Insurance corporations' balance sheets, financial stability and monetary policy*

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Abstract

The euro area insurance sector and its relevance for real economy financing have grown significantly over the last two decades. This paper analyses the effects of monetary policy on the size and composition of insurers' balance sheets, as well as the implications of these effects for financial stability. We find that changes in monetary policy have a significant impact on both sector size and risk-taking. Insurers' balance sheets grow materially after a monetary loosening, implying an increase of the sector's financial intermediation capacity and an active transmission of monetary policy through the insurance sector. We also find evidence of portfolio rebalancing consistent with the risk-taking channel of monetary policy. After a monetary loosening, insurers increase credit, liquidity and duration risk-taking in their asset portfolios. Our results suggest that extended periods of low interest rates lead to rising financial stability risks among non-bank financial intermediaries.

JEL classification: E52; G11; G22; G23
Keywords: Non-bank financial intermediation; monetary policy transmission; risk-taking; portfolio rebalancing

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The views expressed in this paper are those of the authors only and do not necessarily reflect the views of the the European Central Bank, the Banco de Portugal, or the Eurosystem.

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1 Introduction

Insurance corporations (ICs) play an important role in the economy by managing risks for households and firms. The premiums that ICs collect from their policyholders are invested in global capital markets. The size of the IC sector and, thus, its relevance for the financing of economic activity of firms and governments have grown significantly over the last two decades. In the euro area (EA), the sector's total assets nearly doubled from 5 to around EUR 9 trillion between 2008 and 2021, equivalent to more than a quarter of the euro area banking sector's assets (Figure 1, Panel A). This makes the insurance sector the second largest component of the rapidly growing non-bank financial intermediation (NBFI) sector after investment funds.[1]

Due to these massive asset holdings the sector is a major investor in several financial market segments and especially in bond markets. Figure 1 (Panel B) depicts the investor base of different euro area bond markets. Barring the public sector holdings, insurers are the single largest domestic investor in EA sovereign and non-financial corporate (NFC) bonds with holding shares of 25% and 29%, respectively. ICs also hold a sizeable share of financial corporate (FC) bonds, indicating significant interconnections in the financial system and suggesting that ICs are a relevant source of funding for banks. Due to the long maturity of their policy-linked liabilities, insurers tend to act as long-term and hold-to-maturity investors, and provide a relatively stable source of funding compared to other market participants.

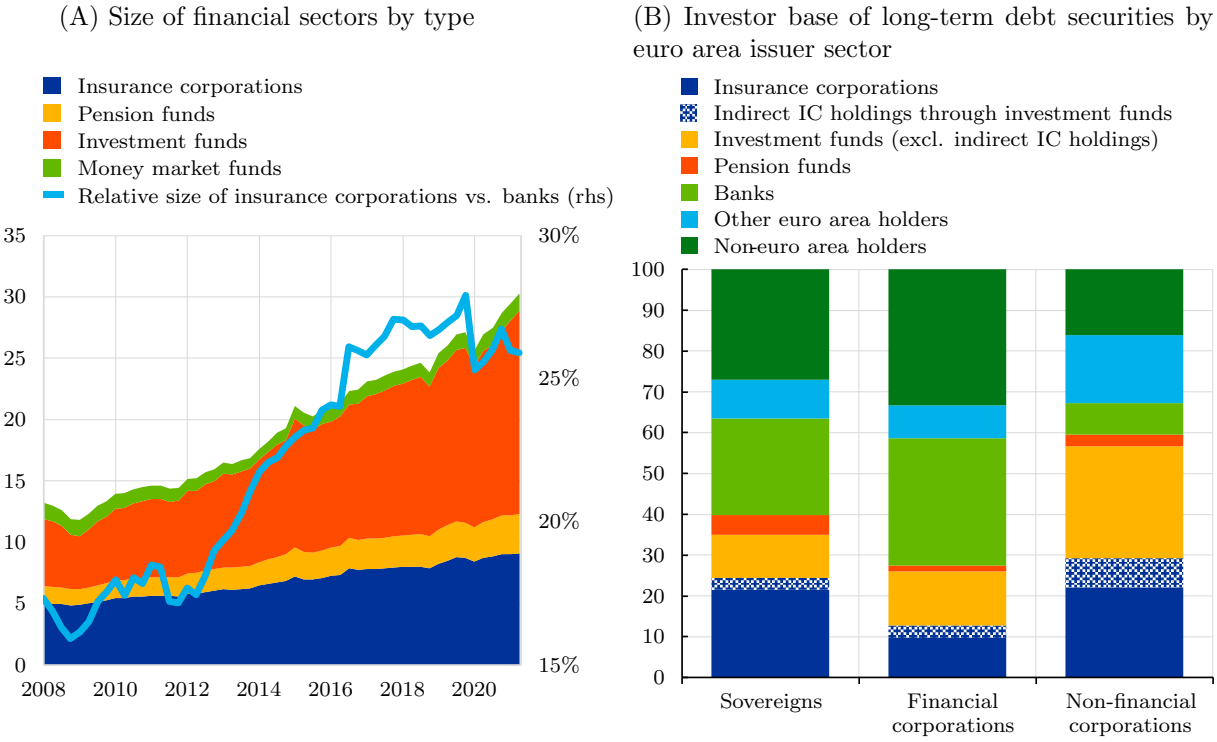
Given their business model and sizeable asset holdings, monetary policy – by setting the interest rate environment – is a key factor for the insurance sector.

In this paper, we examine empirically the effect of monetary policy on the size and composition of insurers' balance sheets, as well as the implications of these effects for financial stability. To the best of our knowledge, the response of the insurance sector to monetary policy has not been studied systematically yet. Monetary policy can affect insurers in several ways. When a monetary loosening stimulates real economic activity and households' disposable income, this can translate into higher demand for insurance services, an increase in premiums collected and ultimately higher demand for assets from insurers. At the same time, lower yield levels dampen investment income and impede insurers' ability to provide guaranteed returns to their policyholders. This can increase incentives for insurers to search for yield. Finally, as many insurers' balance sheets feature a negative duration gap, lower yields may deteriorate the capital position of insurers, providing incentives to extend the duration of their portfolios.

In our analysis, we study the dynamic responses of all main asset and liability side balance sheet items as well as of several metrics for credit, liquidity and duration risk-taking after changes in monetary policy. We run local projections (Jordà, 2005) on country-sector

[1] Similar trends in the growth of the non-bank financial system are observable globally, formerly also known as the "shadow banking system". FSB (2022) estimates the global size of the insurance sector to around USD 40 trillion at the end of 2021.

Figure 1: Size and relevance of insurance corporations



Notes: Panel (A): Areas show the balance sheet size of non-bank financial institutions in EUR trillion. The line shows the size of insurance corporations relative to the banking sector in % (right-hand scale). Panel (B): In percent of total amounts outstanding as of 2021 Q4, excluding holdings of the Eurosystem.

level data for all 19 EA countries with quarterly observations between 2010 and 2019. In a further step, we analyse the bond portfolio, the largest component of ICs' asset holdings, in greater detail. This analysis is based on highly granular security-level information from from the ECB's security holding statistics by sector (SHSS), which covers the whole universe of securities held by investors in the euro area. To identify exogenous changes in the interest rate environment, we employ high-frequency monetary policy shocks based on intra-day data around all ECB Governing Council meeting during our sample period, which is provided by Altavilla et al. (2019). We use shocks to different maturity segments of the yield curve to take into account changes both by conventional and unconventional monetary policy that was prevalent during our sample period. Given the relatively high average maturity of insurer's assets, changes in the longer segment of the yield curve are particularly relevant to the sector. To separate genuine monetary policy yield surprises from other information provided by the central bank, we follow the methodology suggested by Jarociński and Karadi (2020) that is based on the co-movement between stock market and yield surprises around monetary policy events.

Our results suggest that changes in monetary policy have a significant impact on both sector size and risk-taking.

After a monetary loosening that implies 50 basis point lower yields on impact, total assets of the insurance sector increase by 4.5% over the course of one year. Abstracting

from valuation effects, the cumulative rise of the sector's assets amounts to almost EUR 200 billion one year after the shock and implies an active expansion in their investments. The financial intermediation capacity of the insurance sector thus increases after a monetary loosening. We document that these additional funds are used for purchases of stocks, investment fund shares and debt securities – the latter notably also by non-financial corporations. Our results imply that insurers actively transmit monetary policy to the wider economy on a macroeconomically relevant scale. To the best of our knowledge, this role of the insurance sector in monetary policy transmission has not been documented before in the literature. On the liability side, we find that the technical reserves, i.e. the funds set aside by ICs for their underwriting liabilities, and capital rise, while leverage falls.

We find that monetary loosening induces shifts in the composition of insurers' asset holdings, leading to a rise in credit, liquidity and duration risk-taking. On the level of the main balance sheet aggregates, insurers re-balance their assets away from debt securities towards a higher proportion of investment fund shares and riskier stocks. Insurers tend to decrease their cash holdings, pointing towards higher liquidity risk-taking amidst lower interest rates. Credit risk-taking within the bond portfolio is rising, as the share of lower-rated bonds increases after a monetary loosening in a search for yield. We also find evidence of an international risk-taking channel with a rising share of bond holdings from issuers outside the euro area. In contrast, we find that insurers countercyclically reduce their exposures to euro area sovereign and financial corporate bonds. Finally, looking at the maturity structure of the bond holdings, insurers tend to increase their duration risk-taking in response to a monetary loosening by investing more in bonds with longer maturities.

Our results point towards portfolio re-balancing consistent with the risk-taking channel of monetary policy (Borio and Zhu, 2012, Choi and Kronlund, 2017, Koijen et al., 2017, 2021). Various policy institutions warned repeatedly during the episode of low interest rate levels that this can lead to more risks within non-bank financial intermediaries (see, e.g., BIS, 2018, ESRB, 2021, Adrian, 2020, ECB, 2021). Our paper is the first to confirm these observations for the insurance sector using the latest methodological advancements for the identification of the effects of monetary policy.[2]

Our results have several important implications for monetary policy and financial stability. We show that accommodative monetary policy over an extended period indeed can contribute to the build-up of financial stability risks in the non-bank financial system. As such, the low yield environment has increased the vulnerability of the insurance sector to macroeconomic shocks, such as an increase in corporate defaults. The higher demand from insurers for riskier assets after a monetary loosening can, however, also contribute to an intended improvement of financial conditions for firms and the wider economy. The decline in insurers' cash holdings makes the sector more vulnerable towards larger liquidity

[2]In this way, our paper documents one mechanism how loose monetary policy increases the likelihood of financial stress (see Grimm et al., 2023 and Jiménez et al., 2022).

shocks. Such shocks could occur, for example, due to policy lapses or due to margin calls on insurers' derivative portfolios that may become more frequent when interest rate levels start rising again from low levels. Finally, insurers' countercyclical demand for lower-rated sovereign debt could partially alleviate concerns about "fragmentation" in euro area sovereign bond markets.

The rest of the paper is structured as follows. Section 2 reviews the related literature. In Section 3, we provide some stylised facts about the euro area insurance sector and we discuss the channels through which monetary policy can affect ICs' balance sheets. Section 4 describes the empirical setup, including an overview of the data sets used, the monetary policy shock identification, as well as our model specification. All results including several robustness checks are presented and discussed in Section 5. Section 6 concludes the paper.

2 Related literature

Our paper adds to the literature on the effects of monetary policy on non-bank financial intermediaries. To date, the literature focuses in particular on the investment fund sector and the risk-taking channel of monetary policy. Hau and Lai (2016), Choi and Kronlund (2017), Giuzio et al. (2021) and Kaufmann (2023) all find that monetary policy loosening implies higher inflows to the investment fund sector and that these inflows are stronger for riskier fund types. Analysing investment funds' asset portfolios, Choi and Kronlund (2017) and Daniel et al. (2021) document that asset managers tilt their portfolios also to riskier higher yielding assets.

For other segments within the wider NBFI sector, some papers find that monetary loosening can have contractionary effects on size and credit provisioning of certain NBFI types. Xiao (2019) shows that monetary tightening leads to deposit inflows to money market funds due competition about deposits with the banking system. Nelson et al. (2018) find that non-banks involved in asset securitisation activities grow larger when monetary policy rates rise. Elliott et al. (2022) show for certain NBFIs, including fintech lenders and finance companies, that credit supply and risk-taking increase after monetary tightening, as opposed to the traditional banking sector.

None of these papers analyses the reaction of the insurance sector to monetary policy. Our paper shows that the IC sector grows significantly after a monetary loosening. Our results suggest the presence of an insurance sector transmission channel of monetary policy that has previously not been documented in the literature.

Another strand of literature studies the investment behaviour of insurance corporations. In their seminal work, Becker and Ivashina (2015) show that due to the regulatory framework under which insurers operate, notably non-linearly increasing capital requirements for riskier assets, they usually hold higher-rated bonds. Conditional on credit ratings, however, ICs prefer higher yielding bonds. Relatedly, Fringuellotti and Santos

(2021) document risk-taking of insurers in collateralized loan obligations, also driven by capital regulation. Domanski et al. (2017) argue that liability-driven investment strategies of ICs and negative duration gaps between assets and liabilities in ICs' balance sheets can create an upward sloping demand curve of the sector for longer-term bonds. Accordingly, lower interest rates negatively affect the capitalisation of insurers, as the valuations of their assets tends to rise by less than that of their liabilities. The authors then show empirically that this induces the sector to rebalance towards longer-term bonds, thus, exerting further downward pressure on long-term interest rates.[3] At the same time, Chodorow-Reich et al. (2020) show that the value of insurers' equity is usually well insulated from movements in their assets' valuations, except for in crisis times. Ozdagli and Wang (2019) study how changes in interest rates affect investment and risk-taking behaviour of US life insurers. They show that ICs rebalance their portfolios towards bonds with a higher return when interest rate levels fall. They find this shift to be primarily driven by duration rather than credit risk-taking.

Our results confirm risk-taking behaviour also for euro area insurers after monetary loosening using the latest advances in the identification of exogenous variations in yields using high-frequency monetary policy shocks. Consistent with Domanski et al. (2017) and Ozdagli and Wang (2019), we find more duration risk-taking for euro area ICs. However, as opposed to the US case covered in the latter paper, we find that euro area ICs also increase the credit risk-taking in their bond portfolio, especially within the investment grade segment. Additionally, we also document pervasive liquidity risk-taking after monetary loosening, which has not been shown before in the related literature. This is relevant, as liquidity risks can materialise rapidly – for example, due to derivative margin calls, which occured at the onset of the coronavirus pandemic in March 2020 or during the gilt market turmoil in Autumn 2022. Moreover, using data for the German insurance sector, Kubitza et al. (2022) show that policy surrender rates and thus cash needs can rise strongly when interest rates rise.

Further papers estimate how the demand of financial sectors responds to yield changes. Timmer (2018) finds that ICs' demand for securities counter-cyclically rises with the asset return. Koijen et al. (2021), focusing on euro area sovereign bond markets around the onset of the ECB's asset purchase programme (APP), document that ICs did not sell to but rather competed with the central bank for same type of bonds despite falling yields. Giuzio and Fache Rousová (2019) disentangle pro- and counter-cyclical trading behaviour of insurers on sovereign bond markets by separating changes in risk-free rates from risk premia. They find that higher risk-free yields imply counter-cyclical purchases by ICs due to the positive effects on capital positions of ICs with negative duration gaps. Higher risk premia, instead, lead to less bond purchases by the sector.

[3] Carboni and Ellison (2022) implement this mechanism into a New-Keynesian dynamic stochastic general equilibrium framework and show that it can indeed amplify the transmission of monetary policy shocks along the yield curve. Their results suggests a potentially significant role of the IC sector for monetary policy transmission.

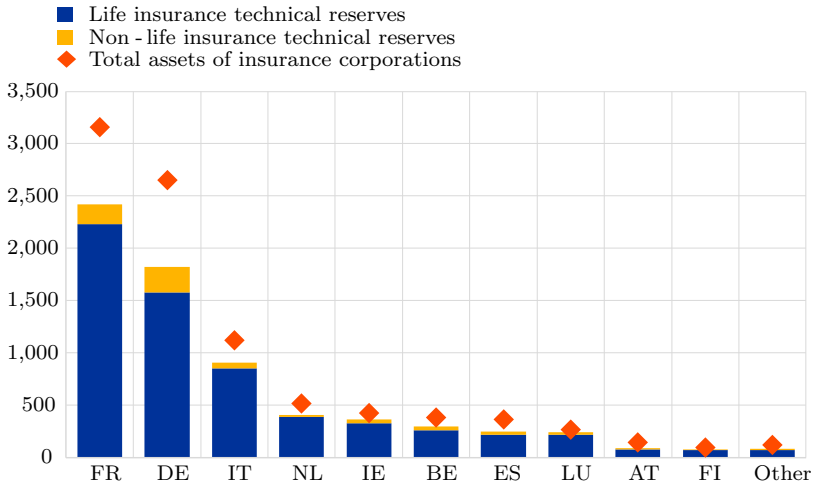
We find that after a monetary loosening that translates into lower interest rate levels insurers' demand for debt securities in general rises, although by less than the demand for stocks and investment fund shares.

3 Insurers' balance sheet structure and monetary policy

3.1 Euro area insurance corporations: stylized facts

Before we delve into the analysis of how monetary policy affects the balance sheet composition and associated risk-taking of ICs, we provide some stylised facts on this growing financial sector in the euro area.

Figure 2: Size of insurance corporations by country and type of insurance activities



Notes: Data is shown in EUR billion in 2021 Q4. "Other" countries includes CY, EE, GR, LT, LV, MT, PT, SI and SK.

Figure 2 shows total assets and technical reserves of euro area insurers by the companies' country of domicile. In terms of their balance sheet size, ICs are concentrated in some of the larger EA economies, such as France, Germany and Italy. The harmonised statistical reporting takes place at the national subsidiary level, ensuring that local operations are reflected in the respective country aggregation. This reduces reporting biases towards countries in which large insurers are incorporated. Nevertheless, the figure illustrates significant variation regarding the size of national insurance sectors. Large differences in so-called "insurance penetration rates", i.e. the ratio of ICs' total assets to national GDP, are largely due to the different roles that insurers play compared to the public sector in offering various insurance services.

Irrespective of the concentration in domicile, insurers' assets under management are invested internationally. In some countries and asset classes (in particular government bonds), ICs tend to have a pronounced degree of "home bias", though.[4] Likewise, poli-

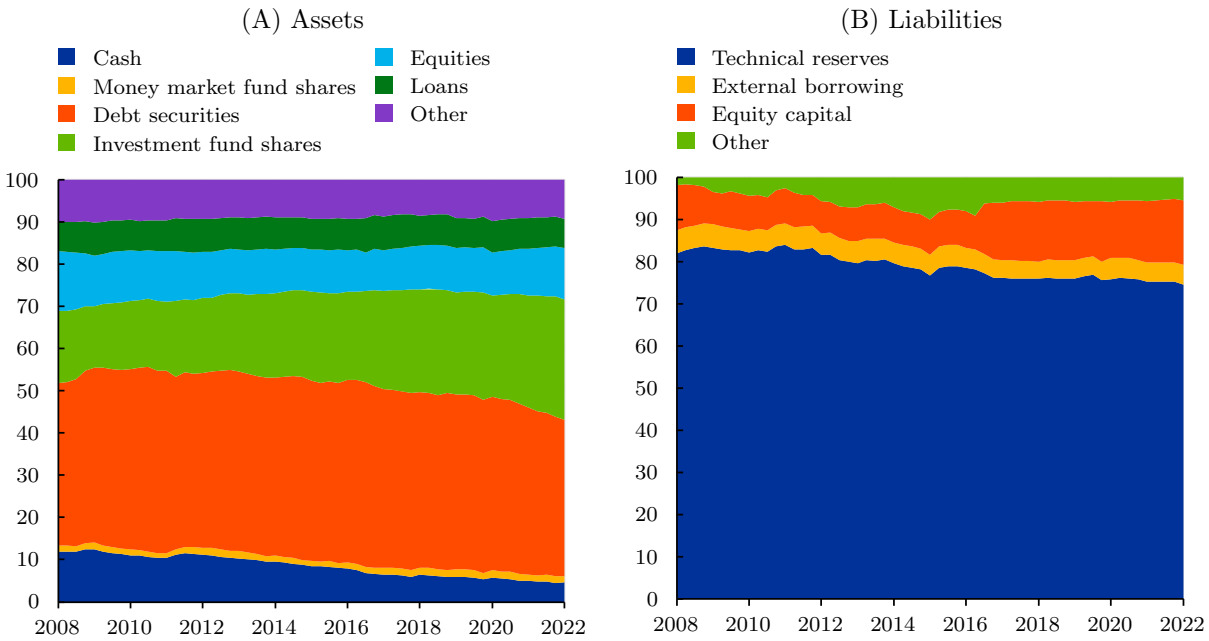
[4]We provide further information on the geographical split of insurer' investments in Section 4.1. For a discussion of the home bias in insurers' investments, see also EIOPA (2021).

cyholders and thus insurers' liabilities may not only stem from the resident jurisdiction of the IC. Instead, technical reserves can also come from households and firms in other countries as well, as, for example, Italian insures also offer their services to, say, German clients, and vice-versa. Insurers in the euro area do, however, tend to offer their services through local subsidiaries incorporated for this purpose, so cross-border technical reserves reported in the aggregate data are in practice very limited (ECB, 2022).

The bars in Figure 2 show the size and breakdown of ICs' technical reserves by business line. The vast majority of the technical reserves (91% of the euro area total as of 2021) is linked to life insurance policies. This business line subsumes not only insurance contracts that pay out upon the death of the insured person. It also includes all types of private pension insurance contracts, akin to the services provided by dedicated pension funds. As such, ICs provide an important function for the channelling of private savings and pension funding in many European countries.

The non-life insurance business lines are significantly less "asset-intensive" and are very diverse. For example, it includes lines such as general liability, medical, trade credit, motor vehicle, fire and property insurances. Most ICs are active in both the life and the non-life business lines. Given the relative size of the two segments, developments in ICs' aggregate balance sheet size and composition can, however, be mainly attributed to the life insurance segment.

Figure 3: Aggregate balance sheet of euro area insurance corporations



Notes: Composition of the aggregate euro area insurance sector balance sheet in % of total assets (Panel A) and liabilities (Panel B).

Figure 3 shows the composition of ICs' balance sheets over time. Given the overall growth of the sector shown in Figure 1 Panel (A), all balance sheet items have increased in absolute amounts. In relative terms, however, Figure 3 reveals that the investment

behaviour of ICs has changed over the past two decades.

Looking at the development of the aggregate balance sheet, we observe a modest decline in the relative share of debt securities held. Debt securities still remain the largest type of assets held at the end of 2021, comprising 38% of total assets. Thus, ICs continue to play a significant role in the bond markets, as also shown in Figure 1. In contrast, holdings of investment fund shares have increased from 17% in 2008 to almost 30% in 2021. As our analysis will show, this change is at least partially driven by the low interest rate environment, in which ICs have operated in the last years. Indeed, the low yield levels have put pressure on the sector's profitability and ability to generate investment returns that are sufficiently high to cover obligations from long-maturity contracts with high guaranteed returns. Increasing the exposures to investment fund shares could be one way to reach for additional yield. Also consistent with this argument, the lowest-yielding assets, cash holdings, have declined from 12% of the total assets in 2008 to 4.5% in 2021, thus making the sector vulnerable to sudden liquidity needs.

Figure 3 Panel (B) depicts the composition of ICs' liabilities over time. Insurers obtain the vast majority of their funding from collected policy premiums that accumulate on the liability side of the balance sheet as technical reserves. While rising in absolute amounts, the share of technical reserves in total liabilities has fallen from 82% in 2008 to around 75% in 2021. The importance of external borrowing has remained broadly stable over this time period, while the capitalisation of the sector has increased from around 11% to 15%.

3.2 Monetary policy effects and transmission

In this section, we discuss the mechanisms through which monetary policy can affect the size and investment behaviour of the insurance sector. We also explain how these mechanisms affect the transmission of monetary policy to the wider economy. In the following, we will argue from the perspective of a monetary policy loosening.

We begin with considering how monetary policy may affect the total size of the IC sector. Monetary policy loosening will ease financing conditions and, thereby, stimulate real economic activity. To the extent that this leads to higher wages and a reduction in unemployment, households' disposable income will rise. Firm profits could also increase. As a result, households and firms can increase their demand for insurance products. For example, households may want to purchase additional life and pension insurance policies to prepare for their retirement. Demand by households and firms can also rise in the non-life insurance segments, such as motor vehicle insurance as well as various other property and liability lines. Written premiums and, thus, technical reserves will then rise. The total assets that the ICs will need to invest on financial markets will increase as well. These additional investments, e.g., in corporate bonds can further ease financing conditions and

transmit to the real economy by allowing for higher corporate investment activity.[5] Vice-versa, the demand for IC products may fall when monetary policy tightens, also driven by increasing surrenders of households on their life insurance policies (Kubitza et al., 2022). In the remainder of the paper, we will refer to this first nexus as the *insurance demand channel* of monetary policy.

Monetary loosening may, by reducing interest rates levels, also affect households' consumption-saving decisions. Specifically, the textbook New Keynesian macroeconomic model would imply that lower real interest rates reduce the growth rate of consumption, as dictated by the Euler equation. Ceteris paribus, current consumption may rise, while savings fall. Consequently, the demand for ICs' life and pension products could fall. As a result, premiums written, technical reserves and total assets of the sector would decline as well. We will refer to this mechanism as the *Euler equation channel*.

The two "real" economic channels discussed so far provide predictions for the development of the IC sector's total size after monetary policy changes. As the signs of the two channels point in opposite directions, it remains an empirical question which of the channels will dominate. The following "financial" channels, instead give guidance on the composition of assets and liabilities as well as on related financial stability risks.

Under full mark-to-market accounting, as it is for example the case under the European Solvency II framework that came into force in 2016, a monetary loosening will induce positive valuation effects on both assets and liabilities. However, as in particular life insurance companies' balance sheets usually feature sizeable negative duration gaps, the valuation increase of the assets will be smaller than the valuation increases on the liability side. ICs' capital positions would, thus, experience adverse pressure when yields fall, while leverage would rise. To dampen these negative effects on their capital, insurers may want to decrease the duration mismatch in their balance sheets. Their demand for assets with longer duration may, therefore, rise (Domanski et al., 2017). This additional demand for, especially, long-term bonds can induce further downward pressure on the longer end of the yield curve, hence, easing financing conditions for sovereigns and firms (Carboni and Ellison, 2022). This mechanism is coined as the *negative duration gap channel*.

The effects of this channel can be dampened in practice, though. First, in actual accounting practice, there are long running transitional periods until full mark-to-market accounting needs to be applied. Moreover, oftentimes mark-to-market is only applied on the asset valuations so far in many European jurisdictions. Hence, when only asset valuations increase after a monetary loosening, capital positions could even improve and there will be less pressure to adjust portfolio duration. Second, even when the negative duration gap effects occur, insurers may simultaneously increase their demand for riskier assets and would, thus, be required to also hold more capital for regulatory reasons (see Becker and Ivashina, 2015).

[5] See Kubitza (2022) for causal empirical evidence on the link between higher insurance premiums collected and more real corporate investment.

Finally, monetary policy can affect ICs' portfolio composition and risk-taking behaviour due to the liability-driven investment strategies they follow. In the largest share of the long-term life and pension insurance policies sold, ICs offer their policy holders a fixed guaranteed return. Falling yields on fixed-income securities like bonds after a monetary policy loosening may, therefore, pose a challenge for the IC sector and incentivise investments in higher yielding but riskier assets.

This could materialise in form of rebalancing away from bonds towards stocks, riskier investment fund types or more alternative asset classes. Insurers may also reduce their liquid asset holdings and cash reserves, as these usually provide lower returns due to their inherent safety and liquidity premia. Within their bond holdings, insurers may increase credit and duration risk-taking to "reach for yield". While such portfolio rebalancing could increase financial stability risks in insurers' balance sheets, it may also provide additional intended monetary easing of financing conditions, including for riskier borrowers. This constitutes the *risk-taking channel* of monetary policy.

4 Empirical setup

4.1 Data sources and description of variables

The first part of our analysis is based on quarterly aggregate insurance sector data for the 19 euro area countries from 2008 Q1 to 2021 Q4, for which we have already provided some stylised facts in the previous section. To avoid potentially distorting effects from outliers during the global financial crisis of 2007/2008 and the onset of the Covid-19 pandemic in 2020, the main data set that we use runs from 2010 Q1 until 2019 Q4, giving us up to 760 usable observations.[6] We source this data from the ECB's Insurance Corporation Statistics (ICB) and until 2016 the Insurance Corporations and Pension Funds Statistics (ICPF)[7]. This data set allows us to study the evolution of the balance sheet size as well as its composition in terms of broad asset and liability breakdowns. Besides the suitably long time series dimension, a key advantage of the data set is the harmonised statistical approach across the different euro area countries. Although the more recently collected sector data also reports additional information on insurance sub-sectors, such as life and non-life ICs, we cannot make use of these breakdowns given the limited number of data points available until now.

While a relatively long time series is available for aggregate country-level insurance sectors, we face a structural break in the data for several, especially liability side, balance sheet items for several countries due to changes in the reporting related to the introduction of the Solvency II regulation in 2016. To ensure consistency across time, we subtract any

[6] In robustness checks, we will show that all main results continue to hold when these two crisis episodes are included as well.

[7] The previously collected data set for both insurers and pension funds was discontinued in Q3 2016 and replaced by the more granular Insurance Corporation Statistics.

Table 1: Descriptive Statistics: Asset side

	Mean	St. Dev.	Median	Min	Max	Obs.
(A) Log-levels market value						
Total Assets	24.59	2.45	24.94	20.39	28.67	760
Cash Holdings	21.86	2.27	22.14	17.23	26.81	760
Loans	20.57	3.34	21.12	13.12	26.36	735
Debt Securities	23.64	2.42	24.36	19.40	28.09	739
Equity	21.70	2.97	22.40	14.51	26.60	739
Money market fund shares	19.27	2.82	19.35	12.21	25.41	632
Investment fund shares	22.99	2.41	23.41	17.96	27.38	656
(B) Log-levels nominal value						
Total Assets	24.54	2.37	24.84	20.40	28.51	678
Cash Holdings	21.93	2.16	22.01	17.36	26.84	678
Loans	20.84	3.16	21.11	13.82	26.46	661
Debt Securities	23.67	2.40	24.31	18.82	27.96	678
Equity	21.82	2.70	22.19	14.51	26.45	653
Money market fund shares	19.47	3.07	19.53	7.94	25.41	585
Investment fund shares	22.95	2.49	23.69	17.91	27.27	631
(C) Share of total assets in market value						
Cash Holdings	8.77	6.56	7.40	0.79	30.15	760
Loans	4.80	7.78	1.58	0.05	45.27	735
Debt Securities	45.14	15.88	44.25	10.52	73.84	739
Equity	7.55	4.63	6.83	0.17	22.47	739
Money market fund shares	1.14	1.29	0.51	0.00	5.37	632
Investment fund shares	20.55	11.38	18.02	3.26	51.28	656
(D) Share of total assets in nominal value						
Cash Holdings	9.76	6.86	8.72	0.80	33.33	678
Loans	5.75	9.13	1.81	0.07	47.09	661
Debt Securities	45.12	16.03	42.94	10.20	74.70	678
Equity	9.00	4.72	8.16	0.19	22.38	653
Money market fund shares	1.38	1.51	0.57	0.00	6.35	585
Investment fund shares	20.13	12.10	17.07	2.06	60.02	631

Notes: Observations at country-sector level for all 19 euro area countries between 2010 Q1 and 2019 Q4. Data in Panels (A) and (B) in log of EUR, Panels (C) and (D) in % of total assets.

significant level shifts that occur in individual country time series between 2016 Q2 and 2016 Q3. More specifically, we compare the growth rate between the two quarters in question and in case of deviations exceeding one standard deviation of the average growth rate, we rebase the following quarters to the level of 2016 Q2. We apply a rescaling factor in rare cases that would otherwise lead to negative values.[8] As an example, Figure 13 in Appendix A shows the time series of capital for all countries in the sample before and after the cleaning of the structural break.

Tables 1 and 2 report summary statistics for all main balance sheet item variables on

[8]Notably, our main results continue to hold also without this transformation and in case the break is defined by exceeding two standard deviations of the average growth rate.

Table 2: Descriptive Statistics: Liability side

Variables	Mean	St. Dev.	Median	Min	Max	Obs.
(A) Log-levels in market value						
Debt Securities	19.77	2.94	20.26	11.44	23.84	492
Loans	20.38	3.21	20.74	11.62	25.41	714
Capital	22.35	2.29	22.45	17.64	26.50	739
Technical reserves	24.25	2.48	24.66	20.01	28.43	739
(B) Log-levels nominal value						
Debt Securities	19.69	2.85	20.04	10.74	23.84	492
Loans	20.30	3.21	19.94	11.54	25.41	673
Capital	22.25	2.17	22.14	17.99	25.99	628
Technical reserves	24.26	2.42	24.57	20.05	28.37	683
(C) Share of total liabilities in market value						
Debt Securities	0.75	0.85	0.38	0.00	4.93	492
Loans	2.50	2.51	1.70	0.00	23.45	714
Capital	13.03	6.86	11.11	2.38	42.51	739
Technical reserves	76.84	6.69	77.22	55.40	95.14	739
(D) Share of total liabilities in nominal value						
Debt Securities	0.76	0.98	0.39	0.00	4.44	492
Loans	2.71	2.92	1.69	0.00	26.31	673
Capital	13.65	6.91	11.43	4.13	38.90	628
Technical reserves	78.66	11.12	79.62	47.18	107.37	678

Notes: Observations at country-sector level for all 19 euro area countries between 2010 Q1 and 2019 Q4. Data in Panels (A) and (B) in log of EUR, Panels (C) and (D) in % of total liabilities.

asset and liability side that we use in our analysis. On the asset side, these items consist of total assets and its following sub-items: debt securities, loans, equity, investment fund shares, money market fund (MMF) shares and cash holdings. On the liability side, these variables are the technical reserves, capital as well as debt securities and loan funding. Despite overall good data coverage, availability for some of these variables slightly varies for some countries over the whole sample period.

To cover both the absolute and relative changes in the balance sheet composition of ICs, we use the variables both in log-levels and as ratios capturing their share in terms of total assets.

We additionally distinguish between two valuation perspectives for the balance sheet variables: market and nominal values. The stock value of a given balance sheet item in market valuation of country i and quarter t is given as

$$S_{i,t}^{MV} = S_{i,t-1}^{MV} + Flow_{i,t} + \Delta Val_{i,t} + \Delta FX_{i,t} + \varrho_{i,t} \ , \tag{1}$$

where $Flow_{i,t}$ are financial transactions, $\Delta Val_{i,t}$ are price revaluation adjustments, $\Delta FX_{i,t}$ are exchange rate adjustments and $\varrho_{i,t}$ are statistical reclassification adjustments. A change in the market value from one quarter to the next can accordingly reflect both

changes in the amounts of assets held, due to financial transactions and maturing assets, and valuation changes due to asset price and exchange rate movements in financial markets. An analysis of developments in balance sheet items at market value can already give valuable insights. They do not allow, though, to separate active financial transaction decisions by the ICs' asset managers from passive changes in the stock value of the balance sheet item due to valuation changes. After changes in monetary policy – the focus of our paper – we expect both active and passive adjustments to occur. We therefore construct nominal stock values S^{NV} that capture only active balance sheet changes in the following way:

$$S_{i,t}^{NV} = S_{i,0}^{MV} + \sum_{\tau=1}^{t} Flow_{i,\tau} \ , \tag{2}$$

where $S_{i,0}^{MV}$ denotes the size of the balance sheet item as reported in the data set at the beginning of sample period. We illustrate these two different valuation concepts in Figure 14 in Appendix A, using total assets of French insurers as an example. Overall and important for our analysis, changes are to the largest part driven by nominal values, while revaluation effects in the aggregate tend to play a smaller role. On average, the total assets in market value in 2021 relative to the sample start in 2008 consist to 88% of total assets in nominal value, i.e. due to active financial transaction decisions, and only to 12% of revaluation effects.

In the second part of our analysis, we complement the aggregate country-sector data for balance sheet items with information from the ECB Security Holdings Statistics by Sector (SHSS). This quarterly security-level dataset allows for additional analyses regarding different types of asset characteristics. It reports for each country and financial sector the aggregate amounts held of each security, thus allowing us to look at further breakdowns of investments by type of security issuer, rating or maturity. As a consequence of the global financial crisis, this collection of new and harmonised statistical data has been introduced with the specific purpose to reduce data gaps in granular securities holdings in the euro area (ECB, 2015). The data from SHSS is available to us as of 2009 Q1.[9] Due to the granular security-level perspective in the data set, SHSS data can be merged via security identifiers with additional information from a wide range of sources. We obtain information on issuer sectors and countries, credit ratings and residual maturity for each security from the Centralised Securities Database (CSDB). The latter collects consistent and up-to-date information on all relevant securities for the statistical purposes of the European System of Central Banks.

We combine information from SHSS and CSDB to calculate risk indicators for ICs' bond portfolio holdings, such as the share of lower-rated securities held or the average

[9] The official start of the dataset is in 2013 Q4, but we can make use of the so-called experimental data of SHSS that was collected as of 2009 Q1. While the data on bond holdings prior to 2013 Q4 is already comprehensive, data for other securities types like equity and investment fund shares is less advanced in this earlier period.

duration in the bond portfolio. For consistency with the analysis of the main balance sheet items, we aggregate the SHSS data to the country-sector level. SHSS has holding information both in market and nominal values. For our analysis, we focus on the nominal holdings that allow us to abstract from valuation effects. Tables 4 and 5 in Appendix A show summary statistics for the constructed variables regarding bond portfolio characteristics.

The main breakdowns for our bond portfolio analysis are by issuer region (euro area and rest of the world), by issuer sector (government, non-financial and financial corporates) and by rating (investment grade and lower-rated). We define lower-rated bonds with a rating of BBB or below. The reason for this split is that insurers only hold very limited amounts of high-yield (rated below BBB) bonds, given non-linear regulatory capital requirements (see also Becker and Ivashina, 2015). Instead, credit risk-taking of insurers in search for higher yields often takes place in the BBB segment at the threshold between investment grade and high-yield. To assess duration risk of the bond portfolio we calculate the following metrics: weighted average maturity in years, bond holdings within different maturity buckets in absolute amounts and as a share of the total bond portfolio.

Finally, we use the following variables in changing compositions as control variables in our analysis. As macroeconomic controls we use country-specific year-on-year GDP growth and inflation rates. As financial controls, we use German Bund yields and overnight index swap rates (OIS) at various maturities, euro area BBB-rated corporate bond yields from iBoxx, and the VSTOXX volatility index. We use corporate bond and Bund yields of the same maturity to construct bond spread measures. We source these variables from the ECB Statistical Data Warehouse (SDW). In some specifications, we also use country-specific demographic variables, such as life expectancy and the old age dependency ratio, which is defined as population aged 65 years and older over the population aged between 15 and 64. The demographic variables are taken from Eurostat.

Table 3 in Appendix A provides a list of all variables used including their data sources.

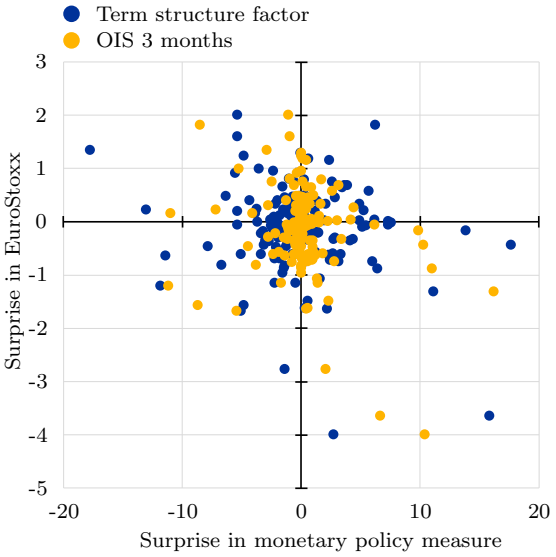
4.2 Identification of monetary policy shocks

We identify monetary policy shocks using high-frequency data. To this end, we employ the Euro Area Monetary Policy Event-Study Database by Altavilla et al. (2019). This data set collects the intra-day changes of several financial variables during a narrow time window around the ECB's Governing Council meetings. We use the whole monetary event window, which includes the press release and the subsequent press conference. Specially, the surprises are calculated as changes between the median quote of a financial variable from the time window 13:25 to 13:35 before the press release and the median quote from the time window 15:40 to 15:50 after the end of the press conference. This tight time window allows to attribute the observed changes in yields and asset prices only to the announcement of monetary policy. Moreover, only effects that were not expected before by

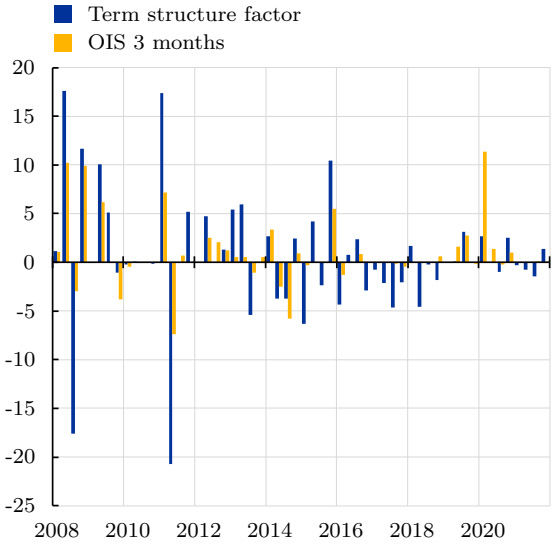
financial markets are captured, thus yielding a clean exogenous policy-induced variation in yields and asset prices. For the shock identification, we use OIS and Bund yield changes at various maturities as well as the change of the EuroStoxx 50.

Figure 4: High-frequency monetary policy surprise measures

(A) Interest rate and EuroStoxx surprise changes



(B) Monetary policy surprises over time



Notes: Panel (A): High-frequency interest rate changes (in basis points) and corresponding EuroStoxx changes (in percentage points) on all ECB Governing Council meeting days between 2008 and 2021 based on Altavilla et al. (2019). Panel (B): Cumulative quarterly monetary policy surprises between 2008 and 2021 in basis points.

Using this high-frequency data, we follow the approach introduced by Jarociński and Karadi (2020), who show that such intraday surprise changes of monetary policy related interest rates do not necessarily coincide with stock market movements in the opposite direction. Such a negative co-movement between a monetary policy indicator and stock markets is, however, the expected result of a monetary policy shock in conventional economic theory. The approach by Jarociński and Karadi (2020) allows for disentangling these pure negative co-movement monetary policy shocks from positive co-movement shocks that the authors interpreted as central bank information shocks, in which the central bank conveys additional information to market participants. For example, an increase in equity markets after a monetary policy tightening could be the result when the central bank reveals information that tightening of monetary conditions was required to prevent the economy from overheating, which financial markets can interpret as positive economic news. The authors show that the responses from macroeconomic and financial market variables can differ decisively under these two types of shocks. Therefore, studies not properly differentiating between these two shock types may not be able to clearly identify the effects of a genuine monetary policy surprise.

For the monetary policy surprise measures, the related literature usually employs interest rates from the short end of the yield curve, such as the 3-month OIS rate, which are

linked mainly to conventional monetary policy instruments. As the ECB's main interest rates were set close to their effective lower bound with little variation over time during our sample period, we construct surprise measures that also use longer-term interest rates. In order to capture surprise changes over the whole longer-end of the yield curve, instead of focusing on the potentially idiosyncratic changes of yields at a certain maturity, we apply the method by Gürkaynak et al. (2005) to separate a "target factor" of monetary policy from a "term structure factor". To perform the principal component analysis, we use the OIS with maturities of 1 week, 1, 3, 6, months, and 1 year, plus changes of the German Bund with maturities of 2, 5, and 10 years.[10] Following the procedure by Gürkaynak et al. (2005), we calculate the first two principal components of this data. After applying the transformations described in Gürkaynak et al. (2005), these can be interpreted as a monetary policy target factor, capturing monetary policy induced changes in short-term interest rates, and as a term structure factor, which captures monetary policy induced movements throughout the yield curve. We normalise the term structure factor such that a one-unit change corresponds to one percent change of the 5-year Bund.

Figure 4 Panel (A) shows a scatter plot of the surprise changes in the 3-month OIS and the term structure factor against the EuroStoxx 50 on all Governing Council dates during our sample. Following Jarociński and Karadi (2020) we identify pure monetary policy surprises when the high-frequency monetary policy shocks are negatively related to high-frequency changes in the EuroStoxx 50, i.e. events in the upper-left and lower-right quadrant. The higher variation of the term structure factor compared to the 3-month OIS is visible, with standard deviations of 4.6 versus 3.2 basis points, respectively. Moreover, the series for the 3-month OIS features 16 observations out of 141 with a surprise change of zero, compared to three observations (close to) zero for the term structure factor.

In our application, the term structure factor has three advantages. First, as opposed to a short-end yield measure, it can also capture the effects of unconventional monetary policies such as forward guidance and asset purchases programmes, which arguably were the instruments with the greatest variation during our sample period when short-term interest rates were kept close to zero with little variation for an extended period. Second, insurers are mainly long-term investors. In 2021 Q4, at the end of our sample period, the average duration of ICs' bond portfolio stood at 7.9 years. Monetary-policy induced changes to longer-term interest rates will, therefore, be of greater relevance for the insurance sector than changes in short-term interest rates. Third, the relatively higher variation of the term structure factor over the sample period facilitates the identification of monetary policy effects statistically.

To combine the high-frequency surprise measures with our otherwise quarterly data, we sum up all daily surprises that occur within one quarter. We plot the quarterly series of the genuine monetary policy surprises that we will employ in the regressions in Panel

[10] We use Bund yields in the medium and longer segment of the yield curve, as OIS quotes at longer horizons only become available after August 2011.

(B) of Figure 4.

4.3 Local projection specification

In order to compute the impulse response functions of the different IC variables, we estimate local projections of the high-frequency monetary policy shocks described in the last section. Local projections allow us to compute the dynamic effect of monetary policy, while keeping a very flexible framework and being more robust to mis-specification than, e.g., a vector auto-regression model, as shown by Jordà (2005). We estimate the following specification at different horizons h:

$$y_{i,t+h} = \alpha_i^h + \theta^h MP_t + \sum_{l=1}^{L} \beta_l^h y_{i,t-l} + \sum_{l=1}^{L} \gamma_l^h Controls_{i,t-l} + \epsilon_{i,t+h} \ , \tag{3}$$

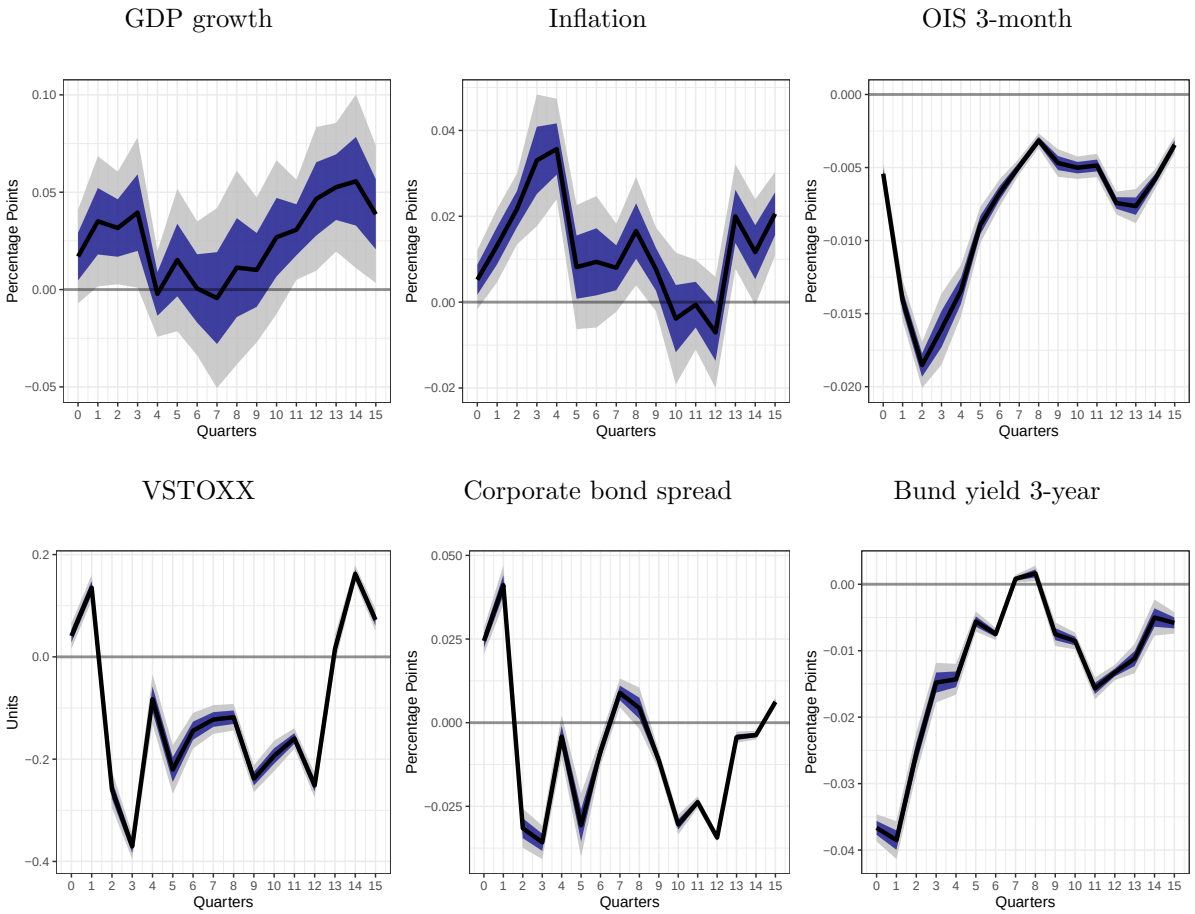
where θ^h represents the causal effect of the monetary policy shock MP_t on the dependent variable $y_{i,t+h}$ at period $t+h$. The impulse response function h periods after the shock is represented by the vector $(\theta^0, .., \theta^h)$.

In addition to the monetary policy shocks and lags of the dependent variable, we add further controls to sharpen our estimates. In the baseline estimations, we control for macroeconomic and financial conditions, as in recent studies that assess the effects of monetary policy such as Gertler and Karadi (2015). The macroeconomic controls are country-specific year-on-year GDP growth and inflation rates. The financial variables are the observed Bund yield at maturity of 3 years, the VSTOXX volatility index, the 3-year euro area BBB-rated corporate spread and the log total assets of the ICs (unless the latter is the dependent variable). The VSTOXX is used to capture the overall risk sentiment in financial markets. The BBB-rated corporate spread captures the tightness of financial conditions and potential frictions (see, e.g., Caldara and Herbst, 2019 and Jarociński and Karadi, 2020). It also measures the excess return from buying financial assets issued by the corporate sector, which is an important variable for the IC sector's profitability.

As shown in Miranda-Agrippino (2016) and Ramey (2016), even if the shocks are identified using high-frequency methods and they are supposed to be uncorrelated with previous values, there still can be some auto-correlation. Hence, we also control for lagged values of the shocks. We also add country-fixed effects α_i^h to capture permanent structural differences in the IC sector across euro area countries. Our setup does not allow for the inclusion of time-fixed effects because they would be perfectly collinear with our shocks. Some of our controls, such as the yield, bond spread and VSTOXX are aggregate variables and, thus, capture some time period specific effects.

In our baseline specification, we choose a a lag length L of two. The results are robust to different lag lengths. The standard errors are clustered at the country level. Finally, $\epsilon_{i,t+h}$ denotes the regression error term.

Figure 5: Impulse responses of macroeconomic and financial variables



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals.

5 Results

We present all results of our analysis in this section. In Section 5.1 we analyse the reaction of ICs' total asset size and all main balance sheet items after a monetary loosening. Subsequently, Section 5.2 examines the reaction of the ICs' bond portfolio in greater detail. Lastly, Section 5.3 provides a broad range of sensitivity analyses.

Before we turn to the analysis of the insurance sector, we assess if our macro-financial control variables behave intuitively, in order to make sure that we properly identify monetary policy shocks. Figure 5 shows impulse response functions (IRFs) to an expansionary monetary policy shock that decreases the term structure factor by one basis point. The grey and blue-shaded areas display 95% and 68% confidence intervals. Consistent with the conventional wisdom and the related literature, we find that real economic activity increases and financial conditions loosen.

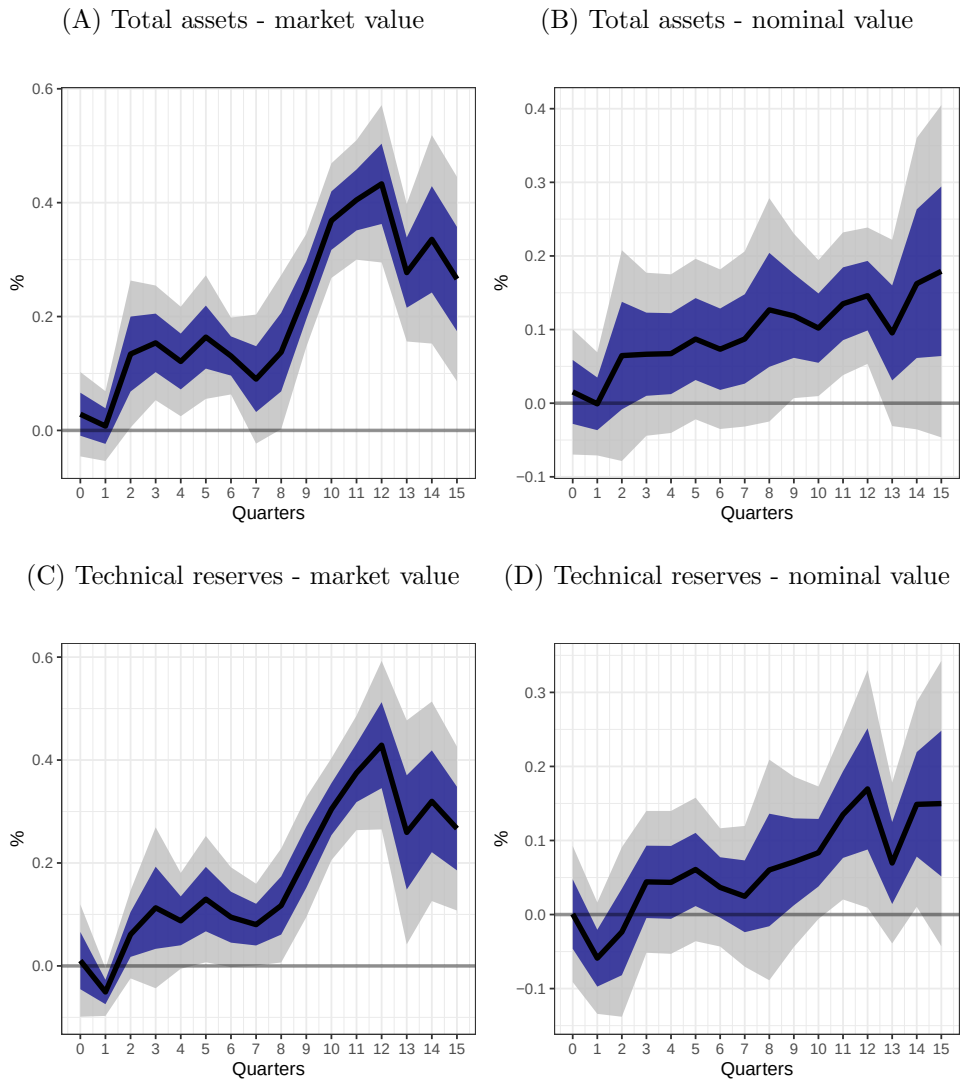
Specifically, the one basis point drop of the high-frequency surprise measure translates into a reduction of the quarterly 3-year Bund yield of almost three basis points on impact.

The shorter end of the yield curve reacts less, as measured by the 3-month OIS rate, and falls by only 0.5 basis points.[11]

GDP growth and inflation increase statistically significant on impact and remain positive during the 16 quarters for which we calculate the local projections. The VSTOXX volatility index briefly rises before falling significantly and persistently after two quarters. This indicates increasing risk appetite among financial investors (Bekaert et al., 2013). Likewise, the BBB-rated corporate bond spread also falls significantly after a short-lived initial rise, suggesting a reduction of financial frictions (Gertler and Karadi, 2015).

Overall, all macroeconomic and financial variables behave intuitively and we conclude that our approach allows us to properly identify surprise changes in monetary policy.

Figure 6: Impulse responses of insurance corporations' total assets and technical reserves



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Nominal values calculated as in (2) to remove valuation effects.

[11] Figure 15 in Annex B shows the response of some further quarterly yields over the whole yield curve.

5.1 Main balance sheet items

We begin our analysis with investigating the reaction of the insurance sector's total size to monetary policy. Panel (A) of Figure 6 shows the impulse response function of total assets in market value. After a one basis point monetary loosening shock, total assets start increasing significantly after two quarter with a quarterly marginal effect of around 0.15%. The marginal effects continue to rise with a peak of more than 0.4% three years after the initial shock.

To assess to what extent this surge is not only driven by valuation effects but also by an actual increase of assets, Panel (B) shows the response of total assets in nominal terms, i.e. free of valuation effects as derived in (2). We find that this measure increases significantly and continuously to a quarterly marginal effect of more than 0.1% two years after the shock. Accordingly, the size of the IC sector is highly responsive to monetary policy induced yield changes.

We gauge the economic significance of this result next. To this end, we consider a high-frequency monetary policy shock that translates into a 50 basis point fall in the (quarterly) 3-year Bund yield on impact. The IRF from Figure 5 implies that the *cumulative* drop of this yields reaches around 150 basis points over the course of one year after the shock. ICs' total assets in market (nominal) value cumulatively increase by 4.5% (2.0%) over the same time.[12] This cumulative rise of the sector's total assets in nominal terms amounts to almost EUR 200 billion one year after the shock and, as we show below, implies an active expansion in ICs' investments. This compares to the euro area GDP in 2021 of around EUR 12.4 trillion. The rise in assets, accordingly, is equivalent to 1.6% of GDP. The financial intermediation capacity of the sector, thus, increases significantly after a monetary loosening. Accordingly, insurers transmit monetary policy changes to the wider economy on a macroeconomically relevant scale.

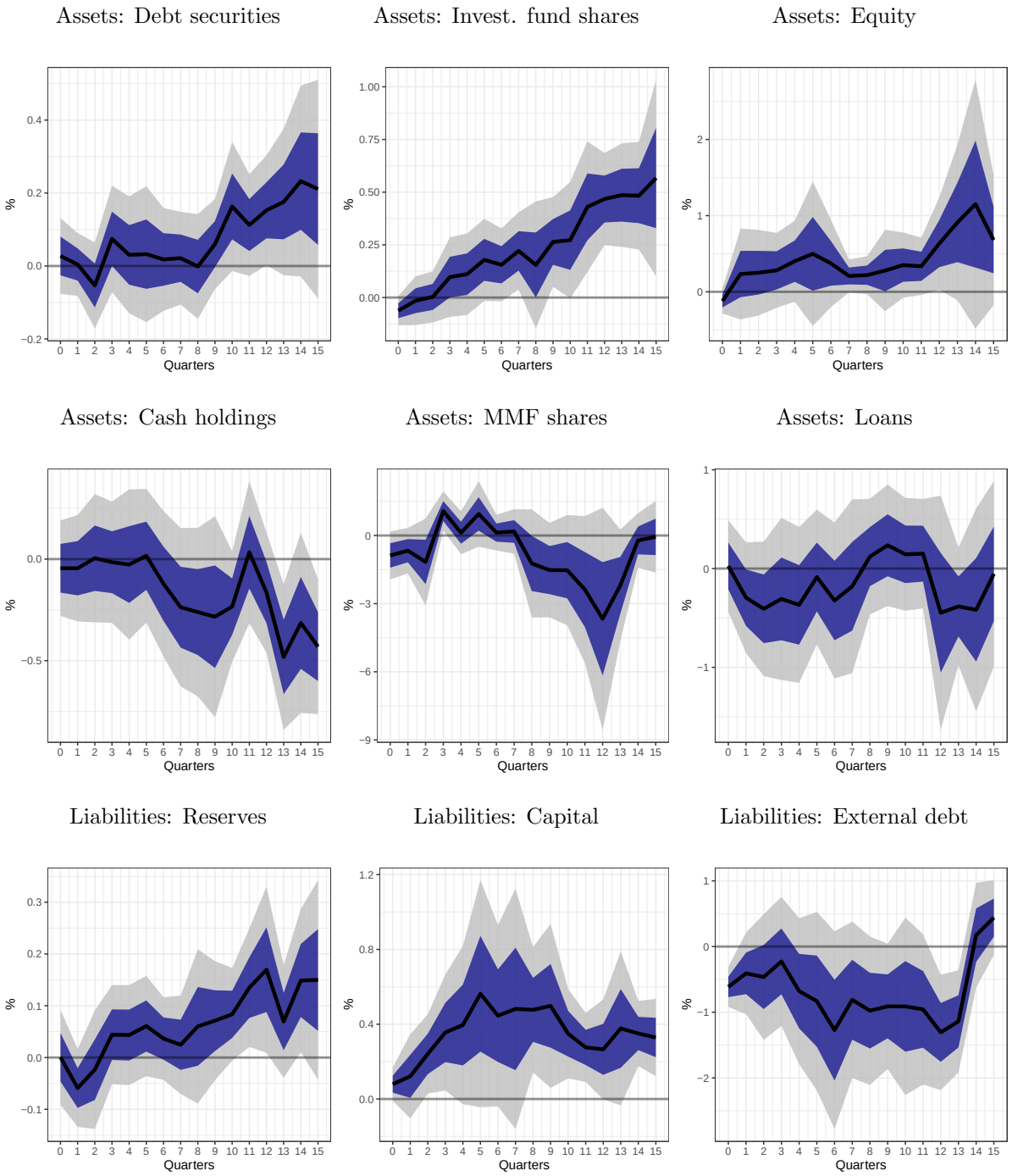
Panels (C) and (D) of Figure 6 display the response of insurers' technical reserves, the largest item on their balance sheets' liability side, in market and nominal value. After a small and short-lived drop, the responses resemble those of the total assets quite closely. In market value, technical reserves start rising by about 0.1% each quarter half a year after the shock. The response peaks three years after the shock at more than 0.4%. In nominal value, technical reserves increase continuously to a peak response of 0.16% three years after the shock.

This result implies that the premia the IC sector collects from existing and new policy holders increases significantly, indicating that households and firms increase their demand for insurance products after a monetary loosening. The collected funds in turn need to be invested on capital markets by the ICs (see Kubitza, 2022). The increase in total assets and technical reserves is, therefore, consistent with the insurance demand channel of monetary policy, described in Section 3.2. The short-lived drop in technical reserves

[12] The necessary high-frequency shock amounts to 13.6 basis points on impact.

after impact would be consistent with the Euler equation channel, before being dominated by a stronger insurance demand channel.

Figure 7: Impulse responses of main asset and liability components: Log-levels of nominal value



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Nominal values calculated as in (2) to remove valuation effects.

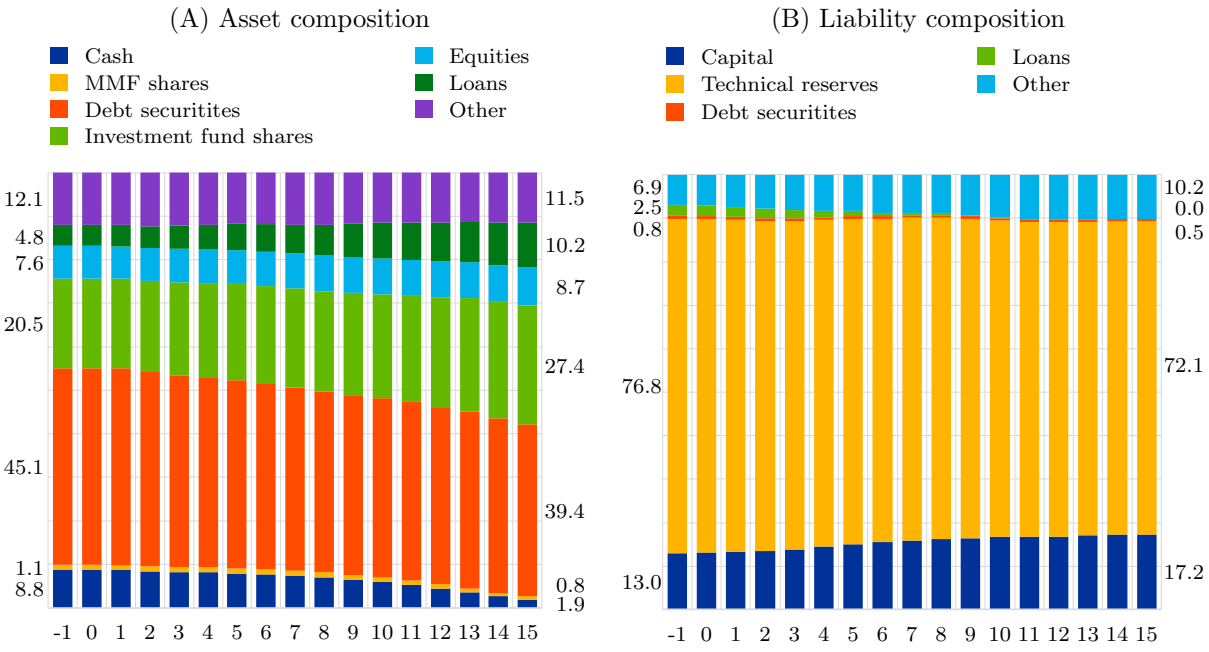
We examine the response of the main asset and liability balance sheet items next. Figure 7 provides results in levels of nominal value, again in order to abstract from

valuation effects.[13] Based on these IRFs, Figure 8 provides a model-implied projection of the whole balance sheet compostion. This graphical represtation takes into account the relative size of every component on the balance sheet, while a conventional IRF would only show the marginal effect of the shock at different horizons. This "balance sheet IRF" shows the projected evolution of the total asset composition after a 10 basis point high-frequency monetary policy loosening shock. In the following,k we first discuss results regarding the asset side and then regarding the liability side.

As shown in the six upper panels of Figure 7, we find that a monetary loosening leads to an increase in the holding amounts of the largest and most important asset classes: debt securities, investment fund shares, and equity. Consistent with our previous finding of rising total assets, this implies more financial intermediation of ICs via capital markets and an active monetary policy transmission to the wider economy.

The response of debt securities starts rising statistically significantly only after about eight quarters. Instead, investment fund shares and equity rise significantly already after two quarters. The percentage increase of these categories is also larger than the one of debt securities. The response of direct loans granted by ICs remains mostly insignificant. Notably, we observe however that the amounts of cash holdings and money market fund shares fall significantly.

Figure 8: Model-implied balance sheet projection



Notes: The charts are a graphical representation of the projected evolution of insurance corporations' balance sheet composition in % of total assets, following an expansionary high-frequency monetary policy shock inducing a 10 basis point decrease of the term structure factor. The x-axis shows quarters after the shock. The bar denoted "-1" represents the sample average for each item. The balance sheet projections are based on the IRFs shown in Figure 17 (Appendix B.1).

[13]Figures 16, 17 and 18 in Appendix B.1 show the responses in levels of market value, and as a share of total assets in market and in nominal value.

Panel (A) of Figure 8 presents these changes relative to total assets. Consistent with the findings in levels, the portfolio share of debt securities falls relatively strongly from the sample average of 45.1% to 39.4% three years later for the 10 basis point shock. The share of the most liquid asset category, cash, falls sizeably from about 9% to 1.9%. The relative portfolio share of investment funds, equity and loans increase strongly instead from about one third to 46%.

Overall, we hence document a sizeable portfolio re-balancing to a higher proportion of riskier stocks, investment funds and loans, while the shares of assets considered more safe, including debt securities, cash and money market funds declines sharply. As lower interest rate levels after a monetary loosening also reduce yields of newly issued bonds and MMF shares, while reducing the remunerations of ICs' cash deposit holdings, this finding is a first indication for a search for yield of insurers, consistent with the risk-taking channel of monetary policy (see Section 3.2).

At the same time, the fact that holdings in the most liquid asset categories are reduced the most also implies a considerable increase in liquidity risk-taking of the insurance sector. This makes the ICs more vulnerable to sudden liquidity needs during market turmoils, as for example experienced during March 2020 related to margin calls (see also Ghio et al., 2023). This shift of insurers towards these different less liquid asset classes after a monetary loosening has not been documented so far using causal identification methods.

We now turn to the liability side of ICs' balance sheets. We find in Figure 7 that the amounts of the technical reserves (discussed above) and ICs' capital increase after the expansionary monetary policy shock. The size of ICs' external debt financing by issuing debt securities and taking loans falls, though. One reason for this could be that there is less need for external funding when there are sufficiently high inflows from written premiums. Generally, such external financing only plays a minor role for insurers with 3.23% of total liabilities. In relative terms (see Figure 8, Panel B), we find that the capital ratio rises and, thus, leverage falls, while the liability shares of the technical reserves and external debt fall.

It is interesting that we do not find a decrease in capital on impact – notably, also not at when measured at market value in Figure 16. This would have been in line with the valuation effects related to the negative duration gap channel (see Section 3.2) that is present in the balance sheet of many insurers (Domanski et al., 2017). The rise in insurers' capitalisation can be due to the regulatory framework under which the IC sector operates. For instance, the insurance regulation demands the calculation of risk-sensitive capital requirements. As our analysis shows, monetary policy loosening leads to increased risk-taking by ICs in terms of their investment profile. As a result their capital requirement will mechanically rise as well. Moreover, while the Solvency II regulation requires full mark-to-market accounting on the asset and liquidity side, there are significant implementation lags and transitional periods. During the sample period of our study, oftentimes mark-to-market is only applied on the asset valuations in many European jurisdictions. Hence,

when only asset valuations increase after a monetary loosening, the market valuation of ICs' capital positions could even improve. Another reason that may explain the increase in capital is the symmetric adjustment of the equity capital charge. This measure implies that during periods of equity price booms, the capital requirement for equity investment increases. By construction, the monetary policy we identify is related to an increase in capital markets, and we also observe that investment in equity increases after the monetary policy shock.

5.2 Bond portfolio responses [work in progress]

Rebalancing and additional risk-taking may occur not only between asset classes, but also within the bond portfolio, which comprises the largest investment class for insurers. We therefore study in greater detail the evolution of the bond portfolio after a monetary policy loosening. Based on more granular Security Holdings Statistics (SHSS) we are able to analyse shifts in bond portfolio in terms of sectoral allocation, credit risk-taking, and duration.Descriptive statistics for these additional metrics are provided in Table 4 in the appendix.

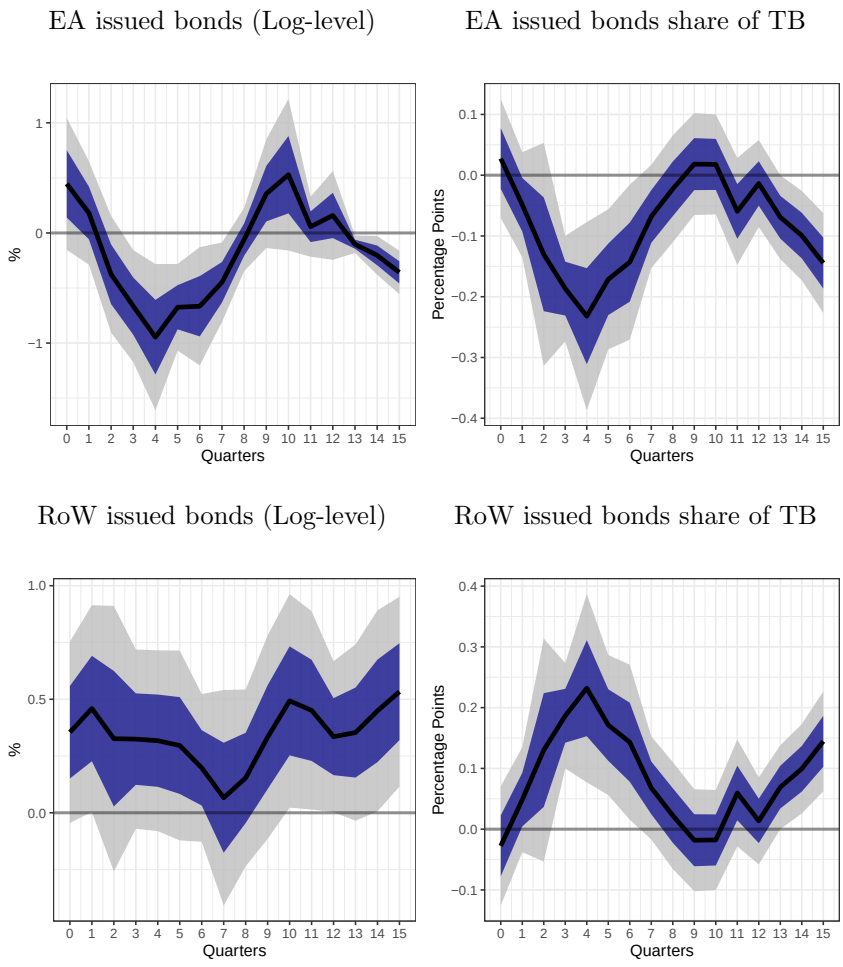
5.2.1 Sectoral allocation

The insurance sector in many European countries exhibits a preference to invest predominately in domestically issued securities. The relative importance of this home bias may however vary as yields decline and ICs are incentivised to search for yield abroad. To test this hypothesis we split the bond portfolio holdings into EA and non-EA, i.e. Rest-of-the-World (RoW) issued bonds. Investing in foreign assets can carry higher levels of risk compared with investing the same amount of money in a EA asset with comparable characteristics. This higher level of risk can come from exchange rate risk or a lower level of expertise in foreign assets compared to EA assets.

After a 1 basis point decrease in the high-frequency shock, we observe that the IC sector reduces its holdings of EA issued bonds, and it increases its holdings of RoW-issued bonds (Figure **??**). Thus, a loosening of monetary policy is related to an increase in the exposure to foreign debt securities. This evidence suggests an important link between monetary policy and the international risk-taking of ICs.

Relative riskiness in bond investments can additional come from exposures to different types of issuer sectors. For instance, EA government bonds are perceived to be safer than most EA NFC bonds. Therefore, we expect that monetary policy will have heterogeneous effects depending on the issuer sector. In Figure 10, we show a balance sheet IRF for the bond portfolio after a decrease of 10 basis points in the high-frequency shocks, employing the same methodology as previously for the aggregate balance sheet evolution. The corresponding IRFs for the individual components are reported in Figures 19 and 20.We see an increase in the share of RoW and NFC bonds. In addition to a higher share of

Figure 9: Impact on Bond Portfolio: Euro Area and Rest of the World



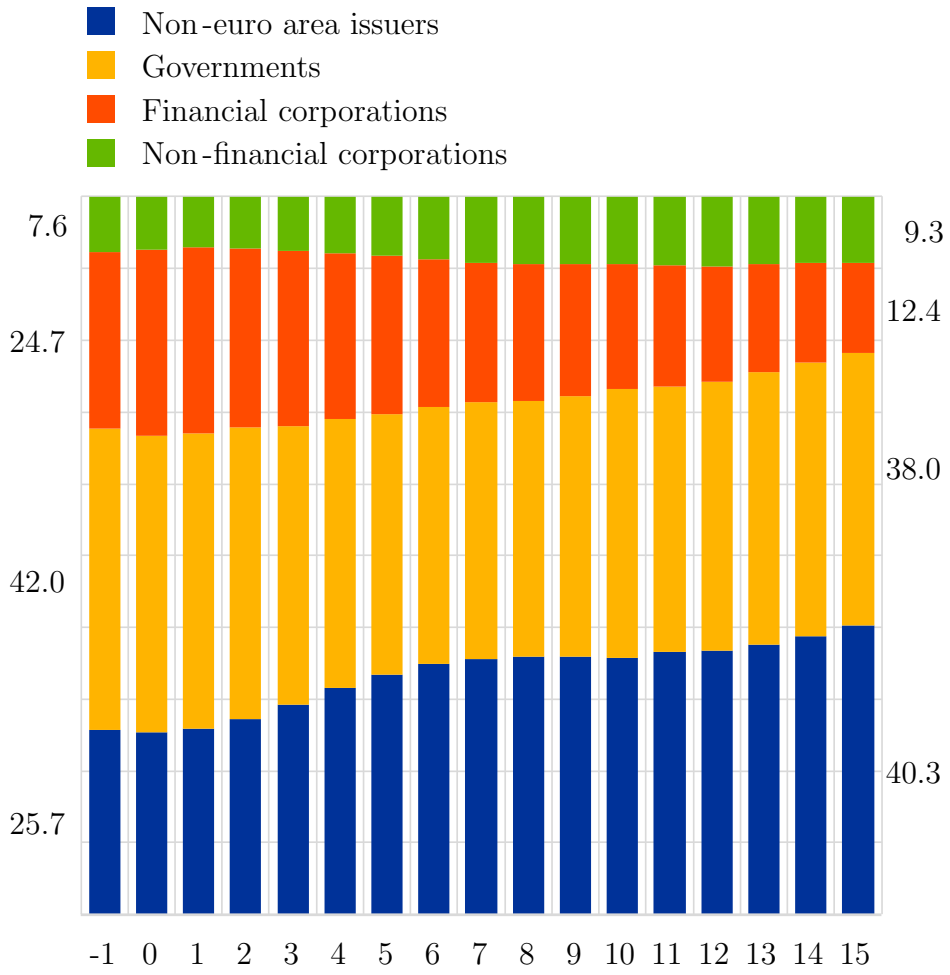
Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point. Dependent variables in nominal value log-levels (left) and share of total assets (right).

investments abroad, this also provides evidence of a transmission channel of monetary policy through ICs to corporates. A monetary policy loosening increases the desired level of NFC debt that ICs want to hold. This reduces financial constraints in the sector, especially for long-term funding, given that ICs hold around 26% of the total long-term bonds issued by NFCs.

In contrast, the share of the bond portfolio allocated to government and financial corporation bonds decreased. This evidence documents a sovereign-insurance nexus as ICs' purchases of government bonds are counter-cyclical: During periods of tighter financial conditions, the IC sector actively purchases government bonds, releasing financial constraints on EA governments. We also find a similar nexus related to the financial sector in the form of counter-cyclical FC bond purchases, which are mostly comprised of long-term bonds issued by banks.

A closer look a the IRFs for non-EA issuer sectors in Figure 20 additionally reveals

Figure 10: Impact on Bond Portfolio: Sectoral Allocation



that the impact on holdings of bonds issued by foreign non-financial corporations, financial corporations, and governments are similar to each other. We thus find that irrespective of the issuer sector, the holdings of foreign bonds increase after a monetary policy loosening.

5.2.2 Credit risk

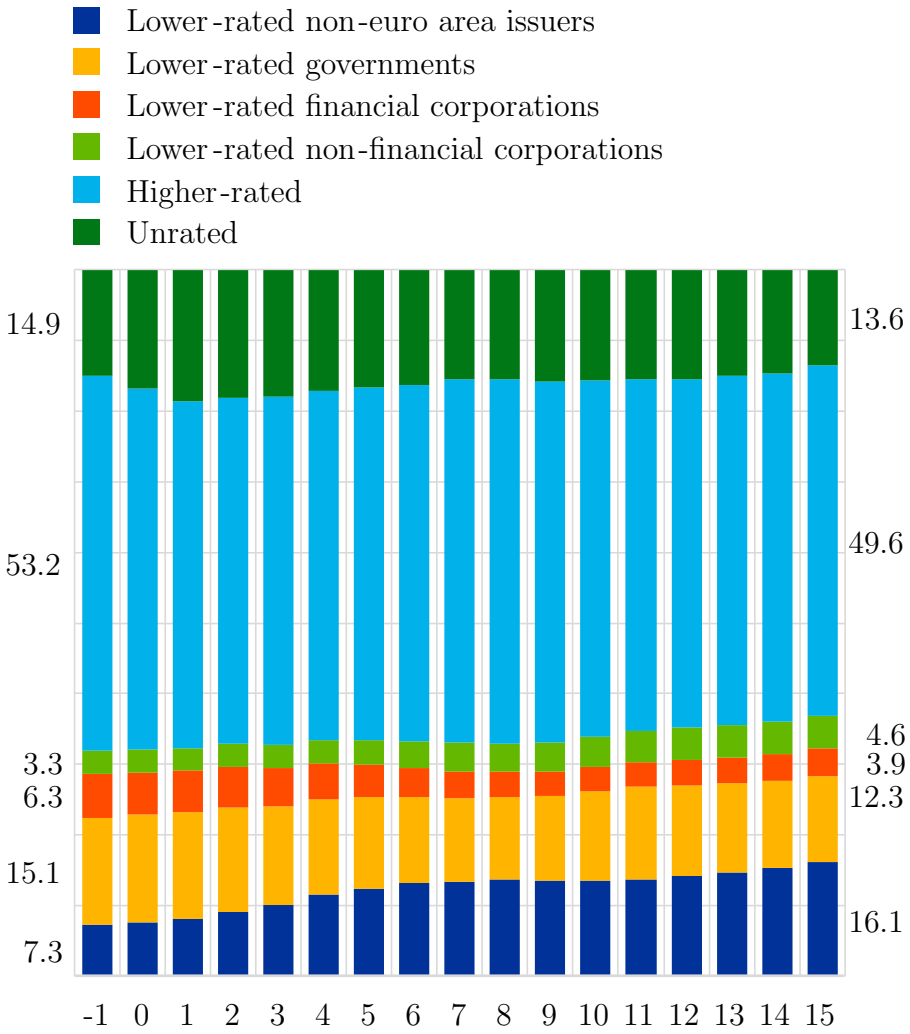
Augmenting our dataset with information on issuer ratings, we can also directly look at he credit risk-taking within insurers' bond portfolios. We distinguish between two broad rating categories: Higher-rated bonds corresponding to debt securities with a rating of AAA, AA and A, and lower-rated bondsincluding debt securities with a rating below or equal to BBB.

We report IRFs to document the results on various issuer sectors in Figures 21 to 23 in the appendix and illustrate the associated evolution of the relative bond portfolio holdings for a 10 basis point monetary loosening shock in Figure 11. We observe that following the high frequency-shocks, the share of higher-rated bonds declines from 53.2% of the total bond portfolio to 49.6%, while the share of lower-rated securities in the bond portfolio increases. This shows that the IC sector's risk preferences change depending on how the monetary policy is set up and the concentration of risk will be higher in the IC

sector bond portfolio after a monetary policy loosening. While this risk increase in the bond portfolio helps to transmit monetary policy and ease financial conditions, even for the riskier agents in the economy, it also implies an additional build-up of credit risk in the insurance sector.

Looking deeper into the composition of lower-rated bond holdings by issuer sector, we find that for government and financial corporations the IC sector acts counter-cyclically. Following a drop in yields, ICs will decrease their holdings of those assets. For lower-rated EA government bonds, we observe a fall in the bond portfolio share from 15.1% to 12.3%. In contrast, ICs will increase their holdings of lower-rated bonds issued by EA NFCs. These changes are consistent with a search for yield among riskier corporates and document that the international risk-taking channel is active.

Figure 11: Impact on Bond Portfolio: Sectoral Allocation and ratings



Notes: Charts are a graphical representation of the projected evolution of insurance corporations' bond portfolio composition by issuer type and rating over 15 quarters following a 10 basis point monetary policy shock. The aggregate changes in the bond portfolio are based on IRFs shown in Figures 21 to 23 in the appendix in percentage points of the total nominal bond portfolio value.

5.2.3 Duration risk

Given the long-dated liabilities of life insurers, the sector has a tendency to present a negative duration gap, as assets of equally long maturities are scarce. After a monetary policy loosening, the market value of assets and liabilities can therefore increase asymmetrically: the increase in the market value of liabilities exceeds that of the assets. This implies a decline in capital, which incentivises the sector to close the duration gap by following an asset-liability matching strategy and accumulate assets with a longer maturity. A drop in yields should therefore induce insurers to buy more longer-maturity assets and lengthen the duration of the bond portfolio. In addition, higher investments in longer-maturity assets should offer a higher return and thus support the profitability of the sector in times of declining yields. After a monetary policy loosening, we therefore expect that the average duration of the insurance sector portfolio will increase as well as purchases of bonds with longer maturities. To better separate duration risk-taking from the different risk channels already investigated, we focus our analysis on EA-issued bonds and look for any changes within different groups of issuer sectors or rating categories. We thereby avoid collinearity with any simultaneous increases in credit risk-taking or shifts to foreign-issued bonds.

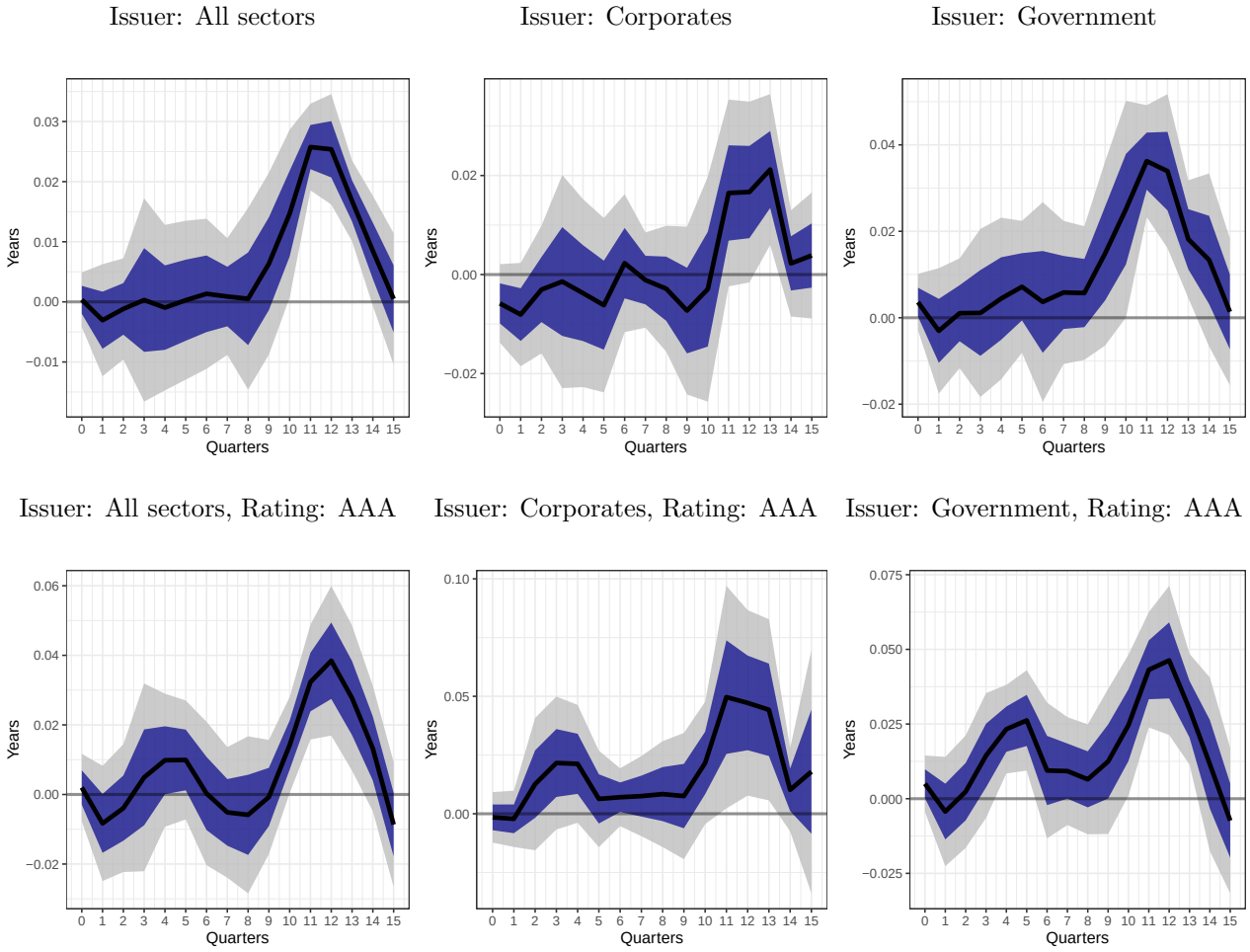
We approximate duration in the bond portfolio by computing the weighted average residual maturity ($WARM$) of the IC sector in country c as follows:

$$Duration_{j,t,r,c} = \sum_{i=1}^{N} \frac{Sec.Holdings_{i,c,j,t,r}}{TotalHoldings_{c,j,t,r}} * \frac{ResMat_i}{365}$$

Where $Duration_{c,j,t,r}$ is the weighted average residual maturity for the IC sector in country c, for bonds issued by sector j, the current quarter t and for a given credit rating r. Dividing by 365 gives the average maturity in days, while $Sec.Holdings_{i,j,t,r,c}$ represents the holdings of a security i in market value. $TotalHoldings_{c,j,t,r}$ are the total amount of holdings in market value held in country c, issued by the sector j, at quarter t and for the same credit rating r. $ResMat_i$ is the residual maturity for the security i expressed in days. Our approximated measure for the duration is similar both in magnitude and dynamics when we compare it with the Macauley duration, which due to data limitations is only available from 2017 onwards. To avoid distortions from short-term debt securities, we restrict our samples to bonds with a residual maturity of at least one year. Descriptive statistics on the duration measures are available in Table 5 in the appendix.

IRFs shown in Figure 12 show that when looking at the aggregate impact across different issuer sectors, the average duration in the EA bond portfolio increases. The fall in interest rates increases the residual maturity of the ICs' debt holdings, while this pattern is most pronounced for the average duration of bonds issued by EA governments. The effect is quantitatively important implying an increase in WARM of the government bond portfolio by around 4.8 months for a 10% monetary policy shock. We also notice

Figure 12: Weighted average residual maturity: Holdings with maturity over 1 year



Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

that two and a half years after monetary policy loosening, the duration of the corporate portfolio increases.

As Domanski, Shin and Sushko (2017) suggest, the duration risk channel should increase the demand for debt securities with long maturities, but lower credit risk. To avoid our results being contaminated by credit risk, we restrict our sample to a bond issuer rating of r equal to AAA in the lower Panel of Figure 12. We confirm our previous results and find even stronger effects, that occur sooner after a loosening of monetary policy. This evidence is suggestive of the duration risk channel that monetary policy creates.

The duration risk-taking so far relates to average maturities and does not necessarily imply an active rebalancing towards longer-maturity bonds. We therefore additionally compute the holdings with residual maturity over 5 and 10 years as a share of the holdings with maturity over 1 year. This measure tells us if the amount of long-term holdings has grown compared to short-term holdings.

$$DurationHoldings_{M,c,j,t,r} = \sum_{i=1}^{N} \frac{Sec.Holdings_{M,i,c,j,t,r}}{TotalHoldingsover1Year_{c,j,t,r}} * 100$$

Where $DurationHoldings_{M,c,j,t,r}$ is the ratio of debt securities with maturities exceeding $M = 5, 10$ years over the total debt securities with maturities over 1 year for holder country c, issuer sector j, quarter t and credit rating r. This measure thus whether the share of bonds with long maturities (over 5 or 10 years) becomes more important in the portfolio after a change in yields. Moreover, in order to identify if the IC sector is actually buying bonds with longer maturities, we compute the reaction of absolute (log-level) holdings of debt securities with a maturityexceeding $M = 5, 10$. IRFs are shown in Figures 24 and 25 in the appendix.

For $M = 5$ and rating AAA, we see that regardless of the issuer sector j, an increase in bond holdings is not visible in the two years following the monetary policy shock. However, long-term bond holdings with respect to total bond holdings start to increase after 3 years. Looking deeper into the results, we find a fall in long-term maturity holdings during the first quarters, which is driven by bonds issued in the corporate sector. As before, increases in holdings are more pronounced for bonds issued by governments. The timing of stronger increases in long-maturity holdings several quarters after the monetary policy shock therby also coincides with the higher increases observed with a lag in the IRFs for WARM.

For $M = 10$ years, we see that regardless of the issuer sector j, the proportion of bonds with maturities greater than 10 years is increasing, both as a ratio and on a log-level basis, and also already during quarters closing in time to the monetary policy shock. Again, the plot pattern is consistent with the IRFs for WARM. Focusing on these very long-maturity bonds, we can document significant impacts on both the very high-rated government and NFC bond portfolios, both in absolute and relative terms.

5.3 Sensitivity analysis [work in progress]

As robustness checks, we show that the results are still consistent if we run the local projections using the sample from 2008 Q1 until 2019 Q4 or from 2010 Q1 until 2021 Q4 but drop the COVID quarters (2020 Q1 and Q2). The main concern when keeping the 2008 great financial crisis period or the COVID quarters is that there is an overreaction of the shocks in those periods that could contaminate the average effect of monetary policy in our analysis.

6 Conclusion

In this paper, we analyse the effects of monetary policy on the size and composition of insurers' balance sheets, as well as the implications of these effects for financial stability.

We find that changes in monetary policy have a significant impact on both sector size and risk-taking. Insurers' balance sheets grow materially after a monetary loosening, implying an increase of the sector's financial intermediation capacity and an active transmission of monetary policy through the insurance sector. Our results suggest the presence of an insurance sector transmission channel of monetary policy that has previously not been documented in the literature. We also find evidence of portfolio rebalancing consistent with a risk-taking channel of monetary policy. After a monetary loosening, insurers increase credit, liquidity and duration risk-taking in their asset portfolios. Our results suggest that extended periods of low interest rates lead to rising financial stability risks among non-bank financial intermediaries.

In the context of rising interest rate levels, our results suggest that medium-term financial stability risks could decline, though, when insurers symmetrically reduce the riskiness of their assets. This would strengthen the sector's resilience to adverse macroeconomic shocks, such as an increase in corporate defaults. Lower demand from insurers for riskier assets may, however, also contribute to deteriorating financing conditions for firms and the wider economy. Increases in insurers' cash holdings could allow the sector to withstand larger liquidity shocks, helping it to absorb policy lapses or large margin calls that may become more frequent as yields rise.

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Appendix

A Additional Information on the Data Set

Figure 13: Capital: Cleaning the structural break

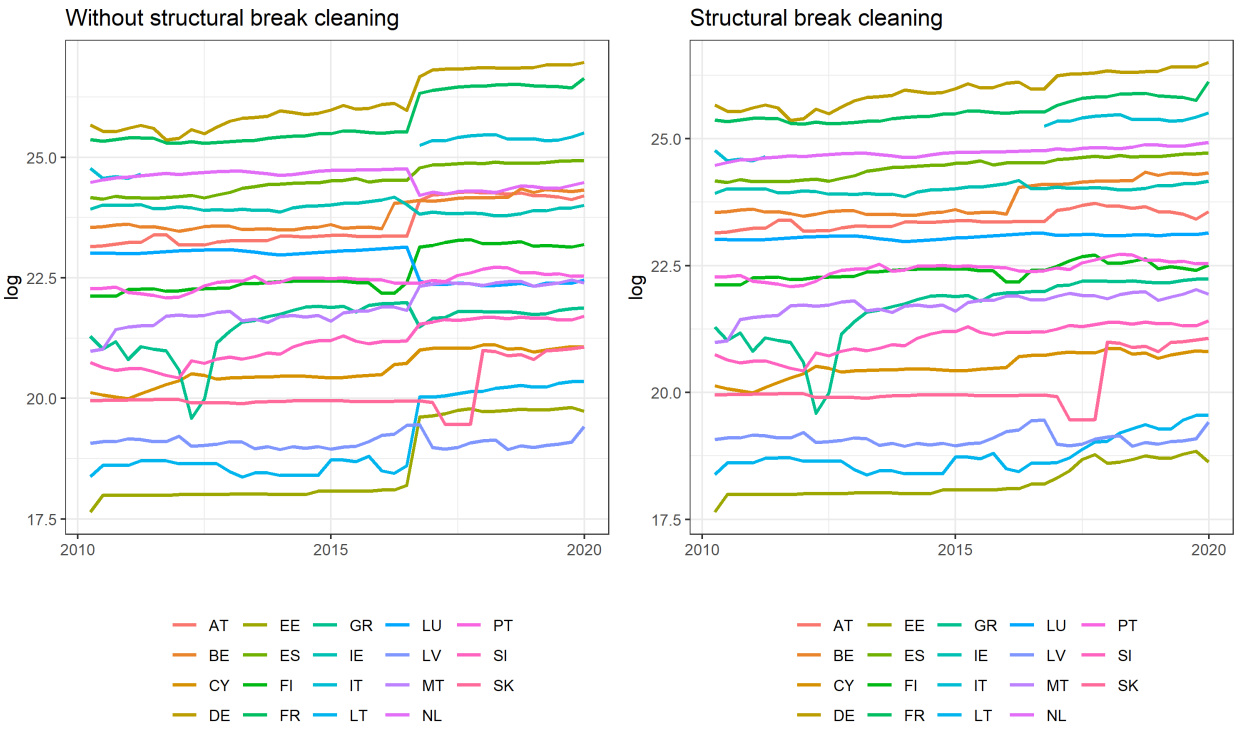
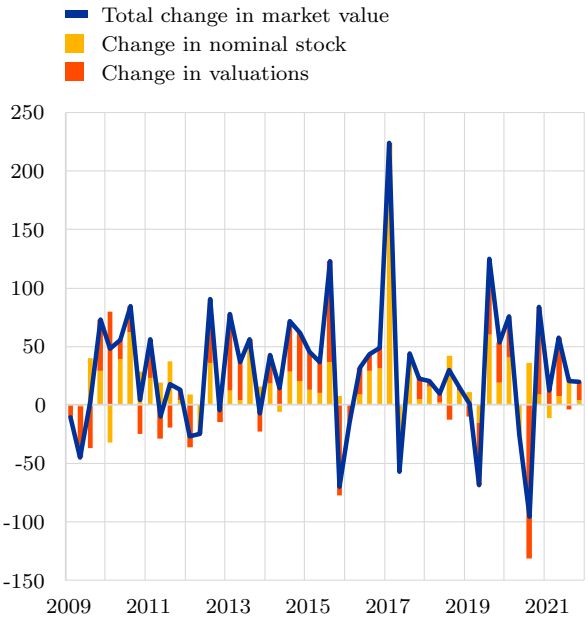
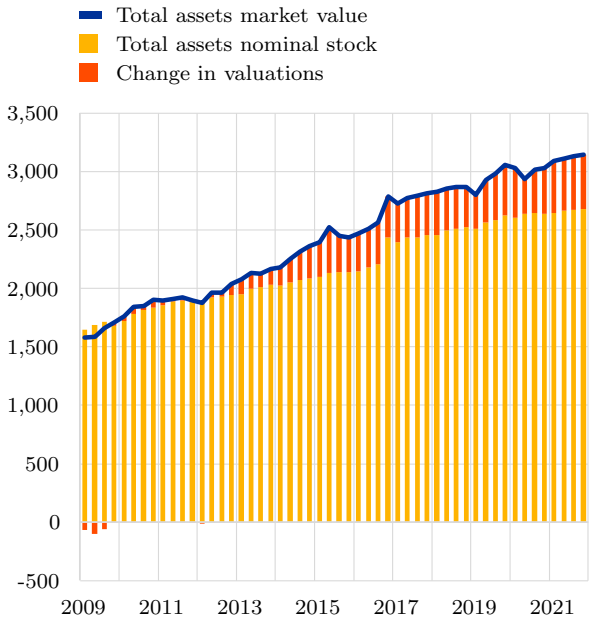


Figure 14: Market and nominal value of total assets for French insurers over time

(A) Decomposition of quarterly changes in total assets



(B) Nominal and market value of total assets 2009–2021



Notes: The charts illustrate the differences in total assets developments due to active (i.e. nominal) and passive (i.e. valuation) changes. Nominal assets are constructed as described in (2). Quarterly changes (Panels A) and stocks (Panel B) of total assets are shown for the French insurance sector, which is the largest euro area sector based on total assets. Numbers are in EUR billions.

Table 3: Data sources and description of variables

Aggregate Insurance Balance Sheet Items
Source: ECB Insurance Corporations and Pension Funds Statistics (ICPF, until Q2 2016); ECB Insurance Corporations Balance Sheet Statistics (ICB; from Q3 2016)
Variables: Total Assets, Cash Holdings, Debt Securities, Equities, Investment Fund Shares, Loans, Capital, Reserves
End-of-quarter country-level balance sheet stocks in market values or nominal values. Nominal values derived as sum of market values at the beginning of the sample period and subsequent cumulative flows. – in levels: log of market or nominal values – as shares: in percent of total assets
Monetary policy surprise measure
Source: Euro Area Monetary Policy Event-Study Database by Altavilla et al. (2019)
Term structure factor derived as principal component of [... ADD DESCRIPTION] following the methodologies proposed by Jarociński and Karadi (2020) and Gürkaynak et al. (2005).
Insurance corporation risk-taking measures
Source: ECB Securities Holdings Statistics by Sector and Centralised Securities Database
Share of lower-rated bonds: End-of-quarter country-level percentage of debt securities allocated to bonds rated BBB or below in the respective issuer segment
WARM: Weighted average residual maturity. Share of...
Additional control variables
Source: XXX
Variables: XXX

Table 4: Descriptive statistics: Bond portfolio holdings

	Mean	St. Dev.	Median	Min	Max	Obs.
(A) Log-Levels in nominal value						
All issuers						
Debt Sec.	23.72	2.45	24.24	18.62	27.95	660
Investment grade	22.99	2.44	23.07	17.94	27.50	660
Low-rated	22.26	2.57	22.59	16.23	26.77	660
Euro Area issued bonds						
All issuers	23.41	2.51	23.94	18.47	27.74	660
Government	22.74	2.55	22.77	17.38	27.00	660
Financial corp.	22.17	2.73	23.06	14.63	26.74	660
NFC	20.99	2.65	21.77	15.61	26.00	660
Low-rated bonds	21.85	2.75	22.18	15.12	26.69	660
Low-rated Government	21.31	2.74	21.42	13.17	26.47	553
Low-rated Financial corp.	20.75	2.84	21.69	13.96	25.28	644
Low-rated NFC	20.31	2.47	20.85	14.79	25.11	622
Rest of the World issued bonds						
All RoW issuers	22.24	2.33	22.75	15.56	26.33	660
RoW Government	20.08	2.12	19.96	14.68	24.55	660
RoW Financial corp.	21.71	2.50	22.43	13.73	25.87	660
RoW NFC	20.20	2.73	20.75	14.18	25.12	660
Low-rated RoW	20.85	2.29	21.41	14.41	25.09	660
Low-rated RoW Government	18.57	2.08	18.73	12.19	22.86	609
Low-rated RoW Financial corp.	20.32	2.44	20.96	12.64	24.34	633
Low-rated RoW NFC	19.61	2.51	20.03	13.87	24.50	601
(B) Share of total bond portfolio in nominal value						
All issuers						
Investment grade	53.15	19.27	59.84	12.26	84.70	660
Low-rated	29.61	19.57	22.93	1.09	84.01	660
Euro Area issued bonds						
All EA bonds	74.32	12.19	77.51	46.81	95.30	660
Government	42.03	18.47	38.68	8.43	89.33	660
Financial corp.	24.66	12.29	22.75	1.02	75.24	660
NFC	7.63	4.18	6.91	0.87	29.10	660
Low-rated EA bonds	22.31	19.36	14.88	0.08	77.54	660
Low-rated Government	15.10	17.64	6.54	0.03	63.11	553
Low-rated Financial corp.	6.27	4.33	5.22	0.08	25.94	644
Low-rated NFC	3.26	1.79	2.84	0.22	10.58	622
Rest of the world issued bonds						
All RoW issuers	25.68	12.19	22.49	4.70	53.19	660
RoW Government	5.12	5.86	3.11	0.05	29.70	660
RoW Financial corp.	15.71	8.44	13.57	0.39	43.52	660
RoW NFC	4.12	3.24	3.46	0.32	17.31	660
Low-rated RoW	7.30	5.38	5.68	0.35	33.04	660
Low-rated RoW Government	1.66	3.04	0.57	0.00	23.35	610
Low-rated RoW Financial corp.	3.88	4.06	2.74	0.12	32.27	633
Low-rated RoW NFC	2.08	1.86	1.68	0.02	9.36	601

Notes: Observations at country-sector level for all 19 euro area countries between 2010 Q1 and 2019 Q4 (unbalanced panel). Data in Panel (A) in log of EUR, Panel (B) in % of total bond portfolio. Low-rated bonds defined with a rating of BBB or below. NFC: non-financial corporate; RoW: rest of the world.

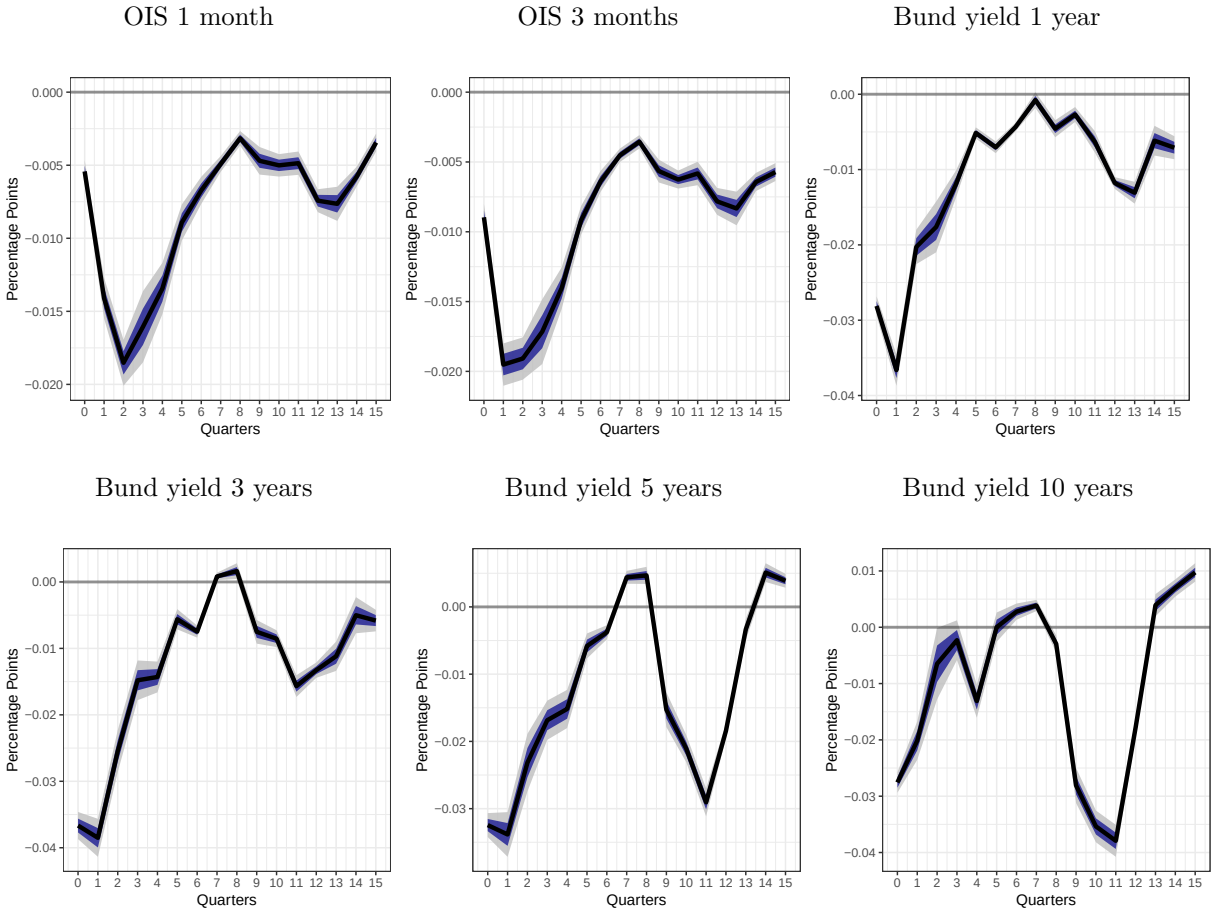
Table 5: Descriptive statistics: Bond portfolio duration

	Mean	St. Dev.	Median	Min	Max	Obs.
(A) Weighted average residual maturity (years)						
Issuer sector						
All sectors	9.15	2.88	8.75	3.49	18.31	660
Government	10.02	3.27	9.66	3.48	21.76	660
Corporates	7.87	2.59	7.65	3.25	17.21	660
(B) Weighted average residual maturity of AAA-rated debt (years)						
Issuer sector						
All sectors	9.94	3.34	9.39	3.75	18.94	660
Government	10.84	3.98	10.17	3.78	23.46	660
Corporates	8.36	3.62	7.72	1.21	30.69	651
(C) Bond holdings at different maturities						
Issuer sector						
All sectors, maturity over 5 years	21.52	2.82	21.45	15.26	26.81	660
All sectors, maturity over 10 years	20.82	2.95	20.49	13.12	26.08	652
Government, maturity over 5 years	21.07	2.87	21.02	15.26	26.40	660
Government, with maturity over 10 years	20.40	3.01	20.25	12.32	25.82	651
Corporate, with maturity over 5 years	20.30	2.75	20.30	12.65	25.74	649
Corporate, with maturity over 10 years	19.41	2.89	19.06	12.65	24.70	639
(D) Share of long-term bonds in total bond portfolio						
All issuers and AAA-rated						
Bonds with maturity over 5 years	63.55	14.97	65.16	22.33	94.32	660
Bonds with maturity over 10 years	34.43	18.16	34.73	1.54	79.21	652
Government issued bonds and AAA-rated						
Bonds with maturity over 5 years	67.01	16.96	69.08	22.24	99.22	660
Bonds with maturity over 10 years	38.29	22.13	37.60	0.65	93.32	651
Corporate issued bonds and AAA-rated						
Bonds with maturity over 5 years	56.59	17.33	57.94	2.59	100.00	649
Bonds with maturity over 10 years	26.94	17.20	24.76	0.63	100.00	639

Notes: Observations at country-sector level for all 19 euro area countries between 2010 Q1 and 2019 Q4 (unbalanced panel). Data in Panels (A) and (B) in years, Panel (C) in log-levels, Panel (D) in % of total bond portfolio.

B Additional Results

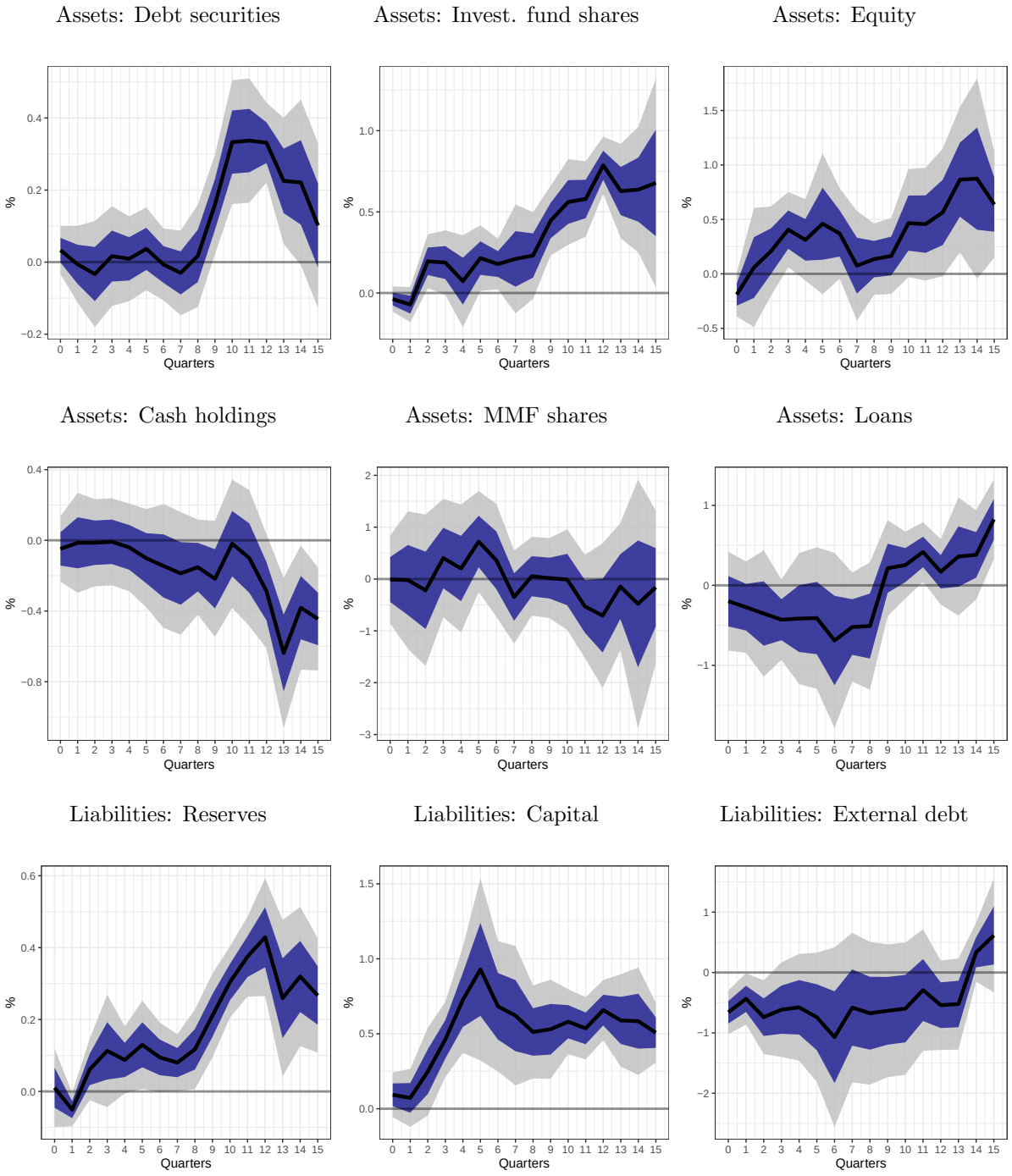
Figure 15: Impulse responses of various interest rates



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals.

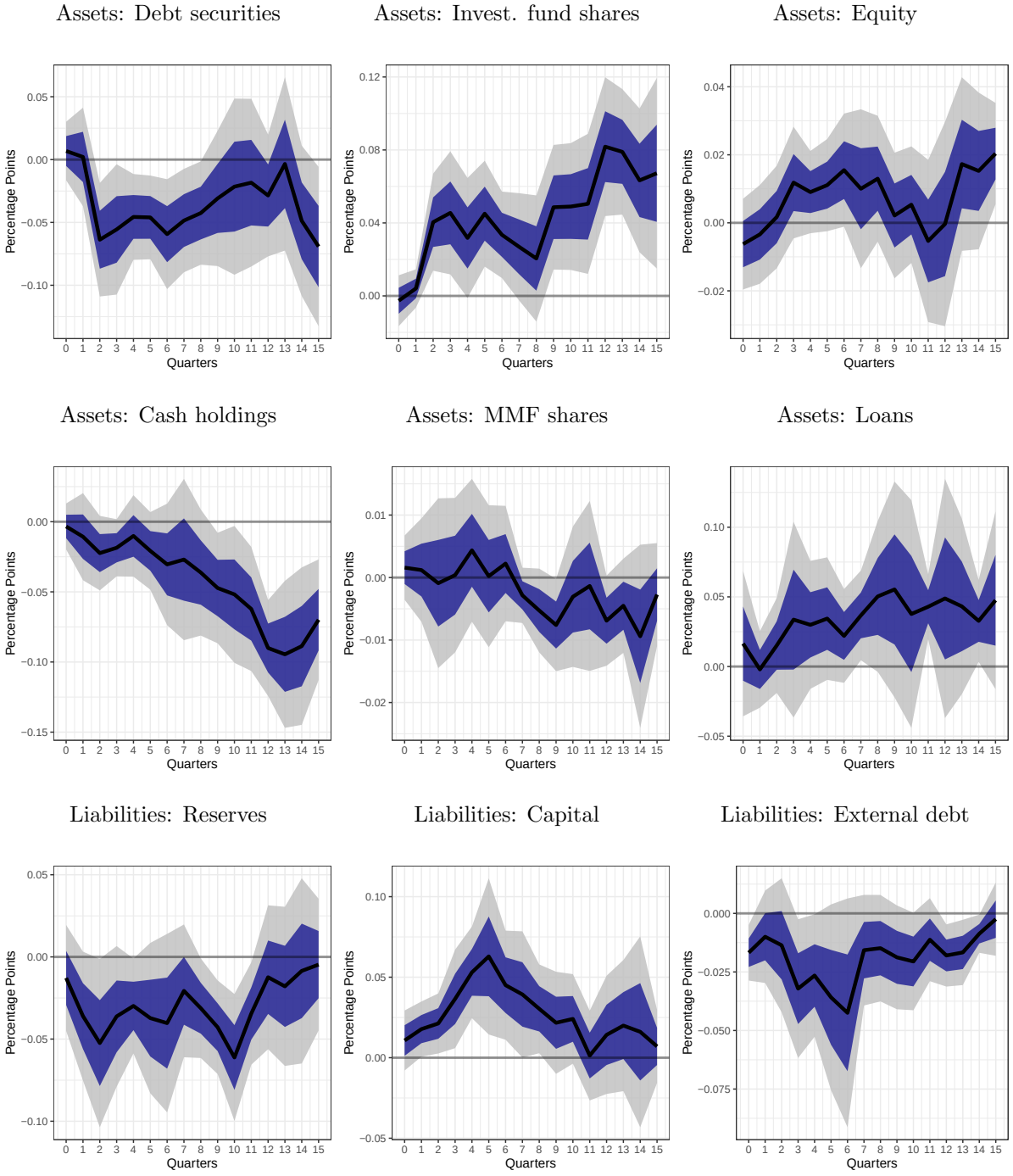
B.1 Main balance sheet items

Figure 16: Impulse responses of main asset and liability components: Log-levels of market value



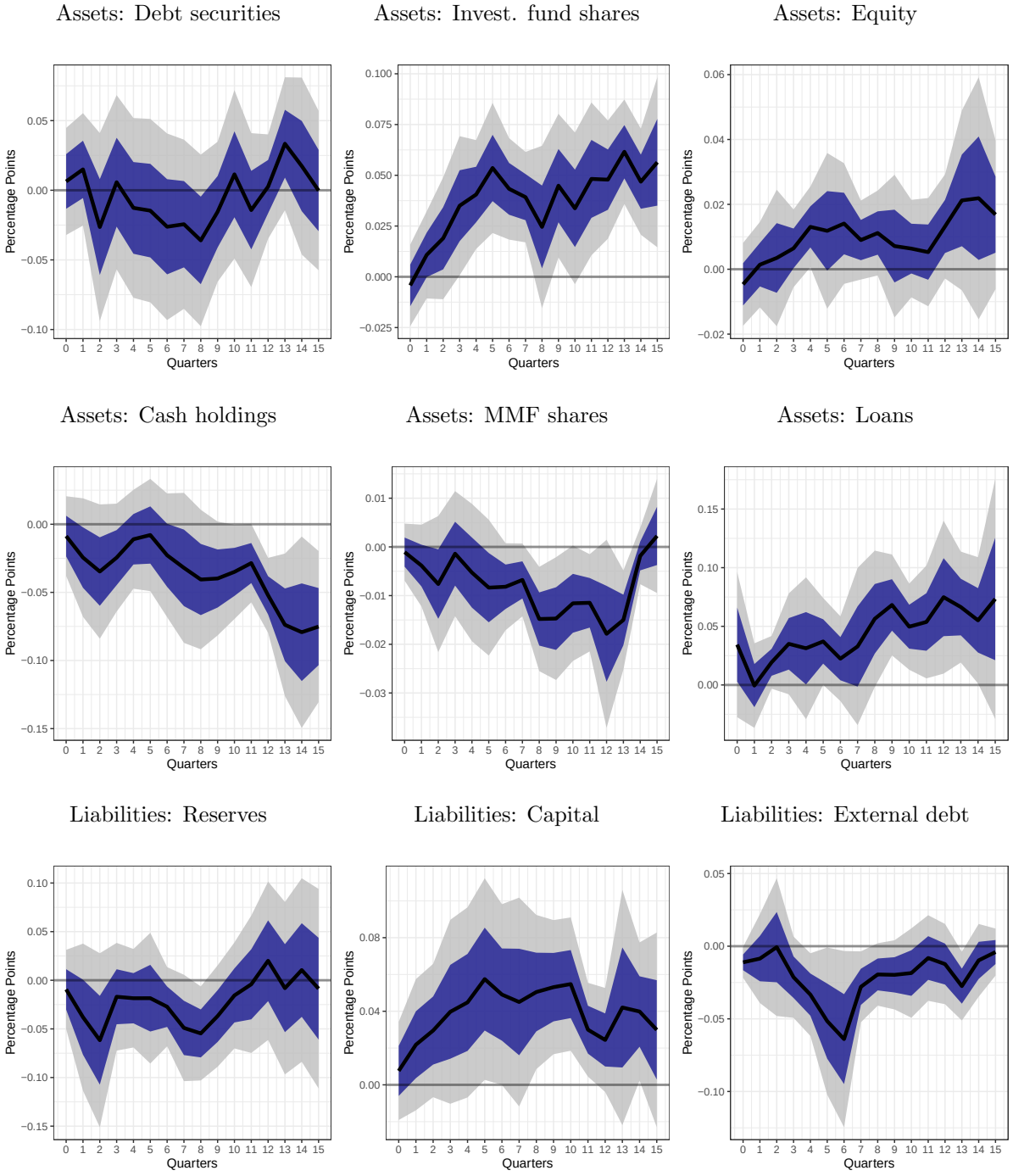
Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals.

Figure 17: Impulse responses of main asset and liability components as a share of total assets: Market value



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals.

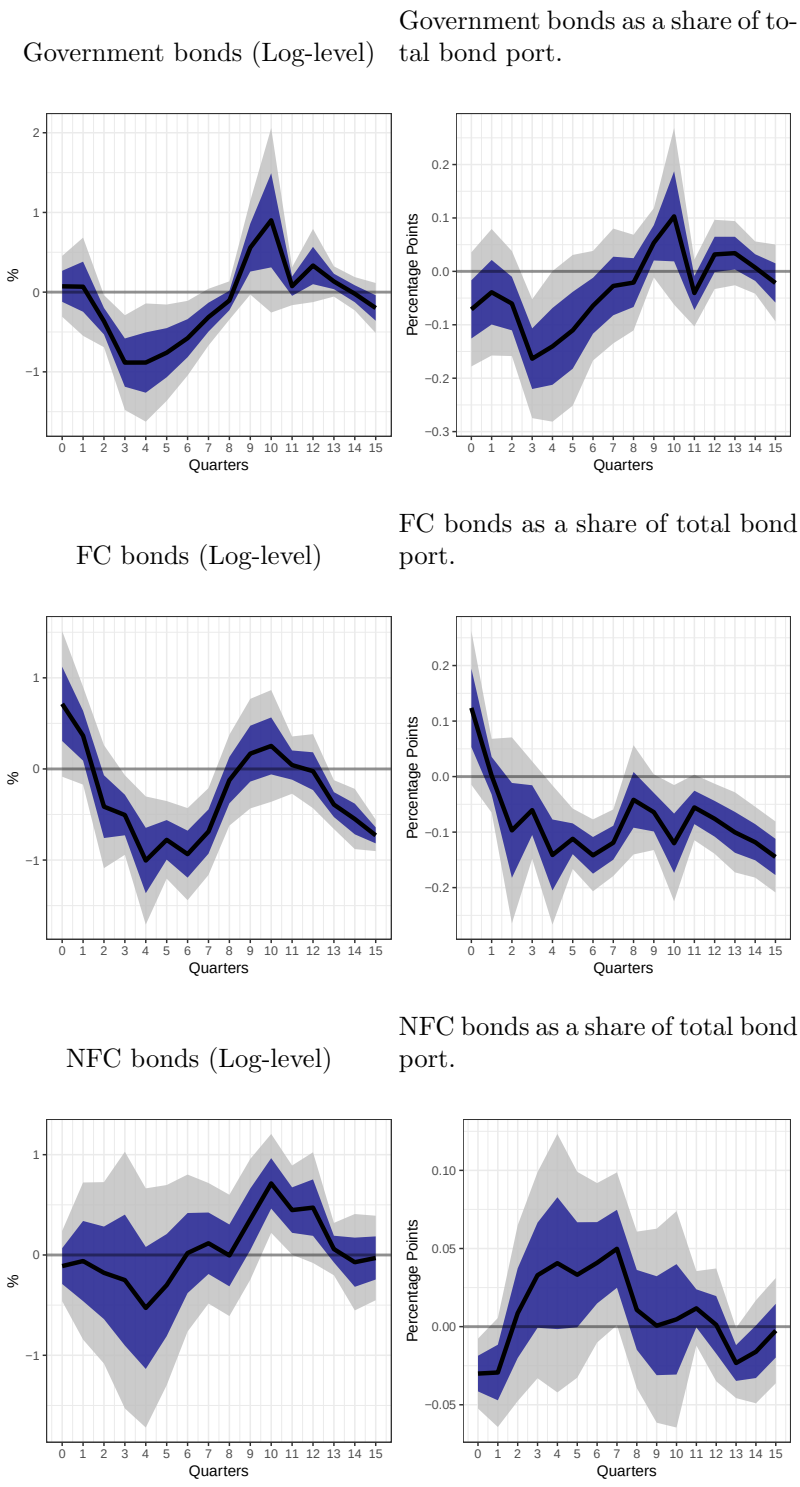
Figure 18: Impulse responses of main asset and liability components as a share of total assets: Nominal value



Notes: Impulse responses based on Model (3) to an expansionary high-frequency monetary policy shock inducing a 1 basis point decrease of the term structure factor. Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Nominal values calculated as in (2) to remove valuation effects.

B.2 Bond portfolio responses

Figure 19: Bond Portfolio by issuer sector for Euro Area bonds

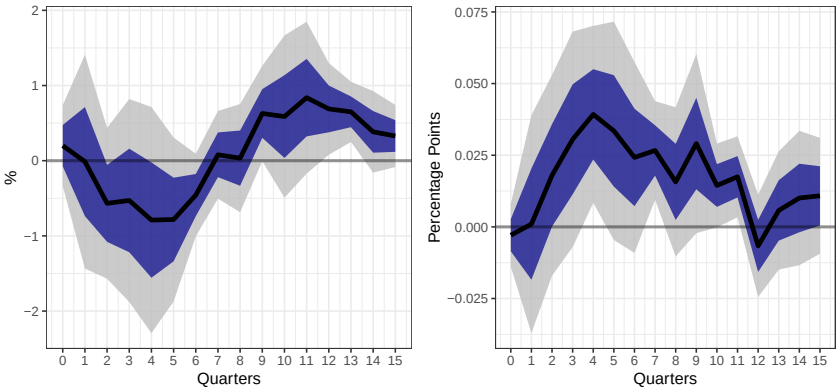


Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 20: Bond Portfolio by issuer sector for RoW bonds

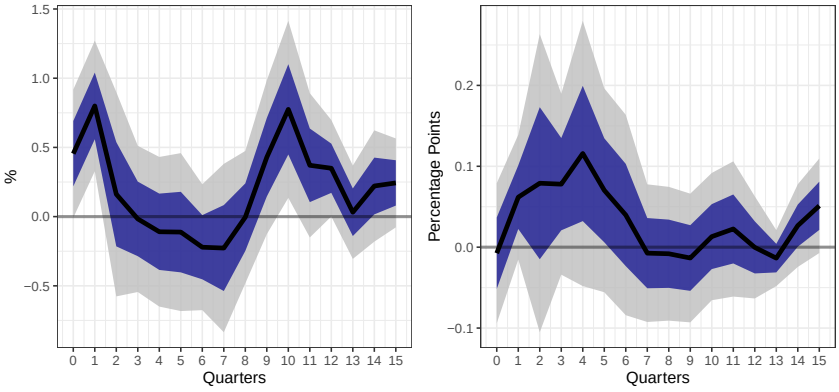
Government bonds (Log-level)

Government bonds as a share of total bond port.



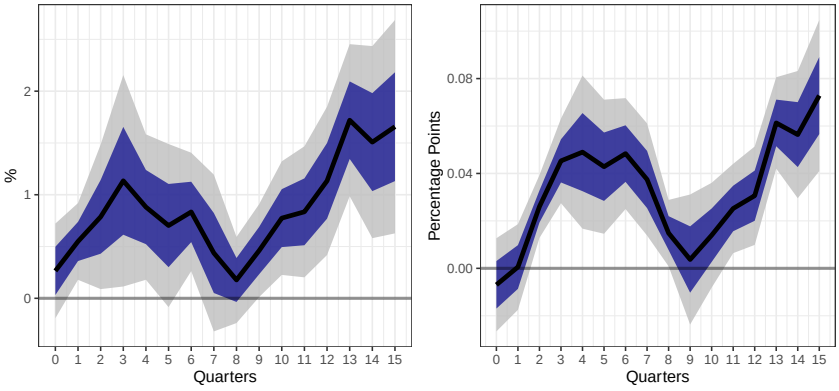
FC bonds (Log-level)

FC bonds as a share of total bond port.



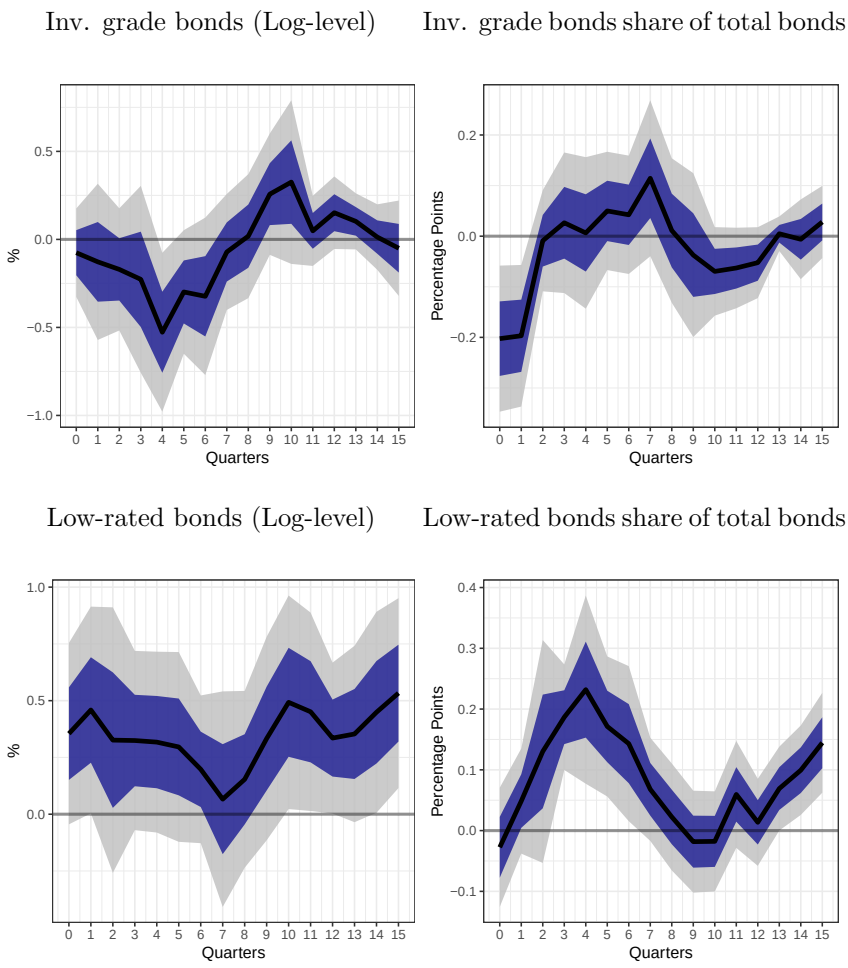
NFC bonds (Log-level)

NFC bonds as a share of total bond port.



Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 21: Bond Portfolio: Overall risk taking behaviour

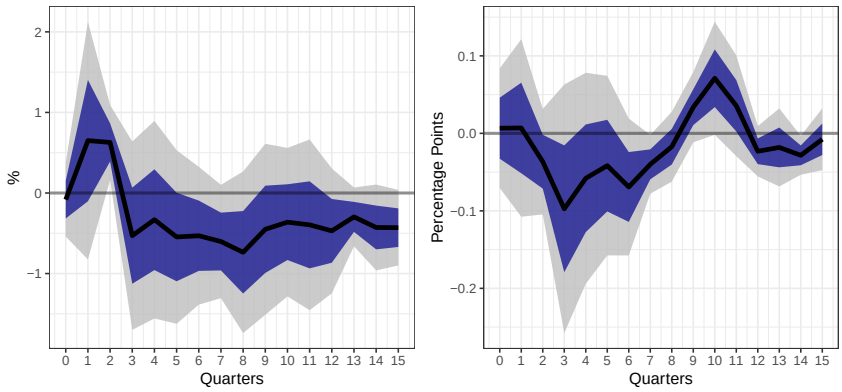


Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 22: Low-rated bonds holdings by issuer sector in the Euro Area

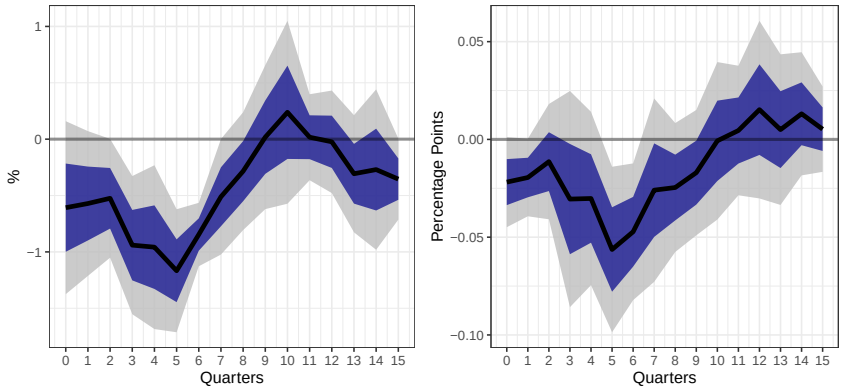
Government bonds (Log-level)

Government bonds as a share of total bond port.



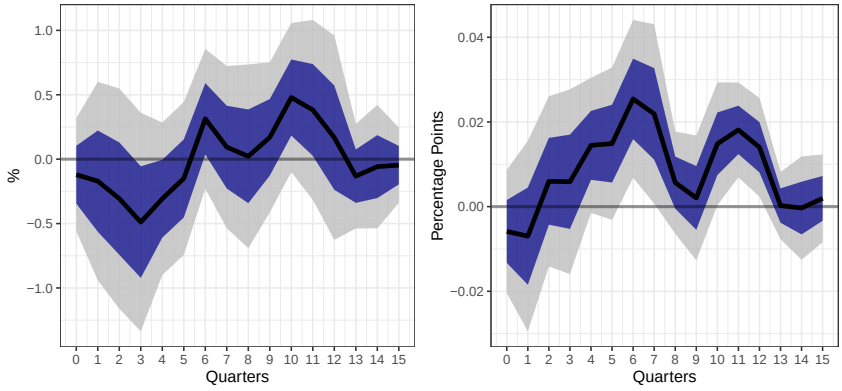
FC bonds (Log-level)

FC bonds as a share of total bond port.



NFC bonds (Log-level)

NFC bonds as a share of total bond port.

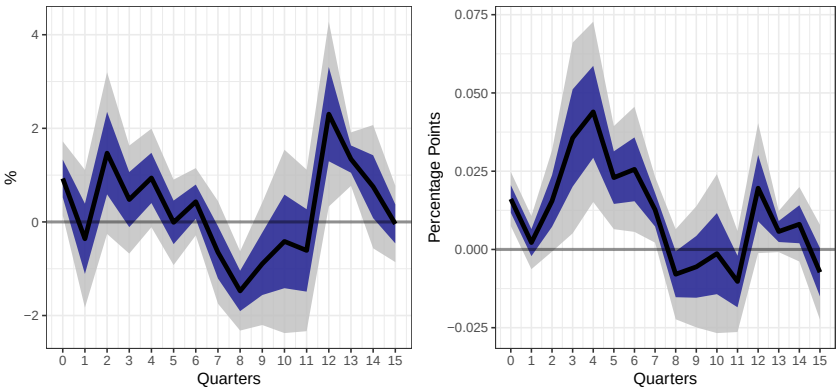


Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 23: Low-rated bonds holdings by issuer sector in the Rest of the Word

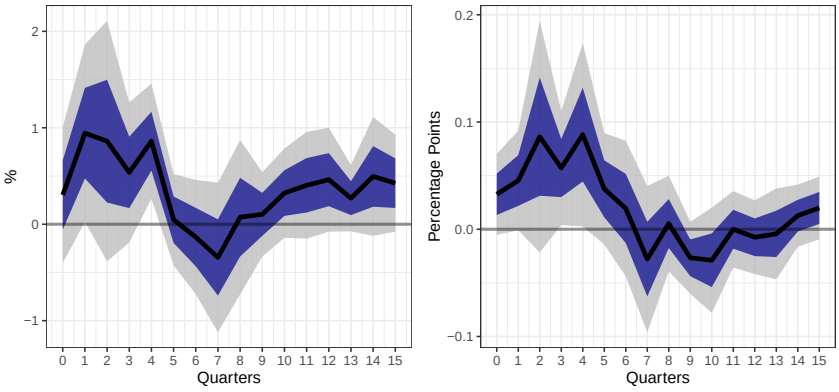
Government bonds (Log-level)

Government bonds as a share of total bond port.



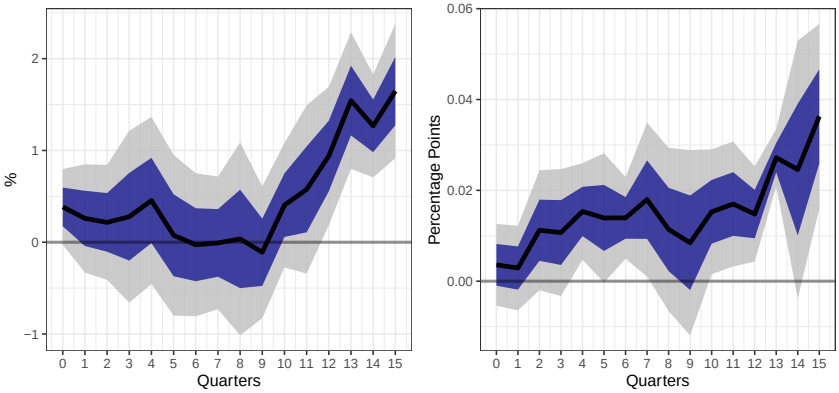
FC bonds (Log-level)

FC bonds as a share of total bond port.



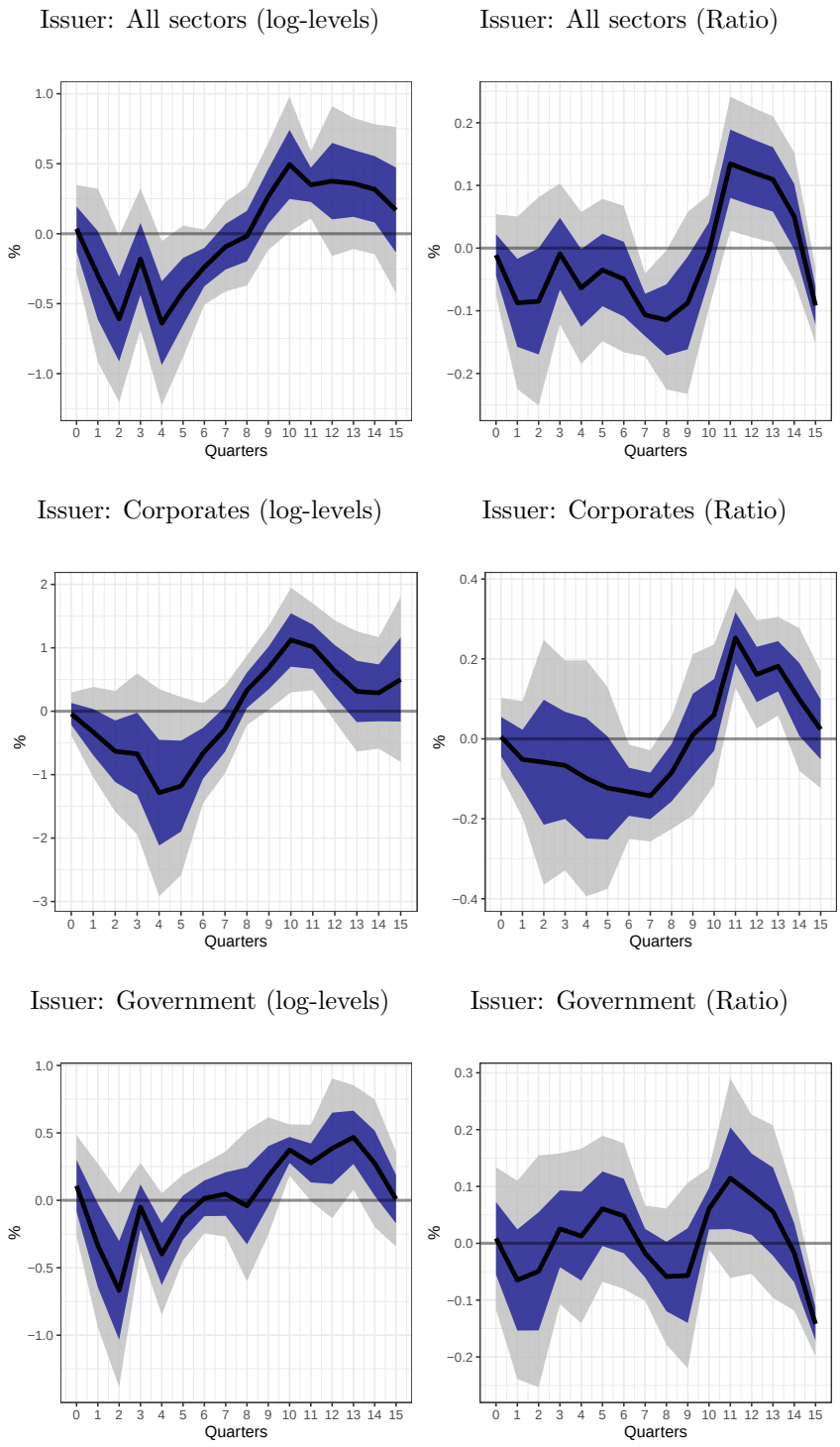
NFC bonds (Log-level)

NFC bonds as a share of total bond port.



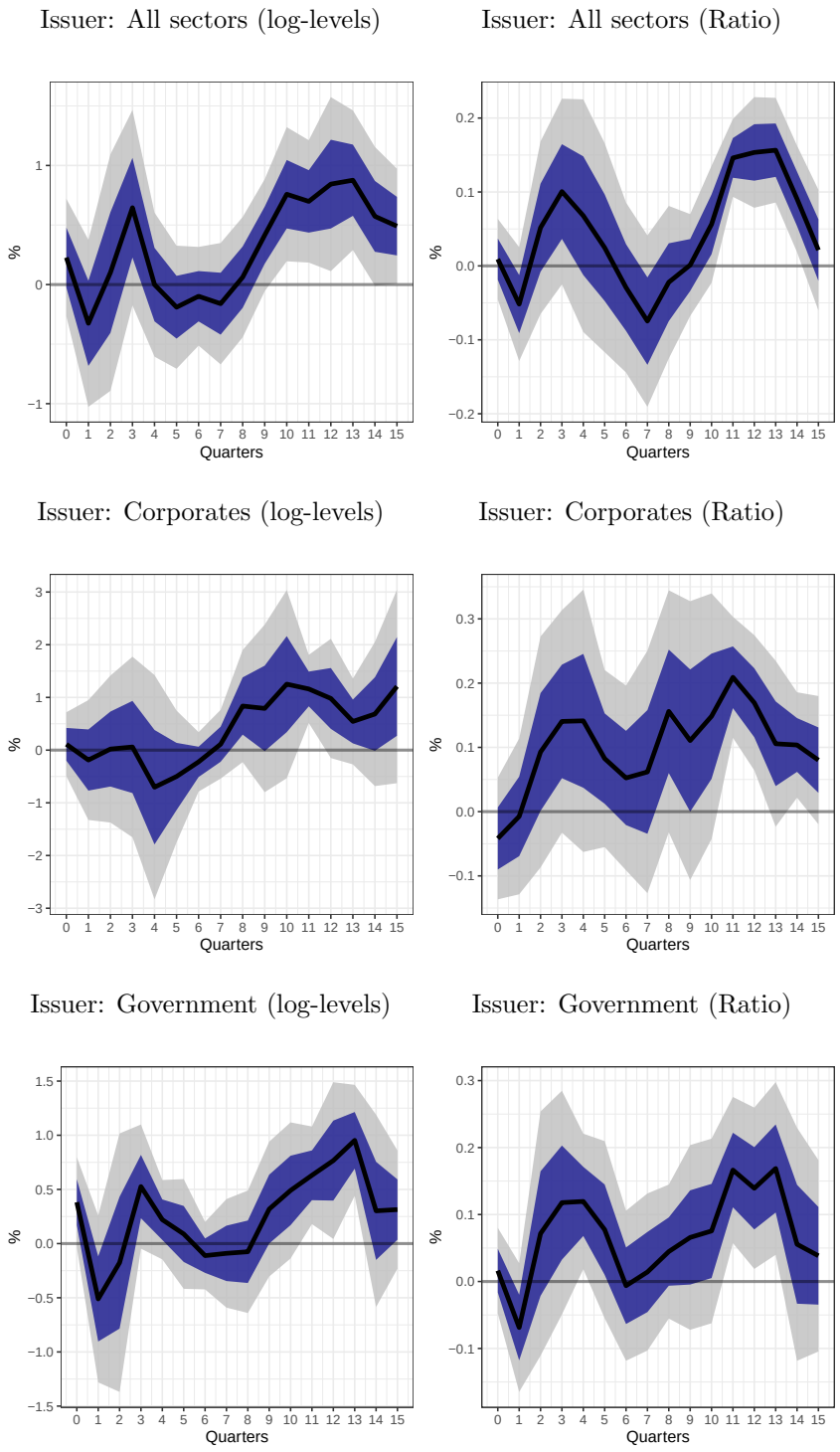
Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 24: Duration risk: Holdings of AAA debt securities and maturity over 5 years



Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.

Figure 25: Duration risk: Holdings of AAA debt securities and maturity over 10 years



Shaded areas denote 95% (gray) and 68% (blue) confidence intervals. Reactions are shown to high-frequency shock of 1 basis point.