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Home country interest rates and international investment in U.S. bonds ☆

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ABSTRACT

We analyze how interest rates affect cross-border portfolio investments. Data on U.S. bond holdings by foreign investors from 31 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 shifts in investment behavior in response to interest rates. We find that low(er) interest rates, now prevailing in many advanced countries, lead to greater investment in general into the United States, with the effects generally driven by investment in (higher yielding) corporate bonds, rather than in Treasury bonds. In addition to affecting overall investments, lower interest rates at home are associated with a greater weight on corporate bonds, consistent with search-for-yield. The results are economically important and robust to controlling for a number of country-specific macroeconomic and financial conditions as well as to sample restrictions and choices of interest rate. Our findings have important policy implications in that they suggest that low interest rates can lead to shifts in the volume and composition of overseas investments.

1. Introduction

Using data on foreign private investment in U.S. bonds from 31 countries for the period 2003–2016, the paper studies how portfolio investment is affected by investors' home country macroeconomic and financial conditions. In particular, we explore how home investment opportunities, proxied by the home country sovereign yield, affect bond investment into the United States in general, as well as the composition of this investment in terms of riskier (corporate bonds) and safer (Treasuries) securities. We find that, in response to a lower interest rate at home, foreign investors increase their aggregate bond investment in the United States, and they also increase risk-taking in their U.S. portfolios through an increased weight on corporate bonds, consistent with search-for-yield.

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Our work relates to two strands of the literature: that on the push and pull drivers of capital flows; and that on the role of country characteristics in international portfolio allocation and the related, but more recent work on portfolio risk-taking in a low interest rate environment. In this paper we expand on these literatures in several ways. First, we use data on foreign countries' holdings of U.S. bonds that distinguish between private and official investors' portfolios. This allows us to focus on portfolio shifts by private investors in response to domestic macroeconomic and financial conditions. The distinction is useful because the motivations of official investors (e.g., central bank reserve managers) for holding U.S. securities likely differ from those of private investors. Second, our empirical identification is strengthened because we are able to combine long time series of portfolio holdings with a cross-section of several dozen investor countries that exhibit significant heterogeneity in the dynamics of their home interest rates and other financial and macroeconomic conditions. Thus, these data allow us to study how investor-country conditions interact with their investment choices. Related, we contribute to the limited empirical work on the effects of interest rates on the composition of investors' debt securities portfolios (Domanski et al., 2017; Choi and Kronlund, 2018; di Maggio and Kacperczyk, 2017; Ammer et al., 2018).[1] The paper complements Ammer et al. (2018), who using security-level data, find evidence of search-for-yield behavior within foreign investors' portfolio of U.S. corporate bonds in that when investing in U.S. corporate bonds, investors facing declining home investment opportunities prefer higher yielding (but riskier) securities. Here, we show that both aggregate flows and the allocation between corporate bonds and safer Treasuries are also affected by home country interest rates.

We explore these advantages in the data by comparing the drivers of investment in the two largest classes of U.S. debt securities: corporate and Treasury bonds. This allows us to investigate both flight-for-safety and search-for-yield. The data on portfolio investment in U.S. bonds is derived from the detailed data underlying the Treasury International Capital (TIC) annual surveys. While much of our focus is on home country investment opportunities, proxied mainly by the home country sovereign yield, we also analyze the role of other country macroeconomic and financial conditions. We also control for certain "gravity" type characteristics for investment, such as countries' trade and financial links with the United States.

We find that the lower the interest rate in the investor's home country, the more investors increase their investments in the United States as a ratio to their home GDP, with the effects generally coming through investment in U.S. corporate sector bonds, rather than in Treasury bonds. These regression results are consistent with international capital flows responding to relative investment opportunities, as well as shifts in portfolio composition reflecting search-for-yield motives. Importantly, regression results using hedged and unhedged sovereign rates show that the incentives to invest in both the more risky U.S. corporate bonds and in Treasuries depend on the (nominal) home, not on the equivalent hedged dollar interest rate. This finding suggests that investors' incentives lead them to place more weight on the unhedged local rate as a measure against which to compare the gross return on a U.S. dollar debt investment. Put differently, investors do not appear to take hedging costs into account. Rather, they appear to compare nominal promised rates of return among investment choices. The effects are economically important. We estimate that when a country's home interest rate is 100 basis-points lower, its investment in U.S. corporate bonds rises by 3.6–5.3% of GDP. The effects for investment in Treasuries are much smaller and only evident in the post-crises period: an equivalent drop in the home interest rate is associated with a rise in investment of 0.2% of GDP.

Analyzing further the portfolio allocation within a country's U.S. bond portfolio, specifically the share of corporate bonds, we find further evidence suggestive of search-for-yield in terms of foreign investors taking on relatively more credit risk. More specifically, a lower home interest rate generally increases portfolio weights for corporate bonds within countries' portfolio of U.S. bonds, although we find less evidence of this during periods of financial crises, when investors shift more toward Treasuries. The results are robust to different choices for the domestic interest rate with which we proxy home investment opportunities as well as to country sample choices. Results are also robust to other controls related to the dollar exchange rate and home investment opportunities.

Overall, our findings suggest that foreign investors' U.S. bond portfolios gravitate toward corporate securities, as opposed to the safe Treasury bonds, when their home interest rates reach low levels. Although, apart from investment in U.S. assets, we do not know how private investors in these countries allocate their overseas investments, our finding that a lower interest rate at home increases U.S. portfolio debt investment disproportionately in corporate bonds, suggests that countries' external investments may rebalance toward riskier assets when their domestic interest rates are low.

The paper proceeds as follows. In Section 2, we review the related literature. In Section 3, we provide an overview of the securities holdings dataset and other data sources we use. Section 4 presents some stylized facts and summary statistics. In Section 5 we outline our empirical methodology and in Section 6 we present the empirical results on how countries' U.S. bond portfolios vary in response to changes in home interest rates and other country conditions and characteristics. Section 7 includes robustness tests. Section 8 concludes and discusses possible policy implications.

2. Related literature

Our work adds to two main strands in the literature on capital flows. The first is the literature on push and pull factors, which has explored the role of source and destination country conditions for capital flows (among others Forbes and Warnock (2012), Fratzscher (2012), and Broner et al. (2013)). Among the push factors, an important one has been (low)

[1] Most of the empirical literature on risk-taking related to interest rates have focused on the effects on either bank lending and bank loan portfolios or mutual fund flows to broad asset categories.

interest rates, especially their effect on capital inflows to emerging markets, and more recently the effects of the use of unconventional monetary policy by several advanced countries.[2] Other papers have analyzed how banks globally reallocate loans in response to changes in interest rates (e.g., Aramonte et al., 2015; Morais et al., 2015). Much of this literature, however, has largely relied on aggregate balance-of-payments data to assess international portfolio composition and capital flows.[3] Research using more granular data on investment choices typically has been limited to a narrower set of investors for which data are available. And rarely have studies covered a broad cross-section of investor countries.

In addition, our paper is related to the growing literature on search-for-yield. A number of papers have pointed out that there could be a search-for-yield effect for institutions with long-term liabilities and shorter-term assets, such as life insurance companies and pension funds.[4] Incentives to reach for yield among asset managers could be greater at low levels of the interest rate (Rajan, 2010; Stein, 2013).

The empirical literature on the effect of low interest rates on investors' portfolio holdings is scarce (Choi and Kronlund (2018) focus on corporate bond mutual funds, di Maggio and Kacperczyk (2017) on U.S. money market funds, Domanski et al. (2017) on German insurance companies; Ammer et al. (2018) on private investors' holdings of U.S. corporate bonds).[5] Our paper is also related to Ammer et al. (2018) which focuses on the risk distribution specifically of the portfolio of U.S. corporate bonds held by foreign investors to study reach-for-yield behavior within this asset class. The authors use security level TIC data for U.S. corporate bond holdings by foreign investors, which are the underlying data for the countries' aggregate holdings of U.S. corporate bonds that we use in the current paper. They find that declines in safe interest rates push international investors toward lower-rated and longer-dated securities within their portfolios of U.S. corporate bonds to increase yield, which is consistent with a search-for-yield behavior.

The paper also relates to the literature on the international (bilateral) allocation of securities, using aggregate data, typically the IMF Coordinated Portfolio Investment Survey (CPIS) but more recently also the newly available data on euro-area security-level holdings (Portes and Rey, 2005; Boermans and Vermeulen, 2016). But these papers do not investigate the role of time-varying country conditions, including (low) interest rates.

3. Data

We use the annual U.S. Treasury International Capital (TIC) surveys of foreign holdings of U.S. securities for the period 2003–2016. Data are (confidentially) reported at the security level for each country holder of that security as of end-June of each year, and for the analysis in this paper we aggregate the holdings to the country and bond type level.[6] This means that for each year in the period 2003–2016 we observe the total holdings per country of each bond type. We focus on the two main classes of U.S. bonds: Treasuries and corporate bonds. Importantly for our analysis, the detailed nature of the data allow us to distinguish between private and official investors' holdings of U.S. bonds. The paper studies the holdings of foreign private investors only, because the motivations of official investors (e.g., central bank reserve managers) for holding U.S. securities may differ from those of private investors. This distinction between private and official investors' portfolios of U.S. bonds is particularly important when we analyze foreign holdings of Treasury bonds since those constitute a large share of foreign official reserves and could thus be driven by different motives. The other advantage of the TIC surveys is that the data include both the face and market value of holdings. In order to isolate the effect of active new investments and portfolio shifts, we use in our analysis the face value of holdings, thus abstracting from the effect of price changes.[7]

For the TIC surveys the main reporters are U.S.-resident custodians which must report all U.S. securities they hold on behalf of foreign residents and reporting is mandatory. Due to the mandatory reporting of holdings by custodians, the data are comprehensive, capturing countries' entire portfolios of U.S. securities at the country level. Country-level holdings data are published on the Treasury Department's website, although without the split between holdings by private investors and holdings by official institutions. Because the TIC data are reported on a resident basis rather than on the basis of the ultimate owner, this creates some data challenges because intermediaries in major custodian countries and financial centers hold securities on behalf of investors from other countries.[8]

Another key component of the data we deploy is investors' home interest rates. We use data on foreign countries' local currency sovereign yields at 1-year and 5-year maturities. The underlying data are from Bloomberg, and the annual rates are calculated as average yields for the month of June of each year so the data are aligned with the holdings data that are reported as of end-June of each year. Since the sovereign interest rate is our key variable for evaluating country-level incentives for risk-taking, the sample excludes bonds held by investors in Caribbean and other financial centers for which we do

[2] See, e.g., Chari et al. (2017), Fratzscher et al. (2016, 2018), Ahmed and Zlate (2014), Bowman et al. (2015).

[3] See also Cerutti et al. (2017) and Rey (2013). Using loan level data, Baskaya et al. (2018) link improving external financial conditions to capital inflows, increased local bank credit, and lower loan rates.

[4] Rajan (2005), Dell'Ariccia and Marquez (2013), Domanski et al. (2017).

[5] To assess a search-for-yield behavior, Hau and Lai (2016) focus on equity and money market fund flows. Neely (2015) and Koijen et al. (2017) analyze the portfolio rebalancing channel of the Federal Reserve's quantitative easing and of the ECB asset purchase program, respectively.

[6] Ammer et al. (2018) use the security-level TIC survey data to study investors' choices specifically within their corporate bond portfolios.

[7] Estimates of monthly positions can be constructed (see Bertaut and Judson, 2014), and have been used recently by Chari et al. (2017) to study the effect of U.S. monetary policy on emerging market asset returns and capital inflows. We use the annual data to study adjustments to (low) interest rates over longer periods, and because the annual survey data are more precise.

[8] See Bertaut et al. (2006) for more details about the TIC data and data collection process.

not observe sovereign interest rates. In robustness checks we also include the U.S. dollar equivalent of the home sovereign rate, which we construct using Bloomberg data on 12-month forward premiums for the U.S. dollar against the investor countries' home currencies and calculate the synthetic dollar yields foreign investors would obtain if they hedged their home-currency 1-year sovereign bonds into the U.S. dollar.

For the other investor-country characteristics we draw on a variety of data sources. We use data from the IMF's Direction of Trade Statistics (DOTS) for imports and exports between the investor country and the United States based on the notion that the intensity of trade is a good proxy for economic and other ties as well as the degree of information asymmetry between the investor country and the United States (Portes and Rey, 2005; Aviat and Coeurdacier, 2007; Okawa and van Wincoop, 2012). To take into account countries' financial linkages to the United States we include in our specifications the share of U.S. dollar bank claims and liabilities for each foreign country relative to total bank claims and liabilities, drawing on a different component of the TIC data. Countries' exchange rates versus the U.S. dollar may influence their cross-border investments, in part through carry-trade related motivations and deviations from (un-)covered interest rate parity. To address this, we collect exchange rate data from the IMF's International Financial Statistics and include in the regressions the volatility as well as the change in the real bilateral exchange rate.

In our specifications we also control for countries' riskiness using their sovereign CDS spread.[9] We use the expected earnings growth of countries' corporate sector as a proxy for the attractiveness of domestic investment opportunities; the data are from IBES. Finally, we obtain GDP data from the World Bank WDI database; in some of the specifications we use home-country GDP to scale foreign countries' bond investments in the United States.

4. Stylized facts

4.1. Sovereign yields

Our analysis relies on the variation in sovereign yields over time and across countries. Fig. 1 captures the range of home country rates in our data panel, showing the median, maximum and minimum for each country. For example, rates in Japan have been low for most of the 2003–2016 period, while rates in many European countries have varied considerably, falling only more recently to low levels in most cases. Rates have not been as low in the majority of emerging markets. In addition, Fig. 2 shows the evolution of 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 approached zero toward the end of the period. This heterogeneity in the panel helps us considerably for identifying the effects of low rates on risk-taking.

4.2. Foreign holdings of U.S. bonds

Fig. 3 shows how foreign holdings of U.S. bonds have evolved over the period 2003–2016.[10] After a sharp increase in the years leading up to the GFC, foreign holdings of U.S. corporate debt declined during the GFC and the subsequent euro sovereign debt crisis, reflecting the "flight home" and search-for-safety during that period that is documented in the literature.[11] However, as interest rates in many foreign countries declined after 2012, inflows into corporate bonds rebounded, leading to a sharp increase in holdings especially towards the end of the sample period suggesting that investors from these countries were compensating for declining returns on safe assets at home by purchasing U.S. corporate debt. In terms of the U.S. safe asset, holdings of Treasuries were stable pre-GFC, but declined during the GFC, which is consistent with the "flight home" documented in the literature. After the GFC, foreign flows into Treasuries resumed. While during the European debt crisis the pick-up of foreign flows into Treasuries combined with a decline in flows into corporate bonds is consistent with a general sense of risk-aversion in turbulent times, towards the latter part of the sample period when interest rate in many advanced countries have been low for some time, the increase in corporate bond holdings surpasses that of Treasury holdings. Fig. 4 shows the composition of the foreign portfolio of U.S. bonds. The corporate share increased approximately 10 percentage points over the period and stood at roughly 60% for the last two years of the sample period.[12]

4.3. U.S. bonds in foreign portfolios

Because of the data availability, the paper focuses on just one part of foreign countries' portfolios: their holdings of U.S. bonds. Using data from the IMF's Coordinated Portfolio Investment Survey (CPIS), columns (1)–(2) in Table 1 give an

[9] In a robustness check we also used the CDS spread for the country's banking system to control for overall riskiness. Since the sample size declines due to availability of bank CDS data and our main results are unchanged, we do not report these results.

[10] The figure plots the face value of holdings as reported in the TIC surveys, thus abstracting from the effect of price changes. Therefore, the change in holdings from one year to the next can be interpreted as investment inflows (or outflows).

[11] See, for example, Giannetti and Laeven (2012) and De Haas and Van Horen (2012). As also noted by Becker and Ivashina (2015), incentives to reach for yield were likely lower during the GFC 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 reaching for yield less attractive.

[12] In Appendix we show that the share of corporate holdings that include corporate asset backed securities (ABS) follows a similar pattern.

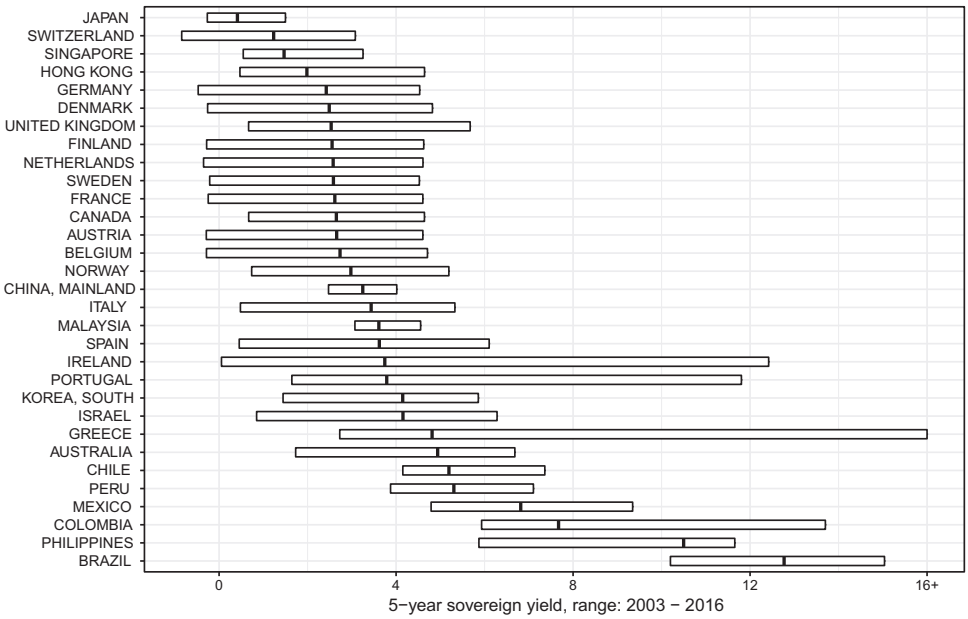

Fig. 1. Sovereign yields by country (2003–2016). The figure plots the 5-year sovereign yield for the countries in our sample. For each country we plot the median (dot) and the min and the max (boundaries of the box) of the sovereign yield for the period 2003–2016. Last value on x-axis refers to values of 16+ for the sovereign yield. Chart includes the countries in the baseline sample. Authors' calculations using data from Bloomberg.

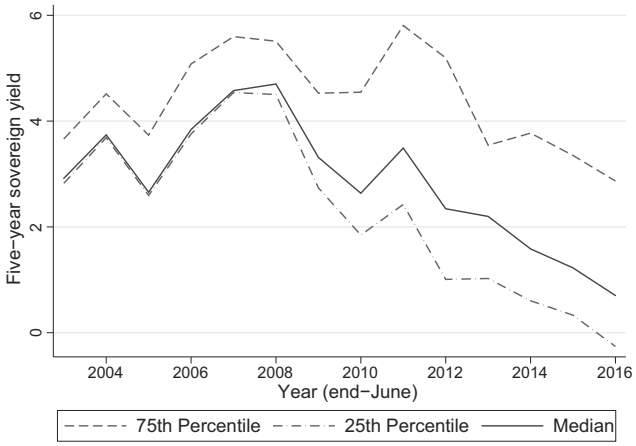

Fig. 2. Sovereign yields over time (2003–2016). The figure plots the interquartile range of the 5-year sovereign yield (in%) for the countries in the baseline sample. Authors' calculations using data from Bloomberg.

overview of how important U.S. bonds are in foreign countries' aggregate bond portfolios.[13] U.S. bonds constitute a significant share of countries' holdings of foreign bonds: as of end-2015, on average for the sample, that share is just under 30%. Because of home bias that is well-documented in the international finance literature, this share is much smaller in the countries' overall portfolios that include domestic bond holdings: bond investment into the United States constitutes just under 7% of total bond portfolios on average for the sample. Also in terms of individual countries, Table 1 shows that for many countries, investment in the United States is a large part of their overall portfolios, and in particular of their international investments. For example, for Mexico and Canada, the CPIS data show that the shares of overseas investment allocated to the United States are some 94% and 68%, respectively. As such, foreign investment in the United States constitutes a relatively large share of these countries' international investments and could thus be representative of their international behavior.

[13] The holdings data in Table 1 include holdings of all types of U.S. bonds. The majority of countries reporting to the CPIS do not distinguish holdings of corporate and sovereign bonds.

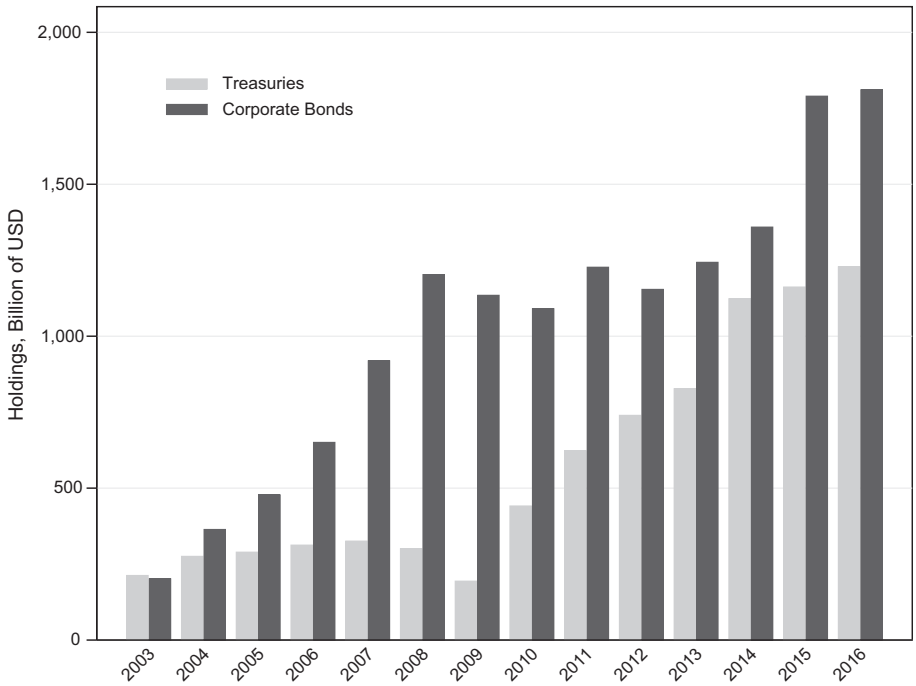

Fig. 3. Foreign holdings of U.S. bonds (2003–2016). The figure plots annual holdings of U.S. corporate bonds (black bars) and U.S. Treasury bonds (gray bars) by foreign private investors. We include all countries in the baseline sample. Corporate bonds exclude corporate ABS. The figure plots the face value of holdings as reported in the TIC surveys. Authors' calculations using data from the Treasury International Capital annual surveys.

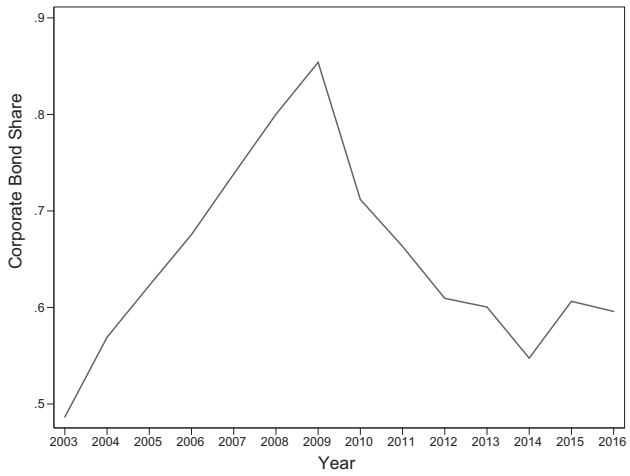

Fig. 4. Corporate share in foreign holdings of U.S. bonds (2003–2016). The figure plots the corporate bond share of foreign private investors' holdings of Treasuries and U.S. corporate bonds. We include all countries in the baseline sample. Corporate bonds exclude corporate ABS. Authors' calculations using data from the Treasury International Capital annual surveys.

While the United States can be a large part of overseas investment for many countries, from the perspective of the United States, the fraction of U.S. bonds held by foreign investors tends to be small. The average country from our sample holds just 0.7% of the outstanding U.S. bonds.[14,15] The last column in Table 1 shows countries' holdings of U.S. bonds as a share of their GDP. Major custodians and financial centers have oversized holdings relative to their GDP. As discussed in detail in the next

[14] The CPIS data are not always directly comparable to the TIC data since major custodians for U.S. securities serve as the most important sources for the data, while in the CPIS, holdings are measured from the investors' perspective and therefore are less subject to custodial biases, although they could in some cases suffer from other measurement idiosyncrasies.

[15] The columns using TIC data are based on publicly available TIC data that do not distinguish private from official holdings of U.S. securities.

Table 1
U.S. share in foreign countries' bond portfolios (as of end-2015).

	CPIS: U.S. bonds % of:		TIC: U.S. bonds % of:	
	Foreign portfolio	Total portfolio	Out-standing	GDP
Australia	38.8	5.3	0.15	4.0
Austria	8.3	4.3	0.02	2.4
Belgium	6.2	3.2	1.50	107
Brazil	57.4	0.1	0.65	13.6
Canada	68.3	10.6	0.56	13.6
Chile	44.4	8.0	0.07	9.6
China	49.4	0.6	4.08	13.2
Colombia	61.5	6.1	0.11	13.5
Denmark	16.9	4.3	0.12	14.5
France	10.0	4.2	0.27	4.0
Germany	10.4	5.7	0.49	5.2
Greece	0.7	0.3	0.00	0.8
Ireland	20.7	13.2	1.31	178
Israel	50.5	10.7	0.06	8.7
Italy	10.4	2.1	0.11	2.4
Japan	43.7	7.4	3.89	31.3
Luxembourg	23.5	19.8	1.84	1175
Malaysia	10.8	0.8	0.06	6.7
Mexico	94.2	8.0	0.27	6.5
Netherlands	14.6	7.9	0.29	14.8
Norway	27.2	17.2	0.30	28.7
Peru	34.0	4.2	0.04	9.1
Philippines	29.2	2.1	0.11	14.6
Portugal	3.6	1.2	0.01	2.1
Singapore	33.2	20.2	0.47	56.9
Spain	8.1	1.6	0.10	3.2
Sweden	22.5	4.5	0.12	9.1
Switzerland	23.9	18.2	0.91	50.1
United Kingdom	19.8	6.1	1.55	20.8
Average	29.0	6.8	0.7	62.7
Median	23.5	5.3	0.3	13.2

Authors' calculations based on IMF CPIS, BIS, TIC data. CPIS: total bond holdings by private residents of that country as reported in the CPIS data. TIC: total bond holdings (private and official) as reported in TIC. Outstanding: U.S. bond market capitalization. Table includes countries from baseline sample for which CPIS data are available. Luxembourg is included in the table for illustration.

section, for these countries, instead of their national sovereign yield we use a composite European sovereign yield in the regressions. In addition, in some specifications, we exclude these countries from the sample.

5. Methodology

We consider first the determinants of a country's total private investment in U.S. corporate and Treasury bonds. We use the face values of holdings reported in the TIC surveys, thus abstracting from the effect of price changes, in order to isolate the effect of active new investments and portfolio shifts. To allow for differences in investor-country size, we scale countries' holdings by their GDP. In country-year panel regressions separately for U.S. corporate bonds and for Treasuries we regress these scaled holdings on countries' home interest rates and a number of other variables that reflect their financial and macroeconomic conditions, including sovereign CDS spreads, exchange rate changes, expected earnings growth of these countries' domestic corporate sector. We also include in the specifications countries' ties to the United States as an investment destination: their share in U.S. trade as well as a measure of banking sector ties that is a proxy for the financial link between the investor country and the United States. In all regressions we include country fixed effects, which allows us to focus on time-varying country developments. We also include time fixed effects, which means 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.

Following the general approach in Ammer et al. (2018), we use local currency sovereign bond rates to represent investment opportunities in investors' home markets. Low rates can drive residents to invest more abroad, including in risky securities. Our sample excludes financial centers such as the Caribbean banking centers for two reasons. First, these countries do not have significant sovereign debt outstanding and therefore lack reliable data on sovereign rates, which is one of our main variables. Second, their investments are predominantly held on behalf of non-residents, for whom the interest rate to use is ambiguous, given our focus on the effect of home investment opportunities on private investors' behavior. In our main specifications that include all country variables specified above, Luxembourg, which is an important financial center, drops out as it lacks data for all variables. That said, our baseline regressions do include the bond holdings of Belgium and Ireland, two

European financial centers that largely cater to investors from other European countries. In terms of investors' home interest rate for these countries, a composite European yield is likely to be a better choice than the national sovereign yield.[16] Accordingly, using the approach in Ammer et al. (2018), instead of using their own sovereign rate, we assign these countries the average sovereign rates of four larger euro zone countries: Netherlands, France, Italy, and Spain. One could also use the German rate in the calculation of an average European rate, but one concern with this approach is that it might reflect Germany's safe haven status, rather than investment opportunities in Germany.[17]

The empirical specification of the model we estimate is then:

$$H_{j,t}/GDP_{j,t} = \alpha + \beta SOV5y_{j,t} + \gamma X_{j,t} + c_j + \nu_t + \epsilon_{j,t} \quad (1)$$

where the dependent variable, $H_{j,t}/GDP_{j,t}$, is the share of U.S. bonds held by residents of country j in year t in country j's GDP. We explore separately the holdings (H) of U.S. corporate bonds and the holdings of Treasuries. $SOV5y_{j,t}$ is country j's sovereign yield measured as the year-end 5-year sovereign yield. $X_{j,t}$ are time varying home country controls that may affect investment:

- the share in total trade (exports plus imports) with the United States (Trade share),
- an analogous measure of bank exposure links to the United States (Bank link),
- the home country 5-year sovereign CDS premium (Sov CDS), to control for risk-related fluctuations in home interest rates,
- the standard deviation of the bilateral (versus U.S. dollar) exchange rate (StDev FX),
- the change in the bilateral exchange rate (Delta FX),
- expected corporate earnings growth (ExpEarnGr), to control for domestic investment opportunities.

In a robustness check, we also controlled for domestic financial risks using the average CDS premium of investor countries' banks. Since the results are similar while the sample size declines quite a bit due to the availability of data on CDS premiums for the banking sector, the results we present in the paper do not include the bank CDS premiums as a control variable. In another robustness check we also included the lagged dependent variable as a control variable to account for autocorrelation. In most specifications the coefficient on the lagged dependent variable is as expected positive and significant, but its inclusion does not alter our main results. Because we include country fixed effects, we do not capture cross-country relations arising from other, time-invariant variables such as distance to and common language with the United States that are commonly used in the literature as proxies for transaction costs and familiarity with the foreign market.

To isolate the effect of the GFC and the European debt crisis we include an interaction term of the sovereign yield with a dummy variable for the period 2008–2012. In addition, in specifications that aim to compare the effects in the pre- and post-crises periods, we exclude the crises period of 2008–2012 and include an interaction of the sovereign yield with a dummy for the post-crises period of 2013–2016. All regressions include country and time fixed effects, denoted by c_j and ν_t, respectively. We estimate the model parameters by Weighted Least Squares, using for weights countries' holdings of U.S. corporate and Treasury bonds. Figs. 1 and 2 show details on the country sovereign rates. Table 2 presents summary statistics for the variables used in the regressions.

Our second set of empirical exercises examines the determinants of the portfolio allocations that foreign investors choose within their U.S. bond holdings. In particular, the unit of analysis here is a particular country's holdings of U.S. corporate bonds as a share of its total U.S. bond holdings on a given survey date. The setup is similar to the one above: we again include the home country sovereign yield and its interaction term with the dummy for the 2008–2012 crises period; as well as an interaction with a post-crises dummy variable excluding the crises period altogether in order to compare the period effects. We also include the same country determinants and fixed effects. Since all regressions include time dummies, they absorb all common factors, including changes in financial conditions in the United States. The empirical specification of the model we estimate is then:

$$H_{j,t}^{Corp} \Big/ \sum_i H_{j,t}^{i} = \alpha + \beta SOV5y_{j,t} + \gamma X_{j,t} + c_j + \nu_t + \epsilon_{j,t} \quad (2)$$

where $H_{j,t}^{Corp}/\sum_i H_{j,t}$ is the country's holdings of corporate bonds ($H_{j,t}^{Corp}$) as a share of its total U.S. bond holdings on a given survey date $\sum_i H_{j,t}^{i}$.

[16] While entities resident in other countries in our sample may also hold some bonds on behalf of ultimate investors in different countries, Luxembourg, Belgium, and Ireland stand out for having TIC holdings in excess of home country data on their investors' U.S. investments. In addition, Table 1 shows that 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.

[17] Alternatively, and as a robustness check, we kept the European financial centers' observations, but treated the entire euro zone as one country, instead of individual euro zone countries' bilateral holdings. This approach might be fine for corporate bonds, but is likely less appropriate for U.S. Treasuries since, as discussed in the text, custodian countries, such as Belgium and other financial centers, could disproportionately influence the reported country holdings of U.S. Treasuries, especially the breakdown of private and official investors' holdings. Nonetheless, using this approach does not qualitatively change our results.

Table 2
Summary statistics (2003–2016).

	Median	Mean	St.Dev	1st p.	10th p.	95th p.	99th p.
Sovereign 5-year LC Yield (%)	3.39	3.77	2.99	−0.35	0.57	10.70	13.70
Sovereign 1-year LC Yield (%)	2.33	2.85	2.83	−0.54	0.07	8.17	13.23
Sovereign 1-Year USD Yield (%)	1.38	2.27	2.23	−0.13	0.28	5.69	7.83
Expected Earnings Growth	0.12	0.16	0.32	−0.30	0.01	0.38	1.61
Bank Exposure Share (Bank link)	0.01	0.03	0.07	0.000	0.001	0.08	0.43
Trade Share	0.01	0.03	0.04	0.000	0.002	0.14	0.18
Sovereign CDS spread 5-year	0.43	1.03	2.16	0.01	0.03	3.63	9.98
Sovereign CDS spread 1-year	0.18	0.81	3.98	0.01	0.01	1.94	10.85
Exchange Rate St. Dev.	0.06	0.07	0.12	0.01	0.03	0.13	0.15
Exchange Rate Change	−0.02	−0.003	0.10	−0.23	−0.14	0.19	0.24
Treasury Holdings/GDP (%)	0.51	2.41	7.40	0.00	0.02	8.82	40.32
Corporate Bond Holdings/GDP (%)	0.85	5.62	14.2	0.01	0.08	38.8	75.9
Corporate Share in Holdings	0.66	0.62	0.24	0.05	0.25	0.95	0.98

Notes: The table reports summary statistics for the country specific variables. The statistics are over the entire sample period 2003–2016. The exchange rate statistics refer to countries' bilateral (versus the U.S. dollar) exchange rate. The exchange rate change is calculated as the log difference. The bank and trade exposure are reported as shares. Sovereign 1-Year USD Yield refers to the 1-year synthetic dollar yield calculated by the authors as explained in the text. In this table bond holdings to GDP statistics are reported in percent; in the regressions they are included as shares.

6. Empirical results

6.1. Determinants of international investment in U.S. bonds

We begin by investigating foreign private investment in U.S. corporate and Treasury bonds following specification shown in Eq. (1). The first four columns of Table 3 show the results for U.S. corporate bonds. In column (1) we report the results from the panel regression of country-level holdings of U.S. corporate bonds (scaled by home GDP) for the entire period 2003–2016 on the home country 5-year sovereign bond yield and its interaction with a 2008–2012 period dummy. The regression includes country and time fixed effects, along with the other country-specific control variables as discussed above. We find a statistically significant negative sign for the coefficient on the sovereign yield, consistent with a "push factor" that would induce flows in the context of a portfolio balance framework. More specifically, the −0.036 coefficient means that when a country's home interest rate is 100 basis-points lower, its investment in U.S. corporate bonds rises by 3.6% of its GDP. We do not find evidence that this relationship is different during the crises period as the coefficient on the interaction of the investor-country sovereign yield with the crises dummy is not statistically significant.

In column (2), we consider whether the home sovereign yield effects differ in the post-crises period compared to the pre-crises period. To do this, we exclude the crises years from the sample completely, but retain a period-interaction. We find that the main result is maintained, and with a larger coefficient than in column (1). However, we do not find that in the post-crises period, when interest rate were generally low in most advanced countries, the relation is much different, as this interaction variable is not statistically significant.

The sample in columns (1) and (2) already excludes the Caribbean banking centers and Luxembourg as they lack sovereign yield and other country-level data, but in columns (3) and (4) we further exclude Belgium and Ireland from the sample. As shown in the last column of Table 1, these countries have oversized holdings of U.S. bonds relative to their GDP. Columns (3) and (4) show that when we exclude financial centers and major custodians the main regression result on the relationship between investors' home interest rates and their investment in U.S. corporate bonds is maintained, but the coefficient does decline considerably, suggesting that investment from the excluded countries is especially sensitive to the composite European interest rate we assigned them. In Appendix Table A.1 we show that these results are unchanged if we include holdings of corporate asset backed securities (ABS) in the sample of corporate bonds.

Important custodian countries such as Belgium and financial centers could have even stronger influence on reported country holdings of U.S. Treasuries, especially when it comes to the breakdown of private and official investors' holdings. As pointed out in Treasury Department reports regarding the TIC survey data, some foreign official holdings likely are misclassified as private holdings because they are held through private intermediaries, and therefore data on private holdings in major custodians may reflect some holdings of foreign official institutions, which are usually disproportionately allocated to Treasuries.[18] Since in this paper we focus on private investors' behavior, for foreign holdings of Treasury bonds in the last two columns of Table 3 we present the results just for the sample excluding the financial centers. We use the same two period samples as before, the full sample and the sample excluding the crises period that compares the pre- and post-crises effects of the home sovereign rates. We find a positive and statistically significant effect for the crises period (column (5)), indicating a decline in Treasury holdings for foreign investors with declining home interest rates. This is consistent with a "flight-home" investor behavior during crises. The insignificant effect of the sovereign yield for the normal times period in column (5) stems from

[18] Annual Treasury Department reports on the TIC survey data: see Treasury Department TIC website https://www.treasury.gov/resource-center/data-chart-center/tic/Pages/index.aspx.

Table 3
Holdings of U.S. bonds as a share of countries' GDP. The table shows the estimated coefficients for Eq. (1) in the text. The dependent variable in columns (1)–(4) is country *j*'s holdings of U.S. corporate bonds at time *t* scaled by country *j*'s GDP. The dependent variable in columns (5)–(6) is country *j*'s holdings of U.S. Treasuries at time *t* scaled by country *j*'s GDP. Luxembourg drops out of the sample as it lacks data for all controls. In columns (1)–(2) we include all countries in the sample; in addition to Luxembourg, columns (3)–(6) also exclude Belgium and Ireland. The sample period in columns (1), (3), and (5) is 2003–2016; in columns (2), (4), and (6) we exclude the crises years 2008–2012. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for the period 2003–2007. Countries' sovereign rates are the year-end 5-year sovereign local currency yields. The sovereign rate for Belgium and Ireland is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	U.S. corporate bonds/GDP				Treasuries/GDP	
	All countries		Excl. fin. centers		Excl. fin. centers	
	(1)	(2)	(3)	(4)	(5)	(6)
Sov5y	−0.036***	−0.053***	−0.010***	−0.008**	0.002	0.006**
	(0.011)	(0.015)	(0.003)	(0.004)	(0.002)	(0.003)
2008–12 = 1 × Sov5y	−0.003		−0.000		0.002**	
	(0.006)		(0.003)		(0.001)	
Post = 1 × Sov5y		−0.009		−0.003		−0.007***
		(0.015)		(0.009)		(0.002)
Bank link	0.358	0.687**	0.001	−0.073	0.010	−0.074**
	(0.229)	(0.281)	(0.070)	(0.090)	(0.030)	(0.032)
Trade share	1.222	1.860	−0.145	−0.257	−0.403***	−0.337**
	(1.166)	(1.214)	(0.178)	(0.266)	(0.135)	(0.137)
Sov CDS spr (5-year)	−1.975	5.951*	0.586	0.387	−0.341	0.094
	(1.260)	(3.215)	(0.475)	(1.376)	(0.212)	(0.308)
StDev FX	0.426	0.428	0.062	−0.131	0.078*	0.019
	(0.328)	(0.457)	(0.117)	(0.198)	(0.042)	(0.048)
Delta FX	0.111	0.163	0.043*	0.062*	0.007	−0.006
	(0.082)	(0.103)	(0.024)	(0.036)	(0.013)	(0.017)
ExpEarnGr	0.066*	−0.016	−0.010	−0.020	−0.015***	−0.011**
	(0.039)	(0.041)	(0.009)	(0.015)	(0.004)	(0.005)
Observations	376	236	349	218	349	218
Adj. R-sq	0.92	0.91	0.89	0.89	0.92	0.93
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

the offsetting effects present pre- and post-crises, shown in column (6). The strong negative coefficient on the post-crises interaction of the sovereign yield indicates that post-crises, when rates were low in a lot of advanced economies, foreign investment in Treasury bonds rose, likely suggesting that investors seeking safe assets were drawn to the relatively higher yielding U.S. Treasuries, compared to home sovereign bonds. We, therefore, view this result as another indication of search-for-yield behavior.

Turning to the other country-specific variables, the positive sign of the bank link coefficient in column (2) suggests that stronger bank lending ties between the investor country and the United States are associated with increased investment in U.S. corporate bonds, but we do not find this effect once we exclude financial centers from the sample. The coefficient on the countries' share in U.S. trade is not statistically significant for corporate bond investment, and the negative sign for Treasury bond investment indicates, somewhat counterintuitively, that an increase in a country's trade volume with the United States is associated with less investment. Less surprising, however, is that higher expected earnings growth at home (ExpEarnGr), which we take as a proxy for risky domestic investment opportunities, also reduces investment in U.S. Treasuries as investors seek higher yielding opportunities. This results could be interpreted as another manifestation of yield searching behavior. Generally, the other country variables do not appear to significantly affect holdings of U.S. bonds. One reason could be that there is no sufficient time variation and the country fixed effects we include in these regressions fully capture the cross-country variation.

6.2. Determinants of composition of international investment in U.S. bonds

We next follow specification 2 to study the composition of private investors' portfolio of U.S. bonds, which implicitly controls for the general incentives to invest in U.S. bonds. The idea is to explore how the share of the riskier, and therefore higher yielding, U.S. assets (U.S. corporate bonds) relative to the safe U.S. asset (U.S. Treasury) is affected by investors' home country interest rates. As outlined in the methodology section above, our variable of analysis here is holdings of U.S. corporate bonds as a share of a country's total holdings of U.S. corporate and Treasury bonds on a given survey date.[19] Table 4 reports the results. In column (1) we include all countries in the sample; in (2)–(3) we exclude the financial centers. The negative coefficient

[19] Results are similar if we instead scale by country's total holdings of all types of U.S. bonds, which include U.S. Agencies.

on the home interest rate in columns (1)–(2) is consistent with international bond investors relatively shifting their U.S. portfolios toward the riskier corporate bonds when domestic investment opportunities are lackluster. The effects are statistically stronger for the sample excluding financial centers. Effects are somewhat muted during the crises period, as the coefficient on the interaction of the interest rate with the crises dummy is statistically significant positive. As such, the effects may be smaller and not even present in crises period.

In column (3), we find that post-crises the effects do not differ in a statistically significant way from those for the pre-crises period. Mirroring the positive sign on the expected earnings growth for Treasury holdings in Table 3, the expected earnings growth effect is negative in Table 4, consistent with Treasuries being a defensive investment when prospects for riskier investments are weaker.

The estimated effects imply that international bond investors increasingly shift their U.S. bond portfolios toward corporate securities as home rates reach low levels, with economically meaningful effects: a 100 basis points decline in the home interest rate entails an estimated shift toward corporates of about 2.3–2.7 percentage points.

7. Robustness

7.1. Sample restrictions and choice of interest rate

Table 5 shows that the baseline results on the effect of countries' sovereign rates on their holdings of U.S. corporate and Treasury bonds are similar when the regressions exclude the country controls. The specifications are the same as in the baseline Table 3, i.e. using investment in U.S. corporate and Treasury bonds as ratio to the home country GDP as the dependent variable, but the sample is much larger than in Table 3 as some countries lack data for all controls. The larger coefficient on the sovereign yield variable in Table 5 is driven by the inclusion of Luxembourg in the sample.

In Table 6 we report robustness checks to further restrictions to the country sample and to using a different maturity for the home country interest rate. The sample in Table 6 excludes the financial centers, and it therefore corresponds to the results in columns (3)–(6) of baseline Table 3. As a first robustness test, in columns (1)–(2) for U.S. corporate bonds and (4)–(5) for Treasuries, we exclude observations where countries' sovereign CDS spread is in the top 5th percentile over the sample period.[20] We find that main regression results are confirmed and the size of the coefficients is very similar to the ones reported in baseline Table 3. As another robustness check, to explore the sensitivity to the specific interest rate used, columns (3) and (6) of Table 6 report estimates of total private investment in U.S. corporate and Treasury bonds, respectively, with regard to the 1-year home sovereign rate, instead of the 5-year rate we use in the baseline. The main results carry through, with slightly smaller estimated effects on investment from a lower home interest rate.[21]

Table 7 presents the same robustness checks but now for Table 4 baseline results on the effects of home country drivers of the corporate share. The sample excludes the financial centers so it is comparable to the one used in columns (2)–(3) of Table 4. In columns (1)–(2) we exclude high sovereign CDS countries, while in column (3) we use the shorter 1-year maturity home sovereign yield. The main story is preserved. As we saw with total investment as a percent of GDP, the coefficient on the 1-year sovereign yield is smaller than on the 5-year yield.

7.2. Hedged and unhedged investment in U.S. bonds

So far, we have used countries' local currency sovereign yields. Now, we examine if and to what extent the country's private investment in U.S. corporate and Treasury bonds also responds to the U.S. dollar equivalent of the home sovereign rate (Y$), and how the effects differ compared to the home sovereign yield measured in local currency (YHC). We test for this by calculating home country yields in U.S. dollar terms. For this, we collect 12-month forward premiums (FP) for the U.S. dollar against the home currencies of each of the investor countries in our sample. We calculate the synthetic dollar yields foreign investors would obtain if each of them hedged their home-currency 1-year sovereign bonds into the common currency, the U.S. dollar ($Y\$ \equiv YHC - FP$). This allows us to test for the role of the synthetic dollar yields (Y$) on foreign investments, while at the same also being able to include both the home-currency yield (YHC) and the synthetic dollar yield (Y$) as two distinct competing factors affecting international investment choices. As before, in this set of results we control for the standard set of linkages and country economic and financial conditions.

Table 8 presents the results for the sub-sample excluding the financial centers. Since here we use the 1-year synthetic dollar rate, these results have to be compared to the results in Table 6 where as a robustness check we use countries' 1-year local currency sovereign rates instead of their 5-year rates. In column (1) of Table 8 we include only the synthetic dollar yield (Sov1y synth. USD), i.e. the hedged sovereign rate, along with our set of controls, and find that it does not appear to affect investment in U.S. corporate bonds in a statistically significant way. This is in contrast to the findings so far that the local currency sovereign yield negatively and in a statistically significant way affects investment in U.S. corporate bonds. However, we get more insights when we include both the hedged and the unhedged rate. In column (2) we report the results

[20] Results are similar if we instead altogether exclude countries whose sovereign CDS spread has ever been in the top 5th percentile over the sample period. Results are also similar for a different cut-off for sovereign CDS spreads.

[21] Results are also robust if for the weights in the estimation we use countries' total U.S. bond holdings rather than holdings of U.S. corporate and Treasuries bonds only.

Table 4
Corporate bond share. The table shows the estimated coefficients for Eq. (2) in the text. The dependent variable is country *j*'s holdings of U.S. corporate bonds at time *t* relative to its holdings of U.S. Treasuries and corporate bonds. Luxembourg drops out of the sample as it lacks data for all controls. In column (1) we include all countries in the sample; in addition to Luxembourg, columns (2)–(3) also exclude Belgium and Ireland. The sample period in (1)–(2) is 2003–2016; in column (3) we exclude the crises years 2008–2012. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for the period 2003–2007. Countries' sovereign rates are the year-end 5-year sovereign local currency yields. The sovereign rate for Belgium and Ireland is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	All countries	Excl. fin. centers	
	(1)	(2)	(3)
Sov5y	−0.027*	−0.023***	−0.027**
	(0.014)	(0.009)	(0.013)
2008–12 = 1 × Sov5y	0.018**	0.016**	
	(0.009)	(0.007)	
Post = 1 × Sov5y			0.001
			(0.013)
Bank link	−0.135	0.199	0.212
	(0.253)	(0.128)	(0.182)
Trade share	−5.556***	−0.918	−1.518
	(1.407)	(0.950)	(1.161)
Sov CDS spr (5-year)	0.094	0.498	−0.200
	(1.085)	(1.132)	(2.602)
StDev FX	0.514	−0.054	−0.057
	(0.353)	(0.179)	(0.245)
Delta FX	−0.117	−0.032	−0.073
	(0.093)	(0.049)	(0.068)
ExpEarnGr	0.035	0.084***	0.134***
	(0.031)	(0.032)	(0.045)
Observations	376	349	218
Adj. R-sq	0.83	0.91	0.90
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Table 5
Robustness: holdings of U.S. bonds as a share of countries' GDP. The table shows the estimated coefficients for Eq. (1) in the text. The dependent variable in columns (1)–(4) is country *j*'s holdings of U.S. corporate bonds at time *t* scaled by country *j*'s GDP. The dependent variable in columns (5)–(6) is country *j*'s holdings of U.S. Treasuries at time *t* scaled by country *j*'s GDP. In addition to the baseline sample, the sample here includes the following countries: Hungary, Jamaica, Luxembourg, New Zealand, Sri Lanka, and Thailand. In columns (1)–(2) we include all countries in the sample; columns (3)–(6) also exclude Belgium, Ireland, and Luxembourg. The sample period in columns (1), (3), and (5) is 2003–2016; in columns (2), (4), and (6) we exclude the crises years 2008–2012. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for the period 2003–2007. Countries' sovereign rates are the year-end 5-year sovereign local currency yields. The sovereign rate for Belgium, Ireland, and Luxembourg is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	U.S. corporate bonds/GDP				Treasuries/GDP	
	All countries		Excl. fin. centers		Excl. fin. centers	
	(1)	(2)	(3)	(4)	(5)	(6)
Sov5y	−0.157**	−0.162**	−0.013***	−0.016***	0.002*	0.005***
	(0.066)	(0.074)	(0.003)	(0.004)	(0.001)	(0.002)
2008–12 = 1 × Sov5y	−0.018		0.004		0.003**	
	(0.033)		(0.002)		(0.001)	
Post = 1 × Sov5y		−0.016		−0.002		−0.009***
		(0.063)		(0.006)		(0.001)
Observations	466	297	424	270	424	270
Adj. R-sq	0.93	0.92	0.88	0.88	0.88	0.91
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

including both the hedged and unhedged rate in a specification that excludes the crises period. The hedged rate (Sov1y synth. USD) is again statistically insignificant, and the coefficient on the unhedged rate (Sov1y) is similar to the one reported in Table 6 column (3) where we use the 1-year unhedged rate on its own in the same type of specification. The story is similar

Table 6
Robustness: holdings of U.S. bonds as a share of countries' GDP. The dependent variable in columns (1)–(3) is country *j*'s holdings of U.S. corporate bonds at time *t* scaled by country *j*'s GDP. The dependent variable in columns (4)–(6) is country *j*'s holdings of U.S. Treasury bonds at time *t* scaled by country *j*'s GDP. The sample excludes Belgium, Ireland, and Luxembourg. The sample period in columns (1) and (4) is 2003–2016. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Columns (2)–(3) and (5)–(6) exclude the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for 2003–2007. In columns (1)–(2) and (4)–(5) we exclude countries whose sovereign CDS spread is in the top 5th percentile over the sample period and use countries' 5-year sovereign rate. In columns (3) and (6) countries' sovereign rates are the year-end 1-year sovereign local currency yields. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	U.S. corporate bonds/GDP			Treasuries/GDP		
	Excl. high CDS		1-year Sov.	Excl. high CDS		1-year Sov.
	(1)	(2)	(3)	(4)	(5)	(6)
Sov5y	−0.010***	−0.006**		0.003	0.007***	
	(0.003)	(0.003)		(0.002)	(0.003)	
2008–12 = 1 × Sov5y	−0.001			0.002**		
	(0.003)			(0.001)		
Post = 1 × Sov5y		−0.001			−0.008***	
		(0.009)			(0.002)	
Sov1y			−0.007*			0.005***
			(0.004)			(0.001)
Post = 1 × Sov1y			0.003			−0.004***
			(0.011)			(0.002)
Bank link	0.005	−0.091	0.329*	0.009	−0.076**	0.173***
	(0.075)	(0.094)	(0.181)	(0.030)	(0.033)	(0.047)
Trade share	−0.156	−0.245	−0.220	−0.380***	−0.323**	−0.380***
	(0.181)	(0.291)	(0.396)	(0.139)	(0.144)	(0.137)
Sov CDS spr (5-year)	0.496	0.012		−0.595	0.086	
	(1.433)	(2.025)		(0.447)	(0.558)	
StDev FX	0.068	−0.110	−0.111	0.077*	0.014	0.041
	(0.110)	(0.165)	(0.180)	(0.043)	(0.049)	(0.043)
Delta FX	0.043	0.056	0.126***	0.009	−0.005	0.027**
	(0.026)	(0.037)	(0.050)	(0.013)	(0.017)	(0.014)
ExpEarnGr	−0.010	−0.017	−0.027	−0.017***	−0.012**	−0.018***
	(0.009)	(0.013)	(0.019)	(0.004)	(0.006)	(0.005)
Sov CDS spr (1-year)			0.408			0.152***
			(0.344)			(0.061)
Observations	332	209	198	332	209	198
Adj. R-sq	0.89	0.89	0.89	0.92	0.93	0.95
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes

in the case of investment in Treasury bonds. As reported in columns (3)–(4) of Table 8, the hedged rate does not appear to affect investment in Treasuries in a statistically significant way, while the effect of the unhedged rate is preserved. These results imply that investment is more sensitive to the unhedged rate, consistent with institutional incentives not to hedge exchange rate exposure. We also interpret these results as consistent with investors being aware of the limited predictive power of forward premiums for future exchange rates. Put differently, investors do not appear to take hedging costs into account nor expect uncovered interest rate parity to hold. Rather, they appear to compare nominal promised rates of return among investment choices.[22]

8. Conclusion

We analyze how interest rates affect international investments and cross-border risk-taking by examining the extent to which investors have shifted toward riskier assets overseas in response to low interest rates at home. Data on foreign investors' holdings of U.S. bonds for 31 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 their home interest rates. Our analytical framework largely avoids concerns that the results might be driven instead by reverse causality from U.S. credit markets to foreign interest rates. For example, although an increase in the supply of U.S. bonds would likely draw in more cross-border investment, it likely would have only second-order effects on rates in other countries, and would tend to raise rates, while our finding is that increased U.S. investment is associated with lower investor-country rates. And, while these foreign investments are likely to have been affected by economic and financial conditions at home, because they are small from a U.S. perspective, they are unlikely to have affected the financing conditions of the issuers.

[22] Focusing on unhedged interest rate differential is arguably rational for informed investors who are tolerant of exchange rate risk; the forward premium puzzle has been well known at least since the 1980s. See, for example, Fama (1984).

Table 7
Robustness: corporate bond share. The table shows the estimated coefficients for Eq. (2) in the text. The sample excludes Belgium, Ireland, and Luxembourg. The sample period in columns (1) is 2003–2016. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Columns (2)–(3) exclude the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for 2003–2007. In columns (1)–(2) we exclude countries whose sovereign CDS spread is in the top 5th percentile over the sample period and use countries' 5-year sovereign rate. In column (3) countries' sovereign rates are the year-end 1-year sovereign local currency yields. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	Excl. high CDS		1-year Sov.
	(1)	(2)	(3)
Sov5y	−0.026***	−0.031**	
	(0.010)	(0.015)	
2008–12 = 1 × Sov5y	0.016**		
	(0.007)		
Post = 1 × Sov5y		−0.003	
		(0.015)	
Sov1y			−0.042***
			(0.013)
Post = 1 × Sov1y			0.024
			(0.015)
Bank link	0.193	0.175	−0.532*
	(0.130)	(0.190)	(0.302)
Trade share	−1.013	−1.658	−5.069***
	(0.963)	(1.172)	(1.170)
Sov CDS spr (5-year)	1.569	2.194	
	(2.383)	(4.476)	
StDev FX	−0.020	−0.023	−0.278
	(0.180)	(0.270)	(0.277)
Delta FX	−0.048	−0.106	−0.108*
	(0.051)	(0.077)	(0.062)
ExpEarnGr	0.091***	0.151***	0.217***
	(0.034)	(0.049)	(0.039)
Sov CDS spr (1-year)			−1.767***
			(0.565)
Observations	332	195	198
Adj. R-sq	0.91	0.90	0.90
Country FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes

Table 8
Hedged and unhedged investment in U.S. bonds. The dependent variable in columns (1)–(3) is country *j*'s holdings of U.S. corporate bonds at time *t* scaled by country *j*'s GDP. The dependent variable in column (4) is country *j*'s holdings of U.S. Treasury bonds at time *t* scaled by country *j*'s GDP. The sample period is 2003–2016. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Sample excludes Belgium, Ireland, and Luxembourg. Weighted regression where the weights are countries' holdings of U.S. corporate and Treasury 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.

	U.S. corporate bonds/GDP		Treasuries/GDP	
	(1)	(2)	(3)	(4)
Sov1y synth. USD	0.028	0.007	0.002	0.000
	(0.020)	(0.010)	(0.002)	(0.004)
2008–12 = 1 × Sov1y synth. USD	−0.023		0.001	
	(0.015)		(0.002)	
Post = 1 × Sov1y synth. USD		0.031		0.004
		(0.027)		(0.004)
Sov1y		−0.010*		0.005***
		(0.006)		(0.001)
Post = 1 × Sov1y		−0.000		−0.004***
		(0.008)		(0.001)
Bank link	−0.030	−0.096	0.073**	0.094**
	(0.051)	(0.115)	(0.035)	(0.048)
Trade share	0.493	−0.178	−0.595***	−0.427**
	(0.337)	(0.539)	(0.136)	(0.180)
Sov CDS spr (1-year)	0.068	0.203	0.043	0.110*
	(0.207)	(0.314)	(0.079)	(0.063)
StDev FX	0.098	0.125	0.098***	0.083*
	(0.083)	(0.140)	(0.040)	(0.047)
ExpEarnGr	−0.005	−0.004	−0.015***	−0.012***
	(0.007)	(0.012)	(0.005)	(0.005)

(*continued on next page*)

Table 8 (*continued*)

	U.S. corporate bonds/GDP		Treasuries/GDP	
	(1)	(2)	(3)	(4)
Observations	325	196	325	196
Adj. R-sq	0.90	0.90	0.93	0.95
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

We find that the lower the interest rate in the investor's home country, the more investors increase their investments in the United States as a ratio to their home GDP, with the effects generally coming through investment in U.S. corporate sector bonds, rather than Treasury bonds. The results show that when a country's home interest rate is 100 basis-points lower, its investment in U.S. corporate bonds rises by 3.6–5.3% of GDP. Furthermore, in terms of portfolio composition, international bond investors increasingly shift their U.S. bond portfolios toward corporate securities as home rates reach low levels, with economically meaningful effects. Since increased foreign investment in the United States is disproportionately allocated to corporate bonds, the results imply that low rates at home induce international investors to assume more credit risk in their U.S. bond portfolios. We find further evidence that the search-for-yield is a function of the home interest rates and not of the hedged dollar equivalent rates.

Our findings have important policy implications in that they suggest that low interest rates can lead to shifts in overseas investments. Although we control for investor country characteristics, since we do not have comparable data on domestic investment portfolios as we do for holdings of U.S. bonds, we cannot say whether the investor behavior we observe is the same or differs from the domestic investment patterns. 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. Or, extrapolating from the small part of their behavior we observe, one could conjecture that foreign investors likely have made risk-increasing shifts elsewhere in their portfolios that could pose financial stability risks abroad, particularly if the low-rate environment persists. Our results are also consistent with central banks' balance sheet policies having a significant effect on demand for foreign financial assets. Regardless, our findings suggest that there are spillover effects from low interest rates through cross-border capital flows.

Conflict of interest

The authors declared that there is no conflict of interest.

Appendix A. Corporate bond sample including ABS

See Table A.1.

Table A.1
Holdings of U.S. corporate bonds and corporate ABS as a share of countries' GDP. The table shows the estimated coefficients for Eq. (1) in the text. The dependent variable is country *j*'s holdings of U.S. corporate bonds and corporate ABS at time *t* scaled by country *j*'s GDP. Luxembourg drops out of the sample as it lacks data for all controls. Columns (1)–(2) include all countries in the sample; columns (3)–(4) exclude Belgium and Ireland. The sample period in columns (1) and (3) is 2003–2016; in columns (2) and (4) we exclude the crises years 2008–2012. 2008–2012 is a dummy variable equal to 1 for the crises period 2008–2012. Post is a dummy variable equal to 1 for the period 2013–2016 and 0 for the period 2003–2007. Countries' sovereign rates are the year-end 5-year sovereign local currency yields. The sovereign rate for Belgium and Ireland is the average of the sovereign rates of the Netherlands, France, Italy, and Spain. Weighted regression where the weights are countries' total holdings of U.S. 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.

	All countries		Excl. fin. centers	
	(1)	(2)	(3)	(4)
Sov5y	−0.036***	−0.049***	−0.007**	−0.006*
	(0.011)	(0.017)	(0.003)	(0.003)
2008–12 = 1 × Sov5y	−0.003		−0.004	
	(0.008)		(0.003)	
Post = 1 × Sov5y		−0.004		0.004
		(0.016)		(0.008)
Bank link	0.498**	0.837***	0.085	0.057
	(0.245)	(0.314)	(0.077)	(0.102)
Trade share	0.602	0.913	−0.175	−0.403*
	(1.224)	(1.365)	(0.188)	(0.242)

Table A.1 (*continued*)

	All countries		Excl. fin. centers	
	(1)	(2)	(3)	(4)
Sov CDS spr (5-year)	−1.238	5.097	0.448	−0.449
	(1.346)	(3.705)	(0.473)	(1.159)
StDev FX	0.372	0.214	0.089	−0.120
	(0.382)	(0.564)	(0.101)	(0.170)
Delta FX	0.129	0.232**	0.046**	0.070**
	(0.094)	(0.110)	(0.023)	(0.034)
ExpEarnGr	0.097***	0.027	−0.006	−0.016
	(0.035)	(0.049)	(0.010)	(0.012)
Observations	376	236	349	218
Adj. R-sq	0.92	0.91	0.89	0.89
Country FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes

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