International Portfolio Frictions *

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Abstract

We study patterns and implications of global asset allocations of European insurers and banks using newly available supervisory data. We show that the total assets of insurance companies and pension funds (ICPF) far exceed the amount of government bonds outstanding in Europe, and that countries with a large ICPF sector tend to have a large corporate bond market. Despite high levels of international investments, the characteristics of domestic financial markets still loom large in insurers' and banks' portfolio allocation, with two newly documented international portfolio frictions playing a prominent role. First, when investing abroad, insurers and banks do not offset attributes of the domestic markets (such as the composition of fixed-income markets, interest rates, and sovereign credit risk), which we label "domestic projection bias." Second, subsidiaries of multinational groups act like local entities, which we label the "going native bias." We propose a theoretical framework to explain our empirical findings and discuss the broader policy implications for European capital market deepening and integration, monetary policy transmission and financial stability, and a multi-sectoral approach to regulatory design.

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1 Introduction

Banks and insurance companies are the largest regulated investors in fixed-income markets. Using newly available supervisory data from Solvency II filings for insurance companies and the restricted version of the BIS Locational Banking Statistics (LBS), we examine the global asset allocation decisions of banks and insurers domiciled in Europe. We present a new set of stylized facts on banks' and insurers' global fixed-income portfolios. Through the lens of two salient new international portfolio frictions, we document and explain why the characteristics of domestic financial markets still dictate the portfolio allocation of these regulated entities. These international portfolio frictions have important implications for European capital market deepening and integration, monetary policy transmission and financial stability, and calls for a multi-sectoral approach to regulatory design.

Banks and insurers have high demand for government bonds, for a variety of reasons including government bonds' favorable regulatory treatments, their liquidity and safety, and their ability to hedge risks in long-duration liabilities. However, we uncover an important fact that the combined size of the European ICPF sector and banks' securities portfolios exceeds the outstanding amounts of government bonds by an immense margin of $16 trillion based on our estimates for 2019, primarily driven by the enormous size of the ICPF sector. Therefore, European insurers and banks cannot all hold safe assets, and they have to tilt their portfolios towards other securities. The split between government and corporate bonds then becomes the most important portfolio decision for insurers and banks. The cross-country heterogeneity in the portfolio share of corporate bonds and its relationship with the characteristics of the domestic financial market is a key focus of our paper.

Our paper makes important empirical contributions to understanding characteristics of European banks' and insurers' global fixed-income portfolios. While asset allocation decisions in domestic fixed income markets have been studied quite extensively for U.S. life insurers,[1] little is known about global asset allocations and how these decisions vary across insurance companies operating in different countries. For the first time, we are able to use granular security-level data from Solvency II filings to examine European insurers' asset allocation across domestic and foreign fixed-income markets. Meanwhile, even though banks' overall exposure to various countries and sectors has been studied in depth, relatively little work has focused on banks' *securities'* portfolio. To our knowledge, the portfolio decision between corporate versus government bonds has not been systematically documented nor explained. The non-public "restricted" version of the BIS LBS fills this data gap, by offering

[1] See for instance Becker and Ivashina (2015), Ellul et al. (2015), Sen and Sharma (2020), Ge and Weisbach (2021), Becker et al. (2022), and Koijen and Yogo (2023b).

cross-country data on banks' foreign and local holdings of debt securities broken down by sectors.

In addition to using new data to answer these questions, a unique feature of our paper is to jointly study the behavior of banks and insurance companies. Despite the evolution of the regulatory frameworks for each type of the institutions in recent decades, the regulatory landscape remains largely sector specific and fragmented.[2] Each regulator determines which assets are safe and liquid, and how to set risk weights, and generally does not routinely share supervisory information on their respective sector with other regulators. However, as banks and insurers are among the largest fixed-income investors, their portfolios should not be examined in isolation. In the presence of scarce supply of safe assets, a segmented regulatory framework leaves important questions unanswered related to which entities are best positioned to bear macroeconomic risks associated with non-government securities. Meanwhile, with some exceptions, academic research is equally specialized and segmented. Our results contribute to the broader research agenda on how to design regulation in a world with heterogeneous institutions that differ in the nature of their liabilities and assets beyond securities.

We focus on a sample of 31 countries in the European Economic Area (EEA) over the period from 2016 to 2021, starting with the introduction of the Solvency II regulatory regime.[3] The sample of countries include all euro-area countries, Scandinavian countries, the United Kingdom (prior to Brexit), and emerging Europe. A major advantage of our setting is that under the pan-Europe common regulations,[4] our sample countries vary widely in terms of the structure of their financial markets, the size of the ICPF sector, and the level of country risk. These differences in macroeconomic and financial characteristics are strongly related across countries. First, countries with a large ICPF sector tend to have a relatively large corporate bond market. This relationship is highly robust and holds for both financial and non-financial corporate bonds, even after controlling for proxies of financial market development, such as per capita income, and the size of the banking sector, suggesting the likely role of a large ICPF sector in promoting the development of the corporate bond market, consistent with the thesis proposed by Scharfstein (2018). Second, countries with a relatively low

[2] Some progress has been made via macro-prudential frameworks more recently.

[3] The 31 EEA countries as of 2016 are Austria, Belgium, Bulgaria, Croatia, Republic of Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Liechtenstein, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, and the United Kingdom

[4] The European Union Capital Requirement Regulation sets forth a single rule-book for European banks. The Solvency II framework harmonizes the solvency regulation and reporting requirements for European insurance companies. However, Solvency II does not harmonize the product or conduct regulation across countries, only the solvency regulation.

government bond yield and sovereign credit risk tend to have large corporate bond markets.

Using these new data on European insurers' and banks' global fixed-income portfolios, we document five novel findings that cannot be explained by traditional international finance portfolio frictions, such as home country and home currency bias.[5] First, there is large cross-country heterogeneity in insurers' and banks' portfolio allocations, in spite of banks and insurers across countries all having access to global capital markets and being regulated under the common pan-European regulations. For example, the share of government bonds in total portfolio range from less than 20 percent for insurers domiciled in Norway to about 90 percent insurers domiciled Hungary. The standard deviation across countries of the portfolio share in corporate bonds is equal to 22 percent for banks, and 19 percent for insurers across countries.

Second, the composition of domestic fixed income markets, as measured by the share of corporate bonds in outstanding domestic fixed-income instruments, is strongly positively correlated with the fraction of the overall portfolio invested in corporate bonds for both insurers and banks. This fact is surprising as European insurers and banks do not exhibit a strong home country bias. Indeed, the share of total investments invested domestically averages to less than 50 percent for both sectors. The relationship also holds within the euro area, implying that home currency bias cannot explain the fact either.

A standard portfolio model predicts that while domestic investments track domestic characteristics due to the home bias, the foreign investments should offset the characteristics of domestic financial markets. Indeed, if the domestic portfolio exposes an insurer to more credit risk, we would expect, all else equal, that the insurer tilts towards government bonds in their foreign allocation. Our third fact is that insurers, if anything, do the opposite. In countries in which insurers and banks have higher corporate bond shares in their domestic fixed income portfolios, their foreign investments tend to resemble their domestic portfolio and feature more corporate bonds. We refer to this phenomenon as the *domestic projection bias*.

Fourth, while the holdings of foreign bonds resemble the domestic portfolio, one might expect that when a multinational insurer operates a subsidiary in another jurisdiction, they use this as an opportunity to form a globally optimal portfolio. Contrary to this hypothesis, the facts point to the opposite. We find that local subsidiaries of multinational groups have very similar portfolio allocations as other local insurers in their market. We refer to this phenomenon as the *going native bias*. The fact that large multinational companies do not use their holding of foreign bonds or use their overseas subsidiaries to form globally optimal portfolios suggests that informational frictions and foreign investment expertise are unlikely

[5]See Coeurdacier and Gourinchas (2011), Coeurdacier and Rey (2013), and Maggiori et al. (2020).

to be primary drivers of these biases.[6]

At first sight, the two biases appear (*domestic projection bias* and *going native bias*) to operate in opposite directions. Whereas the first bias is to project too much the domestic market characteristics to their holdings of foreign bonds, the second bias is not to project enough. However, both biases can well coexist and do not contradict each other. For instance, a French insurer's local subsidiary in Italy may mimic the allocation of domestic, Italian insurers (going native bias), while the characteristics of the Italian fixed income market affect the fixed-income allocation of this Italian subsidiary of a French parent outside Italy (domestic projection bias). The key to reconcile the two biases is that the subsidiary of a multinational group appears to disregard the characteristics of its headquarter country by behaving like other peers in the local market it operates in.

Fifth, we study how asset allocation decisions vary across countries with different levels of domestic government bond yields and sovereign credit risk, and we observe a similar set of facts. An insurer operating in a country with high domestic government yields, which tends to be a country with higher sovereign credit risk or inflation risk, tends to hold a portfolio of foreign bonds that earns a higher yield as well (and is likely to be riskier as well). This is an another example of "domestic projection bias." Also, local and multinational insurance companies behave alike, another manifestation of "going native bias."

Taken together, our key finding is that characteristics of domestic financial markets dictate European insurers' and banks' overall portfolio allocation. This allocation pattern occurs despite a significant fraction of the their assets being invested abroad and despite an active local market participation by large multinational insurance and banking groups. Despite these features, our results imply that capital market integration is more challenging due to the new international portfolio frictions that we document.

Our results raise three broader questions. First, what are the fundamental frictions that explain these asset allocations? Second, if banks and insurers do not offset the additional credit risk in their foreign portfolios, who ultimately bears this additional risk? Third, what are the broader implications for policy makers and insurance regulators? We discuss each of these in turn.

To answer the first question, we first show how theoretical models of fixed income markets featuring regulated institutions (see for instance Chodorow-Reich et al. (2021), Knox and Sørensen (2020), and Koijen and Yogo (2023b)) can easily be applied and extended to explain that, in countries with a larger ICPF sector, (i) the corporate bond share is higher in fixed-income markets and (ii) banks and insurers allocate a larger fractionof their fixed-income

[6] We refer to these deviations from a frictionless portfolio choice model as biases, which may have rational or behavioral root causes. We discuss the potential origins in more detail below.

portfolios to corporate bonds. Intuitively, if the regulated institutions would all be forced to hold government bonds, then the convenience yield of government bonds would be very large. It is then optimal for banks and insurers to reduce their allocations to government bonds and tilt to corporate bonds. If the supply of corporate bonds is elastic, both facts follow.

To explain why foreign portfolios still feature domestic characteristics, the "domestic projection bias," it is useful to think why insurers in safe (risky) countries primarily invest in other safe (risky) countries. For insurers in safe countries, internal risk constraints may prevent them from investing in risky countries. For insurers in risky countries, the additional sovereign credit risk may be less relevant as the company itself may not survive if the sovereign defaults; they have "right-way risk." If sovereign default risk is correlated across countries, as observed during the European sovereign debt crisis, it is optimal to allocate capital to other risky countries.[7] In terms of the allocation to corporate bonds and government bonds, the foreign allocation may mimic the domestic allocation as insurers allocating a significant amount of capital to domestic corporate bond markets may acquire expertise to be used in foreign corporate bond markets. In ongoing work, we are also exploring whether the foreign allocations can be summarized by several clusters (e.g., in terms of proximity, currency denomination, and riskiness).

Inertia and residual influence from national supervisors may explain the "going native bias." Solvency II was introduced in 2016 and, as regulation was more fragmented under Solvency I, insurers may need time to adjust to the new framework. Relatedly, insurers often obtain foreign subsidiaries via acquisitions. Again, it may take time to integrate the new company. In both cases, however, the speed of adjustment is remarkably slow. An alternative explanation is that insurers still interact with national supervisors, depending on the exact organizational structure (e.g., for product approval), despite the harmonized financial stability regulation. Frequent interactions with national supervisors may induce the "going native bias."

That said, these portfolio biases lead to a larger allocation to corporate bonds if the share of corporate bonds is high in domestic fixed-income markets. Under the Solvency II regulatory regime, government bonds are exempted from regulatory capital charge related to credit risk, but corporate bonds carry capital charge. Similarly, for European banks, European government bonds are treated as risk-free under risk-weighted capital regulation, but corporate bonds are not. Using firm-level data, we illustrate how higher corporate bond

[7] As yields converged rapidly following the introduction of the euro, we would also be interested in measuring the allocations following the introduction of the euro until the European sovereign debt crisis. We are exploring whether the Solvency I data, which are more incomplete, are up for that task.

allocations are absorbed in the insurance sector. One option is that the sector as a whole is riskier, implying additional risk for equity holders and, in case of default, policyholders or potentially taxpayers if insurance receive government support. Second, it may be the case that insurance companies raise additional equity to compensate for their riskier asset allocation. Third, insurers may be able to adjust the structure of insurance products so that some of the risk can be shared with policyholders. In this case, the additional credit risk ends up on households' balance sheets.

We find support for all three channels in the data with varying importance. In euro-area countries, insurers that hold more corporate bonds have significantly lower leverage and a somewhat higher ability to pass the losses to policy holders, but do not appear to have worse regulatory capital ratios. In contrast, in non-euro areas, insurers adjust along all three margins to absorb higher credit risk associated with higher corporate bond shares.

Finally, we discuss the broader implications of our results. First, in terms of capital market deepening and integration, we highlight the important role of a large ICPF sector in promoting the development of the corporate bond market. Meanwhile, these new international portfolio frictions of the ICPF sector and banks act as important barriers to European capital market integration. Second, for monetary policy transmission and financial stability, the large cross-country heterogeneity in portfolio allocations implies that monetary policy shocks are transmitted differentially across countries. Understanding how macroeconomic shocks are absorbed and which sector bears the shock are key to assessing financial stability. Third, our joint analysis of banks' and insurers' portfolios suggest that a multi-sectoral approach to regulatory design may yield benefits as there are important cross-sectoral spillovers.

Related literature We build on various strands of the literature in international finance, intermediary asset pricing, and insurance. First, our paper is most closely related to Scharfstein (2018), who provides theory and evidence on the connection between the size of the pension system and the structure of financial markets. Second, our paper relates to the literature on international asset allocation and portfolio frictions, see for instance Coeurdacier and Gourinchas (2011), Coeurdacier and Rey (2013), and Maggiori et al. (2020) among many others. Third, we relate to a literature on asset allocation decisions of long-term investors in Europe, see for instance Greenwood and Vissing-Jørgensen (2018), Koijen et al. (2021), and Jansen (2023). Relative to these papers, we study the international allocation across fixed income markets of long-term investors in a setting in which the solvency regulation is harmonized across countries, yet the insurance companies are operating in countries that in the structure of financial markets and economic conditions.

We also relate to a literature on the asset allocation decisions of U.S. life insurers, see for instance Ellul et al. (2015), Sen and Sharma (2020), Ge and Weisbach (2021), Becker et al. (2022), and Koijen and Yogo (2023b). An important theme in this literature is that asset allocation decisions are sensitive to the capital and solvency regulation. As the insurance companies that we study operate under the same solvency regulation, we focus on variation in the structure of financial markets and economic conditions, which is challenging with a single country.

Given the importance of the level of the domestic interest rate for insurers' allocation, we also relate to a large literature on reaching for yield by institutions, see Becker and Ivashina (2015), Choi and Kronlund (2018), Lian et al. (2019), and Campbell and Sigalov (2022).

Our paper is also related to how the demand of preferred-habitat investors and supply of government bonds affects the term structure of government bonds, see Greenwood and Vayanos (2010), Greenwood and Vayanos (2014), and Vayanos and Vila (2021).

Lastly, we relate to the recent literature on financial of the life insurance sector, see Koijen and Yogo (2015), Barbu (2021), Ge (2022), and Sen (2022). Koijen and Yogo (2023a) provide a comprehensive overview of this literature. The common theme in this literature is that, in particular following the 2008 financial crisis and subsequent low-rate environment, insurance companies have been financially constrained, which affects their product market, asset allocation, and reinsurance decisions.

Outline The paper is organized as follows. In Section 2, we discuss the new datasets and the construction of the main variables. In Section 3, we present macro-level findings on the relative scarcity of government bonds for many European countries, and the implication of a large ICPF sector for the corporate bond market. In Section 4, we examine characteristics of banks and insurers' portfolio, and provide evidence on the international portfolio frictions. We study how the additional credit risk is absorbed by insurance companies in Section 5. We discuss a theoretical model and broader policy implications of our findings in Section 6, and conclude in Section 7.

2 Data and Measurements

2.1 Solvency II Data for European Insurance Companies

With its introduction in 2016, Solvency II harmonised the supervisory reporting requirements for European insurance and reinsurance companies.[8] European (re)insurers subject

[8] Information about Solvency II can be found at https://www.eiopa.europa.eu/browse/regulation-and-policy/solvency-ii_en

to Solvency II have to report as solo entities and if these are holdings of groups they also have to provide details of the full group structure and group capital requirements. The European Insurance and Occupational Pensions Authority (EIOPA) receives quarterly or annually, depending on the information, the full set of quantitative reporting templates (QRTs)[9] from all entities subject to Solvency II through the national supervisors of the European Economic Area (EEA). This puts EIOPA in the position to construct a unique centralised database.[10]

We use detailed firm-level data from the Solvency II reporting templates over the period from 2016.Q4 to 2021.Q1. The data submitted to EIOPA are non-public and are used in this paper as part of the EIOPA External Researchers Platform,[11] and the results are therefore presented at a sufficiently high level of aggregation so that individual companies cannot be identified.

Our sample includes 949 life and composite solos insurers (excluding non-life and reinsurance companies) subject to Solvency II prudential reporting across the 31 EEA countries; data for the United Kingdom are available until Brexit. Insurers report their direct investment holdings at the security level. For indirect holdings through Collective Investment Funds (CIUs), additional data are reported so that we are able to assign the CIUs to the respective asset class and country group. We break down the portfolio into three main asset classes: government bonds, corporate bonds, and equities (including listed and private equities as well as property). We exclude asset holdings associated with unit-linked products as insurers pass all the investment risk to policyholders for these products.

We complement portfolio data with firm-level information such as Total Assets, Own Funds (OF), Solvency Capital Requirements (SCR), drawing from respective reporting tables under Solvency II.

[9] Reporting requirements under the Solvency II Directive can be found at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:02015R2450-20200607&from=EN and the Solvency II QRTs can be cound at https://dev.eiopa.europa.eu/Taxonomy/Full/2.7.0/S2/EIOPA_SolvencyII_DPM_Annotated_Templates_2.7.0.xlsx

[10] Solvency II reporting foremost purpose is insurance supervision, hence the core users of this data are the national authorities and oversight and supervisory experts in EIOPA. This database is used for numerous other purposes, including quality assurance, creating material added value for EIOPA, the national supervisors and external users. Further to the use within the supervisory community, EIOPA supports external data users, like the European Commission, the ECB, the ESRB and the IAIS, with aggregated reports and the general public, industry, academia, etc. with the publication of sectorial reports and statistics based on Solvency II reporting data https://www.eiopa.europa.eu/tools-and-data/insurance-statistics_en

[11] The EIOPA External Researchers Platform is an initiative aimed at leveraging on the work and expertise of external researchers. In this respect, EIOPA launched a call for research proposals in the end of 2019. In total five projects were selected.

2.2 BIS Locational Banking Statistics for Banks

We use BIS Locational Banking Statistics (LBS) to study the composition of securities portfolios of banks domiciled in Europe. For each reporting country, the BIS LBS reports banks' cross-border and local claims by counterparty country and counterparty sector. The public version of the BIS LBS does not include the detailed securities breakdown by sector. Instead, we rely on the restricted version of the BIS LBS (available only to central banks) and the confidential version of the dataset (available only to BIS staff) to obtain the government and corporate bond breakdown. In particular, we define government bonds as all debt securities issued by the general government and corporate bonds all other types of debt securities not issued by the general government.

In addition to the securities held by all banks domiciled in the reporting country, the BIS LBS also includes additional data on securities holdings of domestic banks as well as foreign branches and subsidiaries. We make use of this additional breakdown to compare the portfolio composition of domestic banks and foreign banking organizations (FBOs) located in the same country.

In terms of the sample period of the BIS LBS data, we focus on 2016.Q4 to 2021.Q4 to match the Solvency II data. The sectoral breakdown of the BIS LBS only includes the financial and non-financial sector prior to 2013, and government bond holdings were aggregated with other non-financial corporate bond holdings. The sectoral breakdown is more granular since 2013, including the general government sector. Several major reporting countries report the more granular sectoral break only since 2016.Q4. Among the 31 sample countries covered in the insurance data, 16 countries are BIS reporting countries, of which 15 countries report government and corporate bond breakdown for banks' securities holdings.[12]

2.3 Other Data

In addition to the main data sets from the EIOPA and BIS, we also merge in several additional macro and financial data from various sources.

At the country-level, we construct the size of the insurance sector using total assets for all undertakings reported to EIOPA. We obtain the size of pension funds using pension statistics from the Organization for Economic Co-operation and Development (OECD). The sum of insurance and pension total assets give us the size of the ICPF sector. We use data from the European Central Bank Securities Statistics (SEC) and the BIS Debt Securities Statistics

[12] There are 16 BIS reporting countries in Europe: Austria (AT), Belgium (BE), Cyprus (CY), Germany (DE), Denmark (DK), Greece (EL), Spain (ES), France (FR), the Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Norway (NO), Portugal (PT), and United Kingdom (UK).

to obtain the size of the government and corporate bond outstanding. We obtain per-capita GDP from the World Bank World Development Indicators. In addition, we use 10-year government bond yields from Bloomberg to measure benchmark interest rates and 5-year benchmark sovereign credit default swap (CDS) spreads from Markit to measure sovereign credit risk.

3 ICPF Sector and Structure of Fixed Income Markets

We first discuss favorable regulatory treatments of government bonds for insurers and banks, and the scarcity of government bond supply relative to the size of the ICPF sector in Europe. We then present some cross-country relationships among the size of the ICPF sector and the composition of domestic bond market, and the level of interest rates and credit risk.

3.1 In Search of Government Bonds

European government bonds receive very favorable regulatory treatments for banks and insurance companies. Under the Solvency II regulation, all sovereign bonds from the EEA and the OECD countries are deemed to be default-free and face no capital charge related to credit risk, counterparty-risk, and concentration risk. Under the EU Capital Requirement Regulation, a single rulebook for European banks, government bonds issued by EU member states in the same currency receive a zero credit risk weight when calculating risk-weighted capital requirements. Government bonds are also exempted from large exposure risk for banks. Furthermore, all government bonds of EU member states are considered Level-1 High Quality Liquid Assets for the Basel III Liquidity Coverage Ratio calculation.

Despite favorable regulatory treatments for banks and insurers, the reality is that there are not enough government bonds outstanding relative to the size of ICPF sector and banks' securities portfolio in Europe. Figure 1 compares the the size of total assets of insurance companies and pension funds, together with the size of the banks' securities portfolios, with the amounts of government and corporate bonds outstanding as of 2019.Q4. The bar charts divide our 31 sample countries into four country groups: low-interest rate euro-area countries (EUR-Low i), high-interest-rate euro-area countries (EUR-High i), other non-euro-area advanced economies (Other AE), and other non-euro emerging European countries (Other EM). In EUR-Low i and Advanced AE, the combined size of the ICPF sector's and banks' securities portfolios is 2-3 times the size of outstanding government bonds. In EUR-High i, the size of the ICPF sector plus banks' portfolio remains larger than outstanding government bonds. In the Other EM group, the size of the government bond market is greater than the size of the ICPF sector.[13] By comparing across all four country groups, we can see that the estimated total size of the ICPF sector and the bank portfolio is $16 trillion larger than total government bond outstanding in Europe. Therefore, it would not be possible for the overall sector to invest all in government bonds as the yields on those bonds would be very negative.

3.2 ICPF Sector and Characteristics of Domestic Bond Markets

In Figure 2, we document a significant cross-country relationship between the composition of the domestic fixed income markets and the size of the ICPF sector. Countries with a larger ICPF sector tend to have more corporate bonds relative to government bonds outstanding. The 31 EEA countries are heterogeneous along both dimensions. The share of corporate bonds in domestic fixed-income securities outstanding ranges from less than 0.1 for Hungary to more than 0.8 for Finland, and the size of the ICPF sector ranges from 8 percent of GDP for Romania and 370 percent of GDP for Denmark and 400 percent of GDP for Luxembourg.

Panels (a) and (b) of Figure A1 show that this strong correlation is largely driven by the size of the corporate bond market instead of the size of the government bond market. In fact, the size of the government bond market is essentially uncorrelated with the size of the ICPF sector across countries, as the supply of government bonds is largely driven by fiscal policy considerations. Meanwhile, the size of corporate bonds for both financial and non-financial corporations is strongly correlated with the size of the ICPF sector (Appendix Figure A2).

The natural question is whether the size of the corporate bond market and the size of the ICPF sector are both driven by the level of financial development. In Table 1, we regress the share of corporate bonds in total domestic fixed-income outstanding on the size of the ICPF sector and other macroeconomic variables. We show that the significance of the ICPF sector size remains after controlling for per-capita income as a proxy for the level of financial development (Column 2). Furthermore, using data from the BIS LBS, we can see that banks' securities holdings (Column 3) and banks' total assets (Column 4) do not appear to be significantly correlated with the size of the corporate bond market once we control for the ICPF sector size and per-capita income. Overall, the cross-country relationship between the ICPF sector size and the size of the corporate bond market is very robust.

This cross-country relationship is consistent with the central message in the AFA presidential address by Scharfstein (2018) that a large pension sector promotes domestic capital market deepening. Our focus is on the combined pension and insurance sector and we high-

[13]None of the countries in the Other EM group is a BIS reporting country, so we do not have data on banks' securities portfolios for this group.

light the special role of the size of the corporate bond market as a potential key margin of adjustment.

In addition to the size of the ICPF sector, the share of corporate bonds in domestic fixed income is also strongly negatively correlated with the level of domestic interest rates, as measured by the 10-year government bond yield in Panel (a) of Figure 3, and the level of sovereign credit risk, as measured by the 5-year sovereign credit default swap spread in Panel (b) of Figure 3. Countries with a lower corporate bond share in total fixed income tend to have higher nominal interest rates and higher sovereign default risk.

4 International Portfolio Frictions

We now document the two new portfolio frictions, domestic projection bias and going native bias, for both European banks and insurers. We begin by presenting some portfolio summary statistics for banks' and insurers' securities portfolios.

4.1 Portfolio Summary Statistics

Given that all insurers in the EEA countries are subject to the same Solvency II regulation and have access to global capital markets with little capital controls, one might expect that all insurers have similar portfolio allocations. However, insurers' asset allocations are vastly different across countries. Figure 4 shows the portfolio composition across three major asset classes by country. While fixed-income investments account for the bulk of insurers' investment portfolios in most countries, the share of government bond varies from 15 percent for Norway to 90 percent for Hungary. The cross-currency heterogeneity in portfolio allocation remains strong within the euro area.

In addition, European insurers have significant international investments outside their home country and the "home bias" is not particularly strong for most countries in our sample. Figure 5 shows the shares of government and corporate bonds invested at home. The median home share in fixed income investments is 42%. The home share is on average higher for government bonds than for corporate bonds, again with large cross-country heterogeneity.

As for European banks, the median of the corporate bond share in the debt securities portfolio is equal to 0.57, with a cross-country standard deviation equal to 0.22. This is comparable to a median corporate bond share of 0.47 for insurers, with a cross-country standard deviation equal to 0.19. The median home investment share for banks' debt securities portfolio is 0.57, somewhat higher than the 0.42 median home investment share for insurers' fixed-income portfolio. Home investment shares for banks and insurers are strongly correlated across countries (Appendix Figure A3).

4.2 Correlation with the Composition of Domestic Fixed-Income

As we have seen in Figure 2, countries have a different mix of domestic corporate and government bonds outstanding. Figure 6 shows a remarkable relationship that the share of corporate bonds in insurers' fixed income portfolio mimics the share of corporate bonds in total fixed-income securities outstanding in the domestic market almost exactly. Each dot in the figure denotes the average portfolio of all insurers domiciled in a given country, regardless of the nationality of their parent company.[14] Insurers domiciled in countries with more corporate bonds relative to government bonds also hold more corporate bonds in their fixed income portfolios. A very similar relationship holds for banks' debt securities holdings (Figure 7).[15] In spite of the favorable regulatory treatment of government bonds, banks in countries with more corporate bonds outstanding also hold larger shares of corporate bonds in their debt securities portfolios.

Domestic Projection Bias

Panels (a) and (b) in Figure 8 show the relationship between the share of corporate bonds in domestic fixed-income securities outstanding and insurers' portfolio share of corporate bonds in domestic and foreign fixed-income investments, respectively. While it might not be very surprising that the corporate bond portfolio share in domestic investments tracks the composition of the domestic bond market closely, as shown in Panel (a), standard portfolio theory would predict that investors would offset the domestic characteristics when they invest abroad to achieve an overall optimized portfolio. In other words, a frictionless portfolio model would predict that the corporate bond share in foreign investments should be negatively correlated with the share of corporate bonds in total fixed-income securities outstanding at home. Insurers in countries with a limited supply of domestic government bonds can invest relatively more in government bonds abroad to achieve the optimal overall exposure to credit risk.

However, contrary to the logic implied by standard portfolio theory, Panel (b) of Figure 8 shows that the share of corporate bonds in insurers' foreign fixed income portfolios on average *increases* in the share of corporate bonds in domestic fixed income for the vast majority of countries, an illustration of the "domestic projection bias." In countries with exceptionally

[14]For example, the Italian subsidiary of AXA (a French multinational insurance group) belongs to Italy (IT) in the figure, as it reports to (and falls under the supervision of) the Italian National Supervisory Authority.

[15]Due to the data confidentiality requirement, we do not label country names in Figure 7.

large domestic corporate bond markets (e.g., the corporate bond share exceeds 0.8 of the total domestic fixed income in Denmark and Sweden), the corporate bond share in foreign investments is indeed lower than the share in domestic investments, but it nevertheless remains high. Overall, insurers' foreign investment patterns preserve the strong co-movement between the relative supply of domestic corporate bonds and the share of corporate bonds in the overall fixed income portfolios in Figure 6.

The share of corporate bonds in banks' securities portfolios follows very similar patterns. Due to data confidentiality restrictions, we do not show cross-country scatter plots of banks' portfolio characteristics. Instead, we illustrate the relationship using cross-country regressions. In Table 2, we regress the portfolio share invested in corporate bonds on the share of corporate bonds in domestic fixed-income securities outstanding for both insurers and banks. In Column 1, we find that the slope coefficient is equal to 0.55 for banks' overall securities portfolio, similar to the coefficient obtained for insurers that equals 0.49. In Column 2, we find that banks' corporate bond share in their home investment portfolios increases one-for-one with the share of corporate bonds in domestic fixed-income outstanding. This suggests that banks' domestic portfolio allocation follows the composition of domestic fixed-income securities closely. Meanwhile, Column 3 illustrates the "domestic projection bias" for banks, as the share of corporate bonds in banks' foreign investments is weakly increasing in the relative supply of corporate bonds at home, so the foreign portfolios do not offset characteristics of the domestic fixed-income market.

In ongoing work, we are exploring whether the foreign allocations can be summarized by a small number of clusters with similar characteristics (e.g., in terms of proximity, currency denomination, and riskiness), which may then form more localized, well-integrated financial markets.

Going Native Bias

It is also commonly believed that when large multinational groups operate in foreign countries, they exhibit less home bias compared to local investors due to better information and investment expertise about international markets, and so forth. We divide our sample of life insurers into two subsamples: domestic solos (referred to as "domestic firms"), and local solos that belong to a foreign group (referred to as "foreign firms"). For example, AXA is a French multinational group, its subsidiary in Italy will be considered a "foreign firm" in Italy, whereas its French subsidiary will be treated as a "domestic firm" in France.

Figure 9 shows that the strong relationship between the corporate bond portfolio share and the composition of domestic fixed income markets holds for *both* domestic and foreign firms. When "foreign firms" operate in local markets, they behave as if they were "domestic firms" and their portfolios strongly track the domestic supply of corporate versus government bonds. We refer to this behavior as the "going native bias," i.e., the fact that local subsidiaries of foreign multinational inherit the portfolio bias of domestic firms as a function of domestic characteristics. The similarity between local and foreign firms undermines several traditional hypotheses in explaining portfolio home bias, such as information asymmetries, lack of investment expertise in international markets, and behavioral reasons that lead to more optimistic beliefs about domestic assets.

Furthermore, banks portfolio also exhibit a similar "going native bias." Columns 4 and 5 of Table 2 report regression coefficients of the portfolio share in corporate bonds for local banks, and local branches and subsidiaries of foreign banks, respectively, on the share of corporate bonds in domestic fixed-income securities outstanding. Again, we can see that the portfolios of both domestic banks and foreign banks operating in local markets strongly track domestic characteristics, with the slope for foreign banking organizations being even steeper.

4.3 The Role of Domestic Interest Rates and Sovereign Credit Risk

Another important characteristic of the domestic financial market is the level of domestic interest rates and, relatedly, the level of sovereign credit risk. As shown in Figure 3, the average 10-year government bond yield in our sample varies from 0 to 4 percent. The five-year sovereign CDS spread varies from 10 basis points to 350 basis points. We now examine how the level of the domestic interest rate and credit risk is related to insurers' overall portfolio allocation.

We follow three approaches to study the relationship between the benchmark domestic interest/credit risk and portfolio allocation. First, we merge the Solvency II security-level holdings data with the Centralized Securities Database (CSDB) from the European Central Bank to calculate the value-weighted portfolio interest rate on the overall fixed income portfolio. One important limitation of this approach is that a large fraction of the securities do not have their yields reported in the CSDB dataset. The securities with missing yield information could include private placements directly targeting the ICPF sector and illiquid securities rarely traded in the secondary market. With this caveat in mind, Panel (a) of Figure 10 shows that the overall portfolio interest rate is positively correlated with the level of the 10-year government bond yield. Insurers in high-interest-rate countries tend to have a high overall portfolio yield, although the relationship is not particularly strong relationship within the euro area.

Second, we construct a hypothetical portfolio yield for each insurer as the value-weighted average of the benchmark government bond yields across all investment destination countries. In this case, we can characterize the entire portfolio allocation without incurring the missing data issue. The obvious drawback is that we lose heterogeneity in yields across issuers within a destination country. Panel (b) of Figure 10 displays an even stronger relationship between the level of the domestic benchmark bond yield and the hypothetical portfolio yield, including a robust relationship within the euro area. To interpret this result, we can use the level of the benchmark government bond yield as a proxy for the perceived risk of a country, either from higher inflation or higher default risk. So the hypothetical portfolio yield we constructed gives us an estimate of an insurer's overall country risk exposure. Our finding suggests that when insurers invest abroad, they also tend to invest in foreign countries with similar risk to the domestic market.

Third, using a very similar approach as the second approach, we can calculate the average portfolio sovereign CDS spread as value-weighted average of sovereign CDS spreads across all investment destination countries. Panel (c) of Figure 10 displays an even stronger cross-country pattern and confirms that the credit risk in the overall investment portfolio is higher if the home sovereign is riskier.

In summary, all three approaches arrive at the same conclusion that insurers' overall portfolio yield or credit risk is strongly correlated with the domestic interest rate or credit risk across countries. We next show that the two previously documented portfolio frictions "domestic projection bias" and "going native bias" help to explain the important role of domestic interest rates and credit risk in shaping the overall portfolio.

Domestic Projection Bias

Figure 11 follows the first approach based on the merge of the Solvency II holdings data and the CSDB data, and calculates the value-weighted average portfolio yield on the government and corporate bond portfolio, separately for home and foreign investments. The upper left panel plots the average government portfolio yield against the 10-year domestic government bond yield. Not surprisingly, the overall domestic government bond portfolio tracks the 10-year government bond yield very closely. The slope of the relationship is slightly below 45 degree, largely driven by insurers in several high-interest-rate countries where the duration of the domestic government bond portfolio is lower than that of a benchmark 10-year government bond.

The "domestic projection bias" for government bonds shows up in the upper right panel of Figure 11, where we plot the average portfolio yield on all foreign government bonds against the 10-year domestic government benchmark yield. We can see that insurers domiciled in higher-interest-rate countries also tend to invest in higher-yielding foreign government bonds. In other words, insurers in higher interest rate countries do not neutralize domestic government bond risk via safer government investments abroad.

The bottom two panels show the relationship between the domestic interest rate and the average yield on the domestic corporate bond portfolio and the foreign corporate bond portfolio, respectively. We have similar findings that the yield on both domestic and foreign corporate bond portfolios increase with the benchmark domestic interest rate. Again, the presence of domestic projection bias for corporate bonds means that foreign corporate bond investments do not neutralize the role of domestic country risk.

Due to the very granular security-level data from Solvency II, we have so far focused our discussion in this section on portfolio characteristics of insurers. We present some additional results on banks' portfolio in Appendix Table A1. From the restricted version of the BIS LBS, we have information on banks' portfolio allocation by country. We find that banks' overall portfolio risk is also highly correlated with their own country risk. In addition, we observe the "domestic projection bias" as the risk in banks' foreign investments increases in their own country risk, rather than offsetting it. Banks domiciled in riskier countries tend to have riskier foreign portfolios.

Going Native Bias

While foreign investments do not neutralize the role of domestic interest rates and credit risk, can foreign firms (as before, defined as local subsidiaries of foreign multinational groups) help to break the connection with the local interest rate/credit risk and overall portfolio allocation? Figure 12 delivers a negative answer. Panel (a) of Figure 12 plots the relationship between the weighted portfolio sovereign CDS spread and home sovereign CDS spread for domestic firms, and Panel (b) plots the same relationship for foreign firms. The slope relationship is very similar across the two figures. The going native bias manifests itself as the yield on the overall portfolio of foreign firms domiciled in the local markets also strongly tracks the domestic credit risk. Similar results hold for the portfolio interest rates (Appendix Figure A4).[16]

5 How Do Insurers Absorb Higher Credit Risk?

We have so far documented that countries differ systematically in the size of domestic corporate bond markets and the level of domestic interest rates, which are related to insurers'

[16] We do not have separate portfolio data on domestic and foreign banks' securities holdings from the BIS LBS, so we cannot directly address "going native bias" for banks when it comes to the portfolio yield or credit risk.

portfolio allocations. That said, investing in corporate bonds is significantly more costly from the regulatory capital perspective. The risk-weighted capital charge for banks and insurers to hold corporate bonds depends on the ratings and maturity of the bonds. In this section, we examine how insurers absorb the additional credit risk in their portfolios.

5.1 Decomposition of the SCR Coverage Ratio

Under Solvency II, insurers are required to hold a sufficient amount of own funds (OF) so that they can survive 99.5% of the most extreme losses over the course of a year, which is known as the Solvency Capital Requirement (SCR). The SCR coverage ratio is given by the ratio of eligible own funds (OF) over the required SCR:

$$\text{SCR Coverage Ratio}_{i,t} = \frac{OF_{i,t}}{SCR_{i,t}},$$

and the SCR coverage ratio has to be at least 100% for the insurer to stay in compliance with the regulation.

In Europe[17], it is common to have life insurance products with minimum return guarantees and some form of profit sharing agreements.[18] If the underlying assets increase in value, the realized or unrealized gains that need to be shared with policyholders are known as the future discretionary benefits.[19] When calculating the SCR, Solvency II allows insurers to deduct the impact on the future discretionary benefits from the gross SCR (gSCR) to arrive at the net SCR (nSCR).[20] We can write the net SCR as the gross SCR times an adjustment

[17]The closest example of such a policy in the US life insurance market is the Universal Life insurance contract where the cash value typically earns a minimum guaranteed rate of return. Insurers then tie an extra return on the contract accumulations to the portfolio rate of return earned by the insurer.

[18]For example in Germany, insurers are required by law to distribute the same contract return in a given year to all policyholders. Policyholders with contracts that have lower guaranteed minimum returns are paid a higher bonus. When the minimum guaranteed return is binding only for some policyholders, all policyholders receive the same contract return except those holding a contract with a guaranteed return above that return, who instead earn their guaranteed return. Concretely, if the company decides this year that the contract return is 4.2%, then policies with a 3% guarantee will get 3% (guaranteed part) plus a bonus of 1.2% (profit sharing), 4% guaranteed contracts will get 4% (guaranteed part) plus a bonus of 0.2% (profit sharing), and 5% contracts receive 5% and no bonus.

[19]Across EU countries, national regulations do impose a profit-sharing mechanism and this might happen in different ways. Indeed, by law, French life insurance companies have to pay policyholders at least 85 percent (e.g. in Germany at least 90 percent) of their net financial revenues namely, dividends, coupons, rents, and realized capital gains. Realized capital gains materialize only when the insurer decides to liquidate the investments. Therefore, the timing of distribution is not synchronized with that of asset returns, because these can be hoarded as reserves before being credited to policyholders accounts.

[20]Art. 103 of the Solvency II directive indicates to calculate the SCR by adjusting for the loss absorbing capacity of technical provision. As discusses in Art. 108, this adjustment shall reflect potential compensation of unexpected losses on investments through a simultaneous decrease in technical provisions or deferred taxes or a combination of the two. That adjustment shall take account of the risk mitigating effect provided by

factor $\phi_{i,t}$, which accounts for the future discretionary benefits expressed as a fraction of the gross SCR:

$$nSCR_{i,t} = gSCR_{i,t} \times (1 - \phi_{i,t}).$$

When $\phi_{i,t}$ is higher, an insurer can share more of the portfolio risk with policyholders. In this case, the liability of the insurer has a higher loss absorbing capacity as $\phi_{i,t}$ is higher.

To analyze the effect of higher corporate bond holdings on insurers' capital ratios, we focus on the net market risk SCR, $nSCR^{mkt}_{i,t}$.[21] We can rewrite the SCR coverage ratio with respect to $nSCR^{mkt}_{i,t}$ as:

$$\frac{OF_{i,t}}{nSCR^{mkt}_{i,t}} \equiv \frac{OF_{i,t}}{Inv_{i,t}} \times \frac{Inv_{i,t}}{gSCR^{mkt}_{i,t}} \times \frac{1}{1-\phi_{i,t}}.$$

By taking logs, we can see that an increase in the corporate bond share, can be absorbed through one of three channels:

$$\underbrace{\ln\left(\frac{OF_{i,t}}{nSCR^{mkt}_{i,t}}\right)}_{\text{SCR coverage ratio}} = \underbrace{\ln\left(\frac{Inv_{i,t}}{gSCR^{mkt}_{i,t}}\right)}_{\text{investment risk}} + \underbrace{\ln\left(\frac{OF_{i,t}}{Inv_{i,t}}\right)}_{\text{leverage}} + \underbrace{\ln\left(\frac{1}{1-\phi_{i,t}}\right)}_{\text{loss absorbing capacity}}. \tag{1}$$

An increase in the corporate bond share mechanically increases the gross market risk SCR relative to total investments. An insurer can offset a riskier investment portfolio along three margins. First, the insurer can reduce leverage, which corresponds to a higher ratio of own funds to total investments. If an insurer holds more equity, it increases the capital intensity of the insurance company. Second, the insurer can increase the loss absorbing capacity of its liabilities by sharing the additional credit with policyholders. By partially passing market risk to policyholders, the insurer can sustain greater market risk in its total investments, but it increases the riskiness of households' balance sheets. Third, the insurer may lower its SCR coverage ratio. This lowers the financial stability of the insurance sector.

future discretionary benefits of insurance contracts, to the extent (re)insurance undertakings can establish that a reduction in such benefits may be used to cover unexpected losses when they arise. The risk mitigating effect provided by future discretionary benefits shall be no higher than the sum of technical provisions and deferred taxes relating to those future discretionary benefits.

[21] Besides market risk, the total Basic SCR also includes six other categories of risk: counterparty default risk, life underwriting risk, health underwriting risk, non-life underwriting risk, diversification, and intangible asset risk. In our sample, the market risk on average accounts for the majority of the Basic SCR.

5.2 Empirical Estimates of Different Margins of Adjustments

To estimate the relative importance of these three channels, we regress each term in Equation (1) on the share of corporate bond in total investments ($CorpShare_{i,t}$) and time fixed effects α_t:

$$
\begin{aligned}
\ln\left(\frac{OF_{i,t}}{nSCR^{mkt}_{i,t}}\right) &= \alpha_t + \beta_{cr} CorpShare_{i,t} + \varepsilon^{cr}_{i,t}, \\
\ln\left(\frac{Inv_{i,t}}{gSCR^{mkt}_{i,t}}\right) &= \alpha_t + \beta_{gscr} CorpShare_{i,t} + \varepsilon^{gcsr}_{i,t}, \\
\ln\left(\frac{OF_{i,t}}{Inv_{i,t}}\right) &= \alpha_t + \beta_{lev} CorpShare_{i,t} + \varepsilon^{lev}_{i,t}, \\
\ln\left(\frac{1}{1-\phi_{i,t}}\right) &= \alpha_t + \beta_{lac} CorpShare_{i,t} + \varepsilon^{lac}_{i,t}.
\end{aligned}
$$

The identity in Equation (1) then implies

$$\beta_{cr} = \beta_{gscr} + \beta_{lev} + \beta_{lac}. \tag{2}$$

Panel A of Table 3 reports the regression coefficients from these panel regressions for the full sample. We standardize the corporate bond share based on the full sample. The slope coefficients therefore correspond to a one standard deviation change in the corporate bond share (across countries and years).

In Column (1), we see that a one standard deviation increase in the corporate bond share corresponds to a 13.6% reduction in the ratio of own funds to the net market risk SCR in the cross-section of insurers, or an overall deterioration in the regulatory capital ratio. To see the decomposition of this relationship as shown in Equation (2), Column (2) shows that a one standard deviation increase in the corporate bond share corresponds to a 45.6% increase in the gross market risk SCR relative to own funds. As corporate bonds are subject to credit risk under Solvency II, whereas government bonds are not, insurers with higher corporate bond shares have riskier investment portfolios according to the gross SCR measure. To partially offset this increase in market risk, Column (3) shows that insurers lower their leverage; a one standard deviation increase in the corporate bond share leads to a 23.9% increase in the ratio of own funds to total investments. In addition, Column (4) shows show that the loss absorbing capacity also increases by 8.13% and insurers thus pass some of the investment risk to policyholders.

Taken together, by increasing the allocation to corporate bonds, insurers mechanically raise their gross market risk substantially. On average, they use all three margins to offset the higher risk: a reduction in leverage, pass-through of investment risk to policyholders, and a reduction in regulatory capital ratios. However, the relative importance of the three channels varies across regions. As shown in Panels B and C of Table 3, insurers in the euro area primarily reduce their leverage to accommodate a higher corporate bond share. The net SCR coverage ratio is hardly affected and the pass-through of investment risk to policyholders is also small. However, in non-euro area countries, all three margins carry similar weights. Figure 13 visualizes the relative importance of the different margins. Outside of the euro area, all three margins are important and a reduction in leverage absorbs less than half of the increase in the gross SCR coverage ratio.

6 Implications for Theory and Broader Policy

In this section, we discuss potential explanations of the biases that we document. As will be clear from the discussion below, the observed deviations from frictionless portfolio choice models can be for rational or behavioral reasons. We outline some explanations in this section, and leave an in-depth exploration for future research. In addition, we discuss the policy implications of our findings.

6.1 Implications for Theory

Economic intuition We discuss the implications of our findings for models of fixed income markets featuring regulated investors. While there has been little focus on the asset allocation decisions of banks in terms of government bonds relative to corporate bonds, this question has been explored for insurance companies. An initial observation made in this literature is that frictionless models imply that insurers hold no corporate bonds, which is clearly counterfactual. Intuitively, if insurers cannot create value by generating positive risk-adjusted returns in corporate bond markets, then the optimal allocation to corporate bonds is zero as the risk weights of corporate bonds exceed those of government bonds.

To explain insurers' portfolios, models then allow for abnormal risk-adjusted returns ("alphas") in corporate bond markets due to liquidity premia (Chodorow-Reich et al., 2021; Knox and Sørensen, 2020) or due to leverage constraints of other investors in the economy (Koijen and Yogo, 2023b). However, as the ICPF sector grows, liquidity premia shrink and leverage constraints are less binding, and this weakens these mechanisms.

We discuss a simple extension to these models to match our empirical evidence, motivated by Figure 1. As the size of the banking and ICPF sectors is much larger than the face value of bonds issued by government bonds, government bond yields would be strongly negative if premium income, pension contributions, and a share of deposits are all directed to government bonds. This line of reasoning is consistent with the evidence in, for instance, Greenwood and Vayanos (2010), Greenwood and Vissing-Jørgensen (2018), and Jansen (2023).

The large convenience yields embedded in long-term government bonds would motivate other (unregulated) investors to reduce their allocation to long-term government bonds and ultimately short them, and invest more in corporate bonds (and other close substitutes such as mortgages and covered bonds). This effect is more pronounced when the banking and ICPF sectors are larger. Banks and insurance companies can now create value by reducing the allocation to government bonds and tilt to close substitutes that are not too capital intensive (Koijen and Yogo, 2023b). If, in addition, the supply of safe corporate bonds is elastic, the model is consistent with the cross-country facts on the size of the ICPF sector, the structure of fixed income markets, and banks' and insurers' fixed income portfolios.

In developing the model, we take insurance companies as the representative regulated institutions. The model can easily be extended to feature banks and pension funds. In case of banks, an interesting additional question is what motivates the banks' demand for longer-duration assets, given short-term nature of the liabilities, which is the central question in an active literature (Drechsler et al., 2021).

Outline of the model We summarize the model and main insights here, and provide additional derivations in Appendix A. As discussed, the model follows Koijen and Yogo (2023b), except that we endogenize the price of long-term government bonds and the supply of corporate bonds.

There are two periods indexed by $t = 0, 1$. There are three sets of actors: a continuum of households, insurance companies, and asset managers. Households allocate capital to asset managers and buy annuities. The price of annuities contract per dollar of face value is given by $\pi P_G(1 + \phi)$, where π is the (idiosyncratic) survival probability, P_G the price of the long-term government bond that pays off 1 in case of survival, and $\phi \geq 0$ the markup. The demand for insurance slopes down and is given by $H_I = \frac{\Delta}{P_G}$. The total premium income in period $t = 0$ is then $\pi(1 + \phi)\Delta$ and the payout in period $t = 1$ is πH_I.

In addition to the long-term government bond, investors trade corporate bonds with price P_C and payoff $P_C \sim N(\mu_C, \sigma_C^2)$. Asset managers also hold the equity issued by insurers. The (endogenous) dividend of the insurers is denoted by D_I. We define $P = (P_C, P_I)$, $R_f = \frac{1}{P_G}$ as the long-term interest rate, and $D = (D_C, D_I)$ with $\mu = E[D_1]$ and $\Sigma = Var(D)$.[22]

[22]Formally, Σ is singular as we have two assets and a single risk factor. We add a small amount of additional risk to insurers' dividend to avoid this technical issue if we need to invert the covariance matrix.

Asset managers have mean-variance preferences over period-1 assets, $A_{A,1}$,

$$E[A_{A,1}] - \frac{\gamma}{2}Var(A_{A,1}),$$

where $A_{A,1} = Q_A'D + (A_{A,0} - Q_A'P)R_f$ and Q_A the number of corporate bonds and shares in the insurer held. Asset managers cannot short government bonds,

$$Q_A'P \leq A_{A,0}. \tag{3}$$

Insurers decide on their holdings in corporate bonds, $Q_{I,C}$, and the remainder is invested in government bonds. Insurers start with initial equity E and pay a regulatory cost $C(Q_{I,C}) = \frac{\kappa}{2}(Q_{I,C})^2$ when investing in corporate bonds. Their initial assets are then given by $A_{I,0} = E + \pi(1+\phi)\Delta - \frac{\kappa}{2}(Q_{I,C})^2$, and the dividend is given by

$$D_I = Q_{I,C}D_C + (A_{I,0} - Q_{I,C}P_C)R_f - \pi H^I.$$

Insurers choose $Q_{I,C}$ to maximize firm value, $\max_{Q_{I,C}} P_I$.

Market clearing implies that

$$\begin{aligned} Q_{A,C} + Q_{I,C} &= S_C \\ Q_{A,I} &= 1 \\ Q_{A,G} + Q_{I,G} &= S_G, \end{aligned}$$

where S_C (S_G) is the supply of corporate (government) bonds and the supply of insurers' equity is normalized to 1.

Implications for asset prices and insurers' asset allocation The equilibrium price of corporate bonds is given by

$$P_C = \frac{1}{R_f + \lambda}\left(\mu_C - \gamma S_C \sigma_C^2\right), \tag{4}$$

where λ is the Lagrange multiplier on the short-sales constraint of government bonds (Inequality (3)). Insurers' equity prices, as a function of their corporate bond holdings, equal

$$P_I(Q_{I,C}) = \frac{1}{R_f + \lambda}\left(\frac{\lambda}{R_f + \lambda}\left(\mu_C - \gamma S_C \sigma_C^2\right) Q_{I,C} + (E - \frac{\kappa}{2}Q_{I,C}^2 + \phi\pi\Delta)R_f\right). \tag{5}$$

If short-sales constraints do not bind, $\lambda = 0$, then the optimal allocation is $Q_{I,C} = 0$.

Given the valuation of insurers' equity, we maximize it to determine the optimal allocation to corporate bonds:

$$Q_{I,C} = \frac{1}{\kappa R_f} \frac{\lambda}{R_f + \lambda} \left(\mu_C - \gamma S_C \sigma_C^2\right). \tag{6}$$

Equations (4)-(6) are as in Koijen and Yogo (2023b). Fixing R_f, Koijen and Yogo (2023b) emphasize that $\lambda > 0$ leads insurers to tilt from government bonds to corporate bonds. This reallocated is muted when holding corporate bonds is more capital intensive.

The model also implies that $\frac{\partial Q_{I,C}}{\partial R_f} < 0$ when $\lambda > 0$, implying that the optimal allocation to corporate bonds increases when the yield on long-term government bonds falls.

We solve for R_f from the market-clearing equation for long-term government bonds,

$$A_{A,0} - Q_A' P + A_{I,0} - Q_{I,C} P_C = S^G P_G,$$

which implies that R_f declines if the ICPF sector grows and if the sector can only invest long-term government bonds ($\kappa \to \infty$). The convenience for insurers to satisfy regulatory requirements is offset by lack of convenience for asset managers who do not face such constraints. When the short-sales constraint binds, $\lambda > 0$, it is optimal for the insurers to invest in corporate bonds (for $\kappa < \infty$).

So far, we kept S_C constant. If the supply of corporate bonds is elastic,

$$S_C = s_{0c} + s_{1c} P_C,$$

with $s_{0C}, s_{1C} > 0$, then

$$P_C = \frac{\mu_C - \gamma s_{0C} \sigma_C^2}{\gamma \sigma_C^2 s_{1C} + R_f + \lambda}.$$

Comparing this equation to Equation (4), we see that the impact of declining interest rates is muted as firms increase the supply of corporate bonds. The additional elasticity provided by the corporate sector implies that the size of corporate bond markets increases in the size of the ICPF sector, as we document empirically.

While the theory is intentionally extreme to highlight the economic mechanism at work, in reality asset managers, hedge funds, and households also hold government bonds. This demand, which may be quite inelastic, further reduces the residual supply available to regulated institutions, and it only strengthens the main mechanism that we put forward. At a high level, the simple fact that the assets of regulated institutions far exceed the face value of government bonds outstanding has implications for the structure of financial markets, as we show empirically.

6.2 Explaining International Portfolio Frictions

The model can explain the connection between domestic fixed income portfolios, the structure of domestic financial markets, and the size of regulated financial institutions. We now discuss potential micro-foundations for the new international portfolio frictions that we document. It is straightforward to enrich the model along these dimensions, as we discuss below.

Domestic Projection Bias When investing abroad, we observe that insurers operating in safe (risky) countries allocate capital to other safe (risky) countries. This raises the question why insurers in safe countries do not invest in the government bonds of risky countries and vice versa.

Insurers in safe countries may not want to invest in government bonds of risky countries due to internal risk constraints (even though regulatory risk weights are still zero). The model can easily be extended to feature an additional internal risk constraint.

Insurers in risky countries face "right-way risk:" when the sovereign defaults, the insurer may not be able to survive itself. This state of the world therefore carries little weight and insurers do not value bonds that pay off in those states (that is, safe government bonds). In addition, local insurers may price insurance products with higher yields for the same reason, which may force the insurer to adjust their pricing and allocation as well. When investing abroad, it is then optimal to invest in other risky countries, which is particularly true when sovereign stress is correlated across Europe, as we observed during the European sovereign debt crisis.

Another reason why insurers allocate more capital to corporate bonds when investing abroad when they also invest a larger share of their domestic portfolio in corporate bonds is that they acquire (perceived) unique expertise in corporate bond markets. This explanation has testable predictions for the (risk-adjusted) returns they earn in corporate bond markets that can be explored in future research.

Going native bias The going native bias that we observe can be explained by inertia or residual influence of national supervisors. Oftentimes, the subsidiaries of banks and insurance companies are the result of acquisitions. If regulated institutions are slow to harmonize asset allocation divisions, the going native bias can reflect those legacy acquisitions. A related explanation is that regulation was more fragmented under Solvency I. As Solvency II was introduced in 2016, insurers may not have fully adjusted yet. The same reasoning applies to banks.

In both cases, however, it is puzzling why the adjustment takes so long, in particular as we show that the influence of the structure of local fixed income markets has a significant impact on insurers' regulatory ratios.

A second possibility is that national supervisors still influence the decisions of insurers located in a given country. For instance, the conduct regulation and product approval (in case of subsidiaries) still resides with national supervisors, despite the harmonization of the financial stability regulation. This frequent interaction with national supervisors may induce the going native bias. It may also be the case that some form of financial repression contributes to the observed portfolios.

For both biases, it will be interesting to analyze the allocations of banks and insurance companies prior to the European sovereign debt crisis. During this period, yields on sovereign bonds converged quickly following the introduction of the euro. It may be insightful to understand how regulated institutions adjusted their portfolios both before and right after the crisis. We are exploring whether the more limited Solvency I data can be used to make progress on this important question.

6.3 Broader Policy Implications

We now discuss the broad takeaways of our empirical results for European financial market deepening and capital market integration, monetary policy transmission and financial stability, and multi-sectoral approach to regulatory design.

Financial Market Deepening and Capital Market Integration Against the backdrop of the scarce supply of government bonds relative to the size of the ICPF sector in Europe, our paper provides compelling evidence that the ICPF sector plays an important role in shaping the structure of domestic financial markets, in particular, in promoting the development of corporate bond markets.

Our results on international portfolio frictions also highlight significant barriers to pan-Europe capital market integration. Even with an overall high degree of cross-border holdings of assets, insurers' and banks' overall portfolios closely mimic characteristics of domestic financial markets. The "domestic projection bias" highlights the inability of these investors to deviate significantly from their local market characteristics when investing abroad. The "going native bias" highlights the need of local subsidiaries of foreign firms to conform with the investment strategy of local firms when operating in the local markets. These portfolio frictions also imply that the spillover effects of a large ICPF sector in a single country on financial market deepening in other countries with very different characteristics remain quite limited.

These findings have implications for efforts to foster capital market deepening and integration in Europe. Without overcoming the new international portfolio frictions, the substitutability across countries and segments of the bond market is more limited compared to what we would expect in perfectly integrated and frictionless financial markets. Therefore, understanding and – if at all possible – mitigating the impact of those frictions is a first-order question for academics and policymakers.

Monetary Policy Transmission and Financial Stability Our results also have broad implications for the transmission of conventional and unconventional monetary policy. Given the large cross-country heterogeneity in insurers' and banks' exposure to corporate credit risk, as so far as government bonds and corporate bonds are differently affected by changes in the policy rate or asset purchase programs,[23] monetary policy is transmitted differentially across countries. This logic applies more broadly to the extent that macroeconomic shocks, such as those related to inflation or economic growth, also differentially affect government bond and corporate bond markets.

A key question for financial stability rests on how macroeconomic shocks are absorbed and which sector ultimately bears the risk. Through the decomposition exercise in Section 5 for European insurers, we show that insurers can accommodate higher corporate bond shares by lowering their regulatory capital ratio, which would reduce the resilience of the sector. Alternatively, they can reduce their gross leverage, which makes the insurance business more capital-intensive. Or, they can pass the credit risk to policyholders through profit and loss sharing agreements, which effectively transfers the macroeconomic risk from regulated entities to the household sector. Understanding the relative importance of these margins of adjustments helps policymakers to better assess and manage financial stability risk.

Lastly, our results have implications for the scarcity of government bonds in repo and securities lending markets as a result of the asset purchase programs of central banks. On the one hand, a large ICPF sector demands a large amount of government bonds, which can amplify the scarcity. The flip side is, however, that banks and insurance companies can lend those securities and collect a hefty fee, which in turn limits the scarcity of government bonds in repo and securities lending markets. In ongoing work, we use both the regulatory Solvency II filings as well as data on repo specialness to explore how government purchase programs, the size of the ICPF sector, and repo specialness interact.

Multi-sectoral Approach to Regulatory Design Another important insight from our paper is that a multi-sectoral approach to regulatory design might yield benefits. We have analyzed the portfolio decision of banks and insurance companies jointly, and have uncovered

[23]See Koijen et al. (2021) for estimates of the impact of asset purchase programs on the asset portfolio of institutional investors in the euro area.

remarkable similarities in the portfolio patterns across the two sectors. In the context of the demand for safe assets, both sectors compete for the scarce government bond supply. In particular, given the enormous size of the ICPF sector in Europe, banks' portfolio demand cannot be understood in isolation without a better understanding of the fixed-income demand from the ICPF sector.

Any change to the relative regulatory treatments of government and corporate bonds, especially for banks or insurers, or any other regulated entities, would not only tilt the investment portfolio of the directly impacted sector, but also the portfolios of the other sectors. Given different shock transmission and risk retention mechanisms as discussed above, it would be sub-optimal for regulators to consider their own sector under direct regulation in isolation. Instead, a multi-sectoral approach to regulatory design has the benefits of taking into consideration the effects of cross-sectoral spillovers. Extending our analysis to also cover open-ended fixed income funds, which tend to experience volatile flows during times of stress, is an important topic for research.

Lastly, there have been important changes to the regulatory frameworks of banks and insurance companies since the eighties. A common theme has been to introduce risk weights for assets and to single out government bonds as safe assets. This naturally increases the demand for governments from large, regulated sectors, which may have contributed to the secular decline in long-term interest rates. We leave a precise quantification of this force for future research.

7 Conclusions

We study the asset allocation decisions of European banks and life insurance companies across domestic and foreign fixed income markets using new data from regulatory Solvency II filings and the restricted version of the BIS Locational Banking Statistics. We show that the size of the ICPF sector far exceeds the size of government bonds outstanding in Europe, and countries with a large ICPF sector tend to have a large corporate bond market. While life insurers and banks allocate the majority of their assets abroad, the characteristics of domestic financial markets still dictate their' portfolio allocation along two dimensions. First, the size of domestic corporate bond markets relative to overall fixed income markets is strongly positively correlated with insurers and banks' overall fixed income allocations. Second, the interest rate and credit risk associated with their fixed income portfolio are strongly positively correlated with the level of domestic government bond yields and sovereign default risk.

Our findings cannot be explained by traditional international portfolio frictions such as home country bias and home currency bias, and we provide evidence for two new salient frictions. First, insurers and banks do not offset (and if anything amplify) the tilt inherited from the structure of domestic fixed income markets, which we label *domestic projection bias*. Second, multinational insurance and banking groups act like domestic entities when operating a subsidiary in another country, which we label *going native bias*.

We then explore how differences in credit risk assumed on insurers' balance sheets lead to (i) a more fragile insurance sector, (ii) lower leverage or (iii) insurance products that move the credit risk to the balance sheets of households. We conclude by discussing the importance of our findings for the transmission of monetary policy to insurance companies' balance sheets and broader capital market integration.

Our analysis raises broader questions about the about the interaction between banks and insurance companies in terms of financial stability and the design of regulatory frameworks. There is current little coordination between the regulatory frameworks of banks and insurers, but they naturally interact in fixed income markets. Our results therefore contribute to the broader research agenda on how to design regulation in a world with heterogeneous institutions that differ in the nature of their liabilities and assets beyond securities.

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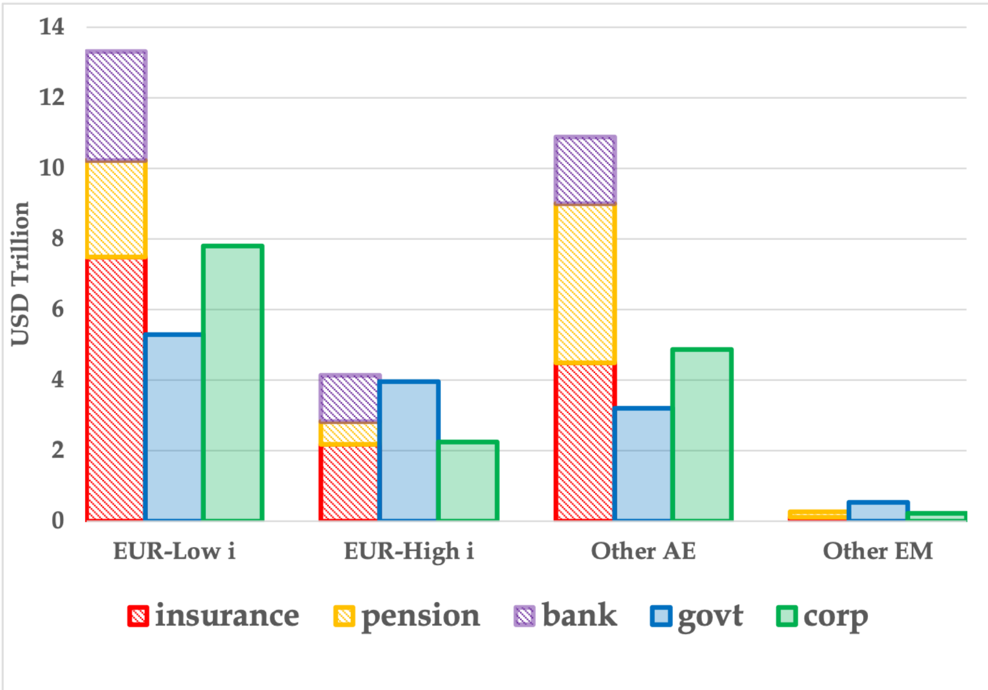
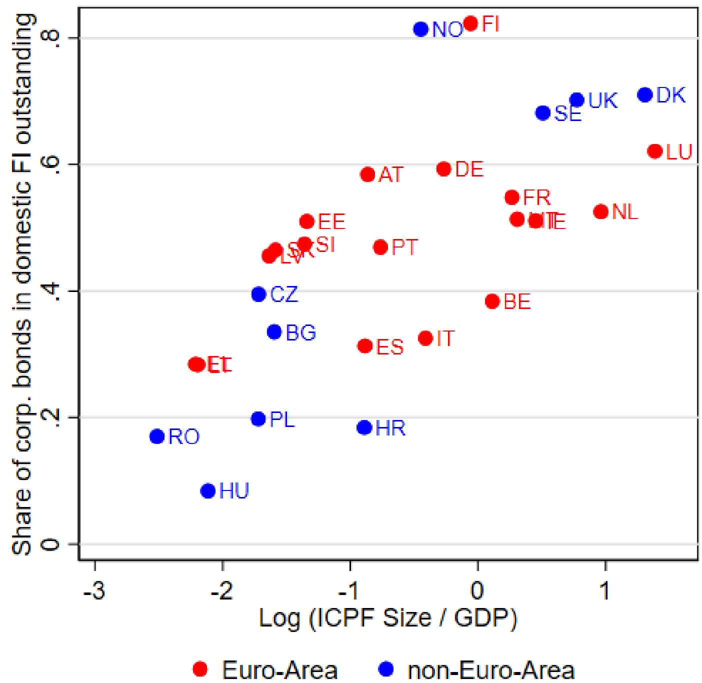
Figure 1: Size Comparison among the ICPF Sector, Banks' Debt Securities Portfolio, and Outstanding Government and Corporate bonds in 2019:Q4



Notes: For each country group, this figure plots total assets of insurance companies in red, total assets of pension funds in yellow, total amounts of banks' securities holdings in purple, total outstanding amounts of government bonds in blue, and total outstanding amounts of corporate bonds in green. We use the data for 2019:Q4. The four country groups are as follows. Low-interest-rate euro-area (EUR Low-i): AT*, BE*, DE*, FI*, FR*, LU*, and NL*; high-interest-rate euro-area (EUR high-i): CY*, EE, EL*, ES*, IE*, IT*, LT, LV, MT, PT, SI and SK; non-euro-area advanced economies (Other AE): DK*, LI, NO, SE* and UK*; and non-euro-area emerging markets (Other EM): BG, CZ, HR, HU, IS, PL and RO. The asterisk denotes countries included the calculation of banks' securities portfolios from BIS LBS. Given several countries do not report banks' securities holdings to the BIS, the purple bar understates total banks' securities holdings in Europe.

Figure 2: Composition of Domestic Fixed-Income and the Size of the ICPF Sector

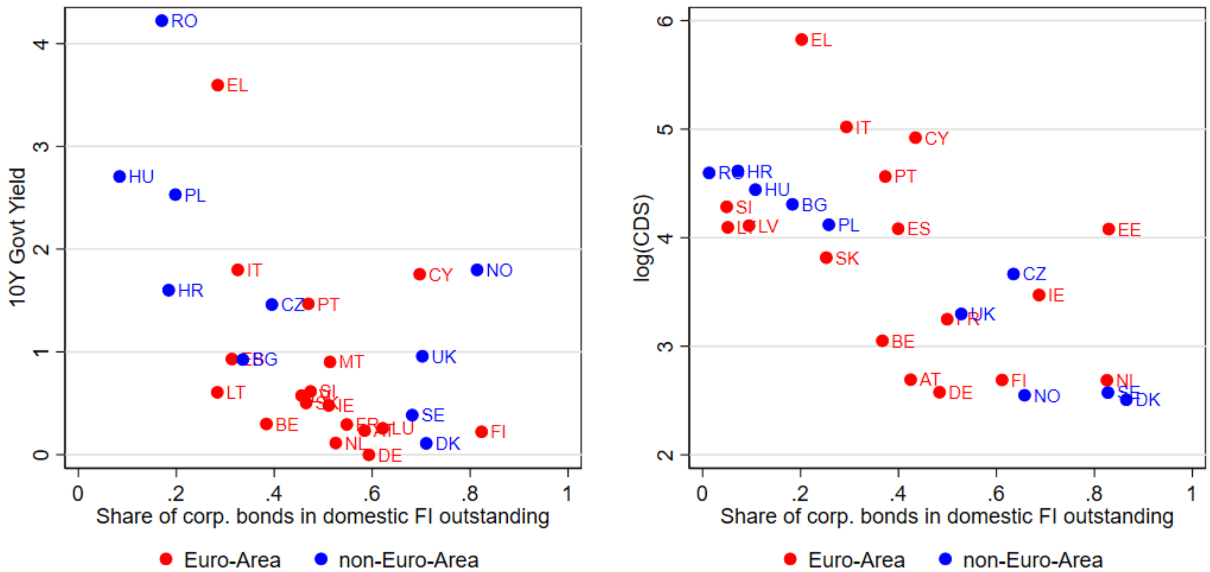


Notes: We plot the average share of corporate bonds in total domestic fixed-income securities outstanding against the log of the average ratio of total assets for the ICPF sector over GDP. Euro-area countries are indicated by red dots, and non-euro-area countries are indicated by blue dots. The sample period is 2016-2021.

Figure 3: Interest Rate and Credit Risk vs. Composition of Domestic Fixed-Income

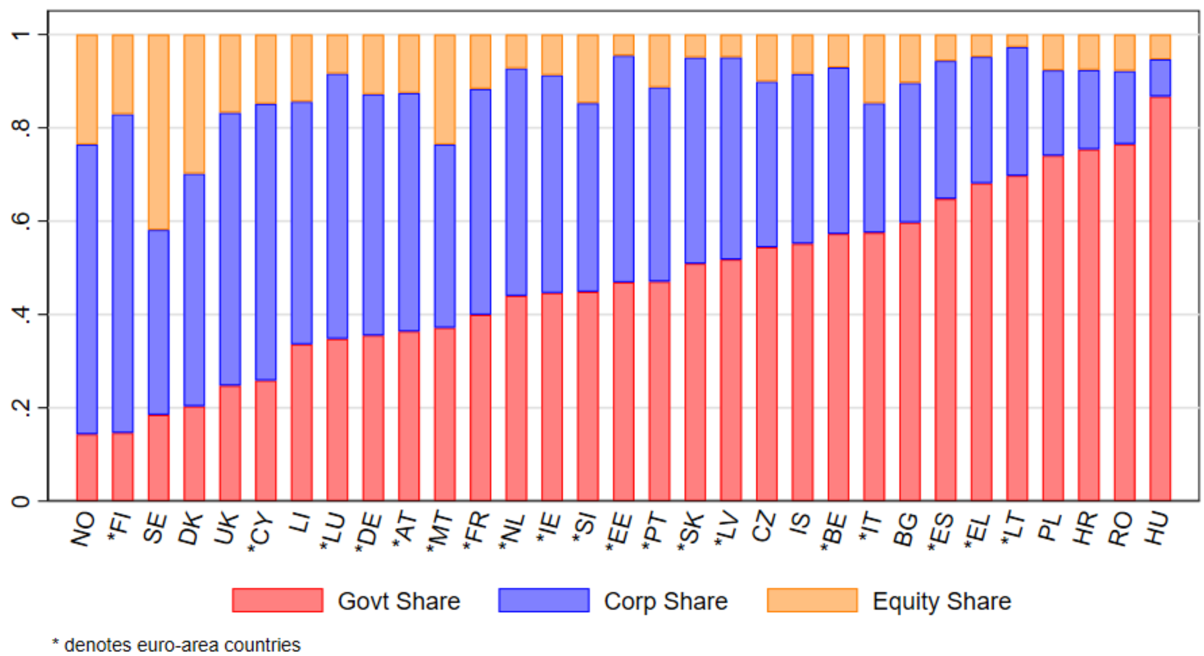
(a) Interest Rate vs. Corporate Bond Share

(b) Sovereign CDS vs. Corporate Bond Share



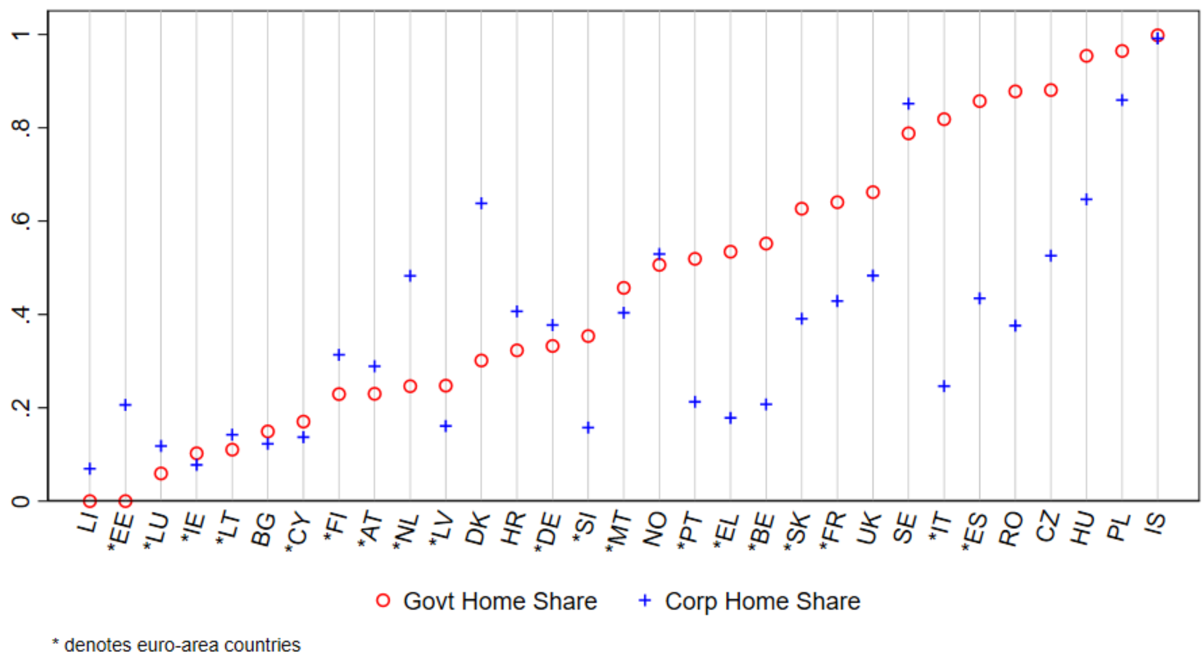
Notes: Panel (a) plots the average 10-year benchmark government bond yield (in percentage points) against the share of corporate bonds in domestic fixed-income outstanding. Panel (b) plots the log of the average 5-year sovereign credit default swap (CDS) spread (in basis points) against the share of corporate bonds in domestic fixed-income outstanding. Euro-area countries are indicated by red dots, and non-euro-area countries are indicated by blue dots. The sample period is 2016-2021.

Figure 4: Portfolio Shares Across Major Asset Classes by Country



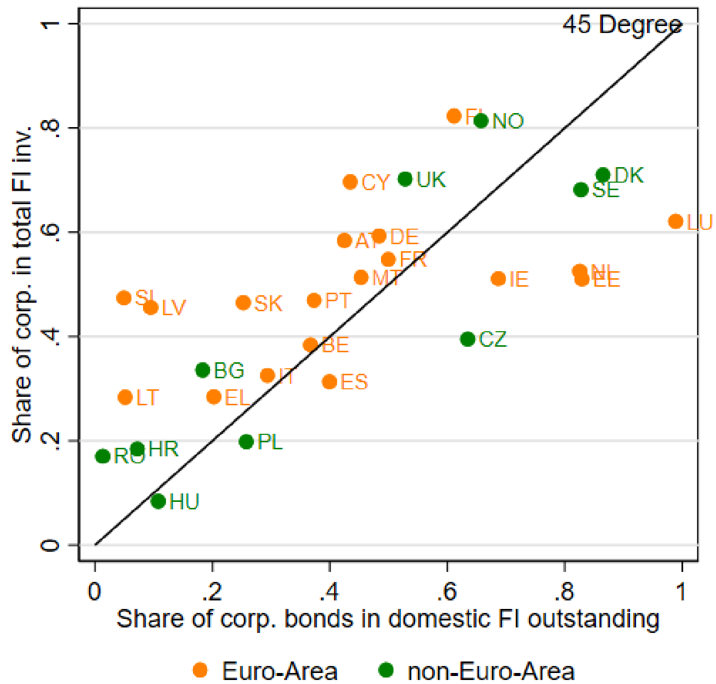
Notes: This figures shows the portfolio shares for major asset categories for insurers (solos) domiciled in the European Economic Area. The government bond shares are indicated by red. Corporate bond shares are indicated by blue, which include all non-government fixed income debt. Equity shares are indicated by orange, which include public and private equities.

Figure 5: Home Shares in Government and Corporate Bonds by Country



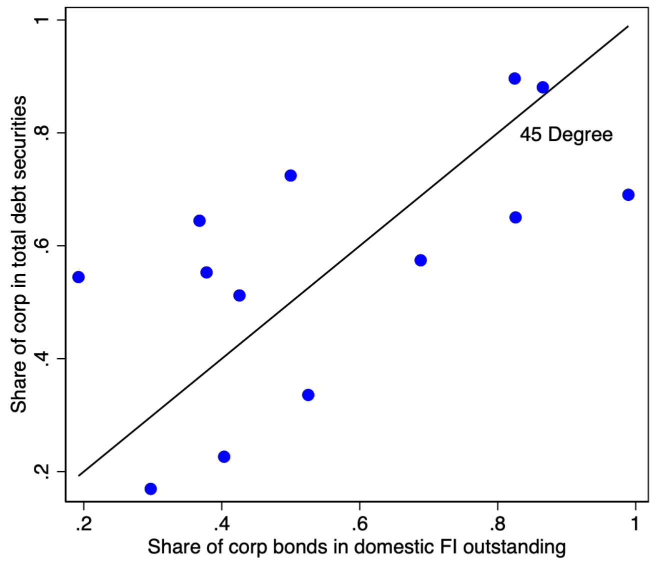
Notes: This figures plots the share of government bonds invested at home (indicated by the red hallow circle), and the share of corporate bonds invested at home (indicated by the blue cross) for insurers domiciled in each sample country in the European Economic Area.

Figure 6: Insurers' Corporate Bond Portfolio Share vs. Composition of Domestic Bond Market



Notes: This figure plots the share of corporate bonds in the fixed income portfolio held by insurers in each sample country on the vertical axis, against the share of corporate bonds in total outstanding of fixed income securities for the given country. The orange dots indicate euro-area countries, the green dots indicate non-euro-area countries.

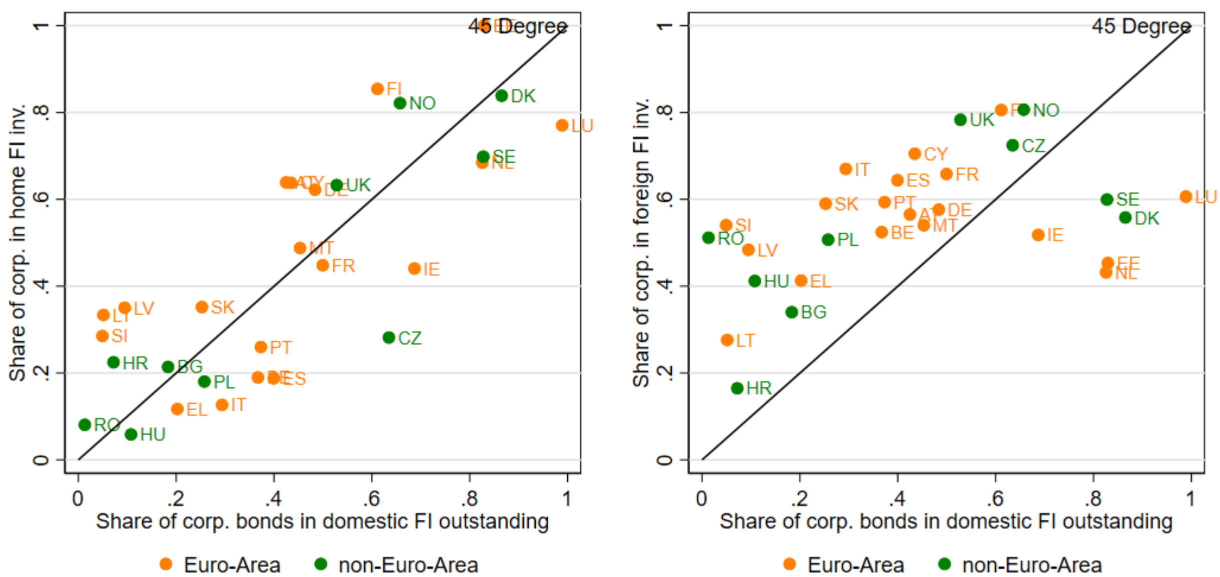
Figure 7: Banks' Corporate Bond Portfolio Share vs. Composition of Domestic Bond Market



Notes: This figure plots the share of corporate bonds in the fixed income portfolio held by banks domiciled in each country on the vertical axis, against the share of corporate bonds in total outstanding of fixed income securities for the given country.

Figure 8: Insurers' Corporate Bond Portfolio Share (Home and Foreign Investments) vs. Composition of Domestic Bond Market

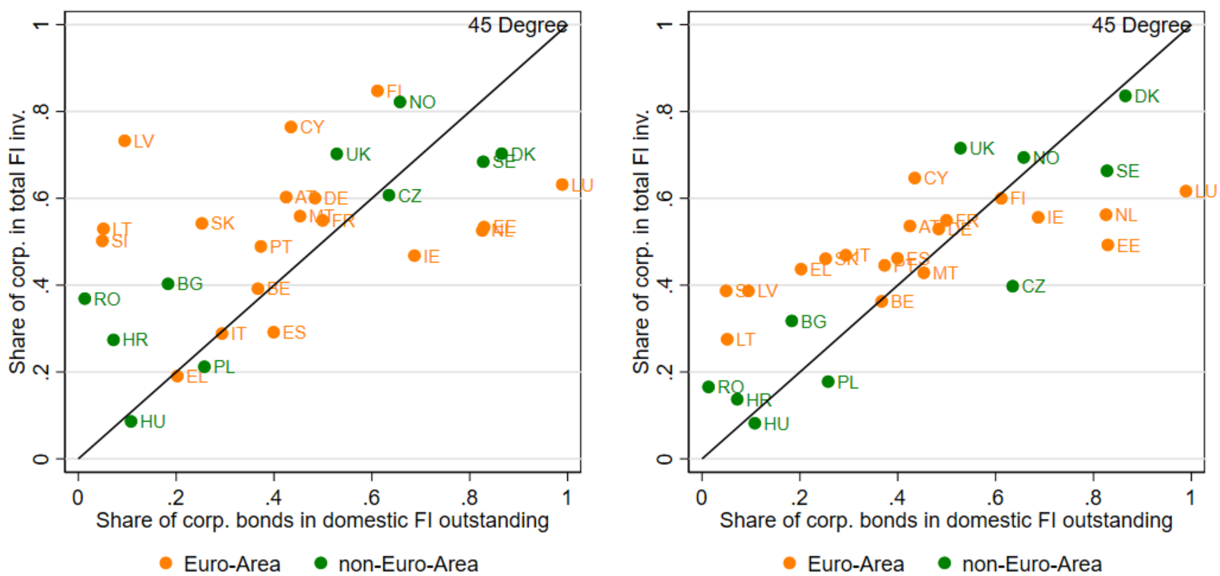
(a) Home Investments (b) Foreign Investments



Notes: Panel (a) plots the share of corporate bonds in *domestic* fixed-income investments for insurers in each sample country against the share of corporate bonds in the outstanding of all domestic fixed income securities. Panel (b) plots the share of corporate bonds in *foreign* fixed-income investments for insurers in each sample country against the share of corporate bonds in the outstanding of all domestic fixed income securities.

Figure 9: Insurers' Corporate Bond Portfolio Share (Domestic and Foreign Firms) vs. Composition of Domestic Bond Market

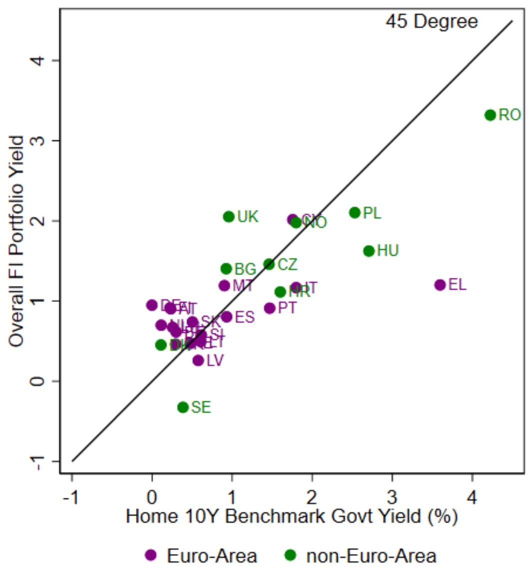
(a) Domestic Solos (b) Local Solos of Foreign Groups



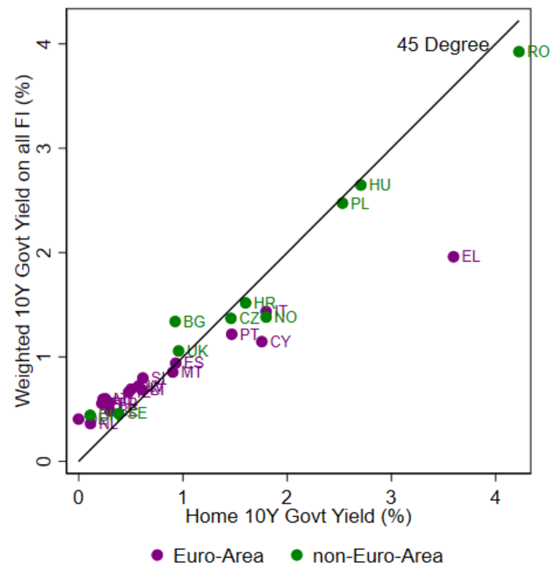
Notes: Panel (a) plots the share of corporate bonds in total fixed income investments for all domestic insurance solos in each sample country against the the share of corporate bonds in the outstanding of total domestic fixed income securities for the given country. Panel (b) plots the share of corporate bonds in total fixed income investments for all local insurance solos affiliated with foreign groups in each sample country against the share of corporate bonds in the outstanding of total domestic fixed income securities for the given country.

Figure 10: Portfolio Interest Rate and Domestic Interest Rate

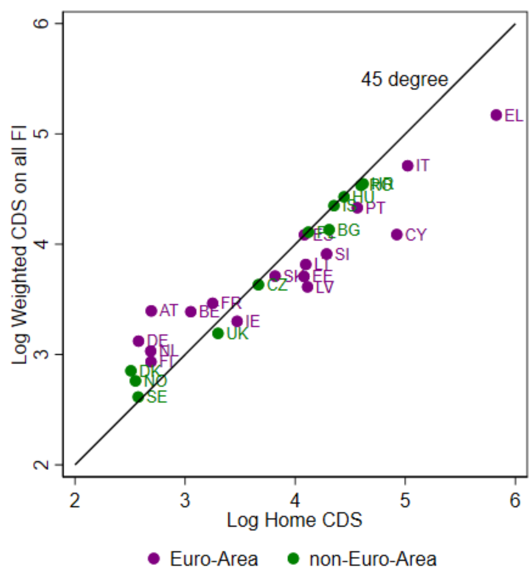
(a) based on CSDB yield



(b) based on benchmark govt yields

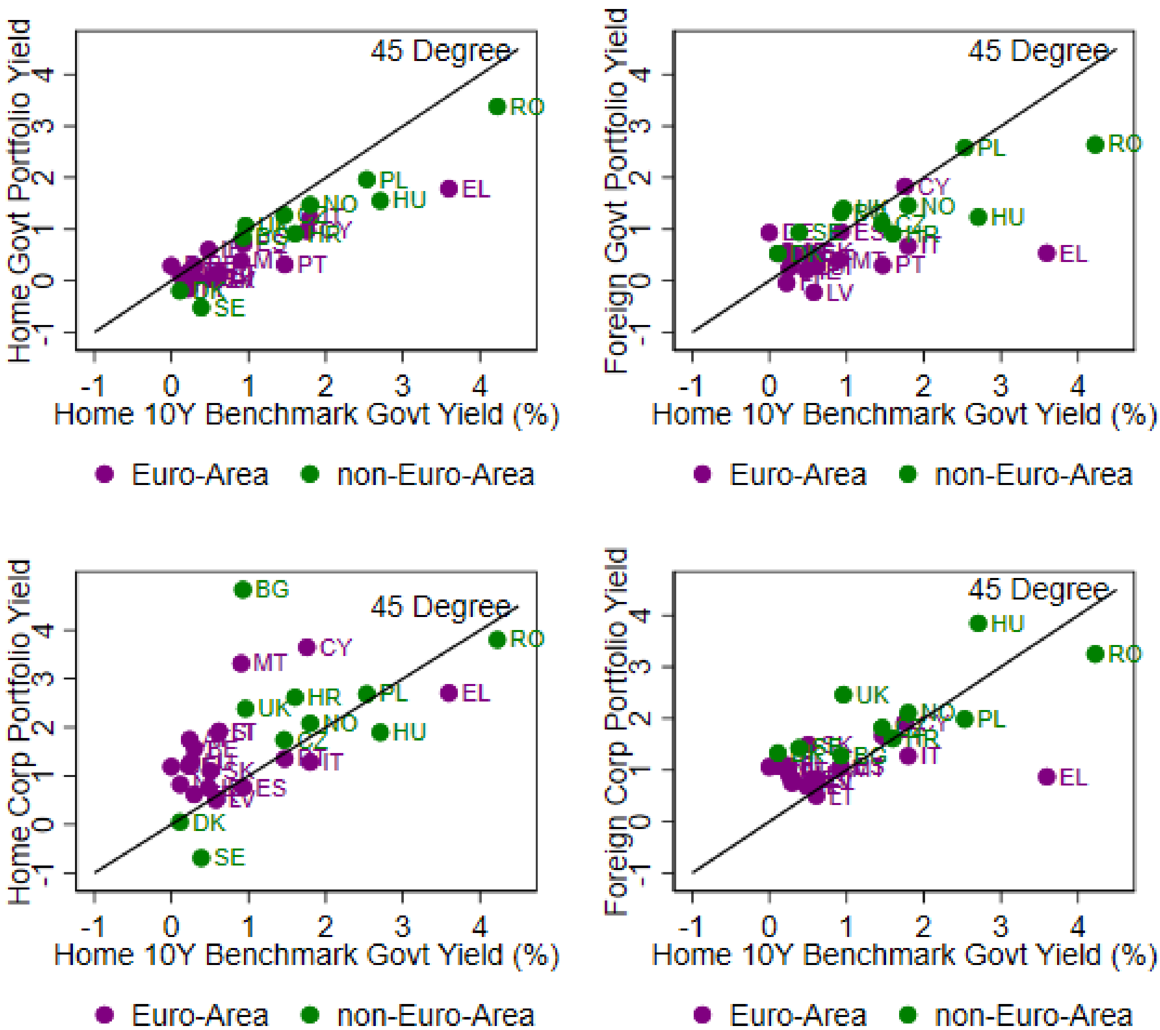


(c) based on sovereign CDS



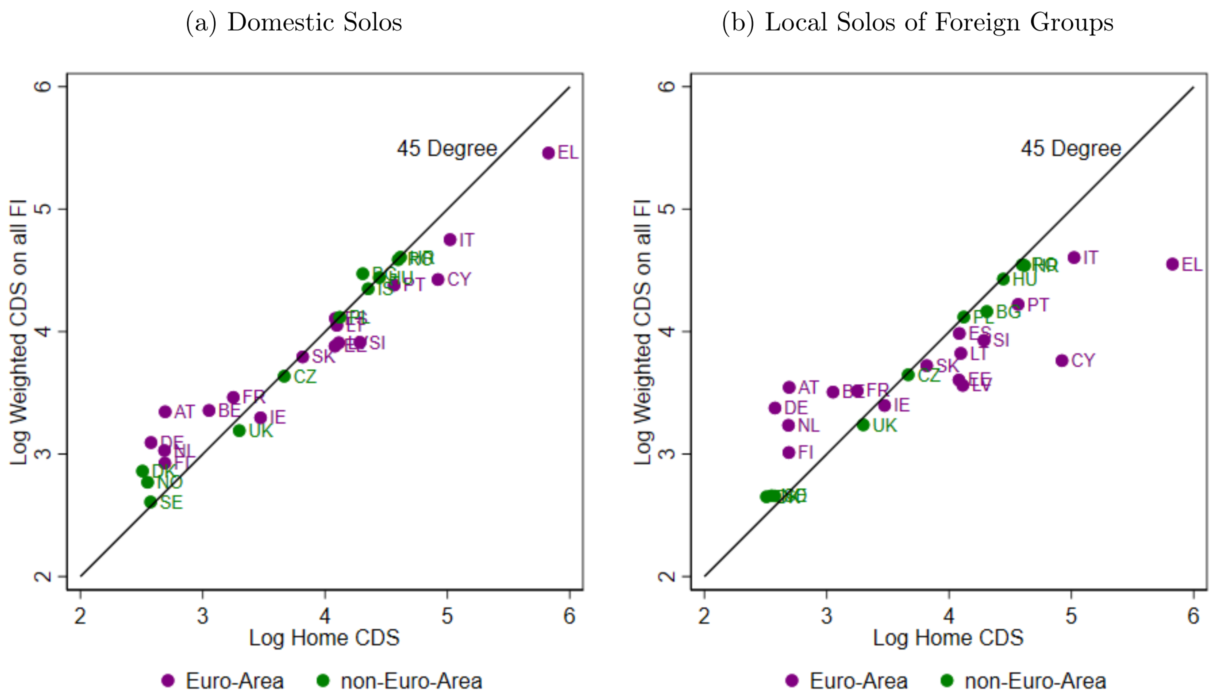
Notes: Panel (a) plots the average portfolio yield calculated from all fixed-income securities with actual yield information from ECB Centralized Securities Database for insurers in each sample country against the average 10-year benchmark government bond yield. Panel (b) plots the hypothetical portfolio yield calculated by weighing the 10-year government bond yields by the respective country share in the fixed-income portfolio against the average 10-year benchmark government bond yield. Panel (c) shows the weighted sovereign CDS spread, weighted by the portfolio share of the investment destination country, against the home country's sovereign CDS spread.

Figure 11: Domestic and Foreign Portfolio Yields vs. Domestic Benchmark Interest Rate



Notes: The top panels plot the weighted portfolio yield on the domestic and foreign government bonds, respectively, against the 10-year domestic government bond yield. The bottom two panels plot the weighted portfolio yield on the domestic and foreign corporate bonds, respectively, against the 10-year domestic government bond yield.

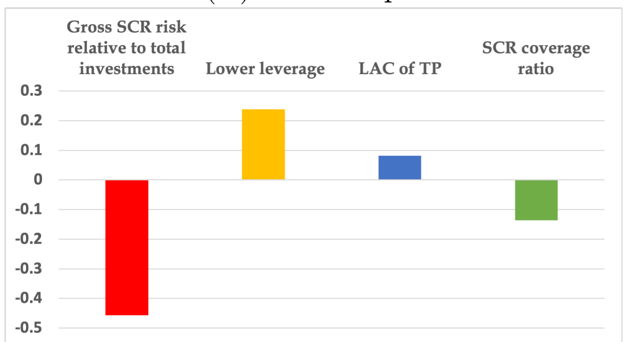
Figure 12: Portfolio Sovereign CDS Spread and Domestic Sovereign CDS Spread (Domestic and Foreign Firms)



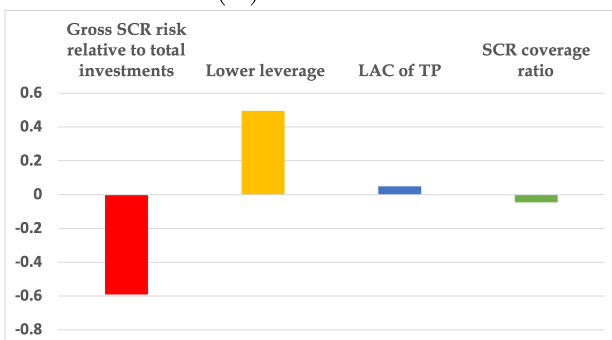
Notes: Panel (a) plots the average portfolio sovereign CDS spread on all fixed-income securities for all domestic insurance solos in each sample country. Panel (b) plots the average portfolio sovereign CDS spread for all local solos affiliated with foreign groups in each sample country. The portfolio CDS spread is calculated as the value-weighted CDS spread, weighted by investments in the respective investment destination country.

Figure 13: Different Margins for Absorbing Credit Risk

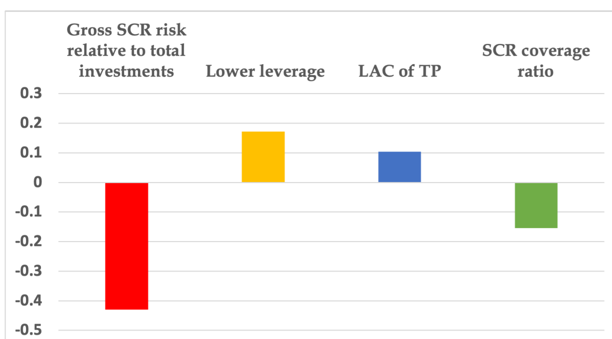
(A) Full Sample



(B) Euro Area



(C) Non-Euro Area



Notes: This figure illustrates different adjustment margins for holding a higher share of corporate bonds in their fixed-income portfolios. The red bar denotes the sensitivity of the ratio of own funds to the gross market risk SCR with respect to a one-standard-deviation increase in the corporate bond share, or β_{gscr} in Table 3. The yellow bar represents the effect of leverage reduction and plots β_{lev} in Table 3. The blue bar represents loss absorption capacity of liabilities and plots β_{lac} in Table 3. The green bar represents the sensitivity of the overall SCR coverage ratio using the net market risk SCR, β_{sc} in Table 3. Panel (A) shows results estimated using the full sample. Panel (B) show results estimated using the euro-area insurers, and Panel (B) shows results estimated using non-euro-area insurers.

Table 1: Regressions of Composition of Domestic Fixed-Income Securities on Macro Variables

	(1) Ratio Corp/FI	(2) Ratio Corp/FI	(3) Ratio Corp/FI	(4) Ratio Corp/FI
Log(ICPF/GDP)	0.219***	0.103**	0.156**	0.130**
	(0.0290)	(0.0470)	(0.0572)	(0.0562)
Log(Per Capita GDP)		0.138***	0.125**	0.138***
		(0.0380)	(0.0549)	(0.0397)
Log(Bank Securities/GDP)			-0.0110	
			(0.0332)	
Log(Bank Assets/GDP)				0.0110
				(0.0253)
Constant	0.556***	-1.794**	-1.613	-1.834**
	(0.0346)	(0.650)	(0.950)	(0.702)
Observations	28	28	15	16
R-squared	0.588	0.658	0.796	0.796

Notes: This table shows cross-country regression results of the share of corporate bonds in domestic fixed-income securities outstanding (Ratio Corp/FI) on several macroeconomic variables. The independent variables are as follows: log(ICPF/GDP) measures log of the ratio of total assets of the ICPF sector over GDP, log(Per Capita GDP) measures per capita GDP, log(Bank Securities/GDP) measures log of the ratio of banks' total securities holdings over GDP, and log(Bank Asset/GDP) measures log of the ratio of banks' total assets over GDP. All independent variables are scaled by their standard deviations in the sample. Columns 1-2 use all 30 countries in the European Economic Area and the UK (Cyprus, Iceland and Liechtenstein are omitted from the regressions due to missing data for debt outstanding or the pension size). Columns 3-4 use data from the BIS Locational Banking Statistics (LBS) and require the country to a BIS reporting country. The list of the BIS LBS reporting countries in Europe can be found in Footnote 12.

Table 2: Cross-Country Regressions of Corporate Bond Portfolio Shares on the Share of Corporate Bonds in Domestic Fixed-income Outstanding

	(1) Overall Port.	(2) Home Port.	(3) Foreign Port.	(4) Domestic Firm	(5) Foreign Firm
			(A) Insurers		
Corp/FI Outstanding	0.485***	0.769***	0.239**	0.364***	0.496***
	(0.0907)	(0.0977)	(0.0986)	(0.106)	(0.0842)
Constant	0.263***	0.112**	0.449***	0.358***	0.249***
	(0.0461)	(0.0472)	(0.0483)	(0.0637)	(0.0418)
Observations	29	29	29	29	29
R-squared	0.488	0.631	0.202	0.277	0.590
			(B) Banks		
Corp/FI Outstanding	0.547**	1.001***	0.152	0.539**	0.749**
	(0.193)	(0.187)	(0.229)	(0.207)	(0.263)
Constant	0.282*	0.0212	0.490***	0.302**	0.112
	(0.131)	(0.141)	(0.153)	(0.135)	(0.181)
Observations	15	15	15	14	14
R-squared	0.368	0.616	0.037	0.396	0.407

Notes: This table shows cross-country regression results of regressing various portfolio shares on the share of corporate bonds in domestic fixed-income securities outstanding (Corp/FI Outstanding). The dependant variables are as follows: the share of corporate bonds in the overall fixed-income securities portfolio (Column 1), the share of corporate bonds in the home fixed-income portfolio (Column 2), the share of corporate bonds in the foreign fixed-income portfolio (Column 3), the share of corporate bonds in the overall portfolio of domestic firms (Column 4), and the share of corporate bonds in the overall portfolio of domestic branches/subsidiaries of foreign firms (Column 5). Panel (A) reports results for European insurers. Panel (B) reports results for European banks (reported to the BIS LBS).

Table 3: Effects of the Corporate Bond Holdings on Components of SCR Coverage Ratio

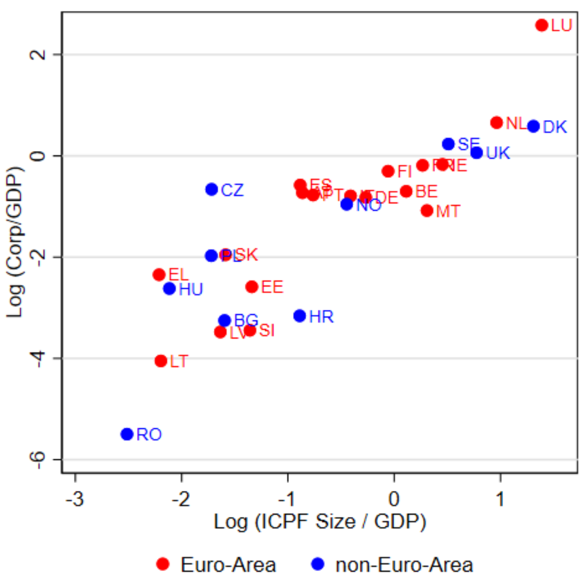
	(1)	(2)	(3)	(4)
	$\ln\left(\frac{OF_{i,t}}{nSCR^{mkt}_{i,t}}\right)$	$\ln\left(\frac{OF_{i,t}}{gSCR^{mkt}_{i,t}}\right)$	$\ln\left(\frac{OF_{i,t}}{Inv_{i,t}}\right)$	$\ln\left(\frac{1}{1-\phi_{i,t}}\right)$
	β_{SC}	β_{gSCR}	β_{lev}	β_{lac}
(A) Full Sample				
Corp Bond Share	-0.136***	-0.456***	0.239***	0.0813***
	(0.0251)	(0.0482)	(0.0464)	(0.0142)
Observations	3164	3164	3164	3164
R-Squared	0.034	0.145	0.035	0.022
(B) Euro Area				
Corp Bond Share	-0.0452	-0.590***	0.497***	0.0477**
	(0.0358)	(0.0617)	(0.0704)	(0.0200)
Observations	2225	2225	2225	2225
R-Squared	0.006	0.177	0.097	0.007
(C) Non-Euro Area				
Corp Bond Share	-0.154***	-0.430***	0.172***	0.104***
	(0.0356)	(0.0672)	(0.0537)	(0.025)
Observations	939	939	939	939
R-Squared	0.061	0.163	0.031	0.045

Notes: The table shows panel regression results of different components of the SCR coverage ratio on the corporate bond share in fixed income portfolio (scaled by one standard deviation of the corporate bond share), as shown in Equations 2.

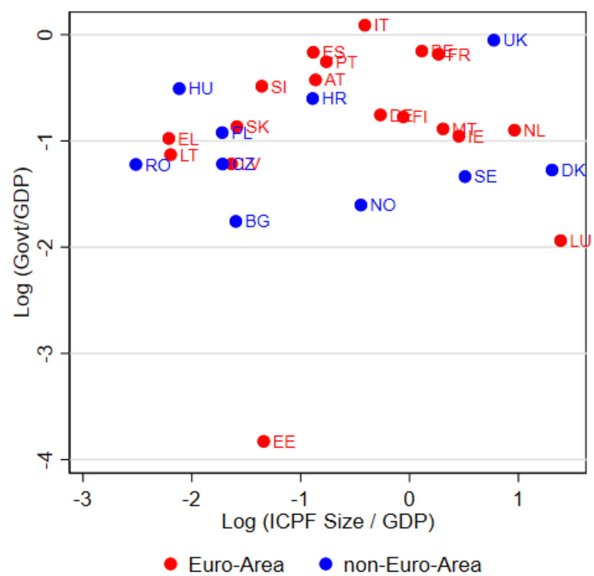
Appendix

Figure A1: Corporate and Government Bond Outstanding vs. ICPF Sector Size

(a) Corporate Bonds/GDP vs. ICPF



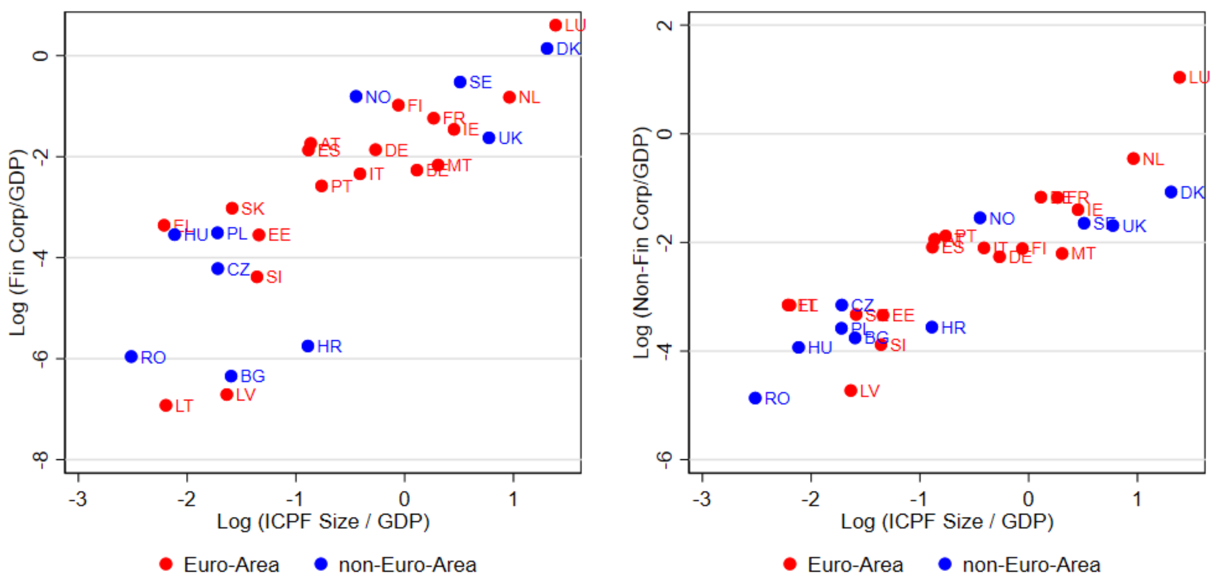
(b) Government Bonds/GDP vs. ICPF



Notes: In Panel (a), we plot the log of the ratio of the share of corporate bonds over GDP against log of the ratio of the ICPF sector size over GDP. In Panel (b), we plot the log of the ratio of the share of government bonds over GDP against log of the ratio of the ICPF sector size over GDP. Euro-area countries are indicated by red dots, and non-euro-area countries are indicated by blue dots. The sample period is 2016-2021.

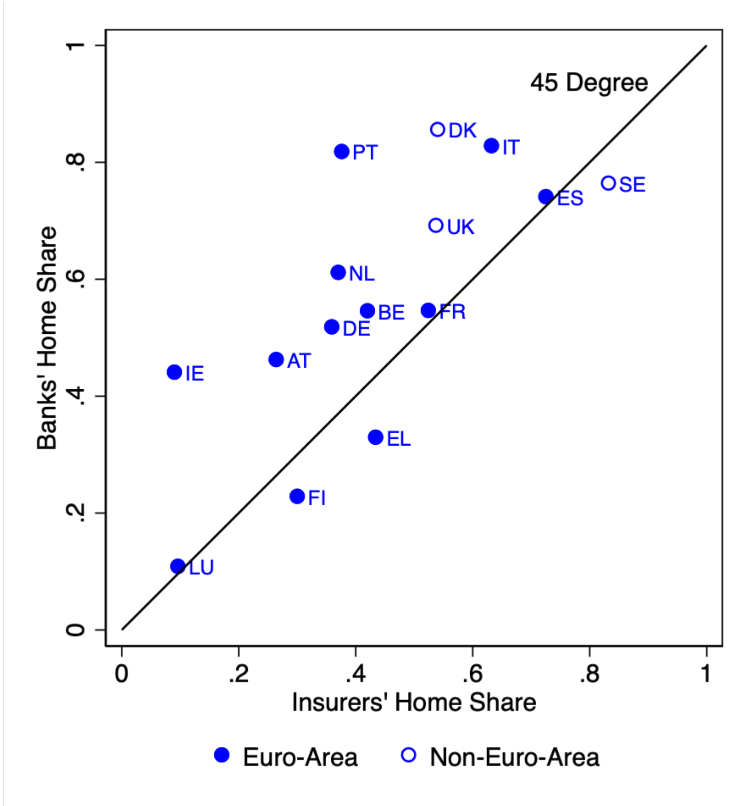
Figure A2: Financial and Non-Financial Corporate Bond Outstanding vs. ICPF Sector Size

(a) Fin. Corp Bond Outstanding vs. ICPF Size (b) Non-Fin. Corp Bond Outstanding vs. ICPF Size



Notes: In Panel (a), we plot the log of the ratio of the share of non-financial corporate bonds over GDP against log of the ratio of the ICPF sector size over GDP. In Panel (b), we plot the log of the ratio of the share of financial corporate bonds over GDP against log of the ratio of the ICPF sector size over GDP. Euro-area countries are indicated by red dots, and non-euro-area countries are indicated by blue dots. The sample period is 2016-2021.

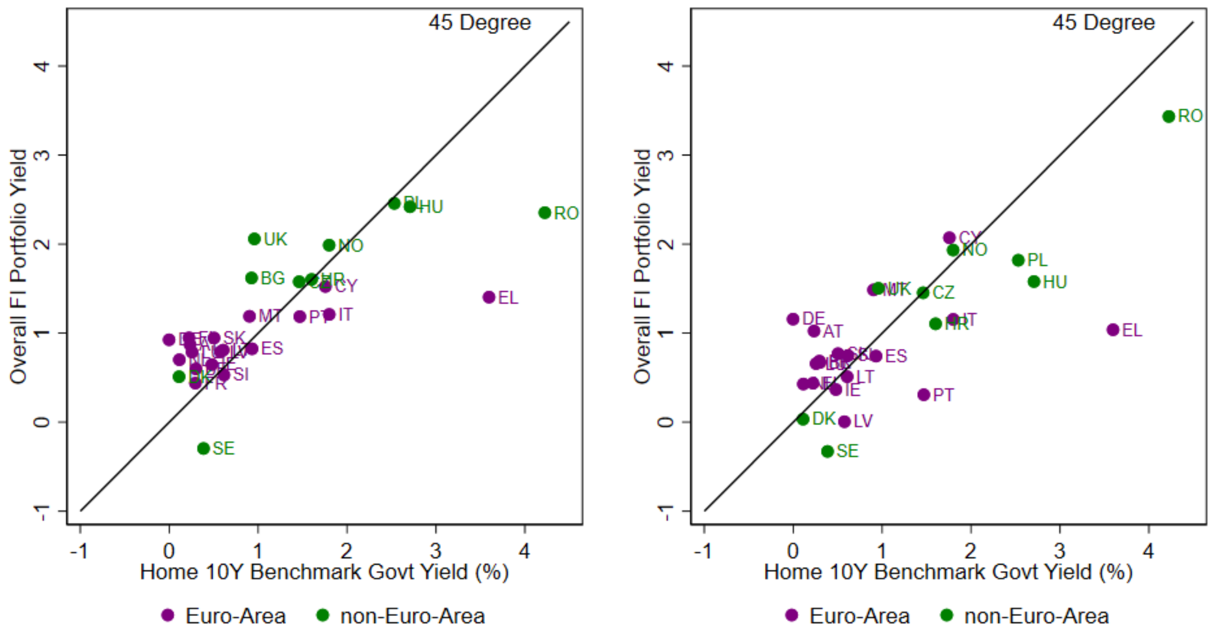
Figure A3: Home Investment Shares for Insurers versus Banks



Notes: This Figure shows banks' portfolio share of debt securities invested at home on the vertical axis, and insurers' home investment share in fixed income on the horizontal axis. Banks' home investment share is constructed from the public version of the BIS LBS.

Figure A4: Portfolio Interest Rate and Domestic Interest Rate (Domestic and Foreign Firms)

(a) Domestic Solos (b) Local Solos of Foreign Groups



Notes: Panel (a) plots the average portfolio yield on all fixed-income securities calculated from the ECB Centralized Securities Statistics (CSDB) for all domestic insurance solos in each sample country. Panel (b) plots the average portfolio yield for all local solos affiliated with foreign groups in each sample country.

Table A1: Regressions of Weighted Portfolio Sovereign CDS Spreads on Home Sovereign CDS Spread

	(1) all	(2) foreign	(3) foreign corp	(4) foreign govt
Log(CDS)	0.755***	0.383**	0.212*	0.375**
	(0.0818)	(0.129)	(0.112)	(0.135)
Constant	0.992***	2.342***	2.637***	2.547***
	(0.311)	(0.447)	(0.380)	(0.487)
Observations	12	12	12	12
R-squared	0.914	0.443	0.240	0.404

Notes: This table shows the cross-country regression of the weighted portfolio sovereign CDS spread for banks on the own country's sovereign CDS spread. Column 1 shows results for the overall fixed-income portfolio. Column 2 shows results for the foreign portfolio. Column 3 shows results for the foreign corporate bond portfolio. Column 4 shows results for the foreign government bond portfolio. The weighted portfolio sovereign CDS spread is calculated as the value-weighted average of sovereign CDS spreads of all the investment destination countries. The data on banks' securities holdings by country are obtained from the restricted version of the BIS LBS.

A Additional derivations

We derive the key equations of Section 6.1. We define $Q_I = (Q_{I,C}, 0)'$. The insurers' dividend is given by

$$\begin{aligned} D_I &= Q_{I,C} D_C + (A_{I,0} - Q_{I,C} P_C) R_f - \pi H^I \\ &= Q_{I,C} D_C + (E - C(Q_{I,C}) - Q_{I,C} P_C) R_f + (1+\phi)\pi H^I P_G R_f - \pi H^I \\ &= Q_{I,C} D_C + (E - C(Q_{I,C}) + \phi\pi\Delta - Q_{I,C} P_C) R_f. \end{aligned} \tag{A1}$$

The FOC for the demand of asset managers is given by

$$\mu - PR_f - P\lambda - \gamma\Sigma Q_A = 0,$$

implying for optimal demand

$$Q_A = \frac{1}{\gamma}\Sigma^{-1}(\mu - P(R_f + \lambda)).$$

We define the vector of supply of corporate bonds and insurers' equity as $S = (S_C, 1)'$. Market clearing then implies

$$\sum_j Q_j + Q_I = S,$$

and

$$P = \frac{1}{R_f + \lambda}\left(\mu - \gamma\Sigma\left(S - Q_I\right)\right).$$

It implies for corporate bonds

$$\begin{aligned} P_C &= \frac{1}{R_f + \lambda}\left(\mu_C - \gamma\sigma_C^2\left(S_C - Q_{I,C}\right) - \gamma\sigma_C^2 Q_{I,C}\right) \\ &= \frac{1}{R_f + \lambda}\left(\mu_C - \gamma S_C \sigma_C^2\right), \end{aligned}$$

using $Q_I = (Q_{I,C}, 0)'$. It holds for insurers' equity prices

$$\begin{aligned} P_I &= \frac{1}{R_f + \lambda}\left(\mu_I - \gamma Cov(D_C, D_I)(S_C - Q_{I,C}) - \gamma V(D_I)\right) \\ &= \frac{1}{R_f + \lambda}\left(\mu_I - \gamma S_C \sigma_C^2 Q_{I,C}\right). \end{aligned}$$

If we substitute the expression for insurers' dividends in (A1), we obtain

$$P_I = \frac{1}{R_f + \lambda}\left(\frac{\lambda}{R_f + \lambda}\left(\mu_C - \gamma S_C \sigma_C^2\right) Q_{I,C} + (E - C(Q_{I,C}) + \phi\pi\Delta)R_f\right).$$

The optimal allocation to corporate bonds solves $\max_{Q_{I,C}} P_I$ and uses $C(Q_{I,C}) = \frac{\kappa}{2}Q_{I,C}^2$,

$$q_C^I = \frac{1}{\kappa R_f}\frac{\lambda}{R_f + \lambda}\left(\mu_C - \gamma S_C \sigma_C^2\right).$$

Lastly, we work out the implications when the supply of corporate bonds is elastic. We define $s_0 = (s_{0c}, 1)'$ and $s_1 = diag(s_{1c}, 0) \in^{2\times 2}$. The market clearing equation then modifies to

$$\frac{1}{\gamma}\Sigma^{-1}(\mu - P(R_f + \lambda)) + Q_I = s_0 + s_1 P,$$

and thus

$$P = (\gamma\Sigma s_1 + (R_f + \lambda)I)^{-1}(\mu - \gamma\Sigma(s_0 - Q_I)).$$

We note that

$$(\gamma\Sigma s_1 + (R_f + \lambda)I)^{-1} = \begin{bmatrix} \frac{1}{\gamma\sigma_C^2 s_{1C} + R_f + \lambda} & 0 \\ 0 & \frac{1}{R_f + \lambda} \end{bmatrix},$$

which implies for corporate bonds

$$P_C = \frac{1}{\gamma\sigma_C^2 s_{1C} + R_f + \lambda}\left(\mu_C - \gamma s_{0C}\sigma_C^2\right).$$