Gambling for Recovery?
Exploring the Riskiness of European Insurers' Assets during the Covid-19 Crisis 2020

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Abstract

In crisis times, insurance companies might feel the pressure to present an investment portfolio performance that is superior to the market, since investment portfolios back the claims of policyholders and serve as a signal for the claims' safety. I investigate how a stock market crisis as experienced over the course of the Covid-19 pandemic influences insurance firms' decisions on the allocation of their corporate bond portfolio. I find that insurers shift their portfolio holdings towards lower credit risk assets as financial market conditions tighten. This tendency seems to be restricted by the liquidity risk of high-yield assets, and the credit risk of lower-rated investment-grade assets. Both effects lead to an increase in the fraction of less liquid assets during the crash and the recovery.

Keywords: Insurance; Covid-19; Financial Stability

JEL Classification: G01, G11, G22, G32

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1 Introduction

Financial institutions tend to increase the riskiness of their asset portfolio to achieve a superior portfolio performance during non-crisis times. The channels through which such behavior manifests are risk-based capital requirements (Becker and Ivashina (2015)), low market interest rates (Dell'Ariccia et al. (2017), Choi and Kronlund (2017)) or regulatory arbitrage concerns (Acharya and Steffen (2015), Swinkels et al. (2018)). However, these studies also observe that as firms face financial constraints or market crises, the tendency towards riskier investments vanishes. This observation seems to hold despite the presence of incentives that endorse investing riskier. For the insurance industry possible sources for such incentives are the pressure to present an investment portfolio performance that exceeds the market expectation thereby signalling the safeness of the claims, a high share of guarantee products[1] and the associated pressure to meet the obligations, or lastly risk-taking incentives fostered by non-risk-based regulatory rules.

The presence of these incentives leads to the research question of this article, whether European insurance companies shift their investments towards higher credit risk assets throughout the Covid-19 induced market crash. I find evidence that contradicts this hypothesis. The exposure of European insurance firms in my sample towards AAA-rated European government bonds increases while the exposure towards BA-rated (high-yield) corporate bonds decreases. These findings on increased demand for lower credit risk assets by insurers during crisis times are in line with previous findings in the literature. However, credit risk manifesting in rating downgrades during market downturns and the liquidity risk associated with lower credit rating assets seem to limit the insurers' scope of action.

Shleifer and Vishny (1992) discuss the issue of fire sales, which is the pressure to sell a assets at disadvantageous prices. Such a pressure might for example arise given rating downgrades on corporate bonds in combination with downgrade-induced regulatory capital charges, as part of the Solvency II regulation. The European Systemic Risk Board (2020b) analyzes the effect of downgrade-induced fire sales and finds that insurance firms potentially face the highest investment

[1] Koijen and Yogo (2022b) find that insurance products with guarantees lead to higher market risk in life insurers' portfolios.

value loss in comparison to other financial institutions. While the ESRB conducts a scenario analysis, which does not include individual firm information, I perform a bottom-up approach that inspects the aggregate behaviour of European insurance firms during the Covid-19 market crash. While I observe a sharp decline in high-yield corporate bonds as a reaction to the market crash in March 2020, I find no clear evidence that insurance firms "fire-sell" their assets during the market turmoil. As the crisis unravels insurers rather steadily decrease their exposure towards high-yield corporate bonds. This observation helps to show that the combination of risk-based capital requirements and rating downgrades does not necessarily induce fire sales.

The Covid-19 induced stock market crash of early 2020 presents an unexpected and sudden change in the market environment. In March 2020 the European stock market index Euro-Stoxx 50 declined by more than 30 percent over the course of two weeks. This represents the largest stock market depreciation around the world since the global financial crisis of 2008. Due to rising infection counts and governments preparing to issue unprecedented restrictions on social life and the economy, the uncertainty about future implications of the spreading pandemic led to a capital market crisis.

On firm level, the uncertainty is reflected in declining share prices and adaptations to default probability expectations. Rising credit default expectations lead to a declining value of corporate debt investments. Further, the demand for government bonds as a "safe haven" increases, resulting in higher prices and lower yields of government bonds. Such market developments impose large challenges on insurance firms whose asset values and liability values are stressed at the same time. The value of liabilities becomes less certain and future claims might increase given health and life expectancy concerns coming along with Covid-19. With respect to assets, insurance companies account for 20 percent of the investments in euro area sovereign debt securities, 20 percent of debt securities of non-financial corporations and 10 percent of financial firms' debt in 2022[2].

The EIOPA Insurance Statistics Report (EIOPA (2020)) aggregates the holdings of over 1.800 EU insurance firms and presents that corporate and government bonds on represent the largest group of assets on insurers' balance sheets. In the last quarter of 2019, government and corporate bonds account for 32 and 27 percent of total investments, excluding the investments for unit- and index-linked contracts. For comparison, the third largest investment category are collective

[2]According to European Central Bank (2022), excluding indirect investments through investment funds

investment undertakings with 20 percent, direct stock investments only account for three percent. EIOPA (2020) further presents that during the first quarter of 2020 the aggregate value of equity holdings of insurance companies decreased by over 24 percent, and the value of corporate bonds decreased by roughly four percent, both represent the largest quarterly movements in the past five years. At the same time the values of technical provisions for non-life and life business grew by 2 % and 3.3 %, respectively.

In addition to the aggregate trends in equity markets and insurers' balance sheets, the trading activity on secondary corporate bond markets spikes heavily in March 2020. Panel one of Figure 1 presents the monthly total trades as reported under the MiFid II post-trade reporting obligation on European markets. The figure shows that in March 2020 the total numbers of trades of corporate, and high yield bonds present an all time high. During March 2020 monthly trading activity for corporate bonds rises by 42 percent compared to the previous month and by 84.51 percent compared to March 2019, the trading activity of high-yield bonds increases by 78.86 percent and 99 percent, respectively. In contrast, the trading activity of government bonds is almost at the level of March 2019. Panel two presents the data on US markets obtained from the TRACE trading repository and draws a similar picture with the main difference, that the increase in corporate and high-yield bond trading is more persistent in the months following March 2020. Additionally, the largest group of traded bonds are corporate bonds, whereas on European secondary markets government bonds prevail. Because the statistic aggregates by total transactions, it does not explain whether insurers act as buyers or sellers given the market circumstances. This raises the question whether insurance firms felt the incentive or the pressure to gamble on the recovery of the market and thereby increasing their return on investment. Unfortunately, European insurance firms are not mandated to disclose a list of investments on a regular basis. The only standardised reporting on the asset composition is the aggregated information in annual reports, which does barely yield insight in the investment decisions throughout the year. To uncover the intra-year investment decisions of European insurance companies, I estimate their asset portfolio composition, by computing the exposure of each firm's stock price to the returns of proxy portfolios that resemble investments in a certain asset type.

This analysis focuses on European insurance companies for three main reasons. First, there are no regulatory differences between firms in EEA member states, given the Solvency II regulation. This prevents that a subset of the sample is affected by a regulatory change[3]. Second, a lack of research on the investment behaviour of European insurance firms. The field of research on insurance portfolios in the United States is far more numerous, most likely because US insurance firms face stronger disclosure obligations regarding their investments. Third, the peak in trading activity of high-yield bonds is more pronounced and during a more narrow time window on the European market compared to the US market, both attributes foster the identification of the estimates in my analysis (Figure 1).

To shed light on insurance firms' investing I use the daily stock market returns of 34 publicly traded insurance companies that are subject to Solvency II regulation during 2019 and 2020. I follow the approach of Acharya and Steffen (2015), who estimate the exposures of European banks' stock market returns to a set of government bond portfolios to infer statements about the investment behavior of those banks. The main advantage of this procedure is the ability to gain additional observations through the daily availability of stock market data, which enables to track the asset exposure on a daily basis throughout the year.

Stock prices should reflect the fair value of the firm's assets, liabilities, and future business. If the European stock market features at least a semi-strong market efficiency regime[4], share prices comprise all publicly available information on the structure of the firm's assets. This implies that insurers' share prices relate to the performance of the assets within their investment portfolio. Therefore, I estimate the exposures to the portfolio assets by regressing insurers' stock market returns on corporate and government bond returns in order to gain insight on the composition of the firms' investment portfolios. I do not inspect the equity investments of insurance firms because stock investments only account for three percent of insurers' assets. Further, their share prices are strongly correlated with the market. Thus, the presented approach works for estimating credit risk exposures, while it is not designed to disentangle interdependencies between equity investments and equity markets.

[3]Section 5 includes non-Solvency II firms to increase the number of observations and test the predictive power of my model beyond Solvency II firms.

[4]Lim and Brooks (2011) provides an overview on the adequacy of this hypothesis. I test the information considered in the stock prices in section 5 and find a significant, positive relation between estimates and reported values.

As the value of the asset portfolio increases (decreases), ceteris paribus, the share price should rise (decline) by a fraction ρ of that change. Thus, in an arbitrage-free market any price change in the asset portfolio would directly translate into a corresponding change in the equity value, given the liabilities remain unchanged, and the fraction ρ would be one. Chodorow-Reich et al. (2020) present a study on the effect of asset value changes to the market equity value of US life insurance companies. The authors' interpret the fraction ρ as a pass-through and estimate that during non-crisis times it is approximately 0.1. They conclude that insurance firms act as asset insulators by holding long-run assets to maturity. If during non-crisis times the price of a held asset suffers temporary dislocations, the pass-through of the dislocation is less than 1, because the long term value is barely affected. However, the authors also show that the asset insulation decreases during crises as insurance firms' financial health worsens and they might have to liquidate their holdings at market prices. The more likely a liquidation becomes, the closer ρ approaches 1. My approach highly benefits from the findings of Chodorow-Reich et al. (2020) because a higher coefficient of the pass-through during crises also means that changes in the asset values become more apparent in stock prices, making it easier to infer statements on the composition of the asset portfolio. The increased pass-through manifests as a jump in the R^2 in my results during the crisis. Given the market perceives the Covid-19 crisis as a signal about rising expected claims, the jump in the explanatory power (R^2) can be interpreted as the fact that the markets take insurers' asset structure stronger into pricing considerations, which then also empowers the hypothesis that the market has sufficient information on the portfolio structure of insurers.

The equity value of insurers not only depends on the asset value but also on the value and the composition of the liabilities. This is especially important for insurance companies as the reservation for insurance claims on the liability side reflects the business areas in which an insurer operates. During the short-run of the market crash in March 2020 the liabilities affect the stock price in two ways. First, the expected profitability of certain business lines changes. Uncertain effects, for instance on health care costs, mortality rates, or business continuity, might increase the expected severity, frequency, or both of policyholder claims in associated lines of business and thus translate through P&L considerations into a downward pressure on stock prices. Given that the market expectations on the Covid-19 effect on insurance claims are the same over all European insurance firms, the influential parameter on stock price changes is, to which extent an individual insurer is exposed to fields of business that are associated with an increase in expected claims. I control for these market expectations on claims by the share of net written premiums of a certain business-line in total net written premiums of that firm with data from the "Line of Business" segment of Solvency Financial Conditions Reports (SFCRs). Unfortunately, those reports are issued annually, thus the annual SFCR data is more static than the daily stock market data. However, in the short-run liabilities are harder to adapt than assets, mitigating the shortfall of the data on liabilities being updated less frequent in the model. Second, the macroeconomic financial determinants of liability valuation, such as interest rates, inflation, or exchange rates, might fluctuate during the economic downturn and thus affect the market value of liabilities. I control for possible discrepancies between insurers' exposure to those factors by imposing a set of macroeconomic control variables.

This paper relates to the literature on exploring the risk-taking of financial firms (Dell'Ariccia et al. (2017); Choi and Kronlund (2017)) and insurance companies in particular (Becker and Ivashina (2015); Ge and Weisbach (2021); Koijen and Yogo (2015)). I show that European insurers reduce the credit risk of their asset portfolios significantly during the Covid-19 despite the presence of incentives to gamble on the recovery of markets, which is in line with the prevalent finding in the literature that insurance firms tend to invest safer as financial market conditions tighten. Becker and Ivashina (2015) for instance report that the "reaching for yield" of US insurance companies is not observable during the global financial crisis 2008.

I further add to the research on the behavior of financial intermediaries during financial crises (He and Krishnamurthy (2011); He and Krishnamurthy (2018)). The authors build a theoretical model that captures frictions between households and financial intermediaries and show that shocks to asset values lead intermediaries to shift their clients' portfolios towards being less risky. I estimate changes in the portfolio composition of insurance companies and thereby track insurance firms' investment behavior and risk appetite. Ge and Weisbach (2021) examine the investment behavior of P&C and life insurers as subject to their financial condition and find that an increase in operating losses induces insurers to invest safer, which is consistent to the pro-cyclicality finding of Becker and Ivashina (2015) and consistent with the pattern I observe during the Covid-19 market crash.

Kirti (2017) investigates whether life insurance firms in the US took on additional risk in their asset portfolio during the global financial crisis 2008 to recover for potential losses and finds that, while theory suggests a "gamble for recovery" motive[5], in practice insurers affected more by the crisis shift their investments stronger towards being less risky compared to less affected firms. Kriti's research question is close to mine, yet my study differs on the one hand by inspecting the market crash associated with the Covid-19 pandemic that concerns income and claim expectations (Coibion et al. (2020); Gormsen and Koijen (2020)) compared to the global financial crisis that unraveled as a credit crisis (Eling and Schmeiser (2010); Baluch et al. (2011)). On the other hand I inspect European insurers which face far less reporting requirements as to asset holding details. Thus, I cannot build on the securities reporting data based difference-in-differences approach Kirti (2017) applies. Yet, my findings are consistent with Kirti (2017).

Ellul et al. (2022) empirically examine the effects of variable annuities on the investment behavior of US life insurers during the global financial crisis and the Covid-19 market crash. The results on the asset allocation are consistent to my observations. Additionally, Ellul et al. (2022) observe significant differences in the net trades of liquid and illiquid bonds between insurers with low and high exposure to variable annuity guarantees. Koijen and Yogo (2021) and Koijen and Yogo (2022a) discuss that variable annuities resemble market risk insurance that may expose the underwriting insurers to equity and interest rate risk mismatches. The authors show that insurers with more guarantee business face larger equity drawdowns during the Covid-19 crisis. I follow the identification of guarantee business as SFCR template S.12.01.02 entry "insurance with profit participation" proposed by Koijen and Yogo (2022b) and incorporate the guarantee business as a control variable in my model.

Ellul et al. (2015) presents evidence that historical cost accounting may lead to gains trading by life insurance firms during the financial crisis, which I do not observe in my sample. Acharya and Steffen (2015) find that Eurozone banks in the period of 2007-2013 systematically increased their exposure to southern European bonds while short-selling German government bonds, which can be associated with risk-shifting and regulatory arbitrage motives. Methodologically, I follow their approach to estimate the exposure of the firms' stock prices to a set of bond returns, but extending the model to suit the business of insurance companies.

[5] Jensen and Meckling (1976) introduce the term, describing the incentive that a firm acts riskier when facing financial distress.

In summary my research contributes to the literature by empirically measuring the asset holdings of European insurance companies using daily market data and relating these estimates to reported data. Doing so bypasses the absence of security specific public reporting requirements. The rest of this article is structured as followed. Sections 2 and 3 present the data and the methodology. In section 4 I discuss the results on the estimated portfolio allocations. To show that these estimations carry information on the investment decisions of insurers and thereby testing the market efficiency assumption, I relate the portfolio holding estimates to reported holdings from annual reports in section 5.

2 Data

I retrieve daily stock prices, market capitalizations and equity index data from 1. January 2016 until 31. December 2020 from Refinitiv: Eikon. The cross-section of the sample consists of 57 insurance firms from 24 countries. Out of these firms 37 domicile in EU member states; the rest splits into 14 firms located in the United Kingdom and 6 companies in Switzerland. To adjust the dataset for stale prices, I apply a truncation that excludes a company if the 25th-percentile of its absolute returns is zero, that is all firms that show no price movements in at least 25 percent of trading days. The truncation drops 15 individual firm observations from the sample, leading to a number 42 firms. The results of the analysis are robust to changing the truncation threshold to the 10 percent quantile or the median. I exclude firms that do not issue SFCR reports whenever applying SFCR related data. Those are all 6 Swiss firms and one firm from the United Kingdom, reducing the sample size in this case to 34 companies. At the end of 2020, the final sample of firms constitutes a total of 37 percent of the European Insurance sector market share[6].

I retrieve company-specific financial information, as for example balance sheet and P&L items, from SNL Financial. The SNL Financial database comprises data of (bi-)annual regulatory reports which I collect for all issuance dates throughout my sample period. All firms in the sample share the same end of period date, 31. December. The SFCR reports are also issued at that date. I track the liquidity of the sample firms, by retrieving quarterly reported cash and cash equivalents. Figure 2 shows the share of cash and equivalents in total assets. One can see that the crisis year 2020 not

[6]Measured in gross written premiums; market size includes non-publicly traded firms

only presents the highest liquidity share over the past five years, it also is the only occasion during the sample period in which the share of cash and equivalents increases between the second and the third quarter. This observation is most likely driven by the uncertainty during the Covid-19 crisis and the desire of insurers to maintain liquid. To consider this information in my model, I include a control variable for liquidity share.

I collect fixed income data from January 2016 to December 2020 from Bloomberg, including prices and maturities of a set of corporate bond indices in Europe that are compound by rating. The returns of those portfolios will serve as a proxy to measure the degree of credit risk exposure of the European corporate bonds in insurance firms' asset portfolios. Bloomberg further provides the data on the Vstoxx volatility index which I use to account for the stock market volatility on the European market.

I obtain macroeconomic variables[7] from the ECB Data Warehouse. Those are the monthly percentage change of the consumer price index, Euro exchange rates, and the yield of an Euro area aggregated AAA-rated government bond portfolio with 1-year maturity. Additionally, I retrieve the level of the one-month Euribor rate and the ten-year European government bond benchmark yield, which I use to construct a measure for the term structure of interest rates. I only consider trading days in my analysis thus removing all day-observations on which at least half of the firms are not traded on the stock markets from all datasets. I winsorize all returns at the 0.5th and 99.5th percentile[8].

The main analysis in this paper uses data between August 2019 and December 2020. The descriptive statistics of the final sample are shown in Table 1. Panel one presents the summary statistics over the time-series of portfolio returns. The average daily stock return of the firms in my sample is 0.028 % with a standard deviation of 1.7 %. The large standard deviation and the extreme minimum and maximum values indicate that the stock prices of the 42 firms in my sample are highly volatile, fluctuating around an average return close to zero, a feature that also applies to the returns of the European corporate bond indices. During the observation period investment-grade and high-yield bonds show an average return close to zero while experiencing negative daily returns of up to −

[7]Regarding the selection of the macroeconomic control variables, I follow Acharya and Steffen (2015), as they incorporate the economic key factors that influence the financial business sector.

[8]In accordance with previous research on crises and financial distress by Ge and Weisbach (2021) and Ellul et al. (2015).

2.5 % and − 3.8 % respectively. The maturities of corporate bond portfolios are on average 4.7 and 6.7 years with very low fluctuations during the observation period. This is intuitive as the maturity of the bond portfolios should not decrease by more than a year over the course of a year of observation, unless the portfolios are re-balanced towards shorter maturities.

Panel two presents the time-series properties of the macroeconomic control variables of the regression model. The summaries are consistent to the observation on the portfolios in panel one. I observe large volatility with an average daily return of 0.028 % in the market portfolio for which I use the Euro Stoxx 50 index. The large volatility during the Covid-19 crash also materializes in the Vstoxx index that exhibits a mean daily return of 0.45 % with a standard deviation of 8.6 %, and a maximum daily return of 43.83 %. The key interest rate during the sample period was negative. The Euribor varied within a range of 15 bps and shows a mean of −47.774 bps. The nominal effective Euro exchange rate against EER-19 group of trading partners as reported by the ECB fluctuates between 95.49 and 102.29 points, with a mean of 99.13. For comparison, the mean of the Euribor in the previous year is −37.49 with a maximum variation of 4 bps and the indexed Euro exchange rate varies within the boundaries of 95.49 and 101.67 points with a mean of 98.2 points. The index value of the CPI monotonically increased during my sample period by on average 0.8 % per month.

Panel three displays the cross-section properties of the insurance firms in my sample. The lines HEALTH, BC, CREDIT, LIFE, and GUARANTEE represent the share of the respective line of business net written premium[9] to their total net written premium according to the 2019 issued SFCR reports. BC represents premiums related to business continuity and miscellaneous financial loss. The largest business line of individual insurance firms in my sample is life insurance with an average of 50.88 % of net written premiums. 13.5 % of the net written premiums stem from guarantee products, followed by health with an average of 6.52 % and a maximum of 58.05 %. Credit and financial loss insurance premiums account for the smallest fraction; one firm in the sample solely provides credit insurance which inflates the average. The lowest asset value in the sample is 221 million € by Deutsche Familienversicherung AG, while the largest firm, Allianz SE, owns assets worth over 1 trillion €. The average firm in the sample has a total asset value of 169 billion €. The median is 60 billion €, indicating that the distribution of the sample firms'

[9] Written premiums net of reinsurance

total assets is positively skewed. A fact that is further illustrated given that the total assets of 24 firms are below the sample average. To account for the large range in firms' asset values I apply the logged value of total assets as a control variable for size in the regression model. The average share of cash, and cash equivalents in total assets of my sample is 3.6 %, the minimum share is 0.4 %, and the maximum is 12.6 %. The spread between the minimum and the maximum is 12.2 percentage points and shows why I decide to control for the firms' liquidity. The index- and unit-linked investment fraction of total assets is on average 19 %. The discrepancy between the minimum value of 0 and the maximum value of 78.2 % arises due to the fact that my sample incorporates both life and non-life firms and emphasizes the importance to control for index- and unit-linked contracts, because the market risks associated with assets held for these contracts are not borne by the insurers but the policyholders.

3 Methodology

To analyse the changes in the portfolio composition of European insurance companies during the Covid-19 crisis, I estimate the exposures of individual insurers' stock returns to the returns of diversified portfolios, representing certain types of fixed income instruments. To control for the influence of macroeconomic interdependence, I apply a set of macroeconomic control variables, following the research on bank's asset allocation by Acharya and Steffen (2015). Further, I include net written (re-)insurance premiums to account for the influences of the business mix of the individual insurers on their asset price, as well as size and liquidity considerations. This leads to the following regression model:

$$\begin{aligned} R_{i,d} =& \beta_{Gov} HPR_{1day}\left(Y_{Gov,d}\right) + \beta_{CorpA} R_{CorpA,d} + \beta_{CorpBAA} E_{CorpBAA,d} + \beta_{CorpBA} R_{CorpBA,d} \\ &+ \gamma' M_m + \delta'_{LoB} LoB_{i,y} + \eta' Firm_{i,y} + \alpha + \epsilon_{i,d} \end{aligned} \quad (1)$$

This analysis builds on a pooled OLS regression. The dependent variable is a panel consisting of the cross-section i and the daily time-series d of each sample firm's daily stock market return R_{id}. Since this sample features varying frequencies of data, I use the indices d for daily, m for monthly and y for yearly. Regarding sovereign fixed income, the model applies holding period returns (HPR) constructed using yield curve spot rates. The corporate bonds are implemented as index returns. I model the exposure of the stock return R_{id} to the yield of a Euro area aggregated AAA-rated government bond portfolio with 1-year maturity $Y_{Gov,d}$ by constructing the one-day HPR of the respective yields. That is the hypothetical return of buying a zero-bond with a similar yield and selling it after one day.

I include corporate bond holdings, using the returns of "Bloomberg Pan-European Aggregate Corporate Bonds Indices" which aggregate European corporate bonds by credit-rating. Inspecting index data instead of individual bond returns ensures that the return reflects the risk-premium associated with the referenced credit-rating of the asset rather than default expectations on individual firms.

Table 2 suggests that multicollinearity might induce problems to this set-up because the bond indices in the investment -grade category[10] show large correlations during the market downturn. Because variance inflation factors further encourage collinearity issues between A-rated and BAA-rated coefficients, I decide to orthogonalize the returns of the BAA-rated corporate bond portfolio to explain only the variation that is not already explained by $R_{CorpA,d}$. The orthogonalized return is called $E_{CorpBAA,d}$. Additionally, I do not further include bond ratings above A-rated as the corporate bonds further up the rating scale induce no additional value for the analysis. The regression with all bond ratings can be found in the appendix. M_t represents the macroeconomic variables at time t. I control for market co-variation and market volatility by using the return of the Euro Stoxx 50 index and the return of the Vstoxx index, respectively. I use the level of indexed exchange rate change of the Euro as reported by the ECB to control for the relative attractiveness of the Euro. Short term interest rates are captured by the Euribor. I do not include controls for the industrial production, the term structure of interest rates and the Economic Sentiment Index proposed by Acharya and Steffen (2015), due to high correlations during the crisis period with other macroeconomic variables during the crisis.

The variable $Firm_{i,y}$ includes the firm specific control variables liquidity, size, and unit-linked business as the share of cash and cash equivalents $CashEq_{i,y}$ in total assets, the logarithmic value of total assets $\log Size_{i,y}$, and the investments held for index- and unit-linked contracts as a fraction of all assets $Unit\_Share_{i,y}$, respectively. Further, I include the business line shares ($LoB_{i,y}$), which

[10]Investment-grade refers to ratings between AAA and BAA, high-yield bonds are rated BA and below.

are the net written premiums in a line of business divided by the total net written premiums per insurer, to account for the business mix. As to the lines of business, I consider Life, Guarantee, Health, Credit, and Business Continuity.

Because a continuous implementation of a variable that is bound between zero and one might lead to limitations in the interpretability (see Bertrand and Morse (2011) and Frydman and Wang (2019)), I include a median split into dummy variables to check for the robustness of the continuous specification. The binary variables equal 1 if the fraction of net written premiums associated with line of business LoB in total net written premiums of firm i is above the median of the sample and zero otherwise.

All firms in my sample share similar regulation and demographics, thus the business line risks should impact the stock prices of insurers consistently over all insurance firms. The net written premiums are reported in the companies' SFCR reports and incorporate the exposure of insurance firm i to risks associated with line of business LoB. Finally, Fama and French (1993) show that firm sizes have a significant impact on stock returns. Thus, I control for firm size by applying the logarithmic values of firms' total assets to the regression formula.

I apply a rolling regression throughout the observation period with a window length of 100 days, which equals roughly five months of trading days. The rolling approach enables me to show daily developments of the regression coefficients, while holding the observations per regression constant. The rolling windows feature a right-sided alignment, which means that each coefficient is calculated using the past 100 data points, leading to $T = 345$ estimations in the output. I track the regression coefficients, standard errors, and adjusted R^2 for each point in time t. The standard errors are heteroscedasticity robust.

4 The Impact of the Crisis on Bond Holdings

Panel one of Figure 3 displays the daily development of the rolling regressions over time. The vertical red lines represent the dates of the first day of the market crash, the day of the lowest point (the reversal) and the day the reversal trend ended. The orange, green, cyan, and purple lines represent the regression coefficients β_{Gov}, $\beta_{CorpBAA}$, β_{CorpA}, and β_{CorpBA}, respectively. Thus, each point reflects the average exposure of the sample firms to respective returns over the past

100 days. A dot signals that the coefficient is significant with respect to the 5 percent level. Panel one of Figure 3 depicts the development of the regression coefficients over time. Therefore, the interpretation of a coefficient at time t is that a change in the return of the held asset by 1 percentage point leads to an average change in the share prices of insures by y percentage points[11]. Correspondingly, a positive coefficient on, for instance, BA-rated bonds does not mean that it has a positive impact on the share price of insurers to invest more heavily in BA-rated assets. Neither does it mean that insurance firms with more investment-grade assets perform worse if the coefficient is negative. The coefficients represent the sensitivity of the insurance firms for a given asset structure. Altering the structure of investments would no longer result in an all else equal interpretation, which proves useful as the change in the sensitivity over time carries information on the structure of assets, as I show in the next section. This property ultimately enables me to track the changes in the asset structure, which is the point of interest for my analysis.

Acharya and Steffen (2015) interpret negative coefficients as short-positions, which might suit the business model of banks but is not sensible in the context of insurance companies. Rather than short-selling, the negative coefficients arise from the fact that all price variables are implemented as returns (holding period return for government bonds). An increase in the return resembles a higher price and a lower yield. Liedtke (2021) provides a qualitative statement proposing that insurance companies do not gain from the price increase in held assets, as they mostly hold their assets to maturity, instead they suffer from lower yields of future investments. As a consequence asset-liability management for insurers becomes more expensive. Thus, the effect of higher purchase prices outweighs the increase in values of owned assets, leading to a negative effect on share prices. The observation of a negative relation between insurance firm share prices and investment-grade bond returns is consistent with previous research by Hartley et al. (2016) and Grochola et al. (2022). Beyond the effect of higher purchase prices, rising prices might also indicate a decrease in the counter-party default probability, which helps to explain why the high-yield coefficients are positive. The fraction of counter-party default risk component in the price for high-yield bonds is higher than in investment-grade bonds. Therefore, the perceived gain in safety coming along with an increase in the price induces a positive effect on the stock price. Since the sign of the coefficients only provides information on the direction rather than the sensitivity of the variables' effect on

[11] All else equal; y is the value on the y-axis in panel one of Figure 3.

returns, I focus in my interpretation on the magnitude of the coefficients and not their sign.

The magnitude depends on the extent of how the investment affects the equity value and thus translates in the level of exposure of a firm to the respective investment. Figure 3 shows in panel one that the average exposure of firms to AAA-rated government bonds, as well as A-rated and BAA-rated corporate bonds is significant and small, going into the crisis. As the crisis unravels the exposure to AAA-rated government bonds more than quadruples, remaining significant. The increase of the coefficient indicates that insurance firms are actively increasing their exposure to AAA-rated government bonds. When the economy recovers after the crash in March 2020, the exposure to safer government assets remains large, though decreasing. During the crisis the sensitivities of A-rated and BAA-rated corporate bonds switch their sign, which indicates that the effect of credit default considerations overrules the need for new assets. While A-rated corporate bonds switch sign only for a short period immediately after the crash, BAA-rated assets remain positive until after full recovery of the stock market.

Beyond the immediate effect of the crash the coefficients on A-rated corporate bonds are at the pre-crisis level and not significant with respect to the 5 percent level, while mostly being significant to the 10 percent level during the crash and the recovery period. The lower test statistics arise from the orthogonalization as the A-rated coefficient only incorporates information that is not already explained by bonds with a BAA rating. BAA-rated corporate bonds which constitute for the lowest rating in the investment-grade, display a significant and increasing pattern (in absolute terms) before March 2020, with a sharp decline prior to the market crash. During the crisis period the BAA coefficient increases compared to the pre-crisis level and remains constant and largely significant until mid-August 2020. Regarding the assets below investment-grade, firms display an increasing exposure to bonds with a rating of BA going into the crisis, which immediately drops as the market crashes and quickly recovers afterwards, slightly decreasing throughout the summer of 2020. The downward spike in September 2020 might reflect the uncertainty associated with the second wave of Covid-19 in fall 2020.

The evidence suggests that insurance firms on average increase their exposure towards AAA-rated government bonds during the market crash in March 2020. The decreasing pattern of BA-rated and the constant pattern of BAA- and A-rated corporate bonds suggests that insurers did not increase their holdings in the respective asset-types throughout the crisis. The absence of increasing exposures of lower credit rating assets after the initial spike is consistent with the literature on insurance firms' investment behavior during crisis times (Becker and Ivashina (2015) and Kirti (2017)) and financial distress (Ge and Weisbach (2021)). Further, the persistent exposures of lower credit risk assets after the stock market recovers is consistent with European Central Bank (2020)[12] and might either be driven by the inability to liquidate these assets or by the fact that insurance firms were waiting for further developments of the Covid-19 situation. Evidence for the inability to liquidate the low credit rating assets is provided by European Systemic Risk Board (2020a). The ESRB reports that BA-rated and B-rated corporate bonds experience a larger peak in bid-ask spreads during the Covid-19 market crash than during the global financial crisis 2008. This indicates that the market saw more willing sellers than buyers and thus supports the hypothesis that insurance firms were not fully able to unwind their positions. Given increased transaction costs and lower prices might also help to explain a reluctance to sell BAA-rated corporate bonds.

The sharp initial drop of the BA-rated coefficient indicates that insurance firms are eager to quickly sell the respective assets. Yet, after the reversal the decline in of the BA-rated coefficients is much slower. The slower decline might be due to the exemption of newly downgraded bonds from risk-based capital charges, or less uncertainty in the market towards the end of the market crash and during the recovery. The reversal pattern in the BA-rated coefficient after the initial drop and the increase in the exposure of the BAA-rated corporate bonds after the market crash from 0.4 to almost 1 (in absolute terms) disturb the picture of insurance companies trying to reduce the credit risk in their portfolios. Both patterns might arise due to rating downgrades of formerly A- and BAA-rated bonds. BAA-rated investments are on the edge of investment-grade and thus they possess an attractive trade-off between risk-based capital charges and return, which might result in "reaching-for-yield" behavior as described by Becker and Ivashina (2015). The spike in BA-rated bonds further indicates that the bonds insurance firms hold are prone to rating downgrades, which is also consisten to the observations of Becker and Ivashina (2015).

I inspect the downgrade hypothesis by inspecting credit rating downgrade data from Bloomberg. In the first two quarters of 2020, 18 western European corporate bonds dropped out of investment-grade, which is the largest number of bonds falling below investment-grade since the European sovereign debt crisis 2012. The downgrades within the category of investment-grade bonds count

[12] Chart 4.2

for 92 cases, which is higher than in previous years but far lower than in 2012 with 346 downgraded bonds. The European Systemic Risk Board (2020b) conducts a scenario analysis on the effects of bond downgrades on financial institutions and finds that insurance firms are the most affected in the total loss amount.

Both, the downgrade aspect and the illiquidity aspect, provide an explanation for the paths of BA- and BAA-rate corporate bonds throughout the crisis. First, the downgrade aspect helps to explain the impact-reversal pattern of the BA coefficients in the end of March 2020. Second, the impact of the large decline in liquidity of high-yield corporate bonds explains the slow decrease of the BA coefficients. Both effects indicate that even though insurance firms show the tendency to shift their portfolio holdings towards higher credit-rating assets they might be limited in their ability of doing so by the pro-cyclical liquidity risk associated with high-yield investments. The fact that high-yield corporate bond funds experience withdrawals of up to 10 % in March 2020[13] empowers this interpretation because investment funds can be redeemed at the net asset value and therefore indicate the behavior of investors without the restriction of finding a buyer.

The path of adjusted R^2 over time is illustrated in Panel two of Figure 3. The fraction of explained variation in total variation of the firms' returns sharply increases during the crisis. The boost in explained variation suggests that the model does a better job in predicting the holdings of insurance firms during the Covid-19 crisis. On the one hand this result might be driven by an increase in trading activities to adjust the portfolio. On the other hand, a higher general volatility in the market induces more variation in otherwise less active variables, which can therefore relate more strongly to the other variables in the model. Most importantly, the jump of the R^2 relates to Chodorow-Reich et al. (2020) who find that the impact of value changes of portfolio assets on insurers share prices is strongest during market downturns.

Table 3 reports the regression results for certain dates defined to represent pre-crash, post-crash and recovered throughout Covid-19 crisis in March 2020. Those dates are represented by the vertical red lines in Figure 3 and correspond to the dates 14. February, 16. April and 15. June. Columns one to three report the unorthogonalized results. In columns four to six I present the orthogonalized data, which is the specification I apply, producing the output in Figure 3. In the

[13] European Systemic Risk Board (2020a)

process of the orthogonalization, the returns of the European BAA-rated corporate bond index are replaced by the residuals of a regression of the BAA-rated corporate bonds returns on the A-rated corporate bond returns. The specification in columns seven through nine replaces the business line variables by firm fixed effects, which should by definition incorporate firm specific properties such as the insurance business mix. Since I do not need to incorporate SFCR data, the fixed effect specification features more observations through the inclusion of non-Solvency II firms.

One can see that the stock market exposure ("Market") of the sample firms is significant and positive throughout all specifications. The market coefficients are increasing, which indicates that the market co-variation of the sample becomes larger during the crash and the recovery. The coefficient on BA-rated government bonds is significant and decreasing in all specifications, which indicates that the exposure to this asset type decreases compared to the pre-crash level.

In the specification without orthogonalization I observe a strong significant increase in the absolute values of the A-rated coefficients, suggesting that the exposure towards A-rated assets rises. When controlling for the variation that is already explained by BAA-rated corporate bonds in the orthogonalized specification the observed effect becomes less significant and lower in magnitude. Both observations are not robust to the specification with firm fixed-effects, where I observe no significant impact of the A-rated corporate bond index on the insurers' share prices after the crash and during the recovery. A reason for this might be that the average effect within the firms differs from the pooled effect across all firms. However, further research would be necessary to shed light on this inconsistency. The BAA-rated coefficients in the pre- and post-crisis regressions are significant and increasing in absolute terms. By construction the BAA-rated coefficients do not change due to the orthogonalization. The fact that with $E_{corpBAA}$ the coefficients on A-rated bonds are less significant and smaller indicates that A-rated and BAA-rated bonds share a joint effect which affects the explanatory power of both variables. Table 2 shows that the correlations of all investment grade corporate bond returns are large. The correlations suggest that a part of the explanatory power of all ratings above BAA might be driven by their categorization as investment-grade. In addition, this covariation is especially high during crisis times leading to higher variance inflation factors of both coefficients, which is one of the main reasons I apply the orthogonalization.

The AAA-rated government bond exposures gain in magnitude and are significant in the post-crash and recovery regressions, consistent for all specifications, suggesting a strong increase during the market crash and a decreasing pattern as markets recover.

As to the lines of insurance business, I observe no significant effects for either the credit, business continuity or health insurance lines. A larger share of life insurance business can be weakly associated with a superior performance before the crisis. The positive effect of life insurers is negated for larger shares of guarantee business within the life insurance portfolios. Larger firms and an appreciation of the Euro are associated with a weaker performance during the market crash which is consistent over all specifications. Further, an increase in the Euribor rate induces a significant negative impact on returns in the post-crash period, which most likely arises due to higher financing costs during the economic downturn.

5 Exposures and Holdings

The interpretation of the regression coefficients as asset holdings raises the question in how far the estimated exposures can be associated with the actual portfolio holdings of a firm. To answer this question, I follow the approach presented by Acharya and Steffen (2015). I estimate the regression coefficients at the end of the fiscal period for each insurer in the sample via non-pooled OLS regression and relate them to holding information published in insurers' annual reports. The publication of the financial reports takes place two to three months after the reporting date. The delay of time proves useful as one may obtain detailed information on the portfolio structure at times when the public has no access to this information. As the share price only incorporates publicly available information, I am able to compare the pre-publication market expectation in the estimates at the year-end to the publicly reported holdings after the publication of the annual report.

I use year-end data of 42 firms in the sample over the period 2016 to 2019. The data includes the firms that are not subject to Solvency II regulation, which provides the benefit of additional observations. Yet, I am not able to control for cross-sectional differences of insurance firms in this set-up, because I apply a non-panel OLS approach to produce results for each firm individually. As a consequence the model loses the controls for firm-specific variables presented in panel three of Table 1, which includes the controls on insurance business lines and is the key drawback of this approach. To mitigate this issue I color the data points in Figure 4 according to their affiliation to the life insurance ("LIFE") business line according to the median split. Blue dots reflect the firms whose share of net written premiums in the given business line are above the median of the sample, the red dots represent firms below the median. Since this categorization relies on data from SFCR reports, non-Solvency II firms cannot be assigned this ratio and are colored in gray. Lastly, the year-end dates do not coincide with any crisis period. On the one hand, this means that the analysis does not profit from the increased pass-through effect Chodorow-Reich et al. (2020) report for crisis periods. On the other hand, I do not face the drawback of increased correlation of the independent variables as reported in Table 2. Thus, I do not need to orthogonalize the corporate bond index returns for this analysis.

Figure 4 presents the results, the color scheme visualizes the life insurance activity. The four panels relate the annual report information to the estimated regression coefficients of the respective ratings. Additionally, the figure depicts a fitted line to illustrate the average relation. In the top left of each panel are the R^2 and the p-value of the fitted line. All panels present a significant, positive relation between the reported bond holdings and the estimations. The positive, significant relation empowers my interpretation of the regression coefficients incorporating information on the portfolio composition of the insurers, and can thus help to answer the question how European insurance companies changed their portfolio composition during the Covid-19 market crisis. Note that the reported data includes not only European corporate or government bonds but all assets that are assigned the respective rating. The resulting dilution is less pronounced for A-rated and BAA-rated corporate bonds because these bonds represent the largest amount of insurance companies' investments in the respective categories[14], which explains the higher significance of these two panels compared to the AAA-rated government and BA-rated corporate bond holdings.

Though I show that the exposure coefficients help to assess insurers' corporate bond portfolio movements, I am not able to translate the coefficients into an asset structure measured in monetary units. There is no indication to assume that the ratio between exposure and holding is constant, particularly between the pre-crisis and crisis period. Furthermore, the lack of detailed data on portfolio holdings prevents me from calibrating a projection of coefficients on holdings.

Regarding the life insurance business, a clear distinction is visible in the holdings of A-rated

[14] See European Systemic Risk Board (2020b) p. 4.

assets. The firms associated with life insurance business seem to be less engaged in A-rated assets compared to non-life firms. All firms above the 40 % threshold in Panel two of Figure 4 are non-life firms. The unequal distribution between life and non-life business lines signals that life insurance companies seem not to concentrate their asset holdings in A-rated European corporate bonds, but rather diversify their credit risk exposure. This observation is empowered by the fact that the majority of life insurers invests between 0 and 40 percent in each of the presented corporate bond categories. Previous literature[15] suggests that during non-crisis times life insurers favor riskier BAA-rated assets to increase the yield in their investment portfolio. I cannot confirm this observation in my data set.

6 Conclusion

Using publicly available data on the stock prices of insurance firms, corporate bond price indices and government bond yields, I propose a regression model which estimates the asset composition of insurance firms' investment portfolios, thereby presenting a bottom-up approach that partly[16] complements the top-down analysis conducted by the European Systemic Risk Board (2020b). The estimated exposures display a positive relation to reported holding information of the inspected firms in annual reports, which indicates that the interpretation of the regression coefficients as estimates for the asset compositions is justified. The analysis provides evidence that European insurance companies reduced their exposure to higher credit risk assets and increased their exposure to assets with lower credit risk throughout the Covid-19 induced market crash in March 2020 and the subsequent period of recovery. This contradicts the hypothesis that insurers gamble on the recovery of the bonds market to achieve a superior return on assets. Regarding sub-investment-grade, the BA-rated asset exposure remains high after March 2020. As a possible reason I suggest rating downgrades of formerly higher-rated bonds and the escalating illiquidity of high-yield corporate bonds. European insurers shift their portfolio holdings towards lower credit-rating assets, trying to free capital bound in risk-based capital charges, but are constrained by the credit and liquidity risk they assume during non-crisis times. An exogenous shock to credit rating quality increases insurers' exposure to lower-rated and less liquid assets. Risk-based capital charges incentivize selling

[15]See for example Becker and Ivashina (2015) and Ge and Weisbach (2021).

[16]In contrast to the European financial system as a whole, I focus only on the insurance sector.

these assets, thereby creating the threat of fire-sales, if portfolios are similar between firms[17]. Yet, the slow but steady decline in the BA-rated exposure suggests that insurers adapt their stressed positions patiently trying to avoid high transaction costs. European Systemic Risk Board (2020a) reports that measures to dampen the effect of rating downgrades after the Covid-19 induced market crash in March 2020 are implemented under EU regulation. Among others, these measures include that additional capital charges due to newly downgraded bonds do not need to be accounted for immediately.

Chodorow-Reich et al. (2020) substantiate financial intermediaries' role as asset insulators. My results are consistent with the finding of Chodorow-Reich et al. (2020) that the influence of investment assets on insurers' share prices increases during crisis times. I observe a large increase in explanatory power of the asset returns on the share prices during the Covid-19 crisis in 2020. The finding that insurance companies pro-actively shift their portfolio assets towards safer investments when the financial situation becomes tighter, strengthens the prevailing finding in the literature that insurance firms favor safety over return during crises.

A possible extension of my research would be to further strengthen the relation between estimated portfolio composition and actual holdings of the firm for example via instrument variables. Furthermore, it would be interesting to see how the findings of this paper are affected by insurers' geographical exposure to differences in country-specific life-expectancy or income, as well as Covid-19 containment measures, though the measures are largely overlapping across European countries. As this paper focuses on corporate bonds, it provides a foundation for further research on fixed-income investment decisions of insurance companies during crises. For example, the absence of gambling for recovery with respect to corporate bonds throughout the Covid-19 crisis might not hold for European government bonds, given the fact that the Solvency II regulation imposes the same capital requirements for governmental bonds of all EEA member states regardless of the issuer's rating[18]. Thus, one could rule out considerations about capital charges as a motive for portfolio reallocation during the Covid-19 crisis.

[17] Girardi et al. (2021) provide evidence for this hypothesis.

[18] For example Swinkels et al. (2018) express their concerns about increased risk-taking by insurance companies as a consequence of the absence of risk-based capital charges.

7 Figures and Tables

Table 1: Descriptive Statistics

This table depicts the descriptive statistics of the financial variables used for the analysis. The variables are grouped according to their categorization as either a daily portfolio or index return (Panel 1), a macroeconomic control variable (Panel 2), or company-specific (Panel 3). Company-specific data is averaged over all reportings during the sample period. The sample covers all actively, publicly traded European insurance companies from August 2019 to December 2020.

Statistic	Unit	Obs	Mean	St. Dev.	Min	Median	Max
Panel 1: Portfolio Returns							
Avg.Stock.Return	%	338	0.028	1.709	−10.783	0.062	7.771
EU.corp.IG	%	338	−0.001	0.272	−2.490	0.012	0.981
EU.corp.HY	%	338	0.0002	0.518	−3.785	0.023	2.105
EU.corp.IG.Maturity	Years	338	6.694	0.052	6.401	6.700	6.798
EU.corp.HY.Maturity	Years	338	4.772	0.096	4.611	4.783	4.951
EU.gov.AAA	bps	338	−0.036	1.532	−8.966	0.050	9.289
Panel 2: Macroeconomic Variables							
Market	%	338	0.028	1.790	−12.401	0.060	9.236
Vstoxx	%	338	0.448	8.662	−18.467	−1.311	43.830
FX Index	Level	16	99.127	1.816	95.490	98.837	102.293
Euribor	bps	16	−47.774	4.461	−56.068	−45.548	−40.959
CPI Growth	%	16	0.889	0.404	0.300	0.900	1.400
Panel 3: Firm-Specific Variables							
HEALTH	%	34	6.519	7.487	0.00	3.710	58.05
BC	%	34	0.705	1.065	0.00	0.283	10.86
CREDIT	%	34	3.316	14.88	0.00	0.004	100
LIFE	%	34	50.878	34.07	0.00	55.312	100
GUARANTEE	%	34	13.495	14.881	0.00	6.963	48.45
Assets	Mn €	42	169,532	249,501	221	60,272	1,035,598
Liquid Share	%	42	3.6	2.7	0.4	2.9	12.6
Unit Share	%	42	19	23.1	0	12.7	78.2

Table 2: Corporate Bond Index Correlations

This table presents the correlations of the European corporate bond returns , the holding period return of the AAA-rated government bond, and the return of the Euro Stoxx 50 index (”Market”). The diagonal of the matrix is left out for brevity during the periods March until August 2019 in Panel 1 and March until August 2020 in Panel 2.

Panel 1: Pre-Crisis

	Gov_EU_AAA	corp_EU_AAA_P	corp_EU_AA_P	corp_EU_A_P	corp_EU_BAA_P	corp_EU_BA_P
corp_EU_AAA	0.59					
corp_EU_AA	0.53	0.95				
corp_EU_A	0.51	0.89	0.91			
corp_EU_BAA	0.25	0.58	0.65	0.76		
corp_EU_BA	0	-0.11	-0.07	0.12	0.33	
Market	-0.13	-0.23	-0.18	-0.05	0.17	0.54

Panel 2: Crisis

	Europe_Gov_Agg	corp_EU_AAA_P	corp_EU_AA_P	corp_EU_A_P	corp_EU_BAA_P	corp_EU_BA_P
corp_EU_AAA	0.49					
corp_EU_AA	0.37	0.89				
corp_EU_A	0.17	0.6	0.72			
corp_EU_BAA	-0.11	0.27	0.43	0.83		
corp_EU_BA	-0.1	-0.02	0.07	0.44	0.55	
Market	-0.3	-0.29	-0.2	0.14	0.38	0.54

Table 3: Regression Coefficients

This table presents the regression coefficients of the main model at points in time representing pre-crash, reversal and recovered throughout the Covid-19 turmoil. Each regression covers the 100 days prior to the presented date. The time points resemble the dates 14. February, 15. April, and 15. June. The rows present the regression coefficients given the three specifications: unorthogonalized, orthogonalized, and business lines as binary variables. The corporate bond returns and the market return are measured in percent; government bond holding period returns in 10 basis points. Robust standard errors are clustered across firms and reported in parenthesis. Insignificant controls on CPI, share of CashEq, share of index- and unit- linked business, Line of Business Health and Business Continuity, and the regression constant are dropped for brevity.

	Dependent variable: $R_{i,d}$, measured in percent								
	Unorthogonalized			Orthogonalized BAA-Rated			Fixed-Effects		
	pre-crash (1)	reversal (2)	recovered (3)	pre-crash (4)	reversal (5)	recovered (6)	pre-crash (7)	reversal (8)	recovered (9)
Gov_EU_AAA	−0.413	−2.113***	−1.641***	−0.413	−2.113***	−1.641***	−0.147	−2.814***	−1.787***
	(0.297)	(0.342)	(0.335)	(0.297)	(0.342)	(0.335)	(0.329)	(0.366)	(0.402)
corp_EU_A	0.201	−1.264***	−1.142***	−0.315**	−0.391*	−0.409*	−0.800***	−0.108	−0.321
	(0.274)	(0.354)	(0.347)	(0.150)	(0.233)	(0.227)	(0.165)	(0.211)	(0.287)
corp_EU_BAA	−0.617**	0.837***	0.695**						
	(0.268)	(0.310)	(0.276)						
$E_{corpBAA}$				−0.617**	0.837***	0.695**	−0.822***	1.123***	1.041***
				(0.268)	(0.310)	(0.276)	(0.295)	(0.362)	(0.334)
corp_EU_BA	2.218***	1.851***	1.573***	2.218***	1.851***	1.573***	2.765***	1.456***	1.551***
	(0.376)	(0.198)	(0.187)	(0.376)	(0.198)	(0.187)	(0.542)	(0.279)	(0.253)
Market	0.644***	0.677***	0.724***	0.644***	0.677***	0.724***	0.669***	0.703***	0.684***
	(0.082)	(0.062)	(0.045)	(0.082)	(0.062)	(0.045)	(0.096)	(0.069)	(0.046)
Vstoxx_growth	0.006	0.017***	0.018***	0.006	0.017***	0.018***	0.012	0.018***	0.014**
	(0.008)	(0.006)	(0.005)	(0.008)	(0.006)	(0.005)	(0.010)	(0.006)	(0.006)
FX	−0.032	−0.092*	−0.104***	−0.032	−0.092*	−0.104***	0.164	−0.099	−0.657***
	(0.053)	(0.052)	(0.031)	(0.053)	(0.052)	(0.031)	(0.228)	(0.236)	(0.228)
Euribor	0.002	−0.259***	−0.041*	0.002	−0.259***	−0.041*	0.050	−0.776**	0.088
	(0.026)	(0.092)	(0.022)	(0.026)	(0.092)	(0.022)	(0.070)	(0.383)	(0.199)
ln_Assets	−0.004	−0.161***	−0.056	−0.004	−0.161***	−0.056	0.006	−0.111***	−0.024
	(0.046)	(0.060)	(0.066)	(0.046)	(0.060)	(0.066)	(0.031)	(0.042)	(0.046)
Life	0.383*	0.320	0.168	0.383*	0.320	0.168			
	(0.212)	(0.277)	(0.278)	(0.212)	(0.277)	(0.278)			
Guarantee	−0.517**	−0.386	−0.145	−0.517**	−0.386	−0.145			
	(0.218)	(0.350)	(0.414)	(0.218)	(0.350)	(0.414)			
Orthogonalized	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE	No	No	No	No	No	No	Yes	Yes	Yes
Observations	3,400	3,400	3,400	3,400	3,400	3,400	4,200	4,200	4,200
Adjusted R^2	0.152	0.406	0.415	0.152	0.406	0.415	0.086	0.266	0.275
F Statistic	41.583***	122.627***	142.687***	41.583***	122.627***	142.687***	40.680***	92.074***	108.028***

Note: *p<0.1; **p<0.05; ***p<0.01

Figure 1: MiFiD II Post-Trade Bond Reporting

The graph in panel 1 shows the monthly aggregated trades of Bonds on secondary European markets. The observations range from January 2018 until December 2020. The y-axis presents the number of reported trades per month. The colored lines represent the different types of bonds. Panel 2 presents the monthly trades from the TRACE bond trade repository of secondary US markets.

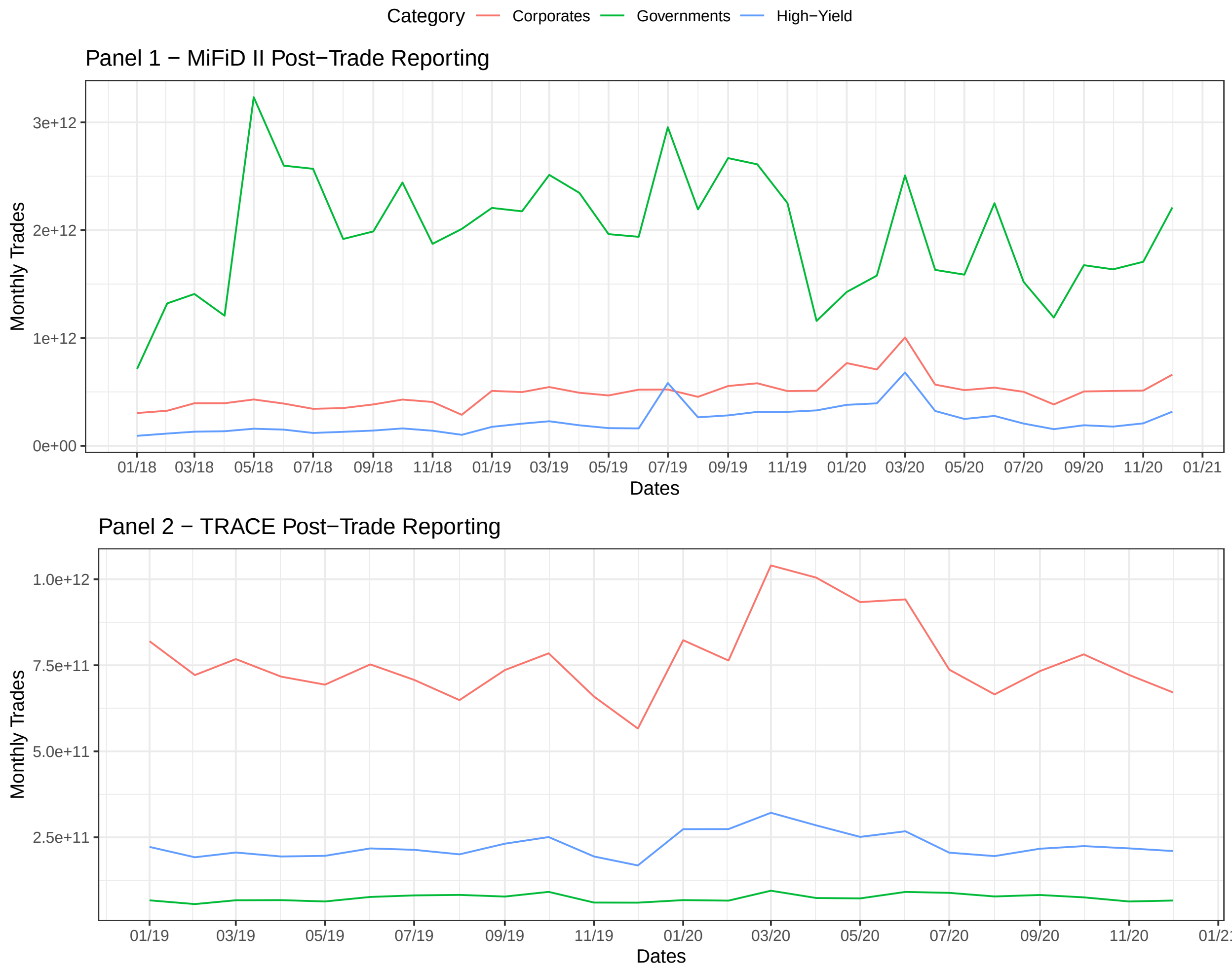


Figure 2: Average Share of Cash and Cash of Liquid Assets

This figure plots the average share of cash, and cash equivalents over each quarter in total assets of the 42 insurance firms in the sample over the years 2015 to 2020. To see possible seasonality effects, the data is presented for each quarter of each year.

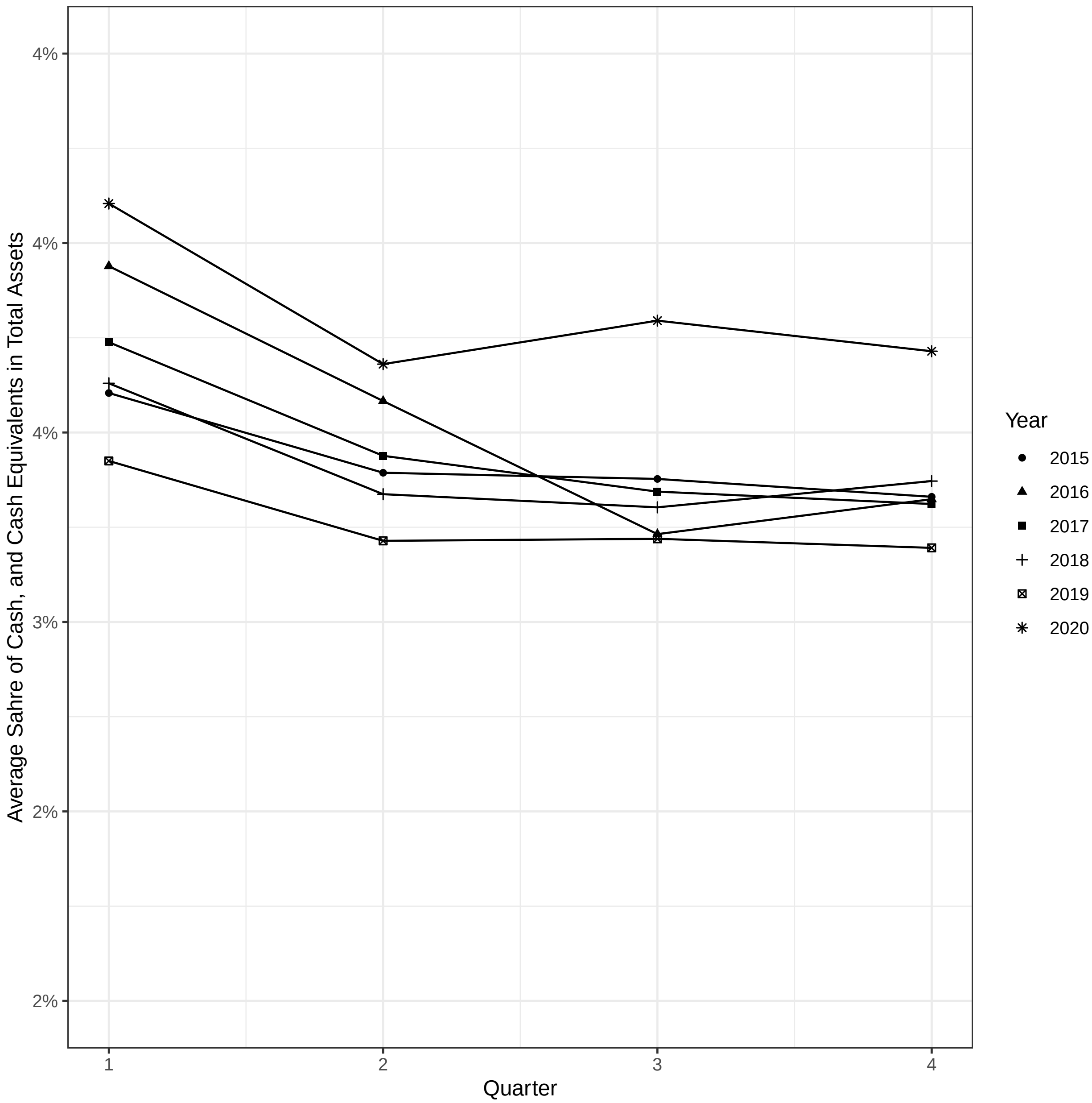


Figure 3: Rolling Regression Results

This figure presents the results of the rolling regression. Panel 1 reports the daily development of the rolling regression between September 2019 and December 2020. The orange, green, cyan, and purple lines represent the regression coefficients β_{Gov}, $\beta_{CorpBAA}$, β_{CorpA}, and β_{CorpBA}, respectively. Each point reflects the average exposure of the sample firms to respective returns over the past 100 days. A dot signals significance with respect to the 5 percent level. Panel 2 presents the path of adjusted R^2 over time. The red lines in both panels represent the dates 14. February, 15. April, and 15. June and resemble the pre-crash, reversal and recovery columns in Table 3.

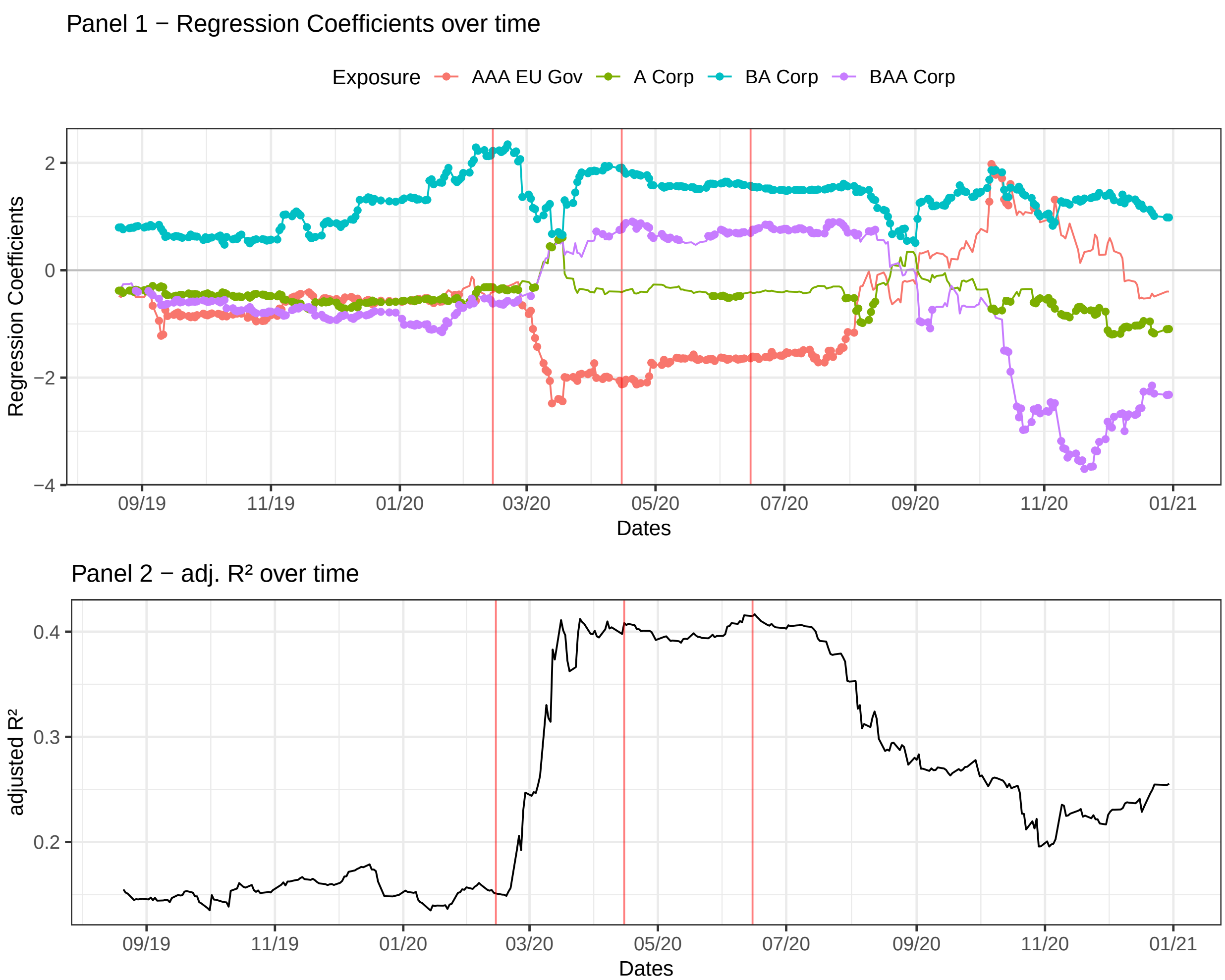
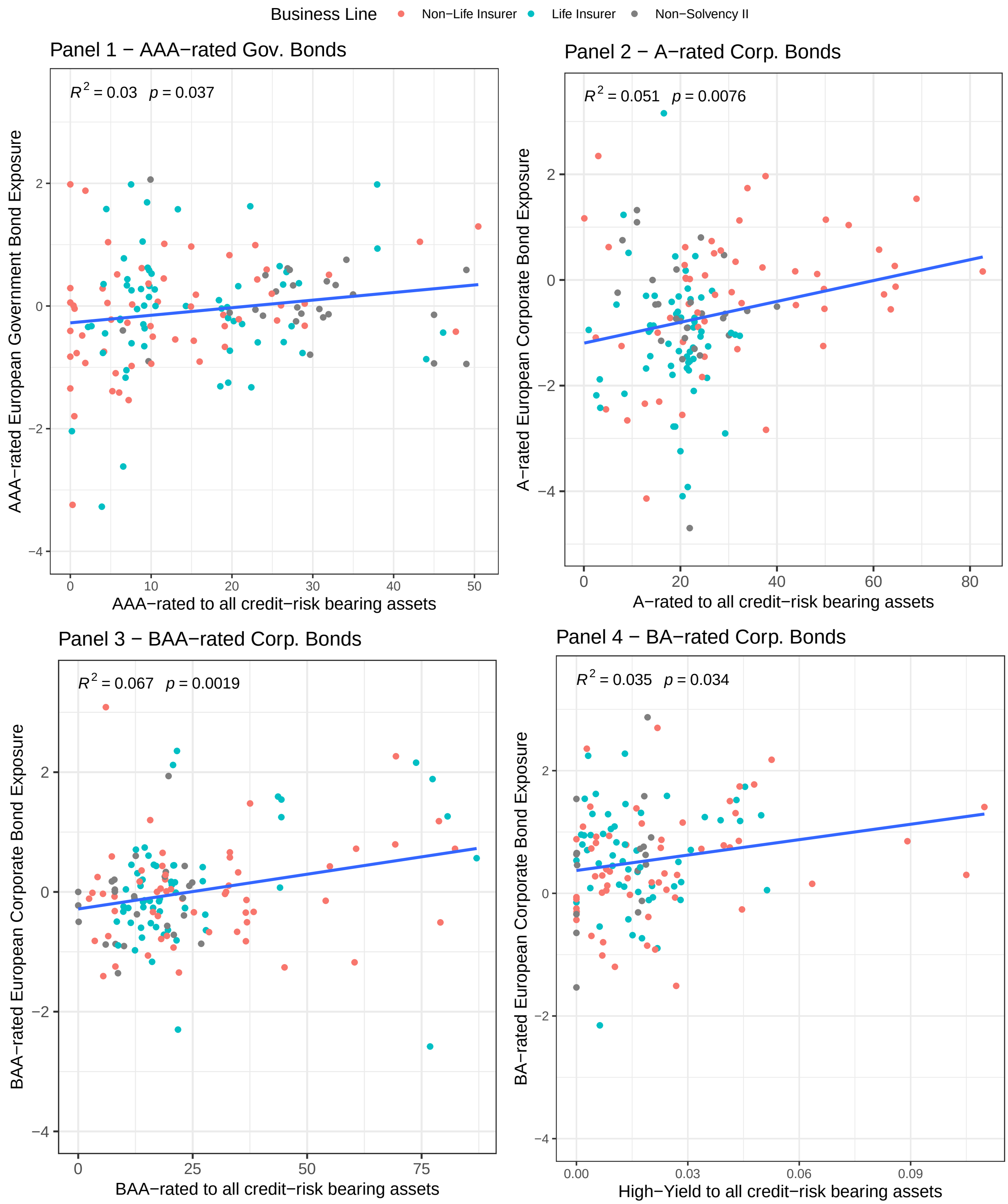


Figure 4: Link Exposures to Holdings

This figure provides evidence for the linkage between the regression coefficients and the portfolio holdings of the sample insurers. The x-axis plots the reported fraction of AAA-rated, A-rated, BAA-rated, and BA-rated assets to all credit risk bearing assets with data from firms' annual reports between 2016 and 2019. The fitted regression line in blue depicts the relation between the estimated exposures on the y-axis and the reported holdings on the x-axis. The R^2 and p-value of the fitted lines can be found in the top left corner of each panel.



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