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Abstract

We use a two factor model of life insurer stock returns to measure interest rate risk at U.S. and U.K. insurers. Our estimates show that interest rate risk among U.S. life insurers increased as interest rates decreased to historically low levels in recent years. For life insurers in the U.K., in contrast, interest rate risk remained low during this time, roughly unchanged from what it was in the period prior to the financial crisis when long-term interest rates were in their usual historical ranges. We attribute these differences to the heavier use of products that combine guarantees with options for policyholders to adjust their behavior by U.S. life insurers relative to their U.K. counterparts.

Keywords: Insurance companies, interest rate risk, life insurance, low interest rates

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1. Introduction

Interest rates have decreased to levels at or near historical lows in many countries around the world including the U.S., the U.K. and continental Europe in recent years (see Figure 1). The interest rate environment is important for life insurance firms because they typically use fixed-income markets to hedge the implicit or explicit return that they promise on core products – life insurance policies and annuities. However, hedging interest rate risk for insurance policies and annuities is not always straightforward. Many life insurers use hedging strategies such as duration matching. These techniques generally do a good job of hedging interest rate risk when rates are relatively stable and near historical averages, as they were in the early part of the century in the United States and Europe. But, these strategies may not do as well when there is a large change in interest rates such as the sustained decrease in rates that occurred after the 2008 financial crisis. In this paper, we measure the interest rate risk exposure of insurers in the U.S., the U.K., and continental Europe during the rate decrease and the subsequent period when interest rates have continued to be very low by historical standards. We compare these measures to measures of their interest rate risk exposure during the more normal interest rate period prior to the financial crisis.

Life insurance firms sell products that promise payments in the future. Most products sold by life insurers offer some combination of protection – either from loss of life (a life insurance policy) or from outliving financial resources (an annuity) – and savings (often in a tax-advantaged way). All of these products involve policyholders paying in funds before, often well before, insurers make any payments. This pattern exposes insurers to interest rate risk. Exposure to interest rate risk varies with the features of particular products. We exploit differences in the features of life insurance products across countries to examine the importance of product features in determining life insurance exposure to interest rate risk.

One important dimension across which life insurance products differ is the degree to which policyholders are guaranteed minimum returns on the savings elements of their policies. In many countries such as the United States, annuities and other savings products offered by life insurers are generally sold with minimum rate guarantees. So, for example, a policyholder might be offered an annuity that guarantees a minimum return of 4% per year on all invested funds. In other countries such as the United Kingdom, it is more common for the return on savings elements in life insurance products to be a function of the return insurers earn on investments.[1] All else equal, products with guarantees are more exposed to interest rate risk than products that with no guarantees.

Of course, all else is not equal. Life insurers can choose assets and use derivatives to hedge the interest rate risk introduced by their liabilities.[2] The task of asset-liability management is an important function at these firms. Insurers seek to invest in a way that ensures that funds are available when they are due to policyholders. This generally leads life insurers to invest heavily in fixed-income assets such as bonds. For example, according to data from SNL Financial, over 87% of Prudential Financial's investment assets were fixed income securities in 2014. Life insurers may choose assets to back their liabilities with interest rate risk in mind but may choose not to—or may not be able to—completely balance the interest rate sensitivity of their assets and liabilities. This conflict arises in part because assets with maturities as long as those of some insurance liabilities are not always available. This often leads life insurers to manage interest rate risk through approximate hedges such as duration matching. Duration matching is effective for hedging small changes in interest rates, but can leave insurers unhedged if interest rates move substantially (the so-called convexity problem).

Another important factor in evaluating interest rate risk is that life insurers can be exposed to interest rate risk through the behavior of policyholders, especially through products with guaranteed returns. Some insurance products offer policyholders the option to contribute additional funds at their discretion (possibly only in specific circumstances) or to close out a contract in return for a predetermined payment (in the latter case, the policyholder is said to surrender the contract). When interest rates change, it is more likely that policyholders will act on these options. For example, they may contribute more to an annuity with a high guaranteed return when interest rates are low or surrender an annuity with a low return guarantee when interest rates rise significantly. The key is that the combined effect of guarantees and policyholder behavior can make hedging interest rate risk much more complex. This can lead life insurers to leave themselves more exposed to changes in interest rates that are large enough to

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[1] Moody's (2015) estimates that guaranteed products account for between 60% and 80% of U.S. life insurance industry reserves and for 40% of U.K. life insurance reserves. However, many of the guarantees in the U.K. are made at interest rates well below market rates at the time they are granted and essentially provide protection against a loss on the policyholders' investments (guarantees are made at 0 – 1% even when market interest rates are much higher).

[2] See Berends and King (2015) for a discussion of derivatives usage by U.S. life insurers.

substantially affect policyholder behavior. We examine whether differences in guarantees and policyholder behavior across countries are related to the interest rate sensitivity of life insurers in those countries.

We propose a measure of the residual interest rate risk that life insurers retain after taking into account their efforts to reduce interest rate risk through asset liability management and other hedging activities. We then examine how this measure has changed in recent years as interest rates decreased and then remained low. The evolution of interest rates has been similar in many countries, including in the U.S. and the U.K., which are the focus of this study (see Figure 1). Despite being exposed to similar changes in interest rates, the residual exposure of life insurers to interest rate risk may differ by country due to differences in the characteristics of products sold across countries. The primary focus of this paper is a comparison of interest rate risk for insurance firms in the U.S. and the U.K. We compare the residual exposure to interest rate risk for firms in the U.S. to that of firms in the U.K. In the U.S., guarantees and policyholder options are common and in the U.K. they are not, so our study design helps to shed light on the role of guarantees in generating interest rate risk.[3]

There are two potential approaches to measuring the interest rate exposure of life insurance firms: bottom-up and top-down. A bottom-up measure would make use of detailed data on insurance assets and liabilities and would involve estimating the interest rate risk of each on an individual- or product-basis. This approach is impractical for us as it would require detailed information that is not publicly available. However, stock analysts and ratings agencies pay close attention to the product mix of insurers and interest rate guarantees of the products that insurers sell. Thus, the interest rate sensitivity of an insurer's liabilities is likely to be factored into the price of their stock. For these reasons, we use a top-down approach that relies on the sensitivity of life insurer stock returns to interest rates.

The top-down measure of interest rate exposure that we use is based on a two factor market model of insurer stock returns. We include a broad stock market return factor to control for changes in the overall economy as well as an interest rate factor. The coefficient on the interest rate factor, which is allowed to vary through time, is our measure of the exposure to interest rate risk.

[3] Many annuities in the U.K. were compulsory for our sample period. Policyholders in the U.K. had little optionality in their investments (Oliver Wyman, 2014) and surrenders are not possible for U.K. annuities (Geneva Association, 2012).

In order to see how interest rate sensitivity is related to the product-specific features of life insurance and annuities, we compare the U.S., where many insurance products have guarantees and some policyholder flexibility, to the U.K., where the combination of both guarantees and policyholder options is much less common. We examine residual interest rate risk exposure for insurers in the two countries along multiple dimensions. However, we are particularly interested in the period beginning in July 2010. This period was after the financial crisis and was when long-term interest rates decreased significantly before leveling off at a historically low level. We refer to this as the low-rate period. During this period, we find that the stock prices of U.K. life insurers were not significantly impacted by small changes in interest rates, suggesting they were not particularly exposed to interest rate risk. Over the same time period, U.S life insurers' stock prices increased significantly when interest rates increased, implying that U.S. life insurers faced considerable interest rate risk and that, in particular, the duration of their liabilities exceeded that of their assets. We interpret this finding to mean that the guarantees and policyholder options that are common to U.S. life insurance products exposed them to considerable interest rate risk in the period following the financial crisis when interest rates fell significantly and stayed low.

We test our interpretation and ensure these results are not due to omitted factors, through a two-stage differences-in-differences test for both U.S. and U.K firms. First, we compare the low-rate period to a period when interest rates were 'normal,' that is to say within historical norms. We define the normal rate period as beginning in 2002 and continuing through June 2007 (ending before the financial crisis). During this period, we find that small changes in interest rates had no effect on life insurer stock prices in *either* the U.K. or U.S. Next, we compare changes in interest rate sensitivity between the normal period and the low-rate period for the two countries. We find that interest rate risk increased for U.S. life insurers between the normal period and the low-rate period. But, there was no change in interest rate risk for U.K life insurers between the same two time periods.

The second stage of the difference-in-difference analysis focuses on ensuring that the differences that we observe between the U.S. and the U.K are due to differences in the life insurance industry in the two countries. In this stage, we compare the changes in interest rate risk exposure for life insurers in the two countries to changes in interest rate risk exposure for a control group of firms. Specifically, we examine the interest rate risk for non-life insurers (primarily property and casualty insurance firms) during the 'normal' rate period and the 'low-rate' period for in the U.S. and the U.K. Non-life insurers typically have liabilities of a much shorter duration (auto or business continuity insurance, for example) and their products do not have a savings element or a guaranteed return. Consistent with intuition, we find that non-life insurers' stock prices had little reaction to small interest rate changes in either the low-rate period or the normal-rate period for either U.K. or U.S. insurers. Thus, the second stage of the analysis shows that life insurers in the U.S. had an increase in interest rate risk in the low-rate period relative to the normal rate period when compared to non-life insurers in the U.S. while there was no such pattern in the U.K.

As a robustness check, we conduct a similar analysis using a sample of large insurers based in continental Europe. This analysis is complicated by two factors: First, there is no clear way to assess the prevalence of a combination of guarantees and policyholder options in life insurance products for most European countries. Second, large continental European insurance firms often have significant cross border activities. To address the second factor, we evaluate insurers by the source country for premiums, not where the firm is headquartered. Then, we split our sample based on the share of life insurance premiums that each insurer earns from Germany. While there is not a perfect consensus regarding the degree to which the life insurance products of each European country combine guarantees and options in a manner similar to U.S. products, there is broad agreement that the products offered in Germany are more similar to those in the U.S. than to those in the U.K. Consistent with the results in our main analysis, we find that life insurers with larger share of German premiums experienced an increase in interest rate risk during the low-rate period relative to life insurers with a smaller share of premiums from Germany, although the difference is statistically significant for only a portion of the low-rate period.

As a further check that our top-down procedure captures residual interest rate risk, we compare the residual interest rate risk from our model to country-level bottom-up measures derived from the European Insurance and Occupational Pensions Authority (EIOPA) 'low for long' stress scenario for European countries. Despite large differences between our approach and the EIOPA procedure, we find that our measure of risk is correlated with interest rate risk estimated from the EIOPA results.

Our overall findings are consistent with life insurance firms in the U.S. retaining a portion of the interest rate risk associated with interest rate guarantees and policyholder options. One interpretation is that during the normal interest rate period insurers successfully hedged themselves against small movements in interest rates using duration matching or something similar. They did not, however, hedge themselves against the effects of rate guarantees and the exercise of policyholder options under the low-probability scenario that interest rates decreased significantly. When this event came to pass, policyholders with guarantees elected to keep their policies longer and, when possible, increased their savings rate. Keeping policies longer effectively delayed the expected pattern of payments from the insurer to policyholders and forces the insurer to pay an above-market interest rate during this extra time. The effect of this was to increase the duration of insurers' liabilities by more than the amount of a fixed-rate coupon bond with the same duration prior to the rate drop. If insurers had assets (which, recall, are primarily fixed-rate coupon bonds) of the same duration as the liabilities before interest rates decreased, this would leave them unhedged.

In contrast to the U.S., in the U.K., where insurers have more flexibility to pass lower returns on to policyholders and where policyholders have much less flexibility to change investments or surrender, insurers were less exposed to the effect of lower interest rates. Our results suggest that these product features allowed U.K. life insurers to remain largely hedged to interest changes across both the normal and the low rate period.

We consider two potential alternative explanations for why the sensitivity of life insurers' stock prices to interest rates might increase when interest rates decrease significantly. The first is that duration matching is only an approximate hedge against interest rate risk (the convexity problem). Given life insurance balance sheets, if insurers do not adjust their asset portfolios as rates fall, the duration of liabilities will increase faster than the duration of assets.[4] This is true even when there are no guarantees and policyholder behavior does not change. Convexity is an issue in both the U.S. and the U.K., yet we find that the sensitivity of life insurers' stock prices to interest rates only increased in the U.S. and not in the U.K. This suggests that convexity from duration matching is not the major driver of our results, perhaps because insurers dynamically adjusted their portfolios as interest rates decreased.

[4] This is true because of the structure of assets and liabilities in life insurers' portfolios. See Section 4 for more details.

A second potential explanation for why a top-down measure of interest rate sensitivity based on stock prices could be larger in the low-rate period is that some insurance products can be difficult to sell at a profit when interest rates are very low. Since insurers' profit is equal to the return they earn on assets plus payments from policyholders less payments to policyholders, a decrease in interest rates lowers asset returns and induces insurers to either increase prices or reduce benefits, making insurance products generally less attractive to customers. Lower demand will show up in insurer stock prices and hence impact our top-down measure of interest rate risk. This effect is likely to impact both U.S. and U.K. life insurers, so it may not seem like an obvious explanation for our findings. However, the combination of guarantees and policyholder options means that insurers have to price in the ability of policyholders to switch out of a product if interest rates rise significantly. This may make it relatively more difficult for life insurers to sell certain product classes in the U.S. relative to those in the U.K. To the extent that this is true, it reinforces our interpretation that the combination of guarantees and policyholder options left U.S. insurers relatively more exposed to residual interest rate risk.

The rest of the paper is organized as follows. Section 2 describes our top-down measure of interest rate risk. Section 3 describes the data we use in the analysis. Our main hypotheses and findings for the U.S. and the U.K. are described in Section 4. In section 5, we present a robustness check of our results using a sample of European insurers. Section 6 concludes.

2. Measuring exposure to interest rate changes

To assess how the interest rate environment affects the exposure of insurance firms to interest rate changes, we use a top-down model that relates stock returns to changes in bond prices. Specifically, we estimate a two-factor model of insurer stock returns where the factors are a broad market factor and a government bond factor. Previous studies of the sensitivity of life insurance firms to interest rate risk have used a similar approach to measure the correlation between insurers' stocks returns and interest rate changes (Brewer, Mondschean, and Strahan 1993; Brewer et al. 2007; Carson, Elyasiani, and Mansur 2008; Berends et al. 2013). In contrast to Fama and French (1992; 1993) we retain the panel structure of the data rather than forming portfolios of stock returns. The results are robust to using portfolios. The benefit of retaining the full information contained in the panel of returns is shown in Ang, Liu, and Schwarz (2010) in the context of testing factor models. The panel data approach allows us to implement difference-in-differences estimates that exploit the full variation in the share of insurance premiums that are due to life insurance products.

We are interested in the coefficient on the government bond return but we include the stock market index to control for common factors such as macroeconomic shocks that influence all equity prices. Thus, our two-factor model gauges the extent to which changes in the ten-year rate that are uncorrelated with moves in the overall market are associated with changes in insurance firm stock prices. For a panel of insurer stocks indexed by *i*, we estimate:

$$R_{i,t} = \alpha + \beta R_{m,t} + \gamma R_{10,t} + \varepsilon_{i,t}, \tag{1}$$

where

$R_{i,t}$ = the return (including dividends) on stock *i* in week *t*,

$R_{m,t}$ = the return on a value-weighted stock market portfolio in week *t*,

$R_{10,t}$ = the return on a government (either U.S. or U.K.) bond with a ten-year constant maturity in week *t*, and

$\varepsilon_{i,t}$ is a mean zero error term.

We estimate the model using weekly (Friday through Friday) data and value weight the regressions using the stock market capitalization of insurers as of the year-end prior to each observation as the weight.[5]

Since we are interested in how the interest rate sensitivity of insurance firms has changed over time, we estimate the coefficients using a window consisting of two years of weekly return data. We re-estimate the coefficients on a rolling basis, sliding the window forward by one week each time. In choosing a window of two years, we are trading off having a long enough window to deliver enough data for estimation with having a short enough window so that the business environment and interest rates can be considered reasonably stable during each window.

Assuming that market expectations for future interest rate movements can be described by a random walk at short horizons (such as a week), we can interpret, γ, the coefficient on the return on the ten-year interest rate, as a measure of how news about changes in interest rates are capitalized into the stock prices of insurance firms. If γ is different from zero, the market perceives there to some interest rate sensitivity in the insurance firms' profits. For example, if γ

[5] We have also estimated the model in terms of excess returns by subtracting the 3-month government bond return from each of the total returns as in Fama-French (1992, 1993). However, we do not have the German government bond series for the first few years of our sample period. Still, the results are almost exactly the same in the pre- and post- crisis periods for both methods.

is negative, the market believes that the insurance firms' future profits will increase when returns on the ten-year government bond decrease, that is, when interest rates increase.

3. Data

We examine data on insurance firm stock returns from January 2002 through July 2015.[6] Our objective is to determine whether interest sensitivity is different in the recent period of decreasing and low interest rates than it would be in a period of 'normal' interest rates. It would be natural to compare the low-rate period to the years immediately preceding it, but that period included the financial crisis when interest rates and stock returns were likely moving for reasons that are outside the focus of the paper. For that reason, we define the time period immediately before the financial crisis (which we assumes starts in August 2007), from January 2002 to June 2007 as the normal period.

The sample of insurance firms includes all publicly-traded insurers based in the U.S. or the U.K. that are included in the SNL Financial dataset and that have stock price data extending back in time to at least two years before the financial crisis.[7] Many of the larger insurance firms in both the U.S. and the U.K. have a mix of life insurance and other types of insurance. We use insurance premiums to divide firms into those that are predominately life insurers and those that are not. Firms are categorized as life insurers if they derive at least 50% of their premiums from life insurance.[8] Firms are divided based on 2014 premium data to keep the portfolios consistent over time. Very few firms would switch groups if we were to reclassify them every year. Note that most of non-life premiums are for property and casualty (P&C) insurers, so the non-life group is largely P&C insurers.

In our main analysis, we focus on four samples: U.S. life insurers, U.S. non-life insurers, U.K. life insurers, and U.K. non-life insurers. In a robustness exercise discussed below, we

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[6] We do not look back further than 2002 because before that there are not enough insurance firms with traded stock to conduct our analysis. Mutual insurance firms are excluded because they do not have publicly traded stock.

[7] We include Manulife, a firm based in Canada, in the U.S. sample since most of its premiums are from John Hancock, its U.S. subsidiary. We exclude American International Group (AIG) since the market's perception of its interest rate risk may be distorted due to government intervention.

[8] We measure premiums using GAAP or IFRS accounting figures, as appropriate (one Swiss company uses Swiss GAAP). Because GAAP revenue does not include fixed and variable annuity premiums, we may understate the extent to which U.S. insurers are involved in interest rate sensitive life insurance activities. This should tend to make the non-life insurance sample more sensitive to interest rate risk. We exclude premiums from reinsurance of life insurers' products because life reinsurance predominantly covers mortality risk.

examine the interest sensitivity of continental European insurers. Descriptive statistics on the sample of life and non-life insurers for the U.S., the U.K., and continental Europe are shown in Table 1. As measured by total assets, the average size of life insurers in all three samples as well non-life insurers in the U.S. were of a similar magnitude during our sample period. The U.K. and continental European non-life insurers were much smaller. A rough measure of leverage, the ratio of assets (excluding separate account assets) to equity, was larger for U.K. and continental European life insurers than for U.S. life insurers. As is to be expected due to the shorter duration of non-life liabilities, on average, non-life insurers had lower asset-to-equity ratios than life insurers. U.K. life and non-life insurers showed the highest profitability among the six samples, while U.S. life insurers showed the lowest profitability, as of the end of 2014.

Tables 2 and 3 list the companies in the U.S. and U.K. samples, respectively. They also report the share of premium income that each insurer earned from life and health insurance products in 2014, the number of weekly stock return observations available for each insurer, and the market capitalization of each insurer as of the end of 2014. We use market capitalization as reported by SNL Financial to form weights, which vary at an annual frequency. All reported regressions are weighted by market capitalization.

4. Hypotheses and U.S. – U.K. Comparison

4.1 Hypotheses

We focus on a comparison of the U.S. and the U.K. because it provides a useful contrast in the types of products sold by life insurance firms. In the U.S., many life insurers offer guaranteed minimum rates of return on the savings elements of whole life policies, fixed-rate annuities, and variable annuities. In addition, policyholders often have the right to withdraw the savings embedded in these policies (sometimes after a penalty) or to borrow against the savings. Policyholders may also have the right to adjust the flow of new savings. Obviously, the value of these options depends on how the current interest rate (and expectations of future rates) compares to the guaranteed rate. As interest rates decrease, there is more incentive for policyholders to increase their savings or to delay plans to surrender policies. This has the effect of increasing the duration of liabilities. By contrast, in the U.K. most products with a savings element offered by insurance firms have either no or de minimus guarantees. This means that for

U.K. policyholders, the return on their savings is proportional to the return that insurers earn on assets financed by policyholders' premiums. This gives policyholders less incentive to time savings to changes in interest rates. As a result, when interest rates decrease, liabilities in the U.K. should lengthen less than those in the U.S. This motivates our main difference-in-differences hypothesis:

> Life insurance firms in the U.S. should become more sensitive to interest rates relative to life insurance firms in the U.K. as interest rates decrease. This should be reflected in a larger decrease in γ, the coefficient on the bond return in the two-factor model, for U.S. life insurers than for U.K. life insurers between the normal and the low interest rate periods.

Since most life insurance products are fairly long term, we expect that this increased interest rate sensitivity could persist for a while if rates remain low after a large decrease.

One complication to a simple test of the difference in interest rate sensitivity between U.S. and U.K. life insurance firms is that conditions for insurance firms in the U.S. and the U.K. might otherwise differ. Some of these differences should be captured by the stock market index variable. However, some insurance-specific factors may not be captured by the broad stock market indices we use. To account for this, we compare life insurance firms to other insurance firms. If there are factors in the U.S. or the U.K. that impact returns to the insurance industry in each country generally, this comparison will ensure that we are focused on differences due to interest rate sensitivity and not to other factors influencing the evolution of returns in each country. As noted earlier, this comparison group of firms is primarily P&C insurers. P&C insurance products typically have a much shorter duration than life insurance products and, partially as a result, P&C insurers typically have fewer fixed-income assets and the fixed-income assets they do have are shorter maturity than those held by life insurers. In addition, return guarantees and policyholder options are not relevant for P&C insurers. Thus, we expect that the non-life insurance firms will be less sensitive to interest rate changes and will be more similar between the U.S. and the U.K. compared to life insurance firms. Still, the non-life firms will be responsive to changes in the local environment for insurers, and that may differ across the two countries. We can refine our difference-in-difference hypothesis as follows:

> The difference between the change in γ for U.S. life insurers and the change in γ for U.S. non-life insurers from the normal rate period to the low-rate period should be

more negative than the difference between the change in γ for U.K. life insurers and the change in γ for U.K. non-life insurers.

We also expect that:

The difference between the change in γ for U.S. life insurers and the change in γ for U.S. non-life insurers from the normal rate period to the low-rate period should be negative.

A substantial decrease in interest rates can affect the interest rate sensitivity of life insurers even if they hedge risk using an approximate method such as duration matching. Life insurance liabilities often have a very long duration. People purchase life insurance policies well before they are likely to die. Similarly, they invest in annuities that are often established prior to retirement and that are expected to make payouts for many years. While insurers would presumably like to hedge these risks by investing in assets of a similar duration to the liabilities, there is often a shortage of high-quality, long duration, fixed-income assets. This is one of the reasons that insurers frequently choose to hedge by matching the overall duration of their asset portfolio to the overall duration of their liabilities. This is in essence, hedging a mixture of new (long-term) and old (shorter-term) liabilities with assets whose duration is somewhere in the middle. If insurers do not adjust these hedges when interest rates decrease, the duration of liabilities will increase more than the duration of assets does. This is the so-called convexity problem. Insurers can mitigate this problem by dynamically re-hedging their portfolios as rates change. We expect the convexity problem to be largely similar in the U.S. and the U.K. except for the impact of guarantees and policyholder behavior given guarantees. As a result, any changes in γ in the U.S. relative to the U.K. should not be driven by convexity, apart from the effects of guarantees and policyholder optionality.

Low interest rates can also affect the ability of life insurance firms to profitably sell certain products. For products with a savings element, it is difficult for an insurer to profitably offer a significant return (whether guaranteed or not) when interest rates are very low. There is little incentive for potential policyholders to lock their money into an annuity or to tie it up through the savings elements of a life insurance contract when the rate of return is mere basis points. This means that the profitability of life insurers may decrease when interest rates decrease because of a reduced ability to sell products. To the extent that this is broadly true for both the U.S. and the U.K., it should affect the interest rate sensitivity of life insurers in both countries. However, there is an additional factor that affects profitability: for products where policyholders have options, insurers have to price in the effect of those options. If interest rates increase, policyholders are more likely to exercise options to leave or reduce payments. This means a policy with those features will have to be priced higher (or offer a lower guaranteed rate), all else equal, than one without those features. Guarantees and policyholder options are present more often in the U.S. than the U.K., so some of what we measure might come from the inability to sell products. Still, this is consistent with our broader story that the complications from guarantees and policyholder options meant that U.S. insurers did not hedge the residual interest rate risk of a large decrease in interest rates, where the risk of not being able to sell products is one component of interest rate risk. Our top-down approach does not allow us to determine the exact sources of the interest rate risk.

4.2 U.S. – U.K. Comparison

Figure 2 plots the estimates of γ from the rolling regressions for the sample of U.S. insurance firms. We use the S&P 500 as our market index. Each point in the black line reflects a point estimate using the past two-years of weekly returns data. The light gray bands reflect 95% confidence intervals constructed from heteroskedasticity-robust standard errors. The dark gray line shows the mean of the ten-year U.S. government bond yield over the past two years.

Panel A of Figure 2 shows the estimates for life insurers. As the figure illustrates, in the normal rate period estimates of γ are very close to zero with very tight confidence intervals. As data from the financial crisis (beginning roughly in July 2007 and continuing through June 2010) become fully incorporated into the two-year window, the point estimates rise and the confidence intervals expand dramatically. Finally, as the crisis abates, the confidence intervals become smaller and the point estimates drop. By 2012, yields on a ten-year U.S. government bond were historically low, and the estimates of γ from the past two years of data were negative and statistically different from zero. By the end of the sample period the point estimate of γ was about -1, indicating that a one percentage point increase in ten-year U.S. government bond returns was associated with a one percentage point decrease in the stock market value of life insurance firms. Using the July 2015 yield on a ten-year U.S. government bond of 2.32%, our results imply that a one percentage point decrease in the yield of the ten-year bond is associated with an 8.8% drop in the stock market value of life insurers.

Panel B of Figure 2 shows that U.S. non-life insurance firms displayed a somewhat similar degree of interest rate sensitivity to the life insurance firms in the period prior to the financial crisis, but were much less interest rate sensitive in the period following the financial crisis. The point estimates of γ in the post-crisis period are small in magnitude and statistically indistinguishable from zero for most of the period after the crisis.

To complete our difference-in-differences estimates, we compare the changes at life insurers to the changes at non-life insurers by pooling the life and non-life samples used to estimate Panels A and B and adding interaction terms to the specification shown in Equation (1):

$$R_{i,t} = \alpha + \beta_1 R_{m,t} + \beta_2 R_{m,t} \times \textit{Life share}_{i,t} + \gamma_1 R_{10,t} + \gamma_2 R_{10,t} \times \textit{Life share}_{i,t} + \varepsilon_{i,t}, \qquad (2)$$

where $\textit{Life share}_{i,t}$ is the share of the premiums at firm i that are from life insurance products. Panel C of Figure 2 is from an estimation of (2). The figure plots γ_2, the coefficient on the interaction between the government bond return factor and the share of premiums from life insurance. In essence, Panel C shows the difference between panels A and B in that it shows how interest rate sensitivity for a pure life insurance firm changed relative to a pure non-life insurance firm. The figure clearly shows that during the low-rate period in the U.S., life insurers became more interest rate sensitive than non-life insurers.

Figure 3 shows a similar set of plots to those shown in Figure 2, but for U.K. insurance firms. Again the samples are split into life insurers (Panel A) and non-life insurers (Panel B). We estimate the regressions in the same manner that we do for the U.S. sample, except that we use the weekly returns on the FTSE100 and the ten-year U.K. government bond as explanatory variables rather than the S&P 500 and ten-year U.S. government bond returns. While the number of firms in both the life and non-life insurance samples is much smaller for the U.K. than for U.S., which contributes to the larger confidence intervals, the estimates of γ in both the pre- and post-crisis periods are almost always statistically indistinguishable from zero for the life insurance sample (Panel A). The same is largely true for the non-life insurance sample (Panel B), except for a short period during 2013. Furthermore, the difference-in-differences estimate shown in Panel C is statistically indistinguishable from zero, indicating that any changes in interest rate sensitivity over time were due to factors that affected both life and non-life insurers similarly.

Comparing the results for the U.S. and the U.K., we find support for our main hypothesis. Running through the pieces of our triple difference hypothesis: In the U.S., the change in γ for life insurers from the normal rate period to the low-rate period is significantly more negative than the change for non-life insurers. However, in the U.K., there is no significant change in γ for life insurers from the normal rate period to the low-rate period and the change relative to non-life insurers is, if anything, positive. We argue that this evidence is consistent with guarantees and policyholder options making U.S. life insurers more sensitive to interest rates in the current low rate period as compared with the normal rate period. We are agnostic as to extent to which this is due to imperfect hedging of pre-existing liabilities versus incomplete hedging of differences in the ability of life insurers to profitably sell new policies when interest rates are low.

We do not explicitly consider differences in the incentives for life insurance firms to hedge across countries. Of course, life insurers in the U.S. understand their potential exposure from a large interest rate decrease. We would expect this to give them a greater incentive than U.K. life insurers to hedge against interest rate decreases. Nonetheless, we find that the residual exposure to interest rates in the low-rate period is larger in absolute value for U.S. firms than for U.K. firms even after any aggressive hedging by U.S. life insurers.

5. Interest Rate Risk in Continental Europe

In this section we turn to continental Europe. We show results that are consistent with our findings for the U.S. and the U.K. using a sample of European insurers and describe how our top-down measure of interest rate sensitivity compares to a bottom-up measure which is uniquely available for Europe.

5.1 Baseline analysis of Europe

Extending our analysis to continental Europe is complicated by several factors. The first of which is that, as in the U.K., there are relatively few large insurers. The second factor that complicates our analysis is that the insurance market in Europe is more integrated than in the U.S. or the U.K. A firm based in one country may sell the majority of its products in other countries and thus be exposed to the guarantees and options that are prevalent in the countries where they sell policies rather than the country in which they are headquartered. Finally, for a number of countries there is not a clear consensus regarding to the prevalence of products that contain both guarantees and options. Given these constraints, we create a panel including all publicly-traded insurers based in Austria, France, Germany, Italy, Spain, and Switzerland.[9] We then group these firms based on their exposure to German and U.S. life insurance customers, since there is a consensus that German insurance products contain long-lived guarantees to policyholders that make their exposure to interest rate risk from life insurance liabilities similar to that of U.S. insurers.

The continental European sample is constructed in a similar manner to our U.S. and U.K. samples. We select insurance firms that are included in the SNL Financial dataset and that have stock price data extending back in time to at least two years before the financial crisis. Again, for each firm, we calculate the share of life and health insurance premiums, net of reinsurance. Since life insurance markets in continental Europe are more integrated than those in the U.S. and the U.K., we construct country-specific measures of interest rate risk exposure by calculating the share of life insurance premiums that each company receives from each of the countries in our continental European sample (Table 3).[10] Our premium-based measure is likely to reflect the exposure that a given firm has to the types of life insurance products that are sold in a given country. Our maintained hypothesis is that the extent of guarantees and of policyholder optionality is related more to the common products typically sold in the country where the policyholder lives than to those sold in the country where a firm has its headquarters.

We then split our sample by exposure to Germany and the U.S. and by whether a firm is predominantly a life insurer. Using data from annual reports, we calculate the share of life insurance premiums from either Germany or the U.S.[11] Firms that earned more than 25% of their life insurance premiums from Germany and the U.S are categorized as high German exposure firms, and those that earned less are categorized as low German exposure firms.[12]

[9] We focus on this set of countries because the sample is deepest in these countries and there is a good mix of life and non-life insurance companies in these countries.

[10] We calculated the share of life insurance premiums that each company earned from each country in our sample using each company's 2014 annual report (see Table 3).

[11] We lump the U.S. and Germany together since they have similar products. However, only AXA and Zurich, Insurance Group, Ltd. (at 21% and 6%, respectively) earn more than 5% of life premiums from the U.S. For this reason, we refer to this measure as 'German exposure'.

[12] We were unable to find information with that the split of life insurance premiums by country of origin in annual reports for Nürnberger Beteiligungs-AG. We assume that it earns the same share of life premiums from Germany and the U.S. (98%) as Wüstenrot & Württembergische AG which is the German firm that most resembles Nürnberger Beteiligungs-AG in terms of the share of premiums earned from life insurance and market capitalization. Our results are robust to assuming that Nürnberger Beteiligungs-AG earns 0%, 50%, or 100% of its life premiums from Germany and the U.S.

Splitting the sample this way classifies 7 firms as having high German exposure and 18 firms as having low German exposure.

Panels A and B of Figure 4 show the results of estimating the same specifications as were presented for the U.S. and U.K. samples in Figure 2 Panel C and Figure 3 Panel C, respectively, except that in Figure 4 the samples used are the high German exposure companies (Panel A) and the low German exposure companies (Panel B). When estimating Equation (2) for the continental European sample, we use German government bond returns to avoid picking up the effects of sovereign credit risk that might influence interest rates in some of the European countries. We use the return on the ten-year German government bond as the bond return factor ($R_{10,t}$) and the return on the German stock market as measured by the DAX as the market return factor ($R_{m,t}$) for all of the countries in our continental European sample.

Panel C of Figure 4 adds another dimension of differencing. We compare the changes at life insurers to the changes at non-life insurers in the high and low German exposure companies by pooling the high and low German exposure sample used to estimate Panels A and B and adding additional interaction terms to the specification shown in Equation (2):

$$R_{i,t} = \alpha + \beta_1 R_{m,t} + \beta_2 R_{m,t} \times \mathit{Life\ share}_{i,t} + \beta_3 R_{m,t} \times \mathit{German}_{i,t} + \beta_4 R_{m,t} \times \mathit{Life\ share}_{i,t} \times \mathit{German}_{i,t} + \gamma_1 R_{10,t} + \gamma_2 R_{10,t} \times \mathit{Life\ share}_{i,t} + \gamma_3 R_{10,t} \times \mathit{German}_{i,t} + \gamma_4 R_{10,t} \times \mathit{Life\ share}_{i,t} \times \mathit{German}_{i,t} + \varepsilon_{i,t}, \qquad (3)$$

where $\mathit{Life\ share}_{i,t}$ is (as previously defined) the share of the premiums at firm i that are from life insurance products, and $\mathit{German}_{i,t}$ is an indicator variable which is equal to 1 if the share of life insurance product premiums from Germany and the U.S. is greater than 25% at firm i, and 0 otherwise. Panel C of Figure 4 plots γ_4 from estimates (3), where γ_4 is the coefficient on the interaction between the government bond return factor and the share of premiums from life insurance and the high German exposure indicator. This coefficient measures the effect of life insurance exposure to bond returns over and above the effect of non-life insurance exposure for firms more exposed to Germany relative to those less exposed to Germany. We interpret this coefficient as measuring how interest rate sensitivity for a pure life insurance firm highly exposed to German products changed relative to a pure life insurance firm with low exposure to German products. In other words, it captures the difference between Panels A and B in Figure 4. While the results are somewhat noisy, the figure clearly shows that during the low-rate period, continental European life insurers with higher German exposure became more interest rate sensitive than continental European life insures with lower German exposure. Due to the complications of small sample sizes and a noisy measure of the extent of guarantees and of policyholder optionality, we are not surprised by the noisiness shown in Figure 4 Panel C. However, we are reassured by the fact that the point estimates change from positive to negative from the normal-rate to the low-rate period. We view this as a robustness check to our main results which compare the U.S. and U.K.

4.2 Comparison to a Bottom-up Measure of Interest Rate Risk

Finally, we consider how our top-down measures of the change in interest rate sensitivities align with a bottom-up measure that simulates the durations of the specific assets and liabilities that insurance companies hold. Bottom-up measures exist for a set of European insurance companies which participated in EIOPA stress tests (see EIOPA, 2014) and the results are publicly available at the country-level.

In order to measure the change in interest rate risk from the normal-rate to the low-rate period at a country level, we run country-specific, value-weighted panel regressions using samples of life and non-life insurer stock returns. Again, we split the sample based on whether 50% or more of premiums come from life and health insurance. We form the country specific weights by multiplying the market capitalization of each company by the share of life insurance premiums that the company earns from the specific country that we are considering.[13] We estimate life insurance and non-life insurance regressions for each country. In order to summarize the difference-in-differences measure of the change in interest rate risk in each country with a single coefficient, we estimate a model using returns data from the normal-rate and the low-rate periods (excluding the financial crisis period), and include an interaction term between an indicator for the low rate period and the return on the ten-year government bond. Specifically, we estimate:

$$R_{i,t} = \alpha + \beta_0 R_{m,t} + \beta_1 L_t * R_{m,t} + \gamma_0 R_{10,t} + \gamma_1 L_t * R_{m,t} + \varepsilon_{it}, \qquad (4)$$

where $R_{i,t}$, $R_{m,t}$, $R_{10,t}$, $\varepsilon_{i,t}$ are defined as before and L_t is an indicator variable which is equal to 1 in the low-rate period and 0 in the normal-rate period.

The coefficient γ_1 in equation (4) is a country-specific measure of the change in interest rate sensitivity between the normal and the low interest rate period for life and non-life insurers. We compare this top-down measure to the bottom-up measures reported by country from the EIOPA 2014 stress test scenario that investigated the impact of a ‘low for long’ interest rate

[13] Based on 2014 premiums converted to a common currency using the exchange rate at the end of the year.

scenario (see Table 5). Importantly, for the sake of comparability, EIOPA conducted their stress tests at the undertaking-level, meaning that the country-specific duration mismatches that they report in the low for long scenario reflect the participating business-units operating in a particular country and thus insurance products that are sold in that country (rather than firms that are headquartered in the country).

For the five countries in both our continental European sample and the EIOPA sample, we find a correlation of -0.40 between our top-down interest rate risk measure and EIOPA's duration mismatch measure.[14] A negative correlation indicates that countries with larger increases in interest rate sensitivity (more negative coefficients) according to the top down analysis were deemed to have liabilities of a longer duration than their assets in the bottom up EIOPA stress tests. This suggests that the top-down approach and EIOPA's bottom-up approach of measuring interest rate risk are aligned. We do not report the correlation between the EIOPA duration mismatch numbers and our interest rate risk measures for the non-life sample due to the fact that the coefficients on our interest rate risk measure are small in magnitude and mostly statistically indistinguishable from zero as we would expect for the non-life insurers.

6. Conclusions

We use a two factor model of life insurer stock returns to measure interest rate risk at U.S. and U.K. insurers. We find that interest rate risk among U.S. life insurers has increased in the recent period of decreasing and low interest rates. In the U.K., in contrast, life insurer interest rate risk has been low in this period and roughly similar to the period prior to the financial crisis when long-term interest rates were in their usual historical ranges as. We attribute the difference in interest rate risk between the U.S. and the U.K. to the heavier use of guarantees and policyholder options among U.S. life insurers relative to their U.K. counterparts.

[14] Switzerland did not participate in the EIOPA stress test.

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Figure 1: 10-year Constant Maturity Government Bond Yields

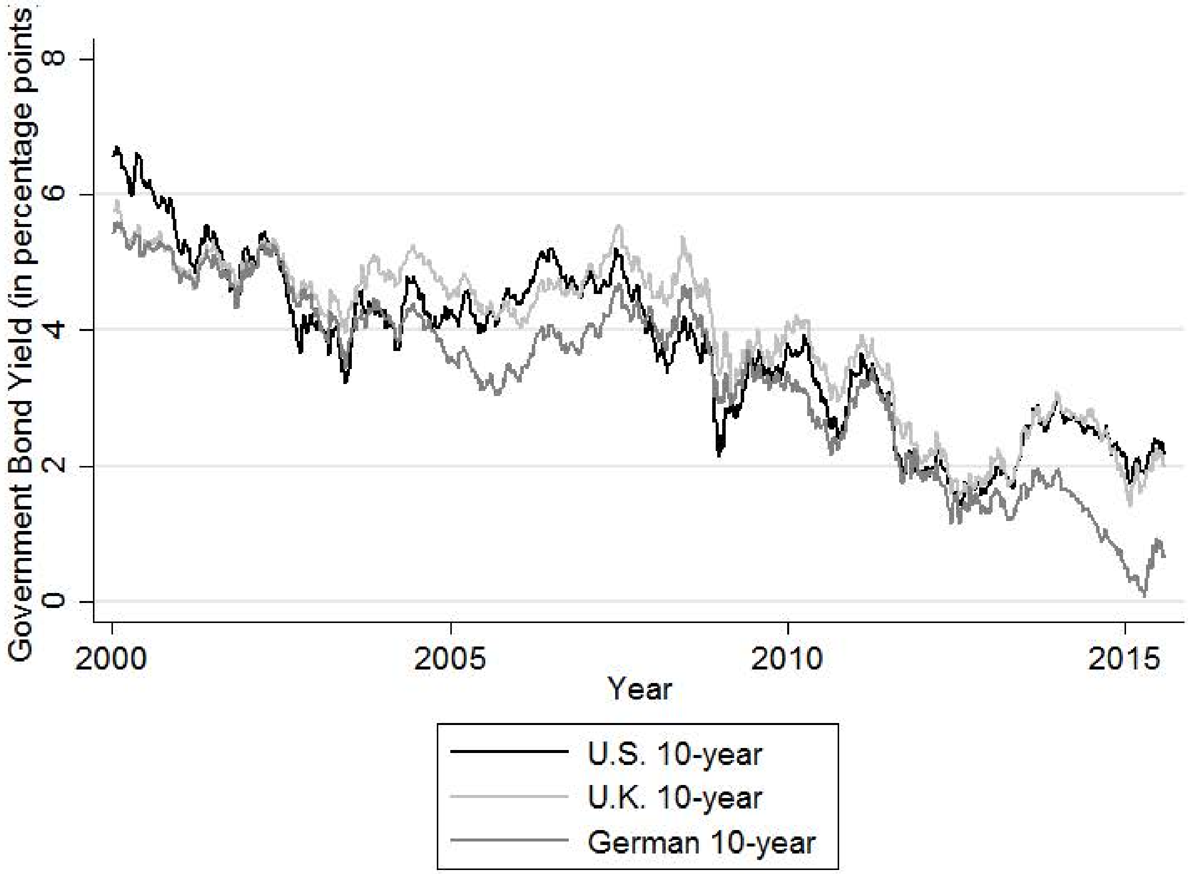
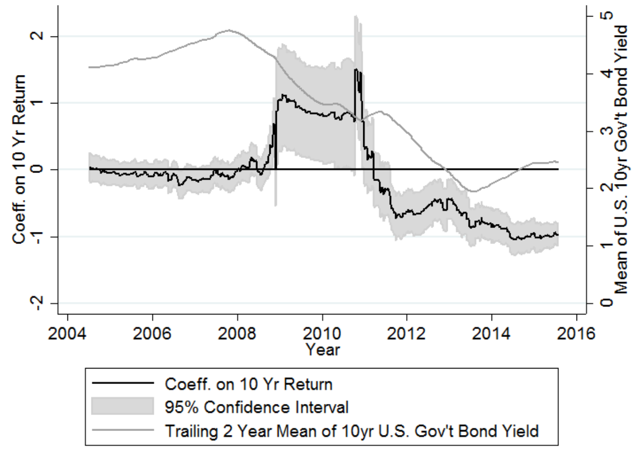
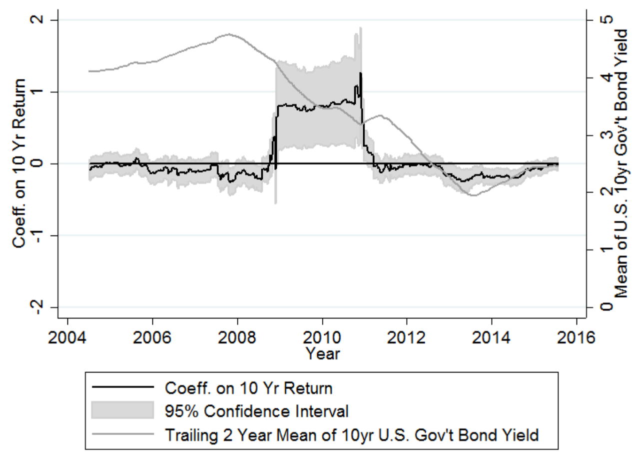


Figure 2: Estimates of Interest Rate Sensitivity for U.S. Insurers

Panel A. Life Insurers



Panel B. Non-life Insurers



Panel C. All Insurers (Difference)

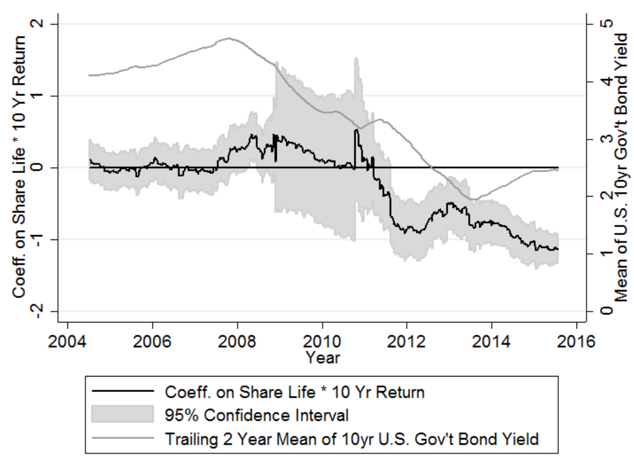
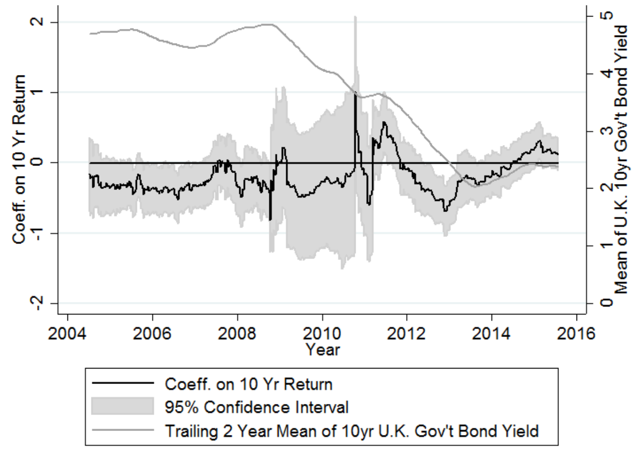
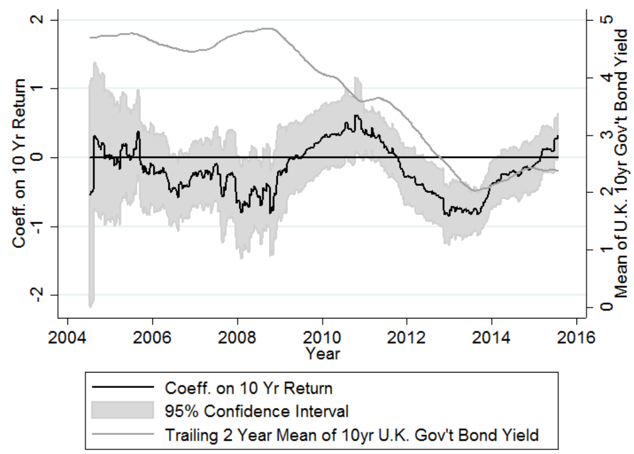


Figure 3: Estimates of Interest Rate Sensitivity for U.K. Insurers

Panel A. Life Insurers



Panel B. Non-life Insurers



Panel C. All Insurers (Difference)

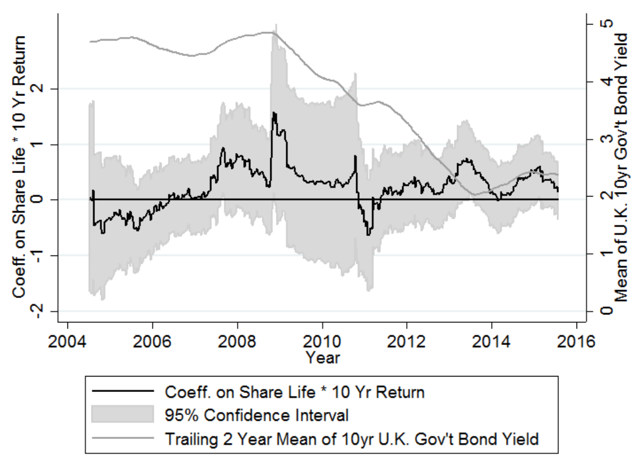
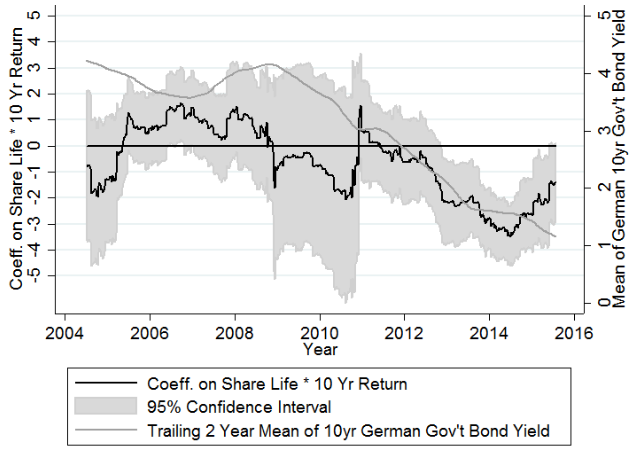
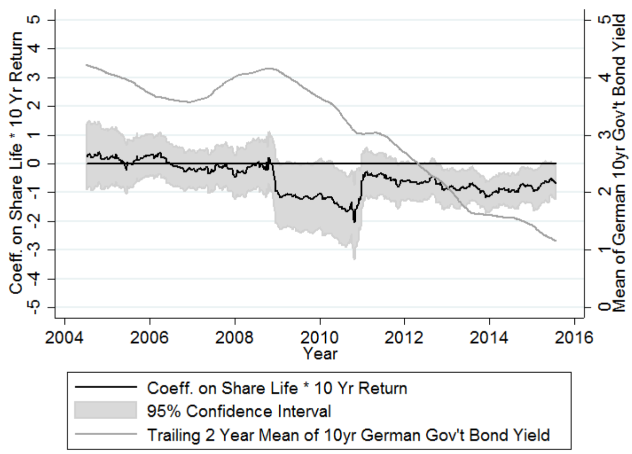


Figure 4: Estimates of Interest Rate Sensitivity for Continental European Insurers

Panel A. High German Exposure (Difference)



Panel B. Low German Exposure (Difference)



Panel C. All Insurers (Difference in Differences)

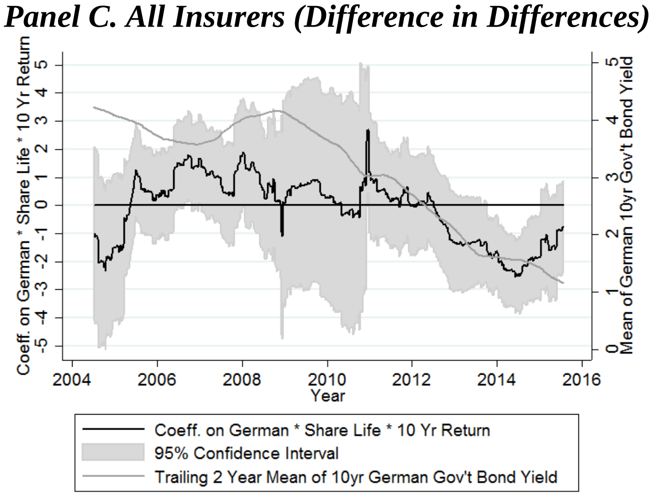


Table 1: Insurer Sample Statistics

Insurer Type	Life Insurers			Non-life Insurers		
	U.S.	U.K.	Europe	U.S.	U.K.	Europe
Size - Total Assets (millions of $)	189	209	141	152	8	24
Financial Leverage - Assets (net of separate accounts) to Equity Ratio	9.6	13.6	13.6	3.7	4.5	6.7
Profitability - Net Income before Taxes to Equity Ratio	6%	21%	12%	14%	28%	14%
Number of Companies	21	6	12	57	4	13

Note: This table shows sample report the sample mean of size, financial leverage, and profitability as of the end of 2014 for the six samples analyzed in this chapter. The number of insurers in each sample is reported in the last row.

Table 2: U.S. Insurer Sample

Company Name	Premium Income from Life and Health Insurance	Observations	Market Capitalization , year-end 2014 (millions of $)
Aetna Inc.	4%	661	31,070
Affirmative Insurance Holdings, Inc.	0%	540	20
Aflac Incorporated	98%	661	27,029
Alleghany Corporation	0%	661	7,441
Allstate Corporation	7%	661	29,365
American Equity Investment Life Holding Company	99%	567	2,220
American Financial Group, Inc.	2%	661	5,326
American Independence Corp.	43%	661	83
American National Insurance Company	23%	661	3,070
Assurance America Corporation	0%	661	14
Atlantic American Corporation	63%	661	83
Baldwin & Lyons, Inc.	0%	661	386
CNA Financial Corporation	5%	661	10,451
CNO Financial Group, Inc.	93%	579	3,501
Centene Corporation	0%	661	6,150
Chubb Corporation	0%	661	24,050
Cincinnati Financial Corporation	4%	661	8,485
Citizens, Inc.	96%	661	381
Donegal Group Inc.	0%	661	432
EMC Insurance Group Inc.	0%	661	481
Erie Indemnity Company	2%	661	4,746
FBL Financial Group, Inc.	56%	661	1,434
Federated National Holding Company	0%	661	329
First Acceptance Corporation	0%	661	105
GAINSCO, INC.	0%	661	50
Genworth Financial, Inc.	56%	544	4,222
HCC Insurance Holdings, Inc.	35%	661	5,166
Hallmark Financial Services, Inc.	0%	661	232
Hanover Insurance Group, Inc.	0%	661	3,131
Hartford Financial Services Group, Inc.	22%	661	17,694
Health Net, Inc.	0%	661	4,179
Horace Mann Educators Corporation	15%	661	1,358
Independence Holding Company	78%	661	242
Infinity Property and Casualty Corporation	0%	605	887
Investors Heritage Capital Corporation	78%	661	24
Investors Title Company	0%	661	148

Kansas City Life Insurance Company	75%	661	520
Kemper Corporation	28%	661	1,893
Kingstone Companies, Inc.	0%	661	60
Lincoln National Corporation	33%	661	14,795
Loews Corporation	5%	661	15,671
MBIA Inc.	0%	661	1,831
MGIC Investment Corporation	0%	661	3,155
Manulife Financial Corporation	100%	671	35,739
Markel Corporation	0%	661	9,534
Mercury General Corporation	0%	661	3,124
MetLife, Inc.	86%	661	61,226
Molina Healthcare, Inc.	0%	588	2,662
National Interstate Corporation	0%	513	590
National Security Group, Inc.	10%	661	34
National Western Life Insurance Company	10%	661	979
Navigators Group, Inc.	0%	661	1,047
Old Republic International Corporation	1%	661	3,818
Phoenix Companies, Inc.	69%	661	393
Principal Financial Group, Inc.	90%	661	15,265
ProAssurance Corporation	0%	661	2,553
Progressive Corporation	0%	661	15,865
Prudential Financial, Inc.	95%	661	41,144
RLI Corp.	0%	661	2,129
Radian Group Inc.	0%	661	3,194
Reinsurance Group of America, Incorporated	95%	661	6,026
Safety Insurance Group, Inc.	0%	617	961
Security National Financial Corporation	98%	661	71
Selective Insurance Group, Inc.	0%	661	1,538
StanCorp Financial Group, Inc.	94%	661	2,940
State Auto Financial Corporation	0%	661	909
Stewart Information Services Corporation	0%	661	889
Torchmark Corporation	100%	661	6,930
Travelers Companies, Inc.	0%	661	34,105
Triad Guaranty Inc.	0%	661	2
UTG, Inc.	73%	661	53
Unico American Corporation	0%	661	61
United Fire Group, Inc.	7%	661	744
Universal American Corp.	3%	661	777
Universal Insurance Holdings, Inc.	0%	661	697
Unum Group	96%	661	8,801
W. R. Berkley Corporation	0%	661	6,497
WellCare Health Plans, Inc.	0%	541	3,604

Table 3: U.K. Insurer Sample

Company Name	Premium Income from Life and Health Insurance Products	Observations	Market Capitalization, year-end 2014 (millions of $)
Admiral Group Plc	0%	538	5,744
Amlin Plc	0%	672	3,738
Aviva Plc	58%	672	22,268
Chesnara Plc	100%	556	669
Legal & General Group Plc	96%	672	22,917
Old Mutual Plc	76%	672	14,573
Personal Group Holdings Plc	0%	672	220
Prudential Plc	99%	672	59,491
RSA Insurance Group Plc	0%	672	6,879
St. James's Place Plc	100%	672	6,549

Table 4: European Insurer Sample

Country	Company Name	Premium Income from Life and Health Insurance Products	Share of Life and Health Insurance Premium Income from Germany and U.S.	Observations	Market Capitalization, year-end 2014 (millions of $)
Austria	UNIQA Insurance Group AG	52%	0%	635	2,915
Austria	Vienna Insurance Group AG	50%	2%	635	5,773
France	AXA	59%	33%	667	56,764
France	April SA	63%	0%	667	611
France	CNP Assurances SA	90%	0%	667	12,231
France	Euler Hermes Group	0%	0%	667	4,560
France	SCOR SE	0%	0%	667	5,676
Germany	Allianz Group	34%	64%	659	75,883
Germany	Hannover Rück SE	0%	0%	659	10,996
Germany	Münchener Rückversicherungs-Gesellschaft	26%	60%	659	33,972
Germany	Nürnberger Beteiligungs-AG	80%	98%	659	999
Germany	Wüstenrot & Württembergische AG	61%	98%	659	2,030
Italy	Assicurazioni Generali SpA	69%	28%	651	32,181
Italy	Mediolanum SpA	99%	4%	651	4,742
Italy	Società Cattolica di Assicurazione - Società Cooperativa	64%	0%	655	1,207
Italy	Unipol Gruppo Finanziario SpA	49%	0%	651	3,563
Italy	UnipolSai Assicurazioni SpA	47%	0%	651	7,066
Spain	Grupo Catalana Occidente SA	26%	0%	653	3,427
Spain	MAPFRE SA	24%	0%	653	10,486
Switzerland	ACE Limited	20%	0%	661	37,756
Switzerland	Bâloise Holding AG	53%	14%	654	6,070
Switzerland	Helvetia Holding AG	61%	7%	654	4,729
Switzerland	Swiss Life Holding Limited	97%	9%	654	7,625
Switzerland	Vaudoise Assurances Holding SA	34%	0%	654	1,331
Switzerland	Zurich Insurance Group Ltd.	23%	29%	654	46,772

Table 5: Comparison of Interest-Rate Factor to EIOPA Results for the Continental European Sample

Country	Coefficient on bond factor (γ)		EIOPA duration mismatch, years
	Life insurers	Non-life insurers	
Austria	-1.00***	0.35	11.33
France	-0.60***	-0.35	5.58
Germany	-0.68***	-0.28	11.32
Italy	-0.84***	-0.25	1.16
Spain	-0.59**	-0.47**	0.89
Switzerland	-0.39	-0.20	--
Correlation with EIOPA duration mismatch	-0.40		

Note: This table shows point estimates from 12 separate panel regressions. Two regressions are estimated for each country. One regression is for the life insurance sample and one is for the non-life insurance sample. In each regression the dependent variable is the weekly stock return of the insurance companies in our continental European sample. Each regression is weighted. The weights are formed by multiplying the market capitalization of each company (expressed in a common currency) by the share of life insurance premiums that the firm earned from the country which the regression is for. The explanatory variables consist of the same two factors contained in our main specifications, the return on the stock market and the return on the ten-year government bond (as noted in the text we use the German stock and government bond return for the continental European sample). We have also added an indicator variable for the low-rate period and an interaction term between the return on the 10 year government bond and an indicator variable for the low-rate period. We can interpret the coefficient on this variable as the change in interest rate sensitivity of insurance company stock returns from the normal-rate to the low-rate period. The sample includes only observations from the normal-rate and low-rate periods. For comparison, duration mismatch measured in years from the low yield module A of the EIOPA 2014 stress tests are also shown. The mismatch figure captures the number of years by which the simulated duration of liabilities exceeds the simulated duration of assets. No EIOPA data are available for Switzerland. The correlation between the mismatch numbers and the life insurer interest rate sensitivity change coefficients is shown below the coefficients. A negative correlation indicates that countries with larger increases in interest rate sensitivity (more negative coefficients) were deemed to have liabilities of a longer duration than their assets.

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