower term premium when the yield curve is more upward-sloping. And Lian, Ma, and Wan (2017) show that reaching-for-yield is consistent with preferences that incorporate reference-dependent loss aversion, as in prospect theory. More generally, papers have stressed that the incentives to reach for yield among asset managers can be greater at low levels of the interest rate, possibly contributing to a buildup of vulnerabilities that can in turn lead to a financial crisis.[7]

The empirical evidence on the effect of low interest rates on investors' portfolio holdings

[5]For further explanations of the risk-taking channel of monetary policy, see for example Borio and Zhu (2012).

[6]See Rajan (2005), and Dell'Ariccia and Marquez (2013).

[7]See Rajan (2010) and Stein (2013).

is scarcer, and often limited to analyses of aggregate asset allocations, mostly due to a lack of detailed data. Choi and Kronlund (2017) show that in a low interest rate environment, corporate bond mutual funds tend to invest in bonds with relatively higher yields than their benchmarks in order to attract flows, with such funds indeed experiencing higher inflows. Focusing on U.S. money market funds, di Maggio and Kacperczyk (2017) find evidence that in response to low rates, money funds invest more in riskier asset classes and hold less diversified portfolios. Domanski, Shin and Sushko (2017) show for Germany that insurance corporations that try to match the durations of their assets and liabilities invest more in longer-duration assets, notably government bonds, as the duration of their liabilities increases with declines in interest rates. This, in turn, can further lower interest rates, setting off an adverse cycle. In the shadow banking sector, Frame and Steiner (2017) document that rapid growth in highly leveraged U.S. mortgage REITs coincided with quantitative easing in the United States. And in an analysis of asset allocation and fund flows, Hau and Lai (2016) show that investors in countries with declining real interest rates shift their portfolio investments out of money market funds and into riskier equity funds.[8] [9]

Our work also relates to the literature on the responses of capital flows to global financial conditions, including (low) interest rates, an important policy issue in international finance, given the high co-movement, relatively large volume, and high volatility of these flows.[10] A special focus of this push-pull literature has been the effects of interest rates in source countries, e.g. United States, on capital flows to emerging markets.[11] The use of unconventional monetary policy (UMP) by several advanced countries lately has also been found to drive asset prices globally and bond and equity inflows, particularly for emerging markets.[12]

[8]For a general review of studies of the effects of low interest rates on financial institutions' profitability and capitalization and risk-taking, see European Systemic Risk Board (2016).

[9]Some papers on risk-taking choices by banks and institutional investors have focused on regulatory arbitrage mechanisms not explicitly linked to levels or changes in safe interest rates. For German banks, Efing (2016) shows that within the class of asset backed securities (ABS), banks systematically choose the securities with the highest yield and the lowest collateral performance among the set of ABS with the same regulatory risk weight. Similarly, Becker and Ivashina (2015) show that U.S. insurance companies aim to achieve higher yields – without triggering higher capital requirements – by investing in higher-yielding bonds within a risk (credit rating) category. Neither consider specifically the effects of (lower) interest rates. Kirti (2017) documents that U.S. insurance corporations did not take more risk after the GFC, i.e., did not gamble for resurrection, as in the specific circumstances, preserving their franchise value was the dominant incentive.

[10]This literature started with Calvo, Leiderman, and Reinhart (1993, 1996), saw a large increase in the 1990s – for portfolio flows, see among others, Chuhan, Claessens, and Mamingi (1998) – and has continued to attract research interest.

[11]See for example Forbes and Warnock (2012), Fratzscher (2012), and Broner et al. (2013).

[12]See Rey (2015), Fratzscher, Lo Duca, and Straub (2013, 2016), Ahmed and Zlate (2014), and Bowman, Londono, and Sapriza (2015).

Finally, some papers, such as Bruno and Shin (2015) and Aramonte, Lee, and Stebunovs (2015), have analyzed how banks globally (re)allocate loans in response to changes in interest rates.

Much of this literature, however, has used aggregate data, mostly balance-of-payments data, and has not specifically analyzed risk-taking behavior. And almost all papers analyze the effects of changes in interest rates in a few advanced source countries, or in global financial conditions, on capital flows to multiple recipient countries, while very few papers analyze the effects of changes in interest rates multiple source countries for flows to one recipient country. Some analysis exists using more granular bank data. Using Turkish loan-level data and controlling for a number of factors, Baskaya, et al (2018) link improving global financial conditions (proxied by VIX) to capital inflows, increased local bank credit, and lower loan rates (although the use of collateral for loans is not reduced). Morais, Peydro, and Ruiz (2017) use, as we do, micro-level data, specifically a Mexican bank loan-level dataset, to document risk-taking by foreign banks' subsidiaries in response to their home-country interest rates. Similarly, Lee, Liu, and Stebunovs (2017) find that interest rates affect risk-taking in cross-border corporate lending, as reflected in ex ante default risk measures.

However, research using security level data that relates changes in investors' portfolio compositions and international capital flows to the level of (or changes in) interest rates, is rather limited.[13] There is also the related literature on the international (bilateral) allocation of securities, using aggregate data, typically the IMF Coordinated Portfolio Investment Survey (CPIS), a survey now conducted semi-annually. A seminal paper here is Portes and Rey (2005) that shows the importance of gravity-model variables, such as distance, for portfolio allocations. Along these lines, Boermans and Vermeulen (2016) analyze the portfolio allocation across countries using newly available data on euro-area security-level holdings. But these papers typically do not investigate the role of (low) interest rates. Otherwise, research using security-level data to analyze international shifts in investors' portfolio compositions and related capital flows as specific responses to changes in interest rates is rather limited.

[13] Ammer, Tabova and Wroblewski (2016), using data on investment from the euro area, U.K., Canada, and Japan in U.S. securities, report some evidence of deterioration in average credit rating and lengthening of average maturity between 2003 and 2014, but they do not formally test for the effect of home-country yields on risk-taking.

3 Data

We use a unique source of security-level data: the annual U.S. Treasury International Capital (TIC) surveys of foreign holdings of U.S. securities for the period 2003 to 2016. The data are collected by the U.S. Department of the Treasury as part of the TIC reporting system. The main reporters are U.S.-resident custodians (including brokers and dealers) which must report all U.S. securities they hold on behalf of foreign residents (including in their own foreign subsidiaries and affiliates). In addition, U.S.-resident issuers are required to report securities that have been issued directly to a foreign resident. Given the mandatory reporting by custodians and issuers, the holdings data are comprehensive, i.e., they capture countries' entire portfolios of U.S. securities at the individual security level. Country-level holdings data for broad categories of assets, aggregated from these detailed annual surveys, are published on the Treasury Department's website, although without distinguishing between private and government holdings.[14]

Data are reported (confidentially) at the security level at the time of the survey date, June 30 of each year, for each country holder of that security, i.e., at those times we observe the holdings of security i by country j. Characteristics reported include general security description and identifier, issue and maturity dates, coupon rate, currency, industry type, and amount held (face and market value). To isolate the effect of active new investments and portfolio shifts, we use in our analysis primarily the face values reported in the TIC surveys, thus abstracting from price change effects. While data include holdings by foreign official institutions and private investors, in our analysis we focus on holdings of foreign private investors only, as motivations of official investors (e.g., central bank reserve managers) may differ from those of private investors. In practice, foreign official institutions' holdings of corporate bonds are relatively small compared to their government bond holdings or to private holdings of corporate bonds.

Data are reported on a resident basis, i.e., we observe the direct owner of these investments as reported by the custodians, but not the ultimate owner. As discussed further later, this means we need to make some adjustment because intermediaries in countries like Belgium, Ireland, and Luxembourg hold significant amounts of securities on behalf of investors from other countries. Individual country-bond holdings that are never above $10 million in the sample period are excluded. Most bonds held by foreigners are denominated in U.S. dollars. To avoid exchange-rate effects from complicating the analysis, we drop bonds in

[14] Appendix A provides more details about the TIC data and data collection process.

other currencies. Since our analysis is based on bond yields, we also exclude floating coupon bonds and focus on fixed rate bonds, which constitute 72% of total corporate holdings. Our final sample comprises over 310,000 individual corporate bond holdings by 36 countries in a total of almost 15,000 unique bonds, with an aggregate value that rises from $268 billion in 2003 to $1.7 trillion in 2016.

Although sizable, the 2016 aggregate foreign holdings represent only 11.4% of total outstanding U.S. corporate bonds.[15] And shares held in U.S. corporate bonds by any individual foreign country are generally much smaller still. In particular, Table 1 shows that the mean share of an individual foreign country's bond holding relative to the bond's outstanding amount is only 3.65% in our sample. Accordingly, we do not expect fluctuations in foreign portfolios to have a strong effect on the supply of financing to U.S. corporations and their respective yields. This helps with identifying the determinants of foreign investor behavior since we can safely assume that foreign investors are price-takers in U.S. corporate bond markets. To further reduce this risk, we nevertheless exclude from the regressions a handful of observations where the share of an individual security held by investors from one country is greater than 45%; this precaution also excludes extreme observations that could reflect data recording errors.

We use CUSIP and ISIN identifiers to match the TIC holdings to additional security-level information from other sources.[16] We collect bond credit ratings from Moody's and from the supplementary data that Bank of America/Merrill Lynch (BofAML) provides for the constituents of its bond indexes. BofAML reports a composite bond rating comprised of all credit agencies when available. When these composite ratings are not available (when a bond is not featured in the indexes) we use the bond's Moody's rating. We use Thomson One Reuters and BofAML corporate bond indexes for data on bond amount issued and outstanding, and whether it pays a fixed or floating rate coupon. Using FINRA's TRACE data on reported trading activity, we compute a measure of bond liquidity: total transaction volume during the month of June of the survey year as a share of amount outstanding. From prices and payment terms, we calculate the bonds' yield-to-maturity and duration at each end-June date. We calculate the bond's spread relative to Treasury yields, choosing the

[15]Data from the Bank for International Settlements (2017) indicate that the amount of outstanding corporate bonds issued within the United States is roughly seven times the corresponding amounts for Japan and the United Kingdom, the two next largest corporate bond issuers. Maggiori, Neiman, and Schreger (2017) find that cross-border mutual fund investments are concentrated in bonds that are denominated either in the investor's home currency or in U.S. dollars.

[16]The security identifier in the TIC surveys is usually either a CUSIP or an ISIN, but in some cases it is a reporter's internal code, in which case we extract a CUSIP or an ISIN from this internal code.

closest match on duration among bonds in the BofAML U.S. Treasury indexes.

Our identification is based on countries' home interest rates. For these, we collect sovereign yields at 1-year and 5-year maturities from Bloomberg, taking the average yield for each June.[17] Since the sovereign interest rate is our key variable to proxy country-level risk-taking incentives, the sample excludes bonds held by investors in Caribbean and other financial centers for which we do not observe sovereign interest rates. In robustness checks, we also investigate whether risk-taking is driven by financial and economic developments in the investors' home countries other than local interest rates. For this, we use (i) the aggregate credit default swap (CDS) spread for the local banking system, constructed from Markit quotes and (ii) the expected earnings growth in the overall corporate sector, obtained from IBES.

4 Stylized facts

4.1 Foreign flows into U.S. bonds

Figure 1 shows how foreign holdings have evolved over time. After a sharp increase in the years leading up to the GFC, foreign inflows into U.S. corporate debt declined sharply during the GFC and remained weak during the subsequent euro sovereign debt crisis, reflecting the "flight home" and search-for-safety during those periods, well documented in the literature.[18] However, as interest rates declined in many foreign countries after 2013, inflows into corporate bonds rebounded, suggesting that these investors were trying to make up for declining returns on safe assets at home by purchasing more (risky) U.S. corporate debt.

[17] One could also consider using a corporate bond index for the home-country yield measure, but this has some drawbacks. For one, it is difficult to obtain for a long enough period of time and for a broad set of countries corporate bond index series measured and defined in ways that are consistent in terms of maturity and credit risk. For example, the market for euro-area corporate bonds has become a fairly unified market, thus precluding using distinct national corporate bond markets (see Burger, Warnock, and Warnock, 2017; and Maggiori, Neiman, and Schreger, 2017). Consistency across countries is another challenge. In some countries, for example, mortgage bonds are more important than corporate bonds as an alternative to government bonds. Also, smaller countries tend to have very few domestic-currency corporate bonds. Importantly, these yields are likely endogenous to investors' behavior, i.e., as risk-taking increases in a country with lower interest rates, local corporate spreads are likely to decline as well, introducing econometric complications.

[18] See, for example, Giannetti and Laeven (2012) and De Haas and Van Horen (2012 and 2013). As also noted by Becker and Ivashina (2015), incentives to reach for yield were likely lower during these periods for several, related reasons: investors were likely more risk averse as owners and regulators exercised more oversight; there was a high general uncertainty, making risk assessments more challenging; and spreads on many instruments were high in the first place, making for lower incentives to reach for yield.

4.2 Bond characteristics and portfolio shifts

Table 1 summarizes the distribution of bond characteristics across our entire 2003-2016 data panel. The average yield is just under 5%, but it varies between 1% and 13%. The average spread over a U.S. Treasury security matched on duration is 2.6% and varies from 0.46% to more than 11%. The duration of the bonds foreigners invest in is generally between 1 and 16 years, but can go up to 50 years. Corporate bonds are in general not heavily traded; on average, only 4.1% of the outstanding amounts changes hands in the month of June in the survey years.

Table 2 summarizes the main bond characteristics for 2003 and 2016, dividing the sample into six ranges of credit ratings. Although corporate yields declined, Treasury yields fell by somewhat more, so that yield spreads increased slightly on net. For both years, lower credit ratings are always associated with wider yield spreads, suggesting that spreads roughly capture the same ex ante information about credit risk as ratings do. A corporate bond yield can essentially be decomposed into its spread (over an equivalent duration Treasury) and the effect of its duration (which determines the interest rate on the equivalent Treasury). We explore in some of our regressions the extent to which search-for-yield involves risk-taking associated with the spread and/or duration dimensions of the yield.

We can also divide the foreign holdings of U.S. corporate bonds into investment and non-investment grade holdings using the BBB- (S&P) or Baa3 (Moody's) rating or higher as a cutoff, following the standard definition. As illustrated in Figure 2, the share of investment grade bonds in foreign holdings declined over most of the period before starting to pick up again in the final two years of the sample, despite a net increase in the investment-grade weight in the set of U.S. corporate bonds included in the BofAML indexes (which we take as the benchmark for the properties of the U.S. corporate bond "universe"). These shifts suggest that there were some strong factors driving foreign investors toward lower-grade securities over this period.

Our identification relies on variations in sovereign yields across countries and over time. Figure 3 captures the range of home-country rates in our data panel, showing for each country the median, maximum and minimum. It shows the large dispersion in rates and the differences in movement across countries over time. For example, rates in Japan have been low for most of the 2003-2016 period, while rates in many European countries have varied considerably, in most cases falling to low levels only more recently. And rates have not been low in the majority of emerging markets. In addition, Figure 4 shows the evolution of the cross-sectional quartiles of sovereign rates over the sample period. Importantly, not only is

there significant variation in sovereign yields over time, but the interquartile range remains substantial throughout, even as the median approaches zero toward the end of the period. This country heterogeneity in the panel helps us considerably for identifying the effects of declining rates on risk-taking.

Figure 5 compares the weighted-average yield spread of the foreign portfolio of U.S. corporate bonds, using the actual time-varying weights from our data, to the weighted-average spread of the BofAML benchmark. The two move together fairly closely, but relatively, the spread on the foreign-owned portfolio, starts below the BofAML benchmark in the first part of the period, and later exceeds it, consistent with more risk-taking by foreign investors. Figure 6 shows that the average spread on the securities held by foreign investors varies significantly across countries. At least anecdotally, the patterns here are consistent with diverging home-country interest rates. The yield spread on bonds held by investors in falling-rate Germany has increased relative to the BofAML benchmark. In contrast, investors from the higher-interest rate emerging markets have held lower-yielding (thus less risky) corporate portfolios, especially towards the end of the sample period. Finally, Figure 7 compares the weighted duration of the foreign portfolio to that of the BofAML benchmark. The foreign portfolio duration is shorter than the benchmark by about half a year. While both increased over the period, the duration of bonds held by foreign investors has risen more steeply after the crisis and as a result the gap has narrowed slightly. In what follows, we explore to what extent this shift by foreign investors toward higher yield (or spread and duration) corporate securities is driven by a lower interest rate at home.

5 Methodology

We focus on changes in the holdings of a specific security by a given country. We scale these holdings by the amount outstanding at the security level to account for the fact that we can expect more foreign investment in securities with larger outstanding amounts. Our dependent variable is then the change in the holdings position (i.e., a flow) of bond i by country j as a ratio to the overall amount outstanding of the specific security i. We use the face values of holdings reported in the TIC survey to match the denominator, which is also a face value. This also abstracts from the effects of price changes and thus accurately captures new investments and portfolio shifts.

For our main test, we rely on an interaction term between the home-country sovereign yield and the yield (or spread and duration, in some specifications) on the specific U.S.

corporate bond. This interaction captures whether the foreign investors' propensity to choose U.S. investments with a different yield (or spread and duration) is affected by the rate of return on their home-country safe investment alternatives. That is, we test if foreign investors' allocations across different categories of riskiness vary inversely with their interest rate at home. We then interpret a negative coefficient as evidence of a search-for-yield motive since it implies that a declining safe interest rate at home increases investment in U.S. corporate bonds with a higher yield (or spread). Since longer duration is another way investors can take on risk, in this case maturity risk, we also test whether it reflects another dimension of search-for-yield, possibly additionally to credit risk.

We use local currency sovereign bond rates since these represent the best overall proxy for investment opportunities in countries' home markets and consequently how declining home sovereign rates can drive residents to invest more in risky securities, including abroad.[19] Our sample excludes financial centers such as the Caribbean banking centers for two reasons that are both related to our focus on the effect of home investment opportunities on investors' risk-taking. First, as noted, these countries do not have significant sovereign debt outstanding and therefore lack reliable sovereign rates. Second, their investments are predominantly held on behalf of a diverse group of non-residents, for whom the interest rate to use is ambiguous. That said, our baseline regressions do include the bond holdings of Luxembourg, Belgium, and Ireland, three financial centers that largely cater to investors from other European countries. For these countries, a composite European yield is likely to be a better choice than the national sovereign yield.[20] Accordingly, instead of using their own sovereign rate (feasible for Belgium and Ireland, but not for Luxembourg which lacks a sovereign bond rate), we assign them the average sovereign rates of four large euro zone countries: Netherlands, France, Italy, and Spain.[21]

[19]We focus on asset composition and not on funding conditions. This means we ignore motives related to carry-trade, i.e., where foreign investors obtain funding in low interest rate countries to invest elsewhere. We do not expect such factors to be large for the type of investments we study as carry trade is typically not done with corporate bonds, which tend to be less liquid.

[20]Entities resident in other countries in our sample may also hold some bonds on behalf of ultimate investors in different countries. However, Luxembourg, Belgium, and Ireland stand out for having TIC holdings in excess of home-country data regarding their investors' U.S. investments. In addition, TIC holdings as a percentage of investor-country GDP are by far the highest in these three countries, suggesting that mismeasurement of investor nationality is much less of an issue elsewhere.

[21]Results are unchanged if we used also the German rate to calculate an average rate for Belgium, Ireland, and Luxembourg. But one concern with using the German rate is that it might reflect Germany's safe haven status, rather than (just) investment opportunities in Germany. We furthermore show in the robustness section that our results are robust to alternative schemes for constructing composite European sovereign rates as well as to simply omitting the three countries from our analysis.

In all specifications, we use country*time fixed effects, which control for any time-invariant and time-varying country differences that may affect the general degree of investment into the United States. This means that time-invariant control variables used in the international portfolio choice "gravity" type models, such as the distance to and common language with the United States, are already absorbed in the fixed effects, and that time-varying country characteristics are controlled for.[22] We include as a time-varying, security-specific variable the liquidity of each corporate bond to proxy for transaction costs.

Note that with country*time dummies, changes in the overall U.S. and global economic and financial environment, including changes in the U.S. safe interest rate, are already accounted for. The GFC and the European sovereign crisis, however, entailed major disruptions to many financial markets. While the country*time fixed effects already control for general effects, the stresses during these periods could have made investors particularly reluctant to invest in U.S. corporate bonds, especially those with higher yields and risks. Indeed, as shown in Figure 1, during both the GFC (2008-2009) and the European debt crisis (2010-2012), foreign investment in U.S. corporate bonds was unusually weak. Related to this, Becker and Ivashina (2015), investigating bond investments by U.S. insurance companies only, report less risk-taking during this period. To control for this possibility, we include the average CDS spread of U.S. high-yield corporate bonds (Figure 8) interacted with the specific corporate bond's yield (or yield spread). If investors are reluctant to buy corporate bonds with higher yields (or yield spreads) in times of heightened overall corporate stress, then the coefficient on this interaction should be negative. Controlling for this effect, which is common to all of the countries in our sample, we can then continue to analyze the presence of search-for-yield behavior, and whether it varies across countries with different home interest rates.

The empirical specification of the model we estimate is then:

$$\begin{aligned}\Delta \mathrm{H}_{i,j,t}/\mathrm{Outstanding}_{i,t} = \kappa + \alpha \mathrm{Risk}_{i,t} + \beta \mathrm{Risk}_{i,t} \Delta \mathrm{Sov}_{j,t} + \\ + \gamma \Delta \mathrm{CDS}_t^{\mathrm{US}} \mathrm{Risk}_{i,t} + \theta \mathrm{Liquidity}_{i,t} + c_{j,t} + \epsilon_{i,j,t}\end{aligned} \tag{1}$$

where the dependent variable, $\Delta \mathrm{H}_{i,j,t}/\mathrm{Outstanding}_{i,t}$, is the change in holdings by resi-

[22] In robustness checks (not reported), we drop the country*time fixed effects and include, beside country-fixed effects, the following time-varying variables instead: bilateral trade (sum of imports and exports, and imports and exports separately), and financial linkages, both as proxies for interconnectedness with the United States; and the change in the bilateral exchange rate, as a proxy for both shifts in investment related to carry-trade and other exchange rate related opportunities. Results are similar.

dents of country j in year t of U.S. security i. $\Delta\text{Sov}_{j,t}$ is the change in country j's sovereign yield measured as the year-end 1-year sovereign yield. $\text{Risk}_{i,t}$ is security i's risk measure defined as either yield-to-maturity (Bond yield) or yield spread (Bond spread), measured as the yield-to-maturity spread over the Treasury yield of similar duration, and duration (Duration). Our main variable of interest is the interaction between the security's risk measure and the change in the sovereign yield, $\text{Risk}_{i,t}\Delta\text{Sov}_{j,t}$. So our key coefficient is β which determines the search-for-yield effects through the credit-risk channel. A negative coefficient ($\beta < 0$) would suggest that the more the home rates decline, the more investment is shifted towards riskier U.S. corporate bonds. $\Delta\text{CDS}_t^{\text{US}}$ is the change in the average CDS spread of U.S. high-yield corporate bonds (D.CDS (US)); $\Delta\text{CDS}_t^{\text{US}}\text{Risk}_{i,t}$ is its interaction with security i's risk measure. We also control for the security's liquidity, $\text{Liquidity}_{i,t}$ measured as the log of the trading volume recorded in TRACE as a share of the bond outstanding amount (Traded share). Using the log of the unscaled volume instead in our regression specifications does not change our regression results. All regressions include country*time fixed effects, denoted by $c_{j,t}$ and we also allow the country fixed effects to differ for newly-issued and seasoned bonds. We estimate the model parameters by Ordinary Least Squares (OLS), reporting heteroscedasticity-consistent standard errors generated from the Hubert-White "sandwich" estimator for the variance-covariance matrix.

6 Empirical Results

Table 3 reports the baseline regression results on how changes in interest rates at home affect the degree to which foreign investment moves into riskier U.S. corporate bonds. In column 1, we document our main result that the (scaled) change in a country's total holdings in a given bond is negatively related to our key interaction term, the product of the yield on that bond and the change in the home-country interest rate. This means that the more the interest rate in the home country declines, the more holdings by this country's investors of higher-yielding U.S. securities increase.[23] Note that the coefficient on bond yield itself has a positive sign, suggesting that a higher yield means more investment in that specific security. The interaction between the corporate CDS index spread and the bond yield is negative, however, suggesting that at times of increasing overall riskiness in the U.S. corporate sector, foreign investors shy away from buying high-yield securities.

[23]Similar regression results are obtained if we use a sovereign rate which is adjusted for hedging the dollar-local currency exchange rate risk, suggesting that exchange rate risk does not affect our regression results.

In column 2, we add a control for the U.S. corporate bond's liquidity. Here we follow Becker and Ivashina (2015) and use the log of the amount traded as a share of outstanding as our bond liquidity measure in the case of secondary market purchases (Traded share). We find that the degree of liquidity positively affects the change in holdings, i.e., foreign investors consider the ability to more easily trade in the security an important characteristic. Our main result on risk-taking remains, with a slightly larger coefficient.

To obtain higher yields on their U.S. corporate bond holdings, foreign investors may be taking on more credit risk, more duration risk (by shifting to longer bonds), or both. To distinguish between these possibilities, we use in columns 3 and 4 the spread of the specific U.S. corporate bond over the equivalent maturity risk-free rate instead of its yield, and also include the duration of the security. This makes these two regressions similar to the ones for the yield, as the credit spread and duration combined determine the yield. As with the yield, we include both spread and duration on their own and interacted with the change in the home sovereign rates. The results show that both the spread and duration interact in a statistically significant negative way with the change in sovereign rates, consistent with investors taking on more risk in both the credit and duration dimensions, when home interest rates decline. The other variables remain statistically significant and are of the same sign and magnitudes. We also find that these results are robust to including in the specification rating fixed effects to take into account investors' preferences for specific rating groups (see Appendix Table B.1).[24]

To quantify the economic significance of these results, we consider the effect of a 215 basis point decline in the home sovereign yield which corresponds to the difference in the sovereign rate decline between 2003 and 2016 of Germany and Japan (countries where sovereign rates took different paths over the period). We then infer the portfolio shifts that investors from countries with different developments in their home sovereign rates would make according to our coefficient estimates for the interaction terms. We then compare several characteristics of the average U.S. corporate bond portfolio held by foreign investors over our sample to the hypothetical portfolio that our estimates imply if instead their home interest rates had been 215 basis points lower. This exercise shows that this reduction in home rates, all else equal, would induce foreign investors to pick up 15 basis points in yield by reweighting their U.S. corporate bond holdings toward higher-yielding bonds. This reallocation would also increase the average spread over U.S. Treasuries by 10 basis points, lengthen the portfolio duration

[24]Results neither change if we winsorize the dependent variable nor if we use weighted least squares for the estimation where we use as weights the bonds' outstanding amounts; see Appendix Table B.2.

by 0.1 years and worsen the average credit rating by a tenth of a notch. These effects, which are economically significant, pertain to the full sample period.

6.1 Secondary and primary markets

The dependent variable we studied so far is similar to that used previously in the literature on risk-taking for institutional investors in individual countries and on home bias in international portfolio choice. In both these strands, the focus is typically on changes in stock positions, i.e., total flows. This means analyses combine secondary and primary market transactions. This could be the right focus if (foreign) investors consider both currently held and newly-issued securities for their portfolio shifts year to year. It implicitly assumes, however, that investors can and do adjust their portfolios easily in both markets. Because of transaction costs or other (internal) constraints, it could be that an investor cannot or does not want to readjust its portfolio continuously in response to changes in interest rates at home. Although we do include in regressions a proxy for the liquidity of the secondary market, and results do not change, we also want to allow for the possibility that investors only adjust their portfolios at the margin and do so only by varying the amounts that they buy in the primary markets, i.e., newly-issued bonds. More generally, as both liquidity and transaction costs can vary between the secondary and primary market, investors may respond differently to changes in interest rates in the two markets.

We define the secondary market flows as the net purchases or sales in a given year of "seasoned" bonds, meaning for our purposes bonds that had already been issued by the time of the previous years' survey date. In notation terms, we use the change in the portfolio held in a particular U.S. security i at time t by country j. Primary market flows are defined as the purchases of newly-issued securities (i.e., issued since the previous years' survey date) that are added to the specific country investors' portfolio. Here, the dependent variable is thus the investment of country j in year t in a newly-issued U.S. corporate bond i. To control for issuance size, we calculate these purchases as a fraction of amount issued, i.e., securities bought by country j out of the total issued of that security in a specific period t. Our definitions of primary and secondary market transactions are similar to those used by Becker and Ivashina (2015) and together comprise the entire change in holdings analyzed above.

Table 4 reports the regression results for the secondary market behavior. The results are similar to those in Table 3. For both the yield and the yield spread interactions with the change in sovereign yields, the coefficients are negative and statistically significant in

all four specifications shown. Furthermore, the coefficients are about as large as in Table 3, suggesting that dynamic portfolio adjustment is an important part of the reach-for-yield dynamics. In contrast, in the secondary market sub-sample, the interaction of the duration variable with the sovereign yield is no longer statistically significant. The control variables largely keep the same signs and statistical significance, with secondary market liquidity positively affecting net purchases. Note that the reach-for-yield that we identify in the secondary market could arise from either sales or purchases of bonds by foreign investors, or a combination (portfolio rebalancing); the regression results reflect the net outcome of the transactions.

For the primary market, the dependent variable is the investment in newly-issued securities only. Since much fewer bonds are issued each year than there are outstanding bonds, we have fewer observations. The right hand side variables are as before; except we no longer include the secondary market liquidity measure. Table 5 presents the results. The main result is confirmed in these regressions. We find in column 1 that the coefficient for the interaction of the change in the sovereign yield with the yield on the newly-issued securities is still negative and statistically significant. Similarly, the coefficient for the bond spread-sovereign yield interaction is again negative (column 2). Compared to the secondary market sample, there is less evidence for search-for-yield through longer duration; the coefficient here on the interaction term is positive, though only marginally significant.

We also test whether clustering the standard errors on the issuer, as Becker and Ivashina (2015) do for their primary market specification, makes a difference. Although we lose some observations, since we cannot always match the security to a parent identifier, we find that the results are unchanged and that the effects are even stronger than those reported in the baseline Table 5 if we cluster on the ultimate parent of the bond issuer (Appendix Table B.3).

6.2 Search for yield and bond type

We next explore whether there are differences in effects by types of bonds. It could be, for example, that foreign investors engage in risk-taking related to declining interest rates, but only within certain categories of corporate bonds. We divide the universe of bonds into various groups: investment grade, non-investment grade, BBB-rated bonds, BBB-rated non-financial bonds, non-financial, and financial bonds. Table 6 shows that the estimated effect for the yield spread interaction is stronger within the set of investment-grade bonds (column 1) than they are for the full sample (Table 3 column 4); the estimated effect for the duration

interaction is similar in both samples. However, we do not find statistically significant effects within the (smaller) sub-sample of non-investment grade bonds (column 2), consistent with foreign investors taking a more cautious approach to the riskiest bonds. Further splits suggest that the spread effects are the strongest for BBB-rated bonds, especially those issued by non-financial corporations (columns 3 and 4) and the duration effects are the strongest among financial bonds (columns 6). Overall, this table suggests that our main results reflect foreign investors' behavior vis-à-vis investment grade bonds.

6.3 Search for yield over time

Next, we explore whether the effects we have documented thus far vary over time. It could be that foreign investors engaged less in risk-taking during the GFC or other periods of financial stress. And it could be that the unconventional policies of major central banks after the GFC, such as quantitative easing and asset purchase programs, affected the behavior of investors. Since we include the corporate CDS interaction, we already control for the general effect of changes in financial stress. In Table 7 we split the sample in three periods: 2003-2007, 2008-2012, and 2013-2016, where the middle period thus includes both the GFC and the euro sovereign crisis. We find evidence of reach-for-yield by taking on credit risk only in the non-crises years: the statistically significant negative spread interaction terms are confined to the 2003-2007 and 2013-2016 periods (columns 1, 2 and columns 5, 6). In the crises period, 2008-2012, the estimated spread interaction is close to zero and no longer statistically significant (columns 3 and 4). We find that foreign investors reach-for-yield by extending the duration of their U.S. corporate bond portfolios only in the pre-crises period. It might be that the unconventional policies of major central banks after the GFC, which involved purchases of longer-dated instruments, altered the responses of investors with respect to risk-taking through longer duration.

Therefore, the main result we document largely reflects investors' search-for-yield behavior in "normal", i.e., non-crises times. In terms of economic impact, we find that when excluding the crises period, a 215 basis points larger decline in home rates, all else equal, would induce foreign investors to a 33 basis points increase in yield by reweighting their U.S. corporate bond holdings toward higher-yielding bonds. This is more than double the earlier reported pick up of 15 basis points over the full period. The predicted reallocation would also increase the average yield spread by 27 basis points (compared to 10 basis points over the full period) and worsen the average credit rating by almost half a notch (compared to a tenth of a notch over the full period). These non-crises effects are thus economically

much larger than those for the full sample period, suggesting that search-for-yield is mainly present in non-crises times.

6.4 Impact of the level of the home interest rate

So far, we have explored the hypothesis that risk-taking relates only to the decline in the home interest rate, irrespective of its level. This presumes that the incentives to adjust investment towards higher yielding securities are mainly related to declines in home interest rates from year to year. It thus also assumes that investors from countries where home interest rates have already been low for some time make fewer adjustments to their legacy portfolios from the previous year. Nevertheless, it could be the case that the level of the interest rate is also important for search-for-yield behavior.

We, therefore, consider next how the level of the sovereign interest rate affects the search-for-yield effects we have documented above. For this, we use again equation (1) but split the sample into two: countries in a low rate environment and countries in a high rate environment. To obtain equal sized subsamples, we define a low rate environment when the home sovereign rate falls below 0.6%. Each year, a country-year is then classified in one of these two categories based on its prevailing sovereign rates. A comparison of the results for the two sub-samples in Table 8 shows that a low level of interest rates is associated with more risk-taking as the coefficients are much higher in that environment (two and a half to three times as high: column 2 vs. column 3 and column 5 vs. column 6). As such, the results confirm our hypothesis that the level of the interest rate matters: when the home interest rate is low, securities with higher spreads see even more investment when the home sovereign interest rate further declines. In economic terms the search-for-yield effects are then also much bigger: a 215 basis points decline in the home sovereign rate is associated with a 23 basis points pick-up of yield in a low interest rate environment compared to 11 basis points in a high interest rate environment. In contrast, the "reach-for-duration" aspect of risk-taking seems to come primarily from countries with higher levels of the home interest rate.

In Table 9, we show that this result is robust to using different cutoffs in terms of what sovereign yield constitutes a low interest rate environment (using either the median, or 25th or 10th percentile). Again, the results show that the search-for-yield effects become larger, the lower the level of the home sovereign rate is. For instance, when we consider only the countries for which the sovereign rate is below the 10th percentile over the sample period (that corresponds to 0.1%), the coefficient on the spread interaction term (column 5) almost

doubles compared to a cutoff of the 25th percentile (corresponding to 0.73%) shown in column 3, and is almost four times larger than the one in column 1 where the cutoff for what constitutes a low rate environment is based on the median value of the sovereign yield (corresponding to 2.36%).

7 Robustness

We next conduct a number of robustness tests.

7.1 Robustness to alternative explanations for search for yield

We first consider the possibility that the change in the sovereign rate may not be the main reason why foreign investors invest in higher yielding (or longer duration) U.S. corporate bonds. We do this by augmenting our baseline regression specification with other investor-country variables. Specifically, we use the CDS of a country's banking system and the expected earnings growth in its corporate sector. If these variables are also correlated with interest rates, this could have led to spurious results in our baseline regressions. It could be that a decline in the local CDS spread similarly induces investors to search for yield abroad. Or investors may invest more in higher-yielding U.S. assets because they forecast low corporate sector earnings growth at home. In that case the (negative) interaction between the banking system CDS (or earnings growth) and the specific security's yield (or spread and duration) could even overturn the significance of the interest rate interaction. Since we want to exclude such relationships mistakenly driving our interpretation, we run regressions with these variables in "horse-races" with the interest rate, all interacted with the specific security's variables (yield, or spread and duration).

Regression results for the countries for which we have the necessary data (the number of observations drops slightly), Table 10, show that interactions with the CDS and expected earnings growth have the expected negative signs, and are most often statistically significant. As such, investments into more risky securities in the United States in part respond to these factors. However, the risk-taking effects we document above cannot be attributed to these other country characteristics since adding these variables (interacted) does not change the sign or statistical significance of the interactions between the sovereign rate and the yield or spread and duration (columns 1-4). Coefficients for the spread interactions are slightly smaller in size, but the main regression results are maintained.

7.2 Robustness to alternative sovereign rates

We next test the robustness of our regression results to the maturity of sovereign rates. In this set of tests, we use the 5-year sovereign bond rates rather than the 1-year rates in the baseline set of regressions. Table 11 shows that the regression results are very consistent in that the coefficients for the respective interaction variables are statistically significant and negative for all four specifications and of comparable magnitudes.

We have so far used the countries' home sovereign yields as a measure of their home (safe) investment opportunity rates of returns, using as a substitute for Luxembourg, Belgium and Ireland the simple average sovereign rate prevailing in four large euro countries. In Table 12 we find that our results are robust to using instead for Luxembourg, Belgium, and Ireland composite European rates with CPIS-reported investment in these countries as weights.[25] As another robustness check, we report in Table 13 regression results where we exclude Luxembourg, Belgium, and Ireland altogether from the sample. The number of observations drops by a third, reflecting the importance of these financial centers as a conduit for cross-border investments. But the main regression results are maintained - the coefficients on the interaction variables, both on the bond yield (columns 1 and 2) and on the bond spread and duration (columns 3 and 4) are of the same sign and statistical significance as in the baseline Table 3, although smaller in magnitude.[26]

8 Conclusion

We analyze how changes in (and the level of) interest rates can affect risk-taking by examining the extent to which investors have shifted toward riskier assets overseas in response to declining (low) interest rates at home. Detailed security-level data on foreign investors' holdings of U.S. corporate bonds for 36 countries for the period 2003-2016 and a large variety in movements in interest rates in these countries provide for a unique way to analyze risk-taking behavior of investors in response to changes in their home interest rates. Notably, our analysis avoids concerns about reverse causality or omitted variables (e.g., due to asset riskiness or yields being related to macroeconomic and financial conditions that also affect interest rates). And, while these foreign investments are likely to have been affected

[25] Although CPIS data suggest that these countries' holdings should reflect mostly European investors' decisions, there can still be some reporting issues.

[26] We also conducted regressions where we allowed the regression coefficients to vary by individual country. Results show generally a narrow range for the statistically significant country-specific coefficients. As such, there do not appear to be individual countries driving our overall results.

by economic and financial conditions at home, since they are small from a U.S. perspective, they are unlikely to have affected the financing conditions, including spreads, of the issuers.

We find evidence suggesting search-for-yield in that the more the interest rate in the investor's home country declines, the greater the likelihood that the composition of investments into specific U.S. corporate bonds shifts towards higher yielding investments. We find these effects for both changes in holdings of seasoned bonds and for purchases of newly-issued securities. The search-for-yield effects are mainly present in normal times and are much stronger at low levels of the home interest rate. In sub-samples, we also find significant evidence of search-for-duration as investors lengthen the duration of their portfolio in response to lower interest rates at home.

We show that these search-for-yield effects cannot be attributed to other country characteristics, such as the CDS of its banking system or expected earnings growth in its corporate sector. The results are also robust to different home interest rates, alternative country samples, and to various econometric robustness checks. Effects are economically important: a 215 basis points decline in the sovereign rate (which is equivalent to the difference in the declines of the German and Japanese sovereign yields during the period) corresponds to a predicted change in holdings toward riskier securities that implies a yield spread pickup depending on the specification and sub-sample in the range of 15-33 basis points and a decline in credit rating of 0.1-0.5 notches.

Our findings have important policy implications in that they suggest that declining and low interest rates can lead to shifts towards riskier types of investments. Although we control for both security and investor-country characteristics, we cannot say whether the investor behavior we observe is the same or differs from their domestic investment patterns, since we do not have similar data for the domestic investment portfolio of these investors. It could be that these investors invest more aggressively abroad and more conservatively at home, and as such their overall portfolio need not be more risky. Nevertheless, extrapolating from the small part of their behavior we observe, one could conjecture that foreign investors likely have made risk-increasing shifts in their portfolios, including elsewhere abroad, that could pose financial stability risks, particularly if the low-rate environment persists. Regardless, our findings suggest that there are cross-border effects from low interest rates through capital outflows directed toward riskier types of securities. Conversely, our findings suggest that if interest rates were to rise, e.g., as monetary policy normalizes in some countries, some adjustments in portfolios towards less risky securities may follow.

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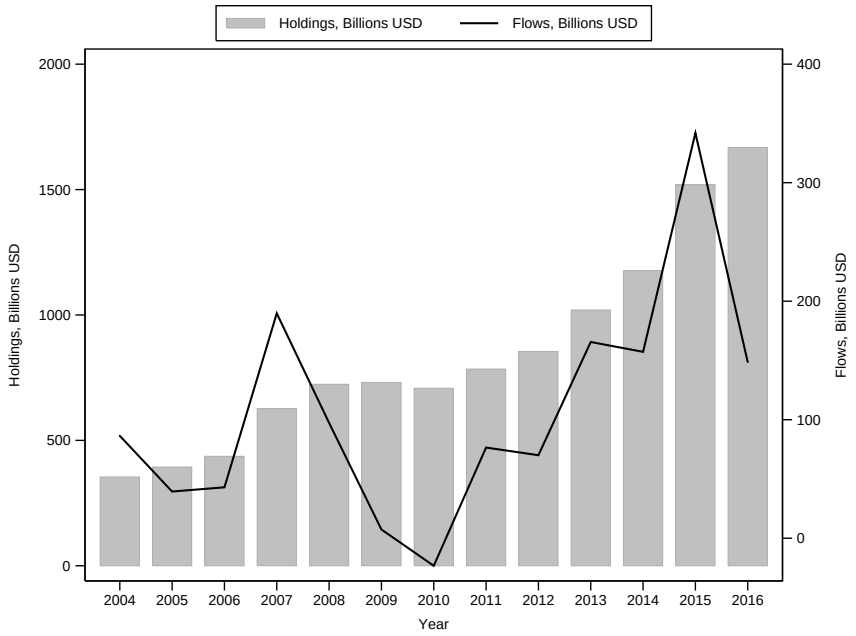
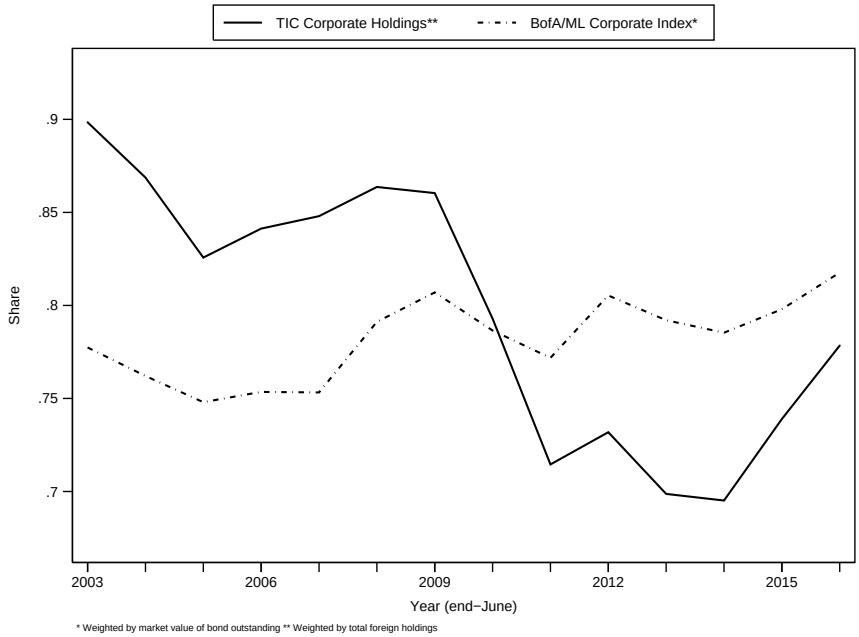
Figure 1: Foreign Holdings of U.S. Corporate Bonds (2004-2016)



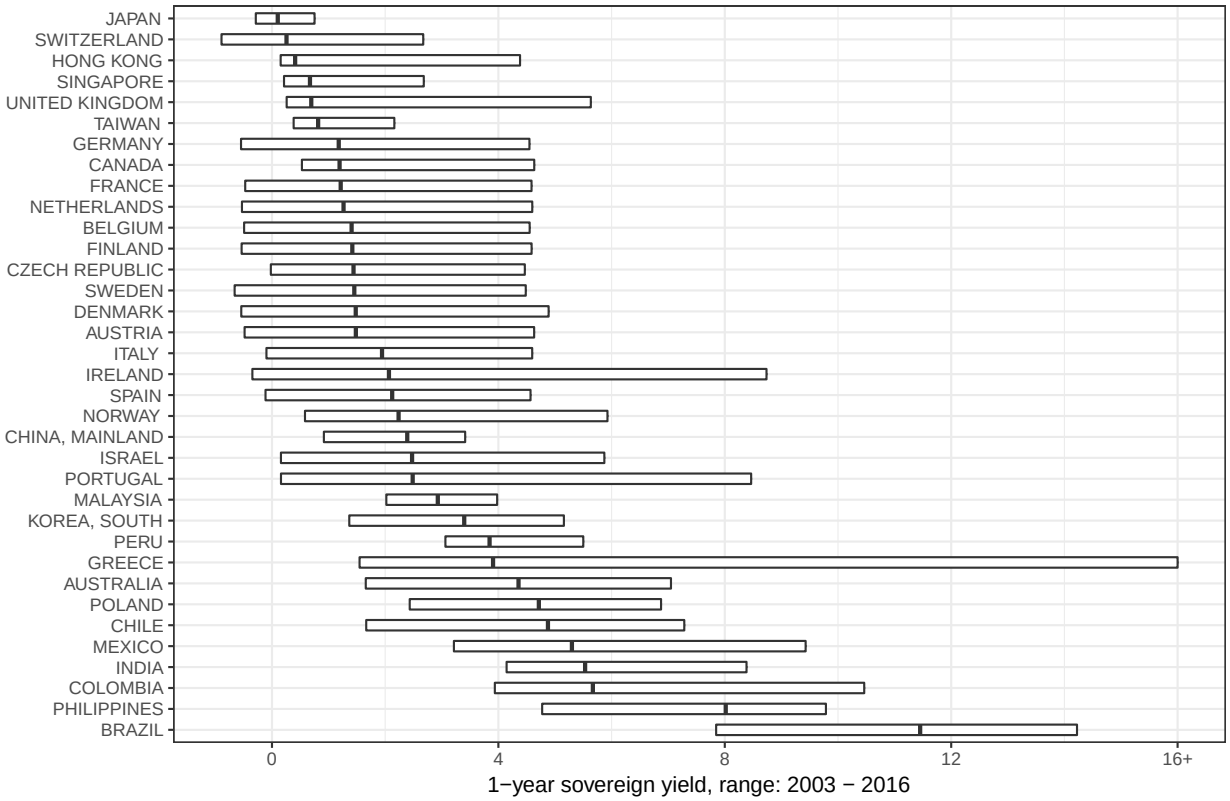
The figure plots foreign investors' annual holdings of U.S. corporate bonds (bars) and the change in these holdings (flows). The holdings are reported in par amounts and as such do not include price effects. The change in the holdings is therefore net of price effects. Authors' calculations using Treasury International Capital Annual Surveys data.

Figure 2: Investment Grade Corporate Bonds in Total U.S. Corporate Bonds Held by Foreign Private Investors



The figure plots the investment grade share of U.S. corporate bonds held by foreign private investors (solid line) for the period 2003-2016. As a reference the figure also shows the investment grade share of the Merrill-Lynch U.S. corporate bond indexes. Authors' calculations using data from Treasury International Capital annual surveys and Merrill-Lynch U.S. corporate bond indexes.

Figure 3: Sovereign Yields by Country (2003-2016)

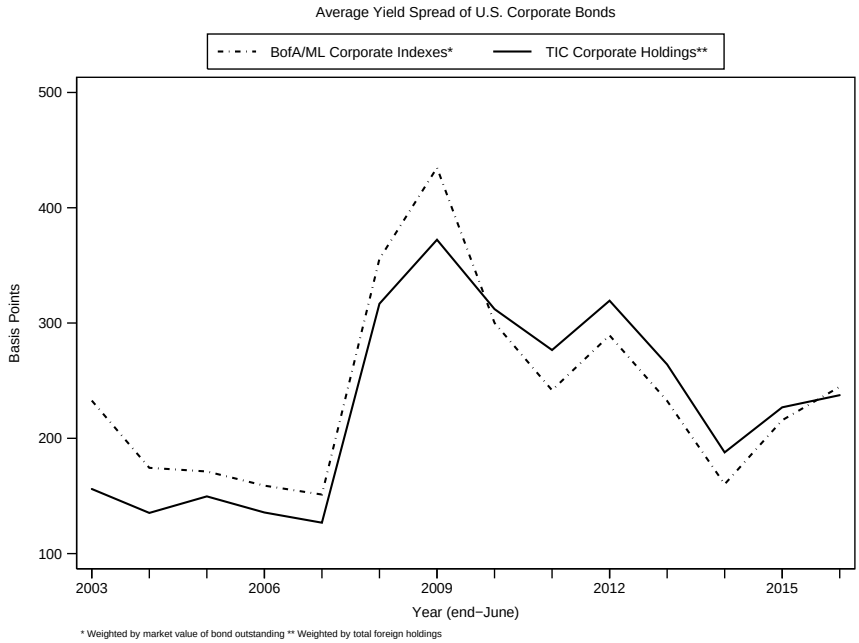


The figure plots the 1-year sovereign yield for all countries in our sample. For each country we plot the median (dot) and the min and the max (boundaries of the box) of the sovereign yield for the period 2003-2016. Last value on x-axis refers to values of 16+ for the sovereign yield. Authors' calculations using data from Bloomberg.

Figure 4: Sovereign Yields over time (2003-2016)

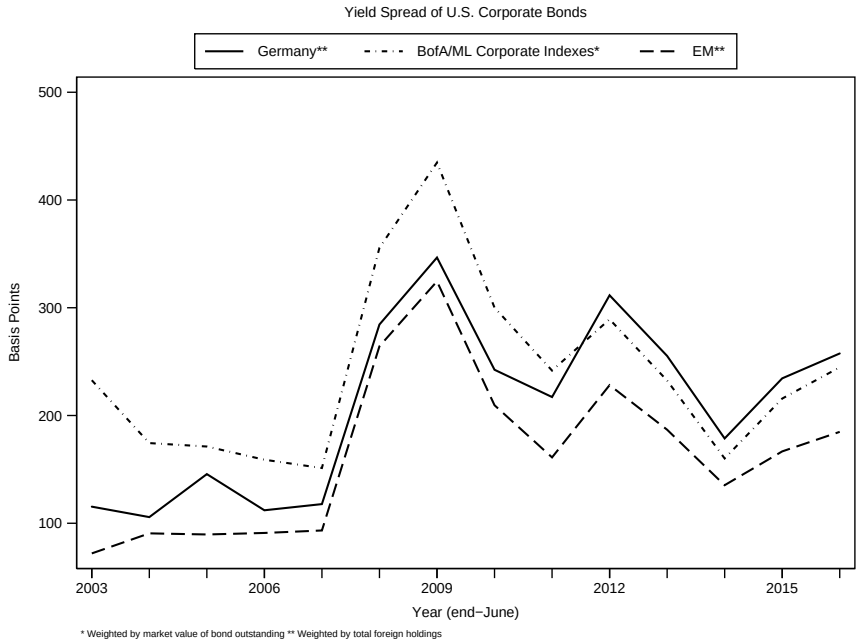
The figure plots the interquartile range of the 1-year sovereign yield over the sample period 2003-2016 for the 36 countries in our sample for which we have data on their sovereign bond yields. Authors' calculations using data from Bloomberg.

Figure 5: Average Corporate Yield Spread in Sample and BofAML Benchmark



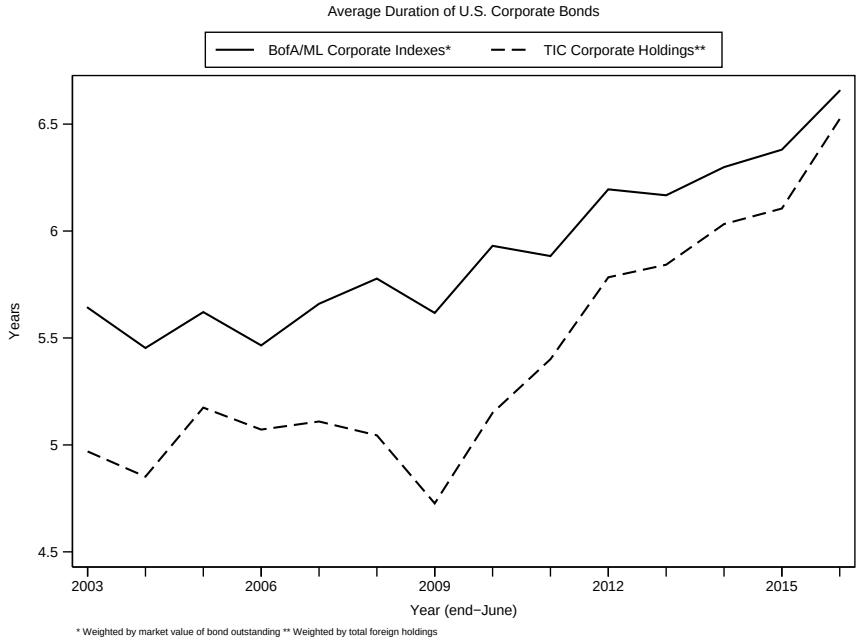
The figure plots the weighted average yield spread of the foreign portfolio of U.S. corporate bonds (dashed line). The yield spread is calculated as the yield to maturity of U.S. corporate bonds held by foreign private investors less the duration matched Treasury yield. As a reference the figure also shows the yield spread of the Merrill-Lynch U.S. corporate bond indexes, for which we took the weighted average of the high-yield and investment grade Merrill-Lynch U.S. corporate bond indexes. Authors' calculations using data from Treasury International Capital annual surveys and Merrill-Lynch U.S. corporate bond indexes.

Figure 6: Select Countries: Average Yield Spread



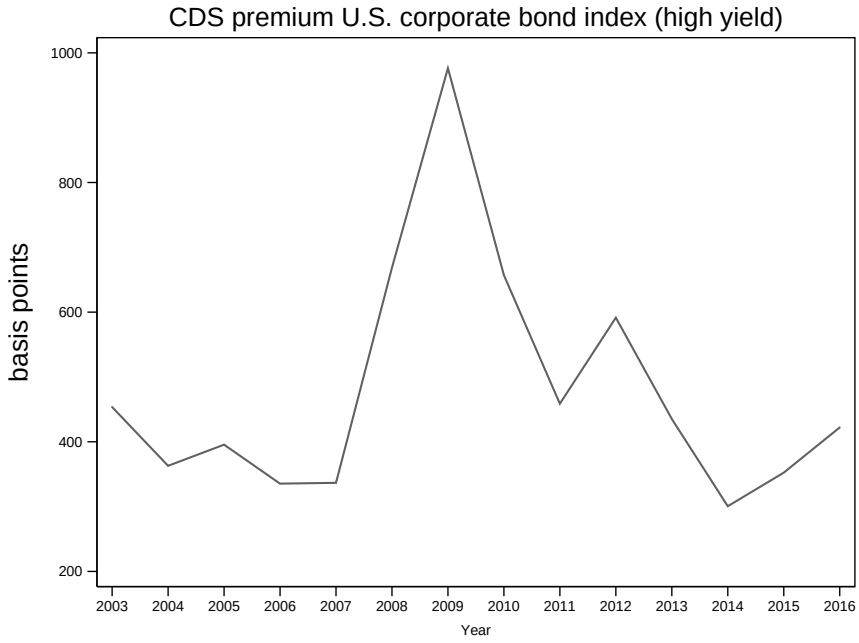
The figure plots the weighted average yield spread of U.S. corporate bonds held by Germany and emerging markets (EM). The yield spread is calculated as the yield to maturity of U.S. corporate bonds held by foreign private investors less the duration matched Treasury yield. As a reference the figure also shows the yield spread of the Merrill-Lynch U.S. corporate bond indexes, for which we took the weighted average of the high-yield and investment grade Merrill-Lynch U.S. corporate bond indexes. Authors' calculations using Treasury International Capital annual surveys and Merrill-Lynch U.S. corporate bond indexes.

Figure 7: Foreign portfolio of U.S. corporate bonds: Average Duration



The figure plots the weighted average duration of the foreign portfolio of U.S. corporate bonds (dashed line). As a reference the figure also shows the duration of the Merrill-Lynch U.S. corporate bond indexes, for which we took the weighted average of the high-yield and investment grade Merrill-Lynch U.S. corporate bond indexes. Authors' calculations using data from Treasury International Capital annual surveys and Merrill-Lynch U.S. corporate bond indexes.

Figure 8: CDS premium U.S. corporate bond index



The figure plots the average CDS spread of U.S. high-yield corporate bonds. Source data: Bloomberg.

Table 1: Bond Characteristics across Entire Sample (2003-2016)

	Median	Mean	St.Dev	5th p.	10th p.	95th p.	99th p.
Yield (%)	4.85	4.93	2.61	1.11	1.61	9.33	13.24
Yield spread (%)	1.86	2.63	2.31	0.46	0.62	7.27	11.25
Duration (years)	5.02	5.90	3.85	1.12	1.74	13.81	16.18
Traded volume/Outstanding (%)	3.17	4.11	4.10	0.24	0.57	11.07	19.39
H/Outstanding (%)	2.11	3.65	8.37	0.22	0.37	11.75	22.44
Newly-issued H/Outstanding (%)	2.42	3.94	9.00	0.27	0.48	12.30	21.91

Notes: The table reports bond characteristics (yield, yield spread, duration, and a liquidity measure) of the portfolio of foreign holdings of U.S. corporate bonds over the entire sample period 2003-2016. The bond liquidity measure, Traded volume/Outstanding, is the amount traded as reported in FINRA's TRACE database relative to the bond's outstanding amount. The table also reports statistics for foreign countries' holdings of a bond relative to the bond's outstanding amount for all bonds (H/Outstanding) and then separately for newly-issued bonds only (Newly-issued H/Outstanding).

Table 2: Bond Characteristics across Credit Rating Buckets for 2003 and 2016.

		2003			2016		
	Credit Rating	Yield	Yield spread	Duration	Yield	Yield spread	Duration
1 (highest rating)	AA through AAA	3.56	0.58	5.21	1.95	0.72	6.27
2	A+ through AA-	3.88	0.74	5.83	1.78	0.75	4.63
3	A- through A	4.19	0.90	6.48	2.21	1.13	5.31
4	BBB+	4.60	1.53	5.72	2.53	1.37	5.64
5	BBB through BB	5.21	1.84	6.08	3.71	2.45	5.29
6 (lowest rating)	BB- and below	8.17	5.25	5.28	6.43	5.46	4.32

Notes: For each year of the sample period, all U.S. corporate bonds held by foreign investors are sorted and grouped in six rating categories. For the first and last year of the sample period, 2003 and 2016 respectively, the table reports the median of the yield, yield spread and duration within each of these rating categories. Duration is reported in years; yield and yield spreads are reported in %.

Table 3: **Regression Results: Baseline**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.046***	0.054***		
	(0.003)	(0.003)		
D.Sov × Bond yield	-0.024***	-0.029***		
	(0.003)	(0.003)		
D.CDS (US) × Bond yield	-0.032***	-0.033***		
	(0.001)	(0.002)		
Traded share		0.024***		0.019***
		(0.005)		(0.006)
Bond spread			0.057***	0.067***
			(0.003)	(0.004)
Duration			-0.004***	-0.006***
			(0.001)	(0.001)
D.Sov × Bond spread			-0.026***	-0.031***
			(0.003)	(0.003)
D.Sov × Duration			-0.003*	-0.005***
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.034***	-0.036***
			(0.002)	(0.002)
Observations	310620	257045	310620	257045
R-sq	0.23	0.26	0.23	0.26
Time-Country FE	Yes	Yes	Yes	Yes

Table 4: **Regression Results: Secondary Market**
The table shows the estimated coefficients for equation (1) in the text using only seasoned bonds. The dependent variable is the holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.021***	0.020***		
	(0.003)	(0.003)		
D.Sov × Bond yield	-0.017***	-0.022***		
	(0.003)	(0.003)		
D.CDS (US) × Bond yield	-0.029***	-0.030***		
	(0.002)	(0.002)		
Traded share		0.017***		0.019***
		(0.005)		(0.006)
Bond spread			0.021***	0.018***
			(0.003)	(0.004)
Duration			0.009***	0.011***
			(0.001)	(0.001)
D.Sov × Bond spread			-0.018***	-0.024***
			(0.003)	(0.003)
D.Sov × Duration			-0.001	-0.003
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.031***	-0.031***
			(0.002)	(0.002)
Observations	257571	203996	257571	203996
R-sq	0.03	0.03	0.03	0.03
Time-Country FE	Yes	Yes	Yes	Yes

Table 5: **Regression results: Primary Market**
The table shows the estimated coefficients for equation (1) in the text using only newly issued bonds. The dependent variable is the holdings by country j of newly issued bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield	Spread and duration
	(1)	(2)
Bond yield	0.187***	
	(0.009)	
D.Sov × Bond yield	-0.034***	
	(0.008)	
D.CDS (US) × Bond yield	-0.049***	
	(0.005)	
Bond spread		0.213***
		(0.009)
Duration		-0.082***
		(0.006)
D.Sov × Bond spread		-0.042***
		(0.008)
D.Sov × Duration		0.012*
		(0.006)
D.CDS (US) × Bond spread		-0.049***
		(0.005)
Observations	53044	53044
R-sq	0.23	0.24
Time-Country FE	Yes	Yes

Table 6: **Regression Results: Bond Types**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. For each regression the sample is split into investment grade bonds (IG), non-investment grade bonds (Non-IG), bonds rated BBB+, BBB, and BBB- (BBB), non-financial sector bonds rated BBB+, BBB, and BBB- (BBB Non-Fin), bonds issued by the non-financial sector (Non-Fin), and bonds issued by the financial sector (Fin). Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	IG	Non-IG	BBB	BBB Non-Fin.	Non-Fin.	Fin.
	(1)	(2)	(3)	(4)	(5)	(6)
Bond spread	-0.051***	-0.032***	-0.038***	-0.045***	0.067***	0.072***
	(0.008)	(0.008)	(0.012)	(0.016)	(0.004)	(0.010)
Duration	0.006***	0.008	-0.001	-0.006**	-0.007***	-0.007**
	(0.002)	(0.007)	(0.003)	(0.003)	(0.002)	(0.003)
D.Sov × Bond spread	-0.048***	-0.005	-0.044***	-0.058***	-0.027***	-0.034***
	(0.005)	(0.006)	(0.008)	(0.010)	(0.003)	(0.006)
D.Sov × Duration	-0.004***	-0.004	-0.006**	-0.005	-0.001	-0.012***
	(0.002)	(0.007)	(0.003)	(0.003)	(0.002)	(0.003)
D.CDS (US) × Bond spread	-0.019***	-0.022***	-0.033***	-0.040***	-0.031***	-0.050***
	(0.004)	(0.004)	(0.006)	(0.009)	(0.002)	(0.004)
Traded share	0.022***	0.056***	0.019**	0.023***	0.021***	0.008
	(0.005)	(0.019)	(0.008)	(0.008)	(0.006)	(0.013)
Observations	185078	71076	81526	67092	185753	70401
R-sq	0.23	0.35	0.23	0.23	0.27	0.27
Time-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 7: **Regression Results: Time Periods**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. The sample period is split into three sub-periods. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	2003-2007		2008-2012		2013-2016	
	(1)	(2)	(3)	(4)	(5)	(6)
Bond spread	0.095***	0.109***	0.102***	0.116***	-0.022***	-0.023***
	(0.013)	(0.015)	(0.005)	(0.005)	(0.005)	(0.006)
Duration	-0.013***	-0.008	-0.002	-0.002	0.017***	0.018***
	(0.005)	(0.005)	(0.002)	(0.003)	(0.002)	(0.002)
D.Sov × Bond spread	-0.133***	-0.167***	0.004	0.003	-0.145***	-0.173***
	(0.018)	(0.022)	(0.003)	(0.003)	(0.013)	(0.016)
D.Sov × Duration	-0.019***	-0.037***	-0.001	-0.002	0.070***	0.078***
	(0.006)	(0.006)	(0.002)	(0.002)	(0.005)	(0.006)
D.CDS (US) × Bond spread	-0.100***	-0.115***	-0.026***	-0.026***	-0.066***	-0.075***
	(0.025)	(0.031)	(0.002)	(0.002)	(0.004)	(0.005)
Traded share		-0.018		-0.004		0.034***
		(0.015)		(0.010)		(0.007)
Observations	56034	43455	118358	97452	136228	116138
R-sq	0.15	0.18	0.21	0.23	0.32	0.34
Time-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 8: **Regression Results: Impact of the Level of the Home Interest Rate (I)**
The table shows the estimated coefficients for equation (1) in the text but here we split the sample into two: countries in a low rate environment and countries in a high rate environment. A low rate environment is when the home sovereign rate falls below 0.6% which gives us an equal size for the two subsamples. Each year countries are classified in these two categories based on their sovereign rate. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield			Spread and duration		
	(1)	(2)	(3)	(4)	(5)	(6)
	Full Sample	Low	High	Full Sample	Low	High
Bond yield	0.054***	-0.015***	0.117***			
	(0.003)	(0.005)	(0.005)			
D.Sov × Bond yield	-0.029***	-0.059***	-0.024***			
	(0.003)	(0.007)	(0.003)			
D.CDS (US) × Bond yield	-0.033***	-0.028***	-0.042***			
	(0.002)	(0.003)	(0.002)			
Traded share	0.024***	0.018***	0.015*	0.019***	0.022***	0.004
	(0.005)	(0.006)	(0.009)	(0.006)	(0.006)	(0.009)
Bond spread				0.067***	-0.026***	0.143***
				(0.004)	(0.006)	(0.005)
Duration				-0.006***	0.015***	-0.025***
				(0.001)	(0.002)	(0.002)
D.Sov × Bond spread				-0.031***	-0.073***	-0.024***
				(0.003)	(0.008)	(0.003)
D.Sov × Duration				-0.005***	0.018***	-0.006***
				(0.002)	(0.004)	(0.002)
D.CDS (US) × Bond spread				-0.036***	-0.032***	-0.046***
				(0.002)	(0.003)	(0.002)
Observations	257045	128190	128855	257045	128190	128855
R-sq	0.26	0.32	0.23	0.26	0.33	0.23
Time-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 9: **Regression Results: Impact of the Level of the Home Interest Rate (II)**
The table shows the estimated coefficients for equation (1) in the text but here we split the sample into two: countries in a low rate environment and countries in a high rate environment. A low rate environment is when the home sovereign rate falls below either the sample median (columns (1)-(2)), the 25th percentile (columns (3)-(4)), or the 10th percentile (columns (5)-(6)). Each year countries are classified in these two categories based on their sovereign rate. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Median		25th percentile		10th percentile	
	(1)	(2)	(3)	(4)	(5)	(6)
	Low	High	Low	High	Low	High
Bond spread	0.061***	0.002	-0.023***	0.154***	-0.061***	0.102***
	(0.004)	(0.013)	(0.005)	(0.006)	(0.008)	(0.004)
Duration	0.005***	-0.041***	0.015***	-0.029***	0.012***	-0.009***
	(0.002)	(0.004)	(0.002)	(0.003)	(0.003)	(0.002)
D.Sov × Bond spread	-0.037***	-0.007	-0.083***	-0.017***	-0.135***	-0.023***
	(0.004)	(0.005)	(0.006)	(0.003)	(0.017)	(0.003)
D.Sov × Duration	0.008***	-0.017***	0.016***	-0.006***	0.031***	-0.006***
	(0.002)	(0.004)	(0.003)	(0.002)	(0.006)	(0.002)
D.CDS (US) × Bond spread	-0.043***	-0.005	-0.044***	-0.048***	-0.037***	-0.036***
	(0.002)	(0.005)	(0.003)	(0.003)	(0.007)	(0.002)
Traded share	0.026***	-0.019	0.029***	-0.010	0.033***	0.009
	(0.006)	(0.015)	(0.006)	(0.010)	(0.008)	(0.007)
Observations	212290	44755	147948	109097	68747	188298
R-sq	0.29	0.16	0.32	0.21	0.34	0.25
Time-Country FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 10: **Regression Results: Alternative Explanations**
The table shows the estimated coefficients for equation (1) in the text where for this robustness check we also include interation terms of our risk variables (yield, spread, and duration) with the CDS of the country' banking system and the expected earnings growth in its corporate sector. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bank CDS		Exp. earnings growth	
	(1)	(2)	(3)	(4)
Bond yield	0.016***		0.025***	
	(0.004)		(0.004)	
D.Sov × Bond yield	-0.016***		-0.019***	
	(0.003)		(0.003)	
CDS_bank × Bond yield	-0.004***			
	(0.001)			
D.CDS (US) × Bond yield	-0.016***		-0.018***	
	(0.002)		(0.002)	
Traded share	0.015**	0.014**	0.017***	0.017***
	(0.006)	(0.006)	(0.006)	(0.006)
Bond spread		0.012***		0.020***
		(0.004)		(0.004)
Duration		0.012***		0.018***
		(0.002)		(0.002)
D.Sov × Bond spread		-0.016***		-0.017***
		(0.003)		(0.003)
D.Sov × Duration		-0.004**		-0.007***
		(0.002)		(0.002)
CDS_bank × Bond spread		0.002		
		(0.002)		
CDS_bank × Duration		-0.010***		
		(0.001)		
D.CDS (US) × Bond spread		-0.015***		-0.015***
		(0.002)		(0.002)
ExpEarnGr × Bond yield			-0.077***	
			(0.011)	
ExpEarnGr × Bond spread				-0.035***
				(0.011)
ExpEarnGr × Duration				-0.089***
				(0.006)
Observations	208186	208186	217863	217863
R-sq	0.22	0.22	0.22	0.22
Time-Country FE	Yes	Yes	Yes	Yes

Table 11: **Regression Results: 5-Year Sovereign Yields**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 5-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.047***	0.054***		
	(0.003)	(0.003)		
D.Sov5y × Bond yield	-0.021***	-0.028***		
	(0.004)	(0.004)		
D.CDS (US) × Bond yield	-0.028***	-0.028***		
	(0.001)	(0.002)		
Traded share		0.023***		0.017***
		(0.005)		(0.006)
Bond spread			0.057***	0.067***
			(0.003)	(0.004)
Duration			-0.005***	-0.007***
			(0.001)	(0.002)
D.Sov5y × Bond spread			-0.022***	-0.030***
			(0.004)	(0.004)
D.Sov5y × Duration			-0.004**	-0.006***
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.030***	-0.031***
			(0.002)	(0.002)
Observations	310620	257045	310620	257045
R-sq	0.23	0.26	0.23	0.26
Time-Country FE	Yes	Yes	Yes	Yes

Table 12: **Regression Results: Alternative Sovereign Rate for BEL, LUX, and IRL**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the weighted average of the sovereign rate of the CPIS-reported top European investors in each of these three countries. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.046***	0.053***		
	(0.003)	(0.003)		
D.Sov1y × Bond yield	-0.023***	-0.029***		
	(0.003)	(0.003)		
D.CDS (US) × Bond yield	-0.033***	-0.034***		
	(0.001)	(0.002)		
Traded share		0.022***		0.016***
		(0.006)		(0.006)
Bond spread			0.058***	0.069***
			(0.003)	(0.004)
Duration			-0.008***	-0.010***
			(0.001)	(0.002)
D.Sov1y × Bond spread			-0.023***	-0.028***
			(0.003)	(0.003)
D.Sov1y × Duration			-0.007***	-0.009***
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.034***	-0.036***
			(0.002)	(0.002)
Observations	302095	249732	302095	249732
R-sq	0.23	0.26	0.24	0.26
Time-Country FE	Yes	Yes	Yes	Yes

Table 13: **Regression Results: Excluding BEL, LUX, and IRL**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample excludes Belgium, Ireland, and Luxembourg. Countries' sovereign rates are the year-end 1-year sovereign yields. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.034***	0.036***		
	(0.003)	(0.003)		
D.Sov × Bond yield	-0.007***	-0.012***		
	(0.003)	(0.003)		
D.CDS (US) × Bond yield	-0.011***	-0.014***		
	(0.002)	(0.002)		
Traded share		-0.002		0.001
		(0.006)		(0.006)
Bond spread			0.031***	0.031***
			(0.003)	(0.004)
Duration			0.016***	0.018***
			(0.001)	(0.001)
D.Sov × Bond spread			-0.006**	-0.011***
			(0.003)	(0.003)
D.Sov × Duration			-0.001	-0.004**
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.009***	-0.011***
			(0.002)	(0.002)
Observations	205630	170076	205630	170076
R-sq	0.18	0.20	0.18	0.20
Time-Country FE	Yes	Yes	Yes	Yes

A Appendix: Treasury International Capital: Annual Survey Data on Foreign Holdings of U.S. securities

The TIC data are collected and released under the authority of the Treasury Department; the operational responsibility for the data lies with the Federal Reserve System.

Data on cross-border holdings of U.S. securities are collected and reported under the Treasury International Capital (TIC) reporting system. The TIC reporting system collects and reports cross-border holdings of foreign securities as well monthly data on cross-border securities transactions. The TIC data are the primary data source for the portfolio components of the balance of payments financial account and for the portfolio positions of the U.S. international investment position reported by the Bureau of Economic Analysis (BEA) as well as for interest payments and receipts reported by the BEA in the portfolio component of net investment income. The TIC data are also used for the construction of the Rest of the World sector in the Financial Accounts of the United States and for the U.S. contribution to IMFs annual Coordinated Portfolio Investment Survey (CPIS).

The TIC data cover only cross-border transactions on a resident basis: i.e., the data capture only financial transactions that involve both a U.S. resident and a foreign resident. Any corporation or organization located in the United States, including subsidiaries, branches and affiliates of foreign entities located in the United States are considered U.S. residents.

The annual cross-border securities holdings data are based on surveys collected primarily from large custodial banks. The data are collected from each reporter at the individual security level with CUSIP or ISIN code. Therefore the data contain details on currency, maturity structure, coupon, and other security characteristics. These underlying security-level data are confidential; aggregated data are released in an annual report published on the Treasury Department website. The Federal Reserve System conducts substantial data checking and cleaning. While the surveys are comprehensive, they can suffer from custodial bias, meaning they show large reported holdings of U.S. securities in custodial centers. The

data do not capture U.S. resident holdings of U.S. securities or foreign resident holdings of foreign securities. This is because the TIC data collection system was designed to capture U.S. financial transactions for balance of payments purposes.

The TIC data cover portfolio investments and exclude direct investment transactions and positions. The data do include holdings and transactions in both equities and debt.[1]

For more information, see:

- The main Treasury Department TIC website: https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/index.aspx
- Annual reports and aggregated data on foreign holdings of U.S. securities: https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/fpis.aspx
- Frequently Asked Questions regarding the TIC system and TIC data: https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/ticfaq2.aspx

B Appendix: Robustness Tables

[1] For more information on the TIC data reporting and collection process, see Bertaut, Griever, and Tryon (2006).

Table B.1: **Regression Results: Including Rating Fixed Effects**
The table shows the estimated coefficients for equation (1) in the text. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include rating fixed effects in addition to the country*time fixed effects; we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	-0.016***	-0.014***		
	(0.004)	(0.004)		
D.Sov × Bond yield	-0.031***	-0.036***		
	(0.003)	(0.003)		
D.CDS (US) × Bond yield	-0.033***	-0.034***		
	(0.001)	(0.002)		
Traded share		0.017***		0.019***
		(0.006)		(0.006)
Bond spread			-0.022***	-0.017**
			(0.006)	(0.007)
Duration			0.005***	0.004**
			(0.001)	(0.002)
D.Sov × Bond spread			-0.033***	-0.038***
			(0.003)	(0.003)
D.Sov × Duration			-0.001	-0.004**
			(0.002)	(0.002)
D.CDS (US) × Bond spread			-0.033***	-0.034***
			(0.002)	(0.002)
Observations	308573	256154	308573	256154
R-sq	0.24	0.27	0.24	0.27
Time-Country FE	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes

Table B.2: **Regression Results: Weighted Baseline**
The table shows the estimated coefficients for equation (1) in the text using weighted least squares where we use as weights the bonds' outstanding amounts. The dependent variable is the change in holdings by country j of bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects and we allow the country fixed effects to differ for newly-issued and seasoned bonds. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Heteroscedasticity-consistent standard errors are reported in parentheses.

	Bond yield		Spread and duration	
	(1)	(2)	(3)	(4)
Bond yield	0.042***	0.047***		
	(0.002)	(0.003)		
D.Sov × Bond yield	-0.020***	-0.024***		
	(0.002)	(0.003)		
D.CDS (US) × Bond yield	-0.025***	-0.026***		
	(0.001)	(0.001)		
Traded share		0.044***		0.042***
		(0.004)		(0.004)
Bond spread			0.056***	0.064***
			(0.003)	(0.003)
Duration			-0.004***	-0.006***
			(0.001)	(0.001)
D.Sov × Bond spread			-0.022***	-0.026***
			(0.002)	(0.003)
D.Sov × Duration			-0.002	-0.003**
			(0.001)	(0.002)
D.CDS (US) × Bond spread			-0.029***	-0.030***
			(0.001)	(0.002)
Observations	310620	257045	310620	257045
R-sq	0.25	0.28	0.25	0.28
Time-Country FE	Yes	Yes	Yes	Yes

Table B.3: **Regression results: Primary Market Robustness to Error Cluster**
The table shows the estimated coefficients for equation (1) in the text using only newly issued bonds. The dependent variable is the holdings by country j of newly issued bond i at time t scaled by the outstanding amount of the bond i at time t. Sample period: 2003-2016. The sample includes all 36 countries. Countries' sovereign rates are the year-end 1-year sovereign yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. All regressions include country*time fixed effects. For brevity the coefficients for fixed effects and the constant are not reported. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$. Standard errors, reported in parentheses, are clustered on the parent of the issuer.

	Bond yield	Spread and duration
	(1)	(2)
Bond yield	0.188***	
	(0.019)	
D.Sov × Bond yield	-0.044***	
	(0.011)	
D.CDS (US) × Bond yield	-0.065***	
	(0.007)	
Bond spread		0.242***
		(0.020)
Duration		-0.077***
		(0.009)
D.Sov × Bond spread		-0.056***
		(0.011)
D.Sov × Duration		0.012
		(0.007)
D.CDS (US) × Bond spread		-0.066***
		(0.007)
Observations	40643	40643
R-sq	0.22	0.23
Time-Country FE	Yes	Yes