Final Demand for Structured Finance Securities

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Abstract

Structured finance boomed during the run-up to the Financial Crisis. Existing explanations for this growth emphasize supply-side factors. Demand, however, was also encouraged by efforts to avoid regulatory capital requirements. We show that life insurance companies exposed to unrealized losses from low interest rates in the early 2000s increased their holdings of highly rated securitized assets, assets which offered the highest yield per unit of required capital. The results are only evident in accounts subject to capital requirements and at firms with low levels of ex ante capital, consistent with regulation creating distortionary incentives fueling the demand for securitized assets.

1. Introduction

According to Flow of Funds data from the Federal Reserve, issuance of private-label (non-agency) structured finance securities (alphabet soup: ABS, RMBS, CLOs, CDOs, CBOs; we will refer to these bonds generically as "ABS" or "structured finance securities") increased from an outstanding balance of $1.4 trillion in 2002 to $3.9 trillion in 2007, an increase of 180% over a brief five-year period. Over the same period, total outstanding nonfinancial corporate debt increased by 30%, agency and Government-Sponsored Enterprises (GSE) backed bond issuance grew 34%, U.S. Treasuries grew 41%, and municipal bonds grew 94%. Among all classes of debt, structured finance securities grew at an unmatched pace (almost twice as fast as the second fastest growing category). In this paper, we explore how final demand for structured finance securities contributed to the explosive growth in this category. Using detailed data on life insurance company holdings of ABS, we show that demand for high-yielding ABS securities was fueled by an interaction between non-linear risk-based capital rules and unexpectedly large declines in interest rates that created large expected losses in certain product categories.

Lack of consistent data has thus far limited studies of demand for structured finance securities. While the Flow of Funds (Federal Reserve data) are transparent in characterizing the suppliers of securities, including issuance of private-label structured finance securities, these data are decidedly less transparent in characterizing who ultimately holds them. For example, in the balance sheet tables of insurance companies, pension funds, mutual funds, and endowments, the structured finance securities are grouped with traditional corporate bonds. Since there is no uniform data source that provides security-level measurement of investment in these securities by all of the major market participants, the demand side of the ABS market has not been well studied. The primary exception is insurance, where regulators require companies to report the

details of their securities holdings. Insurance companies represent an important fraction of institutional investors, holding about 25% of total ABS outstanding in the market. They provide the only consistent, detailed, firm-level data on the ownership patterns in structured finance.[1]

We argue that demand from insurance companies (as well as other similarly regulated ABS demanders like banks) was distorted by a regulatory capital arbitrage that encouraged them to purchase highly rated ABS during the period from 2003 to 2007, when the ABS market took off. This period followed one of sustained low interest rates, which some have argued fueled a general speculative boom (Rajan, 2005).[2] As we explain below, deferred annuities with embedded interest rate guarantees (hereafter, guaranteed annuities) exposed insurance companies to unrealized losses in the low-rate environment, and we exploit this fact to generate cross-sectional variation in negative shocks to capital. Declines in capital have a dual effect in that they move some companies closer to regulatory minimums, and may also have increased their incentive to take risk (or, equivalently to 'reach for yield'). But capital requirements interact with risk-taking incentives for insurance companies by distorting the simple tradeoff of expected risk vs. return. Regulatory capital charges are non-linear functions of credit quality; in the case of an insurance company, the regulatory charge from owning a BB-rated security can be as much as 10 times the regulatory cost associated with owning a AA-rated security. Moreover, during our sample period the capital rules depend only on the rating itself. As Coval, Jurek and Stafford (2009) argue, ratings are insufficient for pricing credit risk because they account only for physical default but take no account of the value of claims in states of defaults. Thus, regulated

[1] Combining aggregate volumes from the security-level data from insurance companies with broad data from the Flow of Funds accounts allows for an estimate that insurance companies held about 25% of outstanding structured finance securities. While 25% represents a large fraction, we acknowledge the possibility that focusing only on insurance companies could limit the applicability of our results to other investors.

[2] More broadly, Aliber and Kindleberger (1978) show that financial crises tend to be preceded by periods of sustained loose monetary policy.

insurance companies with incentives to deliver yield (i.e. those with high exposure to guaranteed annuities) ought to do so where yields are high but capital requirements are low (i.e. in highly rated ABS securities).

To test this idea, we first document that the yields on highly rated ABS securities were in fact higher than similarly rated corporate bonds, based on data from insurance company holdings. This evidence supports Coval et al, who argue that these securities act like 'catastrophe' bonds that only default in states of severe economic distress. (In contrast, low-rated tranches have high default rates across most states of the economy.) We find that highly rated ABS offer yields about 18 basis points higher than similarly rated bonds.[3] We also provide evidence that during the height of the ABS issuance boom (2006 and 2007), AAA rated structured securities delivered higher yields than A rated corporate bonds. The result also extends that of Pennacchi (2012), who shows that measures of systematic risk are priced into corporate bond yields, conditional on credit ratings. We then show that insurance companies with the greatest exposure to the low-rate environment – those with the highest *ex ante* issuance of guaranteed annuities – tilted their portfolios most sharply toward highly-rated ABS securities. These securities offered high yields (due to their high economic risk) yet required low capital (due to their low physical expected default rates). Consistent with capital regulations creating distortionary incentives, we find that the result is stronger among firms with low levels of beginning-of-period risk-based capital (i.e. firms that were ex ante closer to binding minimum capital ratios).

We use several identification strategies to rule out alternative explanations for our results.

[3] Coval et al argue that yields were not high enough based on their estimate of the underlying systematic risk. This fact is consistent with our argument that capital requirements artificially inflated the demand for highly rated ABS and thus lowered their yield relative to what would be expected in an undistorted market.

Life insurance companies sell products that create liabilities that can be tied to the "general account" of the insurance company and represent claims on the assets of the firm. They also sell products that create liabilities that are associated with a "separate account" where the liabilities are supported only by the premium payments and earnings on separate account assets. Assets tied to the general account of the business are subject to regulatory capital requirements. However, assets held in the separate account are *not* subject to capital requirements. Differences in the adherence to capital requirements for general account business as compared to separate account business *within* the same firm creates the opportunity to examine how capital requirements can create differences in the investment decisions of each account, holding constant unobserved firm-level heterogeneity.

We can also rule out the idea that plunging into ABS reflected just an expansion of risk taking across all categories of bonds. Holders of separate account annuities are exposed to the risks of their separate account assets. Thus, either through the decision of an end investor, or a financial advisor, assets are selected to be held in a separate account according to risk and return preferences. In contrast, the general account assets are not tied to specific liabilities. Rather, the general account asset portfolio supports all liabilities incurred by the general account products sold by the company. Thus, we observe asset selection in the general account that is influenced not just by risk and return of the assets, but also by the interplay between market conditions and capital requirements that are mandated by the guarantees inherent in the general account liabilities. We argue that the incentives were distorted by regulatory capital requirements relative to a simple equilibrium allocation based on risk and return as in the separate account, and show that such distortions led to increased investment in highly rated ABS securities, but no

increase in investments in other categories of risky bonds (where capital requirements were less distorting).

Our specific set of results starts with holdings data on more than 130,000 unique securities, representing an aggregate principal balance of almost $500 billion across more than 1,000 unique insurance companies. In this sample we find, first, that the largest insurance companies (those with both a general and separate account) increased their holdings of structured finance securities from an average of 7.2% (11.9%) of total assets (total fixed income holdings) in 2003 to an average of 10.1% (17.4%) of total assets (total fixed income holdings) in 2007. The increased fraction of structured finance securities crowded out their holdings primarily of corporate bonds, as well as municipal bonds and agency securities to a smaller extent. Second, increased holdings were concentrated in the general account (subject to capital requirements, as opposed to the separate account which is not) of insurance companies which had the largest exposure to annuities (and thus had the strongest risk taking incentives). To understand magnitudes, firms that had one-standard deviation larger annuities liabilities as of 2003 increased their subsequent holdings of structured finance securities by an average of 1 percentage point of total assets between 2003 and 2007. This estimate translates into roughly a $50 million increase in holdings per firm over our sample period, on average (roughly $37 billion in aggregate) more in holdings. Third, the positive relationship between ex ante annuities holding and subsequent general-account investment in structured finance securities is evident *only* in the highly rated segment (AAA, AA and A-rated).

An endogenous, omitted variable responsible for these results would have to be correlated with highly rated debt held in the general account but not correlated with highly rated debt in the separate account or poor quality debt held by both account types. However, a

potential limitation of an identification strategy that relies on a general/separate account and credit ratings distinction is that such a variable could exist. That is, general and separate accounts could be different along other unobserved dimensions than their adherence to capital requirements. If unobservable differences between the two types of accounts were correlated with incentives to purchase highly-rated ABS then the exclusion restriction would be violated.[4] A separate approach to identification relies on a regulatory change that was implemented in 2004 whereby insurance regulators offered a one-time lowering of the minimum guaranteed interest rate offered on newly-issued annuities. This allows for a comparison of the effect that annuities sales made under the pre-2004 high minimum guarantee interest rate had on subsequent ABS purchases as compared to the effect that annuities sales made under the post-2004 lower minimum guarantee interest rate had on subsequent ABS purchases. We find that incremental annuities sales made under high guaranteed minimum interest rates predict subsequent ABS purchases, but that incremental annuities sales made in the low minimum guarantee environment do not.

Our results suggest that demand for ABS was driven by a mix of two policies that created distortionary incentives. The first distortionary incentive came from capital regulations that were based solely on credit ratings.[5] The second came from loose monetary policy and the resulting sustained low interest rate environment, which led to a large shock to capital for some insurance companies. Our results complement those of Becker and Ivashina (2012), who study corporate bond holdings (as opposed to ABS) and find that insurance companies engaged in more

[4] To be more specific, a violation of the exclusion restriction would require an unobserved variable to be uniquely correlated with the demand to purchased highly-rated ABS but not highly-rated corporate bonds. Furthermore, the difference in appetite for highly-rated ABS compared to corporate bonds would have to be correlated only with general account investments.

[5] See Glasserman and Kang (2013) for a discussion on the limitations of credit ratings-based capital requirements.

'reaching-for-yield' relative to other bond investors that were not as capital constrained or relative to other investors that were not subject to capital requirements. In our analysis, we exploit cross-sectional variation in insurance company exposure to the interest rate shock of the early 2000s in order to document characteristics of firms with greater likelihood to reach for yield. We find that greater exposure to the shock was followed by an increase in investment in the ABS market, where yields were high and capital requirements insufficient relative to the true economic risk.

Our analysis sheds light on policies and investment decisions that helped fuel a potential misallocation of credit in the economy (see Diamond and Rajan (2009)). As we will describe in the next section, most of the existing literature on structured finance has focused on the supply side. Issuers of ABS, for example, could reduce the burden of regulatory capital by moving loans off balance sheet by securitizing assets. Rating agency incentives to provide accurate risk assessments were skewed by conflicts of interest. A complete explanation of the explosion in structured finance, however, requires understanding not only the supply side but also the demand side. Together with the existing literature, our study suggests that the structured finance market was fueled both by supply-side distortions encouraging financial institutions to sell assets and demand-side distortions encouraging other financial institutions to buy those assets.

2. Demand for Structured Finance Securities

2.1 Most of the extant research has focused on supply

At the heart of the supply-driven view is the idea that lenders found previously negative NPV loans to be positive NPV loans given changes in financing conditions. Government and regulatory policies encouraged both lending to subprime borrowers as well as restructuring loans into securitized assets. For example, the GSEs both lowered the cost of financing mortgages and

lowered barriers to selling mortgage-backed securities by providing credit guarantees (Loutskina and Strahan, 2009). Supply of credit to low-income borrowers was pushed by government policies such as the affordable housing mandate from the Department of Housing and Urban Development (HUD), though the impact of the mandate on credit extension is still under debate (see Leonnig (2008), Barrett (2008), Calomiris and Wallison (2008), and Congleton (2009)). Mian, Sufi, and Trebbi (2013) provide evidence that campaign contributions from the mortgage industry may have influenced government policy on subprime credit.

Innovations in the technology of building structured finance securities also expanded supply, thus lowering lenders' cost of capital. Regulatory arbitrage spurred the growth of these technologies because loan originators could avoid required capital by restructuring cash flows and selling structured finance assets to other investors (Acharya and Richardson (2009)). Acharya, Schnabl, and Suarez (2010) show that the explosive growth of the asset-backed commercial paper market followed a regulatory decision that allowed banks to reduce their required capital to nearly zero without moving the risks to other investors ('securitization without risk transfer'). Gorton and Metrick (2010) attribute the rise in securitization, particularly among broker/dealer investment banks, to the investment banks' increased reliance on the repo market for short-term financing. An alternative, though not contradictory view to securitization's role in bank funding or regulatory arbitrage, is the argument made by Shleifer and Vishny (2010) that securitization is a rational response to mispricing in the underlying fundamentals.

The rapid expansion of structured finance also weakened incentives for lenders to carefully screen and monitor borrowers and for credit rating agencies to carefully assess the risks of bonds ultimately sold to investors. Empirical evidence suggests that securitization altered

screening incentives because loan originators expected to pass risks to third parties (see Keys, Mukherjee, Seru, and Vig (2009), (2010), Keys, Seru, and Vig (2012), and Nadauld and Sherlund (2013)). Moreover, substantial evidence suggests that ratings for structured finance products were inflated because large issuers with substantial bargaining power could pressure the agencies through ratings shopping. Griffin and Tang (2012) find that credit rating agencies consistently deviated from their own models in ways that increased the fraction of financing in the AAA market. He et al. (2012) provide evidence that ratings were less trusted by investors (i.e. more inflated) for securities originated by large issuers with substantial bargaining power. Moreover, Seru et al. (2013) and Griffin et al. (2013) document misrepresentation in asset quality for mortgages that were securitized. Both the reduction in incentives to screen (due to securitization) and inflated credit ratings (due to the concentration in the structured finance business) plausibly led to an increase in the supply of credit.

The rapid expansion of structured finance could have simply been driven by increased demand from borrowers in the primary housing market. Yet this notion is totally at odds with patterns in both credit flows and housing price changes during the boom. Mian and Sufi (2009) provide evidence that contradicts income or productivity shocks as viable explanations for increased housing demand, at least as it relates to the extension of credit in the subprime mortgage market. Loutskina and Strahan (2013) show that financial integration facilitated by the growth of structured finance allowed capital to flow rapidly into booming areas such as the Sun-belt states, thus helping to fuel these booms.

To summarize, the literature has focused on supply-side distortions that increased structured finance issuance and expanded the supply of credit to primary-market borrowers. Naturally investors must purchase ABS supplied, but until recently the literature has remained

surprisingly quiet regarding the important issue of what factors were driving the purchasing patterns of investors.[6] In a contemporaneous paper, Chernenko et al. (2013) explore the possibility of either "bad beliefs" or agency conflicts contributing to the demand for structured securities. They focus on the variation in demand across traditional vs. non-traditional securitization. The contribution of this paper is to provide evidence on the economic factors driving the purchasing decisions of final investors. We observe that those firms with greater urgency to reach for yield and with lower capital adequacy are associated with stronger demand for ABS.

Section 2.2. Regulatory capital and demand for structured finance securities.

Analyzing final demand for ABS (as well as GSE-backed securitized assets) is complex because there are (at least) three segments in the overall market. First, borrowers and lenders write contracts in the primary lending market. Second, large financial institutions (who are sometimes loan originators and sometimes not) transform primary market loans into securitized debt instruments and sell those securities to investors. Third, other financial institutions purchase the securitized assets and represent the final segment. An analysis of supply or demand thus requires a careful explanation of which of these three segments of the market is being analyzed and who represents supply and who represents demand. Institutional features of the first two markets (primary borrower/lender and lender/securitizer) in the securitization value chain have been analyzed in some detail in the literature (Ashcraft and Schuerman, 2008). We focus on the final link, namely the market between securitizers and final investors. In analyzing this market, the issuers of ABS securities can be viewed as expressing supply, and the investors who

[6] Erel, Nadauld, and Stulz (2013) provide an analysis of the holding patterns of U.S. Depository Institutions. Their analysis concludes that banks more active in securitization markets were associated with higher levels of structured finance holdings.

purchase the securities (many of whom are insurance companies) can be viewed as expressing demand.

Traditional finance theory holds that, in equilibrium, asset selection trades off risk for expected return. In a world with financial intermediaries making asset allocation decisions on behalf of diffuse investors, asset managers would simply choose assets that serve to maximize return subject to a given tolerance for risk (e.g. based on clientele preferences). Regulatory capital charges for such intermediaries, however, may distort these decisions and thus the final demand for investments. Regulatory capital charges depend on asset quality as measured by bond ratings that are incomplete measures of risk. As such, risks may be priced in the market but not fully incorporated into bond ratings. To understand the distortion, consider an institution that desires to add risk (to achieve a higher asset yield). The institution may replace a highly-rated security with a lower-rated one (and thus face a higher capital charge). Or, the institution may replace a highly-rated security with a similarly rated one (and thus face no change in required capital) that has more economic (priced) risk. If regulatory capital is costly, the latter choice will be taken. As Coval et al (2009) show, highly rated structured finance securities are designed specifically to achieve the maximum credit rating relative to their true economic risk. This follows because cash-flow tranching implies that the top-rated bonds have no idiosyncratic risk and will likely only default during an economic 'catastrophe'.

Capital regulations for insurance companies depend on a system of risk-based capital ratio calculations. If the ratio of capital to authorized control level risk-based capital (RBC ratio) falls below two, regulatory intervention is required. This is analogous to the regulatory regimes for other financial firms (banks).[7] The first step in the RBC ratio calculation is to multiply the

[7] Comparisons of capital regulations between banking, securities firms, and insurance capital adequacy calculations are provided by Herring and Schuermann (2005).

face value of each bond by its "RBC net factor," which depends on the bond's credit rating. Bonds rated AAA, AA, and A are charged a net factor of 0.004, bonds rated BBB are assigned a net factor of 0.013, BB-rated bonds are charged 0.046, B-rated bonds 0.10, CCC-rated bonds 0.23, and bonds at or near default are assigned a net factor of 0.30. The risk factor charged to bonds rated BBB are 3.25 times larger than the risk factor assigned to bonds rated AAA, AA, or A. Capital charges are thus much more severe for bonds rated below investment grade. In summary, risk charges increase non-linearly as bond credit quality declines. Regulated intermediaries thus would be expected to tilt toward the purchase of highly rated ABS securities, where yields are highest relative to required capital.

Becker and Ivashina (2013) refer to the general distortion of demand from capital requirements as reaching for yield. That is, seeking to enhance yield without incurring increased capital charges. They document yield-reaching within a cross-section of corporate bonds held by insurance companies, and an association between reaching for yield and the regulatory capital position of insurance companies. We focus on highly rated ABS because these products are designed specifically to achieve the highest yield relative to their rating. Conditional, then, on structured finance securities delivering higher yields for a given regulatory capital bucket, regulated insurance companies (as regulated intermediaries) ought to have reallocated away from traditional debt securities and into structured finance securities.[8] Moreover, this effect should have been strongest for those companies experiencing unexpected shocks that pushed capital toward regulatory minimums.

2.3 Testing how capital requirements distort demand for ABS

[8] Whether structured finance securities actually delivered higher yield than similarly rated securities is, ultimately, an empirical question. Empirical evidence that structured finance securities were priced to deliver a higher expected yield is provided later in the paper.

As we have argued, testing for distortions from capital requirements requires an empirical design that delivers two key features. First, we need to compare investment decisions of firms that are subject to capital requirements with those that are not. Second, we must determine, among a cross-section of firms, which firms have the strongest incentives to respond to distortions from regulatory capital rules.

We start by observing that some assets within the insurance business are subject to capital requirements and some assets are not subject to capital requirements. Life insurance companies sell products (life insurance policies or annuities) that show up as balance-sheet liabilities. When products expose the company to risk (associated with guaranteed performance or variation in asset values), liabilities are booked in the general account. Assets in the general account are subject to capital requirements. In contrast, products that expose customers (as opposed to companies) to risk are booked in the separate account. For example, variable annuities allow policyholders to direct the investment of the premium among several alternatives that act like mutual funds. In this case, the policyholder would bear the market risk during the accumulation period. The general account / separate account distinction thus allows us to compare investment decisions *within the same firm,* while varying whether or not the investment decision may have been influenced by capital requirements.

Data for life insurance companies allow us to tie investment decisions (bond holdings) to each account type. That said, general accounts may differ from separate accounts along dimensions beyond capital requirements. Thus, we build a cross-sectional measure of exposure to the large and unexpected decline in interest rates in the early 2000s. In our setting, life insurance companies that have sold a large amount of fixed-rate deferred annuities with minimum interest rate guarantees during the late 1990s are especially exposed to rate declines.

A guaranteed rate is in force for the life of the policy and may not be changed once a policy is issued. In contrast, while life insurance policies have longer average duration than annuities, they are much less vulnerable to large declines in rates; interest rate floors in annuity contracts increases convexity when rates fall through the floor, thus exposing companies to large losses when rates fall as they did in the early 2000s.

Figure 1 compares the variation in the market value of a typical guaranteed annuity v. life insurance policy written when rates were equal to 5% (say in the late 1990s). The higher duration of the life insurance policy creates a greater slope around the initial yield, but the high convexity of annuities implies a large increase in its value when rates approach the guaranteed floor of 3%. Convexity for annuities stems both from declines in policy lapses when market rates fall below the guaranteed minimum, as well as from increases in premiums paid in by annuitants. Thus, sharp interest rate declines expose companies to large losses, to the extent that these exposures are not fully hedged.

In our model, we do account for interest-rate hedges crudely, but our conversations with practitioners suggest that exposure to large declines in rates (convexity risk) are typically not hedged using derivative products, as such hedges would be expensive. Creating a natural hedge for the convexity in annuity values using asset selection would also be difficult. The ideal asset that would provide a natural hedge would need to increase in value *more* than a strait bond. And, there are very few bonds that increase their payouts as interest rates reach very low levels. Ironically, mortgage backed securities have negative convexity at low interest rates due to prepayment risk due to optimal mortgage refinancing decisions. These securities actually have the potential to exacerbate the exposure of annuities to interest rate declines. Moreover, until the early 2000s the regulatory rate that defined the minimum reserve value for the policy, as well as

the minimum cash value of the policy, had not been binding. Thus, long term exposure to the guaranteed rate was not hedged and required a change to the law. [9]

So, guaranteed interest rates on annuities create a risk for the insurance companies that market rates may decline, forcing them to commit their own capital to meet their liabilities. These contracts, however, are held at book value on insurance company balance sheets. Declines in interest rates would thus lead to declines in company earnings over the life of the contract. Meeting the cash flow burden implied by these guarantees in the low-rate environment required such firms either to increase yield (risk) on their assets, or liquidate assets to generate cash. Thus, it is reasonable to conclude that insurance companies under these circumstances had both a stronger incentive to reach for yield and also to alter their portfolio holdings to be able to avoid binding regulatory capital constraints.

The combination of general accounts versus separate accounts and the existence of minimum interest rate guarantees provides an empirical framework to identify the impact of capital requirements on holdings of structured finance securities. We propose a simple, linear specification of the following form:

[9]Deferred annuities sold by life insurance companies offer a variety of accumulation alternatives. Fixed deferred annuities offer an initial fixed interest rate (guaranteed for one, or more, years) and then the declared interest rate for subsequent years may vary depending upon the company's investment and expense experience during the accumulation period. Fixed deferred annuities usually have a guaranteed minimum interest rate. A guaranteed rate is in force for the life of the policy and may not be changed once a policy is issued. Thus, guaranteed interest rates create a risk for the insurance companies that market rates may decline, forcing them to commit their own capital to make good on their liabilities. This has, in fact, happened often during interest rate declines over the past decade. In addition to any contractually specified minimum guaranteed interest rate, regulators impose "nonforfeiture requirements" that specify the minimum cash value that an annuity may return to a policyholder. Prior to 2004, this was 87.5 percent of premium accumulated at an annual rate of 3%. In more recent years the interest rate may be as low as 1% and is tied to Treasury rates. For more details, see the Appendix below.

$$\Delta\left(\frac{Struct.Holdings_{i,2003\rightarrow2007}}{Total\ Assets_{i,2003\rightarrow2007}}\right)_{General\ Acc.} - \Delta\left(\frac{Struct.Holdings_{i,2003\rightarrow2007}}{Total\ Assets_{i,2003\rightarrow2007}}\right)_{Separate\ Acc.} =$$

$$\beta_1 \frac{Annuities_{i,2003}}{Liabilities_{i,2003}} + \gamma' X_i + \varepsilon_i \qquad (1)$$

This specification estimates a cross-sectional regression on the difference in the change in the portfolio weight between general and separate account investments in ABS from 2003 to 2007. Subscript *i* represents life insurance company *i*. No time subscripts are required because it is a cross-sectional regression estimated as of 2007. Modeling the change in the portfolio weight within a given account takes out unobserved heterogeneity in *levels* of exposure to ABS securities. To account for unobserved firm-level heterogeneity we estimate *differences* in the changes in exposure and test whether the effects of annuity exposure (β_1) differ across account types (but within firm).

Annuities/Liabilities, our proxy for shocks to life insurance capital, is measured as of 2003 for two important reasons. First, the level of annuities as of 2003 should capture annuities originations that occurred over a period of rapidly declining interest rates. For example, 5-year Treasury rates fell from more than 6.5% to below 2.5% between 2000 and 2003. Second, a regulatory change in 2004 allowed for a one-time lowering of the minimum guaranteed interest offered in annuity contracts, precisely because of the decline in market rates. Thus, firms with high levels of annuities liabilities as of the end of 2003 were those exposed to minimum interest rate guarantees; policies written after 2003 had less exposure.[10]

[10] We estimate regressions that directly exploit the 2004 change in the level of minimum interest rate guarantees in section 5.4 of the paper.

We also control for a set of firm-level and investment-account controls (X_i in equation 1).[11] Firm-level controls include the level of ABS holdings as of 2003, the log of total assets as of 2003 and the change in total assets from 2003 to 2007, the log of the Risk-Based Capital (RBC) ratio as of 2003, an indicator for firms that use derivatives to hedge interest rate risk (equal to one for any firm in our sample with non-zero derivatives exposure as of 2003), and the log of total surplus as of 2003 as well as the change in total surplus. Controls that can be measured at the investment account level include the size of the total bond portfolio as a fraction of investment account liabilities as of 2003 and the change in the size of the total investment account bond portfolio over the sample period.[12]

In summary, our specification proposes that the fraction of annuities to total liabilities as of 2003 can explain cross-sectional variation in the *growth* of total structured finance holdings over the subsequent 2003 through 2007 time period. It also proposes that the relationship between annuities and structured holdings will be concentrated in investment accounts that are subject to capital requirements as opposed to investment accounts not subject to capital requirements. By comparing the effects across account types we potentially sweep out unobservable firm-level influences.

2.4. Validating the instrument

Our identification strategy argues that guaranteed annuities as of the end of 2003 exposed firms to future accounting losses (and thus pressure on capital ratios) due to the subsequent drop in interest rates. Such losses should have already been captured by market valuations by 2003.

[11] We have estimated the multi-variate relationship between 2003 firm characteristics and their annuity exposure (not reported). Large firms are more exposed to annuity exposure, but our main results are robust to including higher-order firm size controls. Moreover, firms with high annuity exposure are (slightly) more likely to hedge with derivatives, although as we show below controlling for this effect has no impact on our results.

[12] Our key results are robust when we drop the variables representing changes from 2003 to 2007, which are not strictly predetermined.

Thus, to validate our approach we compare the equity returns at publicly traded life insurance holding companies with their annuity exposure. Our main sample is measured at the operating company level, as opposed to the holding company level, so we first "roll up" numerous operating company-level data items to the holding company level. This allows us to evaluate the returns of 22 publicly traded life insurance holding companies as a function of their total annuities, scaled by total liabilities.[13] Figure 2 plots the relationship. The y-axis represents cumulative abnormal returns from 1998 through 2003. The x-axis represents total annuities/liabilities as of 2003. The figure confirms a negative relationship between cumulative abnormal returns and companies' exposure to annuities. The slope of the plotted line is -0.76, suggesting that an increase in annuities-to-liabilities ratio of 0.3 (~one σ) is associated with 22.8% lower cumulative returns over the five years. The coefficient is large economically and statistically significant (t-stat = 2.53) despite the small sample. The figure suggests that annuity products with guaranteed minimum interest rates exposed life insurance companies to substantial expected losses as interest rates declined.

2.5. External validation of annuities exposure as a source of regulatory capital pressure.

To further validate our measure of annuities exposure as a source of regulatory capital pressure, we briefly compare our annuities exposure measure to the results of Koijen and Yogo (2014) who report estimates of the shadow cost of regulatory capital for 45 large life insurers. Under our hypothesis, high levels of annuity sales created subsequent capital constraints for life insurers, creating incentives to engage in regulatory arbitrage through the purchase of high-yielding structured securities. Under the Koijen/Yogo hypothesis, capital constrained firms were

[13] We drop two observations from an original sample of 24 publicly traded life insurers. One observation is dropped because we are unable to find sufficient annuities data for a majority of the subsidiaries of the firm. A second observation is dropped because significant idiosyncratic issues that arose out of a merger substantially negatively skewed its returns data.

more likely to sell products at a loss during the financial crisis in order to obtain regulatory capital relief. As such, we would expect to find some correlation between the Koijen/Yogo estimates of the shadow cost of capital and our measure of annuity exposure. One important caveat is that the Koijen/Yogo measure is estimated during the crisis, while our measure of annuities exposure is calculated as of 2003. As such, an appropriate form of analysis is to simply compute the correlation of their shadow cost of capital with our measures of annuity exposure. We are able to match our ABS purchasing data with 34 firms for which Koijen/Yogo also report shadow prices of capital and find a positive correlation coefficient of 19.8% between firms' 2003 annuity exposure and the Koijen/Yogo estimates of the shadow price of regulatory capital. Figure 3 provides a scatter plot of the relationship. We interpret the positive correlation as further, supplementary evidence that annuities exposure created regulatory capital constraints for life insurers.

3. Data and Summary Statistics

3.1. Constructing the sample.

We begin with securities holdings data of life insurance companies, measured within the general account and separate account. The National Association of Insurance Commissioners (NAIC) requires life insurance companies to report individual securities holdings and associated transaction data. Companies report holdings annually. We identify non-agency, private-label structured finance securities as follows. Insurance companies assign security classification codes to each of the securities in their portfolio. These codes correspond to broad classes grouped by issuer type: U.S. governments, U.S. agencies, municipals, industrial issuers, utilities, and other. "Industrial" issuers of structured finance securities represent the private-label, non-agency bonds we seek to measure. These are reported under four separate headings: "single class mortgage-

backed/asset-backed securities" (code 4099999), "multi-class residential mortgage backed securities" (code 4199999), "other multi-class residential mortgage-backed securities" code (4299999), and "other multi-class commercial mortgage-backed/asset-backed securities" code (4499999). We then sum the par value across each category within a given firm-account-year. Finally, we match the holdings data to insurance company characteristics, also made available by the NAIC. Every firm with available securities holdings data has corresponding company-attribute data.

Of the 1,166 unique life insurance companies that report any amount of securities holdings between the years 2003 and 2007, 747 firms have enough data on general account holdings to calculate the change in the ratio of structured holdings to total assets between the years 2003 and 2007. Of the 747 firms with sufficient general account data, 169 report annuities that are tied to a separate account. Of the 169 firms with separate account annuities data, 86 firms have non-zero ABS holdings. We make the assumption that separate accounts with any annuities data that report no ABS holdings effectively have made the choice to hold zero ABS. As such, our final separate account sample includes all 169 observations. That said, we have checked and verified that our baseline results hold for the sample with only non-zero observations.

3.2 Summary statistics.

Table 1 reports summary statistics on securities holdings by security type. All securities holdings are measured as a fraction of the total assets of the firm. Table 1 measures aggregates across general and separate account holdings; thus, it calculates the total holdings of each firm. Structured securities holdings rose between 2003 and 2007. Average firm-level holdings of non-agency structured ABS as a fraction of the total firm assets was 6.6% in 2007, up from 5.6% in

2003. This increase appears to have crowded out corporate bonds, which fell from an average of 26.3% in 2003 to an average of 23.8% in 2007. Holdings in agency securities also declined slightly, as did holdings of municipal bonds. U.S. Treasuries remained stable. When we constrain the sample to firms that have both general and separate accounts (which are the larger firms), the trends are more pronounced. Average non-agency structured holdings increased from 7.2% to 10.1%, largely at the expense of corporate bonds.

Table 2 reports trends on holdings by account type and by credit quality. Note that the holdings reported in Table 2 within the general and separate accounts are scaled by the size of the general and separate account assets, respectively. As such they do not sum to the total holdings measures reported in Table 1, which are scaled by total assets of the firm. Table 2, Panel A reports holdings for ABS, Panel B reports corporate bonds, and Panel C reports municipal bonds. Highly rated ABS trends upward in both the general and separate accounts, likely reflecting increased supply of these assets over time. For corporate debt in the general account, however, the higher rated bond holdings *increase* slightly while lower rated ones *decrease*. These aggregate patterns suggest firms substituted highly rated bonds for lower rated ones without sacrificing yield. That is, holdings in the general account add high-yield and low-capital requirement assets (highly rated ABS) and subtract high-yield and high-capital requirement assets (low-rated corporate bonds). In the separate account, which has no required capital, we see declines in corporate bond holdings irrespective of credit quality.

Panel A of Table 3 reports firm-level statistics. Aggregate holdings of structured securities in our sample reached nearly $470 billion by 2007, a 55% increase from 2003. The average firm in the sample held $628 million in 2007, up from $403 million in holdings as of 2003. Annuities activity at the firm level remained relatively stable over the sample period. The

median RBC ratio increased over the heart of our sample period, from a median of 8.4 in 2003 to 9.7 in 2007.

Panels B and C of Table 3 report summary statistics on the general and separate accounts. The data confirm that general accounts and separate accounts differ along dimensions beyond the capital requirement. The average asset size of the general account is almost twice that of the separate account. In addition, total general account annuities represent a smaller fraction of total liabilities compared to separate accounts. Consistent with our hypothesis, general account's hold a larger amount of structured securities on average.

4. Do Structured Finance Securities Deliver Higher Yields than Corporate Bonds?

It has been argued that highly rated structured finance securities delivered more yield than other similarly rated securities by concentrating 'catastrophe' risk. In this section, we provide evidence supporting this claim, comparing yields on structured finance securities with those of similarly rated corporate bonds. We first identify all structured finance and corporate securities with an S&P credit rating of AAA, AA, or A. We require the date of issuance of the rating to be within one month of the date the security was acquired by the insurance company in order to avoid stale ratings. Second, we compute the expected maturity for each bond. Expected maturity for structured finance securities depends on the seniority of the security within the issuance. We use Bloomberg's estimate of expected maturity for both structured finance securities and corporate bonds. Our measure of yield is the yield-to-maturity reported in the insurance company holding data. We also remove any convertible bonds from the sample.

We begin by reporting simple summary statistics on the yield-to-maturity of highly rated structured securities and corporate bonds over various maturity horizons. The average yields tabulated in Panel A of Table 4 indicate that AAA, AA, and A-rated structured securities were

purchased at higher yields than corporate bonds of similar expected maturity. At the short end of the yield curve, highly rated structured securities delivered 33 basis point higher yields than corporate bonds, while at the longest end of the yield curve the yield difference was 21 basis points. Yield premiums for structured securities persist over all maturity horizons with the exception of bonds with maturity between 4 and 6 years. Subsequent regressions test the statistical significance of the differences in yield.

As described in Section 2.2, capital requirements for insurance companies are identical for AAA, AA, and A-rated securities. Traditionally, A-rated securities are likely to be the most efficient security to own to exploit a regulatory arbitrage given that A-rated securities traditionally deliver higher yields than AA or AAA-rated securities (Ivashina and Becker (2014)).[14] However, the evidence provided in the lower portion of Panel A suggest that, at least unconditionally, AAA-rated structured securities were associated with slightly higher average yields than A-rated corporate bonds during our sample period.

Panels B and C of Table 4 report the number of observations used in the average yield calculations. Panel B reports the total number of bonds held by life insurers in the sample over each maturity horizon. Panel C reports the number of unique bonds in the sample over each horizon. The data reported in Panel C indicate that 71.4% (1,686/2,361) of the unique structured securities in our sample were rated AAA while 62.9% (1,202/1,910) of the unique corporate bonds in the sample were rated A.

The yields reported in the summary statistics of Table 4 indicate that average yields for AAA rated structured securities were potentially higher than yields on A rated corporate bonds.

[14] Though A-rated securities traditionally deliver higher yields than AAA rated securities, making them more efficient in a regulatory capital regime that treats AAA, AA, and A rated securities similarly, A-rated securities do pose the threat of downgrades that would substantially increase capital requirements. The argument that A-rated securities are unambiguously better in exploiting regulatory arbitrage ignores this possibility.

In Table 5 we construct regressions to evaluate whether these differences are statistically significant after controlling for bond maturity, bond maturity squared, credit ratings, the log of bond size, and year fixed effects, with standard errors clustered by bond. Column (1) of Table 5 reports estimates using a sample of AAA, AA, and A rated structured securities and AAA, AA, and A rated corporate bonds. The dependent variable is the reported yield-to-maturity at the time of the bond's acquisition. The estimates indicate a statistically significant 18 basis point yield premium for structured finance securities. Column (3) reports estimates when the sample is constrained to only include AAA-rated structured securities and A-rated corporate bonds. The estimates indicate a statistically significant 11 basis point premium for AAA-rated structured securities as compared to A-rated corporate bonds.

The estimates reported in Columns (1) and (3) report structured securities' yield premiums averaged over the full sample period. In Columns (2) and (4) we evaluate whether structured security yield premiums increased over the sample period as investors became more aware of the systemic risk embedded in structured securities. We estimate the structured security premium for each of the years 2004 through 2007 (2003 is the omitted year) by interacting the structured finance indicator with year indicators. Results suggest that the yield premium did not exist in 2004, but increased monotonically through time, peaking at 76 basis points for securities acquired in 2007 (from Column 2: 89 - 13). When the sample is constrained to AAA structured securities and A-rated corporate bonds (Column (4)), the results are similar.

The yield differences imply, first, that AAA-rated structured securities were a capital efficient means of delivering high yield. Second, though not central to our hypothesis, the results indicate that market participants, at least the insurance companies in our sample, appeared to price some of the systemic risk inherent in structured securities, despite their reported credit

ratings. The fact that yield premiums did not exist early in our sample but were much more pronounced in 2006 and 2007 indicate that the market became increasingly aware of the risk inherent in structured securities through time and priced the securities accordingly.

5. Explaining Growth in Holdings of Structured Finance Securities

As we have argued, the urgency to deliver yield, subject to capital requirements, increased demand for structured finance securities. Our proxy for cross-sectional differences in demand for ABS is the amount of outstanding guaranteed annuities as a fraction of total liabilities as of 2003 (held in the general account). These contracts subjected firms to large unrealized losses when interest rates fell sharply; the losses would become manifest over time in the form of lower future earnings and thus would tend to move firms closer to binding minimum regulatory capital ratios. Since firms exposed to guaranteed annuities in 2003 could expect pressure from binding regulatory capital requirements (absent changes in behavior), they had a strong incentive to find ways to alleviate such requirements by finding 'capital efficient' investments without sacrificing yield (i.e. ABS).

Figure 4 characterizes our main result in the simplest possible way. We plot the change in the median portfolio weight for ABS between 2003 and 2007 for investments in the separate v. general accounts. For each of these, we divide the sample based on top and bottom quartiles of exposure to annuities in 2003. For the full sample of firms in the general account (Panel A), ABS investments rise by almost five percentage points for top-quartile annuities firms but by nearly zero for bottom-quartile annuities firms. In contrast, we see no such pattern for ABS holdings in the separate account (Panel C). Annuities demonstrate no power in explaining variation in structured ABS holdings within the separate account.

While the patterns in Figure 4 suggest that high exposure to annuities encouraged firms to invest in structured finance bonds, they do not control for possibly confounding factors. So, we

now present results from regressions explaining the growth of structured finance holdings from 2003 to 2007 among a cross-section of life insurance companies (recall Equation 1).

5.1 Baseline Regression Results

Table 6 tabulates the results of cross-sectional regressions within the general and separate accounts (columns 1 & 2). In columns 3-5, we model the difference in the change in portfolio weights across account types. Column 1 includes all firms (N=747); the subsequent four columns include only firms with both general and separate accounts (N=169). Comparing across account types helps remove unobserved heterogeneity at the firm-level.

Within the general account, we find a positive and statistically significant relationship between outstanding annuities as of 2003 and subsequent changes in holdings of structured finance securities, after controlling for a host of firm and investment account-level factors (column 1). The estimated coefficient of 0.033 suggests that a one-standard deviation increase in annuities (=29%) is associated with a 1 percentage point increase in the ratio of structured finance holdings to total assets. In comparison, the average increase in the ratio of structured finance holdings for the estimation sample is 1 percentage point (Table 1, column 2).

Some of the general accounts included in the estimation sample in column 1 reported zero annuities liabilities as of 2003. Zero annuities exposure represents a meaningful economic value in our specification. Nevertheless, to ensure that our results are not unduly influenced by the zeroes, we have estimated the same model without them (not reported). Even among positive annuity exposure firms, those with larger exposure were associated with higher growth in structured finance over subsequent years. In column 2 of Table 6, we repeat the analysis using just the separate account holdings. In contrast to the general account, 2003 annuities exposure in

the separate account demonstrates no statistical relationship with changes in structured finance holdings over the subsequent four years (consistent with Figure 4).

These baseline results indicate that firms with larger exposure to annuities as of 2003 increased their structured finance holdings more rapidly over the subsequent years, but that the result is concentrated only in the general account, where capital requirements matter. This is because capital requirements impose a substantial cost on low credit quality investments which deliver the highest yield. Given that structured finance securities were 'capital efficient' in delivering yield within a given ratings category, it makes sense that investment accounts subject to capital requirements exhibit stronger demand for structured securities compared to those not subject to capital requirements.

Columns 3-5 of Table 6 formally test whether the differences in the estimates between the general and separate accounts are statistically significant. In these models, we include only firms with both account types, and we model the dependent variable as the difference in the change in ABS holdings (general account – separate account). Such differencing removes firm-level unobserved heterogeneity. The results indicate that, for a given level of annuity exposure as of 2003, general accounts exhibit statistically significantly larger subsequent growth in the holdings of structured finance securities compared to separate accounts. The estimated coefficient of 0.049 (column 5) suggests that a one-standard deviation increase in 2003 annuities exposure is associated with a subsequent 1.4 percentage point increase in structured finance holdings of the general account as compared to the separate account.

5.2 Structured holdings, Hedging, and Required Capital.

We have argued that firms exposed to annuities experienced more pressure to invest in high-yield assets with low required capital. The large and unexpected drop in interest rates

negatively shocked the capital of firms heavily exposed to annuities; since these losses did not affect capital immediately (due to book value accounting), their effects were mitigated by tilting the investments over time toward more 'capital efficient' assets. These results, however, should be *smaller* for firms hedging exposure to interest rate changes and *larger* for firms with lower level of capital as of 2003.

Table 7 evaluates these implications. We do so by introducing an indicator variable equal to one for firms with above median capital, and interacting this indicator with exposure to annuities (column 1). In column 2, we test whether firms that use derivatives for hedging interest rate risk respond less to annuities exposure. The results suggest that the effects of annuities exposure is concentrated among low-capital firms (coefficient = 0.054); in contrast, the overall effect of annuities exposure for high-capital firms is close to zero (0.054-0.051). (The interaction effect is significant, but the sum of the two coefficients is not statistically significantly different from zero.) Hedging, in contrast, does not interact with annuities, nor is it significant on its own. This non-result is consistent with the observation that while many life insurance companies hedge against normal rate fluctuations, they may not hedge against larger, out-of-the-money liabilities.

Our results suggest that distortionary incentives created by capital requirements are at the heart of the increase in demand to hold structured finance securities. Many have argued that this market boomed because of an agency conflict between asset managers who faced contractual incentives to purchase AAA-rated ABS due to their high yield, rather than alternative AAA investments such as corporate bonds with lower yields. Such an explanation, however, is not consistent with the sharp differences that we observe between investments in the separate account v. the general account. Agency explanations would seem to make similar predictions

across both account types, as both are situations in which investment decisions are delegated to portfolio managers; yet, we only find that annuities exposure as of 2003 affects investments in highly rated ABS in the general account, where capital requirements matter. Moreover, we find this result only among firms with low levels of ex ante capital. Thus, it seems unlikely that agency (or more generally governance) conflicts can explain the patterns documented in our results.

5.3 Structured holdings and asset quality.

The yield advantage for ABS over similarly rated corporate debt, described in Tables 4 and 5 above, is strongest in the highest rated tranches. For lower-rated ABS, there is no capital advantage relative to investments in other bonds with similar ratings, such as corporate bonds. As such, highly rated ABS offer the most capital efficient way to deliver yield; investing in such securities reduces the 'bindingness' of capital requirements without sacrificing yield. So, we test whether variation in the growth in structured finance holdings as a function of annuities exposure is concentrated in the highly rated segments (AAA, AA or A).

In Table 8, we test whether annuities exposure as of 2003 explains growth in AAA, AA, or A-rated assets as compared to ABS assets of a lower credit quality. We focus on the general account investments only, and include all firms (N=747). Columns 1 and 2 report the baseline specifications, and in columns 3 and 4 we add the interaction of annuity exposure with the above-median capital indicator. Annuity exposure *only* predicts increases in investment in the highly rated ABS (coefficient = 0.038), whereas its effect on investment in lower-rated ABS is approximately zero (coefficient = -0.005). And, the effects of annuity exposure are driven by firms with low risk-based capital ratios (coefficient = 0.062).

Table 9 reports similar regressions to those in Table 8, replacing ABS securities with corporate bonds. This approach allows us to compare investments changes across ratings categories in an asset class where insurance companies have large exposures for both highly rated and low-rated bonds. The results indicate that annuity liabilities as of 2003 in the general account forecasts *decreased* holdings of corporate bonds, irrespective of the rating. Thus, life insurance companies that faced the greatest declines in capital due to the interest rate shock – those heavily exposed to guaranteed annuities – were not simply moving into highly rated bonds. If they were, we would not observe a decline in highly rated corporate debt (columns 1 & 3). Instead, they moved *into* highly rated ABS securities (Table 8) and *out of* corporate bonds generally (Table 9). These changes allowed such firms to conserve capital (by increasing their relative holding of highly rated ABS debt) without sacrificing yield (because highly rated ABS securities offered the highest yield relative to the credit rating).

Section 5.4 Changes in annuities and holdings of structured ABS

The results presented thus far have relied on the general, separate account distinction for identification. One potential limitation of this identification strategy is the possibility of unobserved variables that are correlated with both differences between the general and separate accounts and firms' incentives to invest in highly rated ABS. In this section we exploit time series changes in annuities holdings to explain changes in structured ABS holdings.[15] Our hypothesis that higher levels of annuities liabilities influenced firms' demand for ABS is predicated on the contractual obligation of annuities to deliver a minimum guaranteed interest rate to annuitants. Our previous results have focused on the outstanding level of annuities as of

[15] The identification assumption in the time series test is that any unobserved, endogenous variable plaguing the general, separate account identification strategy is likely to be time-invariant, or at least is not likely to be perfectly correlated with the timing of a rule change surrounding interest rate guarantees on annuities.

2003 because this variable captures the exposure of firms to annuities that were originated in the years 1998 through 2003, a period that represents sharply declining interest rates. There is, however, still the possibility that our results are driven by an omitted variable.

A regulatory change that was implemented throughout 2004 allowed for a one-time lowering of the minimum guaranteed interest rate offered on newly-issued annuities. The regulatory change was enacted precisely because of the pressure that high levels of guaranteed rates were placing on insurance companies writing annuities in a lower-rate environment. Abkemeier (2003) observed, "Low interest rates have created current and potential future squeezes between affordable interest crediting on deferred annuities and the requirements of the Standard Nonforfeiture Law for Individual Deferred Annuities."

The 2004 change in the Standard Nonforfeiture Law allows us to compare how incremental changes in annuities affect ABS demand relative to annuity exposures written prior to the change. If annuities written in a relatively high-guaranteed-rate environment create incentive to hold structured ABS, we should see *changes* in annuities exposure between 2002 and 2003 impact the subsequent demand for structured ABS.[16] Similarly, if lowering the minimum guaranteed rate reduces pressure to deliver yield, changes in annuities exposure between 2003 and 2004 should not impact subsequent demand for structured ABS. While the rule changed in 2004, enforcement occurs at the state level, creating some ambiguity as to how contracts issued during 2004 would have been treated. We thus evaluate both the 2003-2004 and 2004-2005 changes in annuities holdings in the regressions.

[16] While it might seem that interest rate declines could be, in some way, priced in to annuities offered in 2002-2003, Standard Non-forfeiture Law still imposed a minimum interest rate that was binding under then current conditions. Koijen and Yogo (2014) document that insurance companies will sell annuities, at an economic expected loss, when such sales would raise statutory capital. In addition, insurance companies often issue policies in a "fire sale" in order to develop or maintain market share.

Table 10 reports the results of this test. Changes in holdings of structured ABS are regressed on the change in annuities exposure between 2002 and 2003. We control for the level of annuities exposure as of 2002 and include the standard set of control variables used in previous tables. Column (1) measures changes in ABS holdings from 2003 through 2007, columns (3)-(5) measure changes in holdings from 2004 through 2007, and columns (6) and (7) measure changes in holdings from 2005 through 2007.

The results indicate that changes in annuities exposure between 2002 and 2003 predict subsequent growth in ABS holdings. The coefficient in column (1), 0.054, suggests that an increase of annuities exposure of 0.08 (one σ) between 2002 and 2003 is associated with a 0.4 percentage point increase in the holdings of ABS from 2003 to 2007. Consistent with the primary result in previous tables, the level of annuities exposure as of 2002 also predicts subsequent changes in structured ABS holdings. Columns (2) and (4) indicate that changes in annuities exposure prior to the rule change also explain changes in ABS holdings over subsequent 2004-2007 period. The results are of similar economic magnitude as the 2003-2007 result.

If a lowering of the minimum guaranteed rate did relax the pressure to deliver yield, we should observe that incremental changes in annuities exposure from 2003-2004 have less effect on subsequent ABS holdings. Column (3) reports a not-statistically-significant coefficient of -0.045 on the variable measuring the change in annuities exposure from 2003-2004. Column (4) controls for both annuities change variables and indicates that changes in annuities exposure from 2002-2003 had a positive and significant impact on changes in ABS holdings from 2004-2007 while changes in annuities exposure from 2003-2004 did not. An F-test indicates that the estimated coefficient on the 2002-2003 annuities change (=0.047) is statistically different from the estimated coefficient on the 2003-2004 annuities change (= -0.036).

Finally, columns (5)-(7) repeat the exercise but measure changes in ABS holdings from 2005-2007 using the change in annuities over the 2004-2005 period. Annuities growth from 2004-2005 has a negative and insignificant impact on subsequent ABS holdings, as predicted. When changes in annuities over both periods are included (column (7)), changes in annuities from 2002-2003 are positive but not significant at traditional levels (t-stats of around 1.38) while changes in annuities exposure from 2004-2005 are negative and not significant.

Taken together, the results indicate that incremental annuities exposure has power to predict subsequent changes in structured ABS holdings, but only under the high minimum interest rate guarantee regime. This result provides further evidence consistent with the hypothesis that guaranteed interest rates on annuities created a risk for the insurance companies that market rates may decline, potentially forcing them to commit their own capital to meet their liabilities. Meeting the cash flow burden implied by these guarantees in the low-rate environment created an incentive for such firms to look for higher yield in the form of structured ABS.

Section 6. Quantifying the impact of final demand for ABS on structured finance issuance.

Estimates provided in Table 6, our main set of results, indicate that a one-standard deviation increase in annuities exposure resulted in a one percentage point increase in the ABS portfolio weight, on average. Taken literally, this estimate suggests a one standard deviation increase in annuities per firm would result in an extra $50 M in ABS demand for each firm in our sample, on average, which translates into roughly $37.5 Billion in aggregate. Aggregate holdings in ABS in our sample increased from $301.3 B in 2003 to $469.3 B as of 2007, an increase of roughly $168 B. Thus, our estimates indicate that about 22% of the total increase in ABS demand from insurance companies between 2003 and 2007 could be the result of a one standard

deviation increase in annuities exposure. Estimates of the impact of annuities exposure on total issuance of ABS over the 2003-2007 period are more modest. The $168 B increase in ABS holdings for the insurance companies in our sample represents about 10% of the increase in total ABS issuance over the sample period, suggesting that the incremental annuities exposure of firms in our sample could explain about 2-3% of total increase in ABS issuance. These estimates of economic magnitude likely understate the total effect of regulatory capital distortions on ABS demand, however, because all life insurance companies may have tilted toward highly rated ABS as a means to achieve return without needing to hold additional capital. That is, because our estimates come from the cross-section, we are not able to estimate how much of the total holdings in the insurance industry were driven by the economics we describe. Rather, our estimates only allow us to quantify how much more certain firms demanded ABS relative to others, and how much those differences in relative demand might have influenced total ABS issuance.

Section 7. Conclusion

The explosion in issuance of structured finance securities over a short time period represents a puzzle for financial economists. Some argue the episode represents a misallocation of credit to the real estate sector (Diamond and Rajan (2009)). In this paper we investigate the demand to hold structured finance securities. Although issuance of ABS generated substantial deal fees for the banks, it seems unlikely that issuance could have occurred at the rates observed without strong demand from final investors.

We focus on the holdings of life insurance companies, who represent the only large investor class for which comprehensive bond-level holdings are available. Life insurance companies face capital regulations that potentially distort their demand for certain types of

securities. Asset managers at firms constrained by regulatory capital have an incentive to search for securities that deliver the highest yield for a given credit rating. Highly rated structured finance securities achieve 'regulatory capital efficiency' by combining a low physical default rate with a high exposure to systematic risk. In fact, we show that firms expecting erosion of regulatory capital demanded such securities. Insurance companies with large exposure to annuities with minimum interest rate guarantees – our proxy for companies most likely to face binding capital requirements – exhibited faster growth in their subsequent accumulation of highly rated structured finance securities. We find no such patterns for investments in unregulated accounts managed by insurance companies, or in low-rated structured securities which do not benefit from regulatory capital distortions. Moreover, the patterns are driven by companies with low levels of ex ante capital. Such patterns are hard to explain with alternative motivations to hold ABS, such as agency problems between asset managers and investors.

Although our results are specific to insurance, the economic forces likely extend to other regulated entities such as banks. Much of the existing explanations for the explosive growth of the ABS market rely on supply-side explanations, such as misaligned incentives for credit rating agencies that led to ratings inflation. Our results suggest that demand for these assets for firms seeking to avoid the costs of regulatory capital requirements can also help explain the securitization boom.

References

Abkemeier, Noel J., 2003, Annuity Nonforfeiture: The Sound of Falling Rates, *Product Development News* 55, 14-15.

Acharya, Viral V., Philipp Schnabl, and Gustavo Suarez, 2013, Securitization without risk transfer, *Journal of Financial Economics* 107, 515-536.

Acharya, Viral V., and Matthew P. Richardson, 2009, Causes of the financial crisis, *Critical Review* 21, 195-210.

Aliber, Robert, and Charles P. Kindleberger, 1978, *Manias, Panics, and Crashes: A History of Financial Crises* (Palgrave Macmillan, New York, NY).

Ashcraft, Adam B., and Til Schuermann, Understanding the securitization of subprime mortgage credit, *Foundations and Trends in Finance* 2, 191-309.

Becker, Bo, and Victoria Ivashina, 2013, Reaching for yield in the bond market, Journal of Finance, forthcoming.

Bhattamishra, Ruchira, and Christopher B. Barrett, 2008, Community-based risk management arrangements: an overview and implications for social fund programs, *Social Protection Discussion Papers*, 46333, The World Bank.

Calomiris, Charles W., and Peter J. Wallison, 2008, The last trillion-dollar commitment: The destruction of Fannie Mae and Freddie Mac, American Enterprise Institute, Sept 30.

Congleton, Roger, On the political economy of the financial crisis and bailout of 2008–2009, *Public Choice* 140, 287-317.

Coval, Joshua, Jakub Jurek, and Erik Stafford, 2009, The economics of structured finance, *Journal of Economic Perspectives* 23, 3-25.

Diamond, Douglas W., and Raghuram G. Rajan, 2009, The credit crisis: Conjectures about causes and remedies, *American Economic Review* 99, 606-610.

Erel, Isil, Taylor Nadauld, and René M. Stulz, 2013, Why did U.S. banks invest in highly-rated securitization tranches?, *Review of Financial Studies*, forthcoming.

Glasserman, Paul and Wanmo Kang. 2013, Design of Risk Weights, Columbia Business School Research Paper No. 13-39.

Gorton, Gary, and Andrew Metrick, 2012, Securitized banking and the run on repo, *Journal of Financial Economics* 104, 425-451.

Griffin, John M., Jordan Nickerson, and Dragon Yongjun Tang, 2013, Rating shopping or catering? An examination of the response to competitive pressure for CDO credit ratings, *Review of Financial Studies* 26, 2270-2310.

Griffin, John M., and Dragon Yongjun Tang, 2012, Did subjectivity play a role in CDO credit ratings?, *Journal of Finance* 67, 1293-1328.

He, Jie, Jun Qian, and Philip Strahan. 2012, Are all ratings created equal? The impact of issuer size on the pricing of mortgage-backed securities, *Journal of Finance* 67, 2097-2137.

Keys, Benjamin J., Amit Seru, and Vikrant Vig, 2012, Lender screening and the role of securitization: Evidence from prime and subprime mortgage markets, *Review of Financial Studies* 25, 2071-2108.

Keys, Benjamin J. et al., Financial regulation and securitization: Evidence from subprime loans, 2009, *Journal of Monetary Economics* 56, 700-720.

Keys, Benjamin J. et al., Did securitization lead to lax screening? Evidence from subprime loans, *Quarterly Journal of Economics* 125, 307-362.

Keys, Benjamin J. et al., Mortgage financing in the housing boom and bust (chp. 4), *Housing and the Financial Crisis* (University of Chicago Press, Chicago, IL).

Koijen, Ralph S.J. and Yogo, Motohiro, 2014, The Cost of Financial Frictions for Life Insurers, Working Paper.

Leonnig, Carol D., 2008, How HUD mortgage policy fed the crisis, *Washington Post*, June 10.

Loutskina, Elena, and Philip E. Strahan, 2009, Securitization and the declining impact of bank finance on loan supply: Evidence from mortgage originations, *Journal of Finance* 64, 861-889.

Loutskina, Elena, and Philip E. Strahan, 2013, "Financial integration, housing and economic volatility" , *Journal of Financial Economics,* forthcoming.

Mian, Atif R., and Amir Sufi, 2009. The consequences of mortgage credit expansion: Evidence from the U.S. mortgage default crisis, *Quarterly Journal of Economics* 124, 1449-1496.

Mian, Atif R., Amir Sufi, and Francesco Trebbi, 2013, Resolving debt overhang: Political constraints in the aftermath of financial crises, working paper.

Nadauld, Taylor D., and Shane M. Sherlund, 2013, The impact of securitization on the expansion of subprime credit, *Journal of Financial Economics* 107, 454-476.

Pennacchi, George, and Joseph Haubrich, 2012, Inflation expectations, real rates, and risk premia: evidence from inflation swaps, *Review of Financial Studies* 25, 1588-1629.

Piskorski, Tomasz, Amit Seru, and James Witkin, 2013, Asset quality misrepresentation by financial intermediaries: Evidence from RMBS market, working paper.

Rajan, Raghuram G., 2005, Has financial development made the world riskier?, Proceedings, Federal Reserve Bank of Kansas City, Aug, 313-369.

Shleifer, Andrei and Robert W. Vishny, 2010, Unstable banking, *Journal of Financial Economics* 97, 306-318.

Figure 1: Price – Yield Relationship for Annuities and Life Insurance

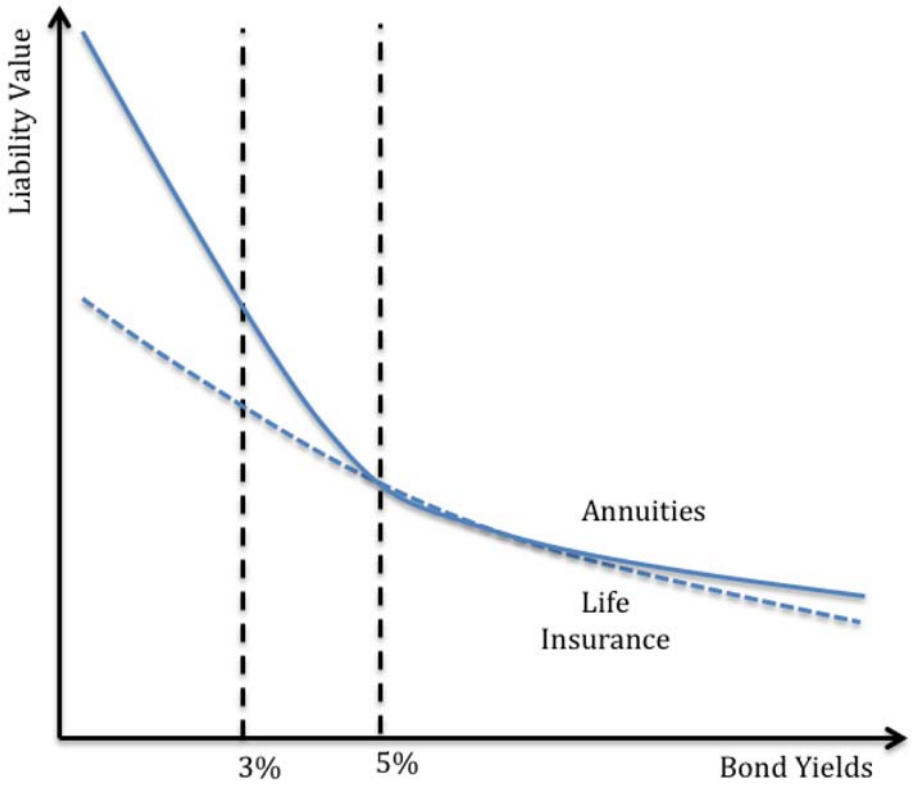


Figure 2. Life Insurance Company Abnormal Returns and Exposure to Annuities

This figure plots the cumulative abnormal returns of publicly-traded life insurance company stocks against our measure of exposure to annuities. Abnormal returns are calculated from 1998-2003, a period which represents sharply falling interest rates. Annuities data are from the National Association of Insurance Commissioners (NAIC) filings, scaled by total liabilities. Our main sample of 747 firms do not have stock return data because they are measured at the operating company level as opposed to the holding company level. To obtain insurance companies with stock returns, we "roll up" numerous operating company-level data items to the holding company level. The sample consists of 22 publicly traded life insurance companies for which all the returns and annuities data are available. The negatively-sloped line is estimated to have a slope of -0.76 and a t-statistic of 2.53.

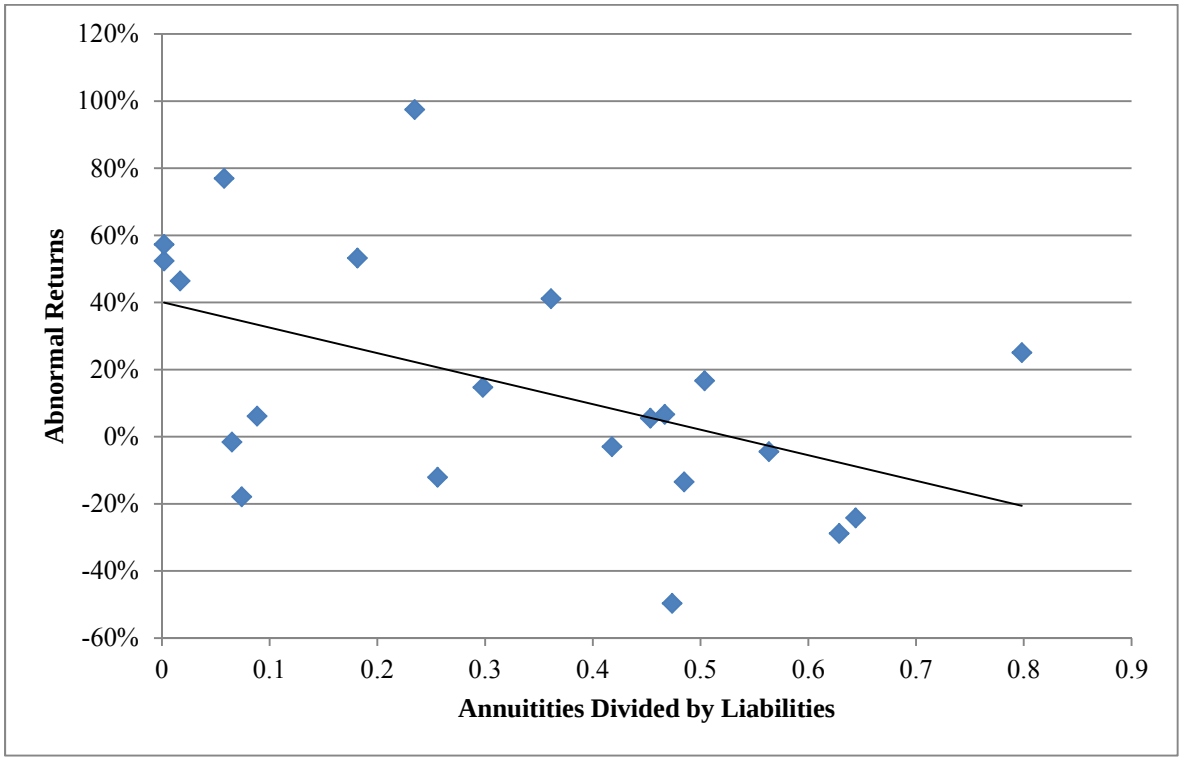


Figure 3. Annuity Exposure and the Koijen/Yogo Estimates of the Shadow Cost of Capital

This figure plots the relationship between annuities exposure and estimates of the shadow cost of regulatory capital as produced by Koijen and Yogo (2014). The figure is calculated using the 34 firms in our sample that overlap with the Koijen/Yogo sample. Annuities exposure in our sample is measured as of 2003 while the Koijen/Yogo estimates reflect the actions taken by insurance companies during the financial crisis. We estimate a correlation coefficient of 19.8% between firms' 2003 annuity exposure and the Koijen/Yogo estimates of the shadow price of regulatory capital.

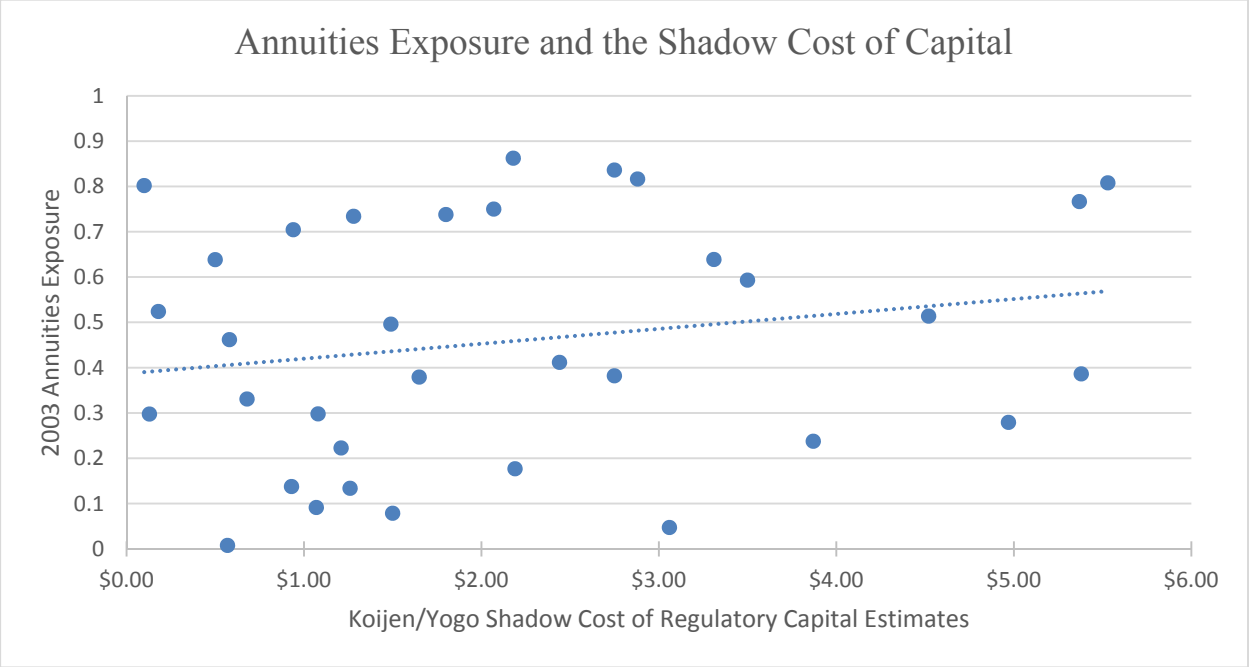
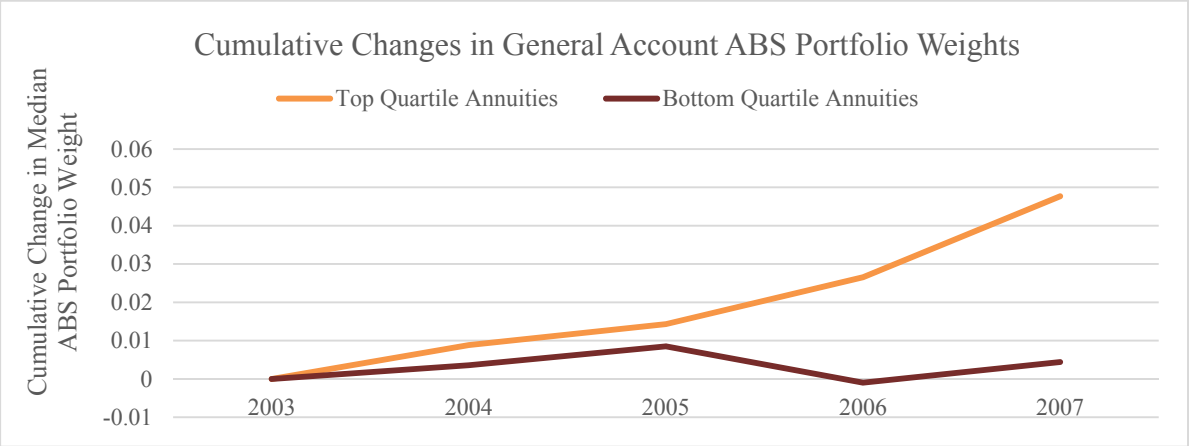
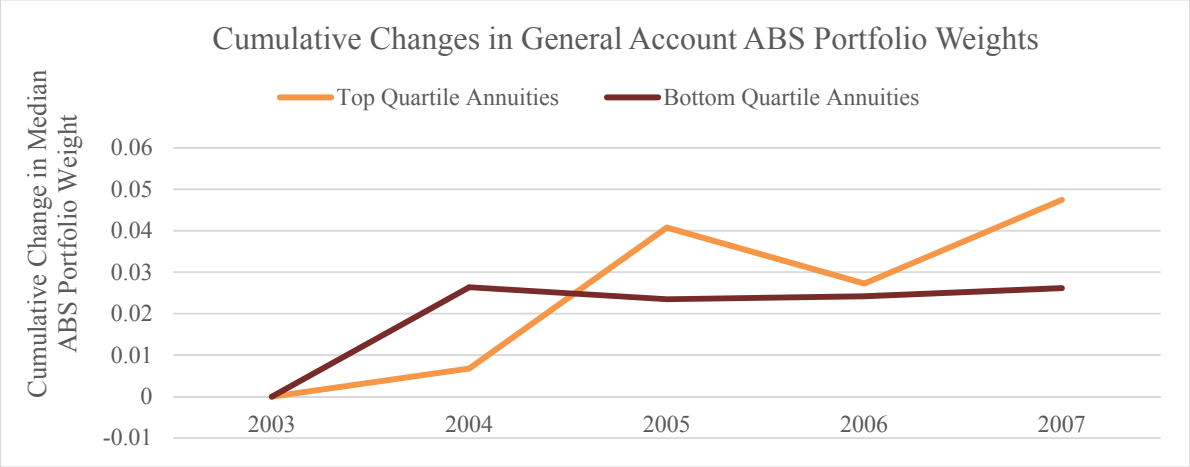


Figure 4. Changes in ABS Portfolio Weights as a Function of Annuities Holdings

These figures plot cumulative changes in median holdings of structured ABS securities as a fraction of total assets. Structured ABS holdings are plotted separately for top quartile and bottom quartile annuity holding firms, where annuity holdings are calculated as a fraction of total liabilities as of 2003. The top panel plots holdings for the full sample of 747 firms. The bottom two panels plot holdings for the sample of 169 firms that have both general and separate accounts.





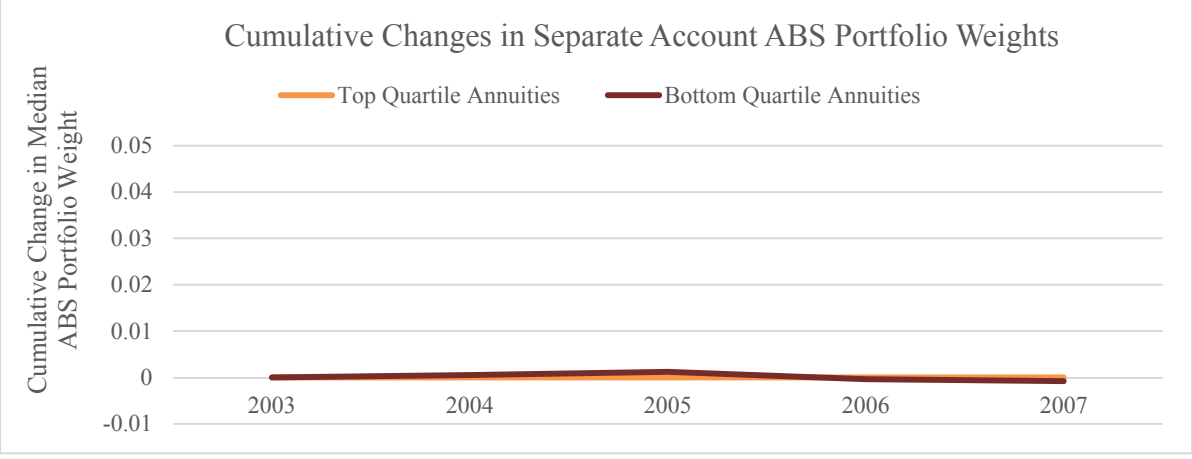


Table 1. Summary Statistics on Life Insurance Company Securities Holdings by Security Type

This table documents the aggregate general account and separate account securities holdings of Life Insurance companies between 2003 and 2007, scaled by total assets. Panel A tabulates holdings for all insurance companies in our sample. Panel B tabulates holdings for life insurance companies that have both a general account and a separate account. Non-agency structured ABS includes CLOs, CDOs, RMBS, ABS, and CBOs. Securities classifications are reported by insurance companies in their annual holdings filings made available by the National Association of Insurance Commissioners (NAIC).

Panel A. Firm Level Holdings by Bond Category as a Fraction of Total Assets

Year	Sample Size	Non-Agency Structured ABS	Corporate Bonds	Agency Securities	U.S. Treasuries	Municipal Bonds	Foreign Bonds	Other Bonds
2003	747	5.6%	26.3%	9.4%	15.7%	8.6%	0.4%	0.4%
2004	747	5.7%	26.7%	9.6%	16.1%	8.1%	0.5%	0.3%
2005	747	6.3%	25.3%	9.8%	17.0%	8.0%	0.5%	0.3%
2006	747	6.4%	24.0%	8.9%	17.0%	8.0%	0.5%	0.3%
2007	747	6.6%	23.8%	9.3%	15.6%	7.6%	0.4%	0.4%

Panel B. Firm Level Holdings By Bond Category (Firms with General and Separate Account Holdings)

Year	Sample Size	Non-Agency Structured ABS	Corporate Bonds	Agency Securities	U.S. Treasuries	Municipal Bonds	Foreign Bonds	Other Bonds
2003	169	7.2%	27.3%	7.1%	5.9%	6.6%	0.6%	0.5%
2004	169	7.7%	28.4%	7.1%	5.4%	5.8%	0.8%	0.4%
2005	169	8.7%	26.9%	7.0%	5.6%	5.8%	0.6%	0.4%
2006	169	8.7%	23.8%	6.3%	5.0%	5.2%	0.4%	0.4%
2007	169	10.1%	23.9%	6.1%	4.5%	5.1%	0.4%	0.4%

Table 2. Holdings by Security Type and Ratings Category.

This table documents the time series patterns in the holdings of three types of securities segregated by general and separate account: Non-agency structured ABS, corporate bonds, and municipal bonds. We report total holdings in the general account for all firms, and the holdings of a subsample of firms that have both a general and separate account. Holdings are scaled by total assets. Securities rated either AAA, AA, or A are considered NAIC Level 1 securities and receive identical regulatory capital treatment.

Panel A. Non-Agency Structured ABS Holdings

	Total General Account Sample			Firms with both General and Separate Account				
				Separate Account		General Account		
Year	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated
2003	747	5.7%	0.66%	169	1.6%	0.22%	9.1%	1.4%
2004	747	5.9%	0.65%	169	1.8%	0.32%	10.3%	1.3%
2005	747	6.9%	0.48%	169	2.5%	0.21%	12.8%	1.0%
2006	747	6.7%	0.42%	169	2.6%	0.16%	11.2%	0.9%
2007	747	7.1%	0.42%	169	2.8%	0.13%	13.3%	1.0%

Panel B. Corporate Bond Holdings

	Total General Account Sample			Firms with both General and Separate Account				
				Separate Account		General Account		
Year	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated
2003	747	16.4%	12.1%	169	3.3%	3.1%	17.2%	19.4%
2004	747	17.6%	11.3%	169	3.1%	2.8%	19.4%	18.7%
2005	747	17.1%	10.5%	169	2.8%	2.5%	19.7%	17.6%
2006	747	16.7%	9.3%	169	2.3%	1.9%	18.7%	15.5%
2007	747	16.5%	9.8%	169	2.3%	2.0%	18.5%	16.3%

Panel C. Municipal Bond Holdings

	Total General Account Sample			Firms with both General and Separate Account				
				Separate Account		General Account		
Year	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	Sample Size	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated	AAA, AA, or A-Rated Sample	Non-AAA, AA, and A-Rated
2003	747	6.9%	2.0%	169	0.6%	0.4%	5.1%	3.2%
2004	747	6.7%	1.8%	169	0.5%	0.4%	5.0%	3.1%
2005	747	6.7%	1.9%	169	0.4%	0.4%	5.1%	3.1%
2006	747	6.3%	1.7%	169	0.3%	0.3%	4.7%	2.7%
2007	747	6.4%	1.7%	169	0.3%	0.3%	4.7%	2.7%

Table 3. Summary Statistics on the Attributes of Life Insurance Companies in the Sample.

Total holdings of structured ABS represent the sum of all holdings across all firms in the sample. Average holdings represent the average amount of holdings for a life insurance company in our sample. Risk-based capital (RBC) ratio is calculated as the ratio of total adjusted capital to total control level capital. Panel B reports statistics for the general account. Panel C reports statistics for attributes of the separate account.

Panel A. Insurance Company Summary Statistics

Year	Sample Size	Total Holdings of Structured ABS ($ Million)	Average Holdings of Structured ABS ($ Million)	Average Asset Size ($ Million)	Total Annuities as Fraction of Liabilities (%)	Std. Dev. Of Total Annuities as Fraction of Liabilities	Median RBC Ratio
2003	747	$301,300	$403	$4,710	22.3%	30.3%	8.42
2004	747	$364,500	$489	$5,180	22.9%	30.4%	9.05
2005	747	$445,200	$596	$5,510	23.3%	30.8%	9.25
2006	747	$421,700	$564	$6,240	22.8%	30.6%	9.66
2007	747	$469,300	$628	$6,630	22.2%	30.2%	9.68
Panel B. General Account Statistics							
2003	747	$274,000	$366	$3,190	20.0%	28.9%	--
2004	747	$328,000	$440	$3,450	20.6%	29.0%	--
2005	747	$398,000	$533	$3,630	21.0%	29.1%	--
2006	747	$379,000	$507	$3,960	20.6%	28.5%	--
2007	747	$420,000	$562	$4,100	19.4%	27.2%	--
Panel C. Separate Account Statistics							
2003	169	$27,300	$36.6	$1,520	64.0%	38.4%	--
2004	169	$36,500	$48.8	$1,730	64.0%	38.0%	--
2005	169	$47,200	$63.3	$1,880	64.4%	37.7%	--
2006	169	$42,700	$57.1	$2,280	63.2%	38.0%	--
2007	169	$49,300	$66.0	$2,530	63.4%	37.4%	--

Table 4. Comparing Yields on Structured Finance Securities Relative to Corporate Bonds.

Panel A computes the average yield-to-maturity of bonds held by life insurance companies at the time of purchase for which maturity estimates are available from Bloomberg. Yields are reported by insurance companies in regulatory filings to the NAIC. Estimates of maturity are provided by Bloomberg. Panel B reports the total number of bonds held by insurance companies in the sample while Panel C reports the unique number of bonds in the sample.

Panel A. Average Yield-to-Maturity at Purchase

	Bond Maturity Buckets (in years)				
Bond Category	2-4	4-6	7-9	9-11	> 10
AAA, AA, A Rated Structured Finance Securities	4.10%	4.30%	4.86%	5.41%	5.71%
AAA, AA, A Rated Corporate Bonds	3.77%	4.47%	4.63%	5.32%	5.50%
Difference (Structured Finance minus Corporate Bonds)	0.33%	-0.16%	0.23%	0.09%	0.21%
AAA Rated Structured Finance Securities	4.09%	4.49%	4.73%	5.41%	5.68%
A Rated Corporate Bonds	3.82%	4.48%	4.67%	5.33%	5.49%
Difference (Structured Finance minus Corporate Bonds)	0.27%	0.01%	0.05%	0.09%	0.19%

Panel B. Total Number of Bonds Owned by Insurance Companies in Each Category

	Bond Maturity Buckets (in years)				
Bond Category	2-4	4-6	7-9	9-11	> 10
AAA, AA, A Rated Structured Finance Securities	1,806	1,038	623	988	621
AAA, AA, A Rated Corporate Bonds	1,193	3,395	892	6,563	8,497
AAA Rated Structured Finance Securities	1,670	675	444	633	518
A Rated Corporate Bonds	811	2,478	696	5,584	6,811

Panel C. Total Number of Unique Bonds in Each Category

	Bond Maturity Buckets (in years)				
Bond Category	2-4	4-6	7-9	9-11	> 10
AAA, AA, A Rated Structured Finance Securities	798	537	287	414	325
AAA, AA, A Rated Corporate Bonds	257	342	110	404	797
AAA Rated Structured Finance Securities	738	289	188	213	258
A Rated Corporate Bonds	163	217	61	281	480

Table 5.Yields on Structured Finance Securities Relative to Corporate Bonds.

This table reports the results of regressions that explain variation in yield-to-maturity on a sample of structured finance bonds and corporate bonds. The dependent variable, *yield-to-maturity*, is reported by life insurance companies in their annual holdings reports, and measures the yield of the bond at the time of purchase. The sample in Columns (1) and (2) includes bonds rated AAA, AA, or A based on the S&P ratings, where the S&P ratings were issued within the same month of the bond acquisition by the insurance company. *Structured finance indicator* equals one for structured finance bonds and zero for corporate bonds. The sample in Columns (3) and (4) includes AAA-rated structured securities and A-rated corporate bonds. The variable *AAA rated structured finance indicator* is equal to one for structured finance securities with a AAA rating. The omitted category for the AAA rated finance indicator is A rated corporate bonds. The estimates control for year fixed effects and standard errors are clustered by bond.

	Dependent Variable: Yield-to-Maturity at Purchase			
	Sample: AAA, AA, and A Rated Structured Finance Securities and AAA, AA, and A Rated Corporate Bonds		Sample: AAA Rated Structured Finance Securities and A Rated Corporate Bonds	
	(1)	(2)	(3)	(4)
Structured Finance Indicator	18.145***	-13.138		
	(3.659)	(-1.627)		
AAA Rated Structured Finance Indicator			11.457***	-24.713***
			(2.763)	(-2.983)
Structured Finance Indicator * Year 2004 Indicator		8.979		
		(0.955)		
Structured Finance Indicator * Year 2005 Indicator		56.010***		
		(6.509)		
Structured Finance Indicator * Year 2006 Indicator		71.601***		
		(7.442)		
Structured Finance Indicator * Year 2007 Indicator		89.004***		
		(6.753)		
AAA Rated Structured Finance Indicator * Year 2004 Indicator				12.589
				(1.181)
AAA Rated Structured Finance Indicator * Year 2005 Indicator				57.718***
				(5.840)
AAA Rated Structured Finance Indicator * Year 2006 Indicator				78.513***
				(7.154)
AAA Rated Structured Finance Indicator * Year 2007 Indicator				86.849***
				(5.912)
AA Rated Indicator	1.746	5.456		
	(0.303)	(0.979)		
A Rated Indicator	8.332	11.078**		
	(1.596)	(2.184)		
Expected Bond Maturity	24.569***	24.381***	25.363***	25.130***
	(23.588)	(23.732)	(25.351)	(24.622)
Expected Bond Maturity^2	-0.547***	-0.537***	-0.575***	-0.563***
	(-16.367)	(-16.739)	(-19.366)	(-19.281)
Log Bond Size	-0.690	-0.455	-0.507	-0.195
	(-1.151)	(-0.809)	(-0.722)	(-0.300)
Constant	405.264***	280.693***	352.595***	283.461***
	(35.712)	(23.896)	(28.407)	(21.831)
Year Fixed Effects	Yes	Yes	Yes	Yes
Std. Errorr Clustered by Bond	Yes	Yes	Yes	Yes
Observations	19,921	19,921	15,639	15,639
Adj R2	0.555	0.572	0.574	0.592

Table 6. Explaining Growth in Non-agency Structured ABS Holdings.

This table reports cross-sectional regressions explaining variation in the change in ABS holdings for life insurance companies over the 2003 to 2007 time period. The dependent variable in Columns (1) and (2) is the change in the structured ABS portfolio weight between 2003 and 2007. The dependent variable in Columns (3)-(5) measures the difference in the change in portfolio weights between the General and Separate accounts. The key explanatory variables are measures of outstanding annuity liabilities as of 2003 for the General and Separate accounts, respectively. Control variables include the level of structured ABS holdings as of 2003 in the General and Separate accounts, the size of the bond portfolio as a fraction of total liabilities as of 2003, and the growth in the size of the total bond portfolio over the sample period. Additional control variables include the log of the risk-based capital ratio (RBC) as of 2003, log assets as of 2003, change in asset size over the sample period, log surplus as of 2003, and the change in surplus over the sample period. *Hedging indicator* is equal to one for life insurance companies with non-zero levels of outstanding derivatives exposure. We report t-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight in Non-Agency Structured ABS Holdings, 2003-2007		(Change in General Account Portfolio Weight, 2003-2007) Minus (Change in Separate Account Portfolio Weight, 2003-2007)		
	General Account	Separate Account			
	(1)	(2)	(3)	(4)	(5)
(General Account Annuities/Liabilities) as of 2003	0.033***		0.050*		0.049**
	(2.738)		(1.691)		(2.033)
(Separate Account Annuities/Liabilities) as of 2003		0.008		0.007	0.017
		(0.591)		(0.205)	(0.530)
General Account ABS Portfolio Weight as of 2003	-0.461***		-0.592***		-0.663***
	(-7.834)		(-5.723)		(-6.508)
Separate Account ABS Portfolio Weight as of 2003		-0.595***		0.284	0.569***
		(-2.787)		(1.093)	(2.638)
Total Bond Portfolio/Liabilities as of 2003	-0.0002	0.335***	0.001	-0.022	-0.003
	(-1.575)	(2.837)	(0.037)	(-1.159)	(-0.232)
Growth in Total Bond Portfolio, 2003-2007	0.004	0.368***	-0.002	0.003	-0.001
	(1.490)	(2.927)	(-0.428)	(0.454)	(-0.325)
Hedging Indicator	-0.003	-0.002	0.015	0.021	0.015
	(-0.292)	(-0.238)	(0.824)	(0.967)	(0.872)
Log Risk Based Capital Ratio (RBC) as of 2003	0.001	0.001	-0.021	-0.023	-0.022
	(0.598)	(0.094)	(-1.281)	(-0.999)	(-1.141)
Log Total Assets as of 2003	0.006***	-0.011**	0.001	-0.016	-0.001
	(3.804)	(-2.236)	(0.079)	(-0.816)	(-0.082)
Growth in Total Assets, 2003-2007	0.020***	-0.005	0.052***	0.051***	0.046***
	(2.741)	(-0.519)	(2.905)	(2.884)	(3.176)
Log Surplus as of 2003	0.001	0.012**	0.003	0.009	0.002
	(1.237)	(2.079)	(0.203)	(0.598)	(0.168)
Growth in Total Surplus, 2003-2007	-0.008	0.007	-0.037	-0.039	-0.032
	(-1.262)	(0.445)	(-1.516)	(-1.617)	(-1.498)
Constant	-0.149***	-0.020	-0.008	0.270	0.061
	(-4.825)	(-0.266)	(-0.050)	(1.162)	(0.368)
Observations	747	169	169	169	169
Adj R2	0.241	0.368	0.271	0.044	0.323

Table 7. Growth in Non-agency Structured ABS Holdings Based on Capital and Hedging.

This table reports cross-sectional regressions explaining variation in the change in ABS holdings for life insurance companies over the 2003 to 2007 time period. *Above median capital* is an indicator variable for life insurance companies with above-median levels of risk-based capital (RBC) in the year 2003. *Hedging indicator* is equal to one for life insurance companies with non-zero levels of outstanding derivatives exposure. The key explanatory variable, (*general account annuities/liabilities)* is a measure of outstanding General Account annuity liabilities as of 2003 scaled by total liabilities as of 2003 for the General and Separate accounts, respectively. We also create an interaction term of annuities with the above-median capital and hedging indicators. Control variables include the level of structured finance holdings as of 2003 in the General and Separate accounts, respectively, the size of the bond portfolio as a fraction of total liabilities as of 2003, and the growth in the size of the total bond portfolio over the sample period. Additional control variables include the log of the risk-based capital ratio as of 2003, log assets as of 2003, change in asset size over the sample period, log surplus as of 2003, and the change in surplus over the sample period. We report t-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight in Non-Agency Structured ABS Holdings in the General Account, 2003-2007	
	Sample: Full Sample	
	(1)	(2)
Above Median Capital * (General Account Annuities/Liabilities) as of 2003	-0.051**	
	(-2.311)	
Above Median Capital	0.013*	
	(1.887)	
Hedging Indicator * (General Account Annuities/Liabilities) as of 2003		0.040
		(1.100)
Hedging Indicator	-0.007	-0.019
	(-0.637)	(-1.073)
(General Account Annuities/Liabilities) as of 2003	0.054***	0.028**
	(3.568)	(2.200)
General Account ABS Portfolio Weight as of 2003	-0.464***	-0.459***
	(-7.927)	(-7.859)
Total Bond Portfolio/Liabilities as of 2003	-0.0004**	-0.0003
	(-1.980)	(-1.610)
Growth in Total Bond Portfolio, 2003-2007	0.004	0.004
	(1.473)	(1.487)
Log Risk Based Capital Ratio (RBC) as of 2003		0.002
		(0.612)
Log Total Assets as of 2003	0.006***	0.006***
	(3.564)	(3.861)
Growth in Total Assets, 2003-2007	0.021***	0.020***
	(2.858)	(2.761)
Log Surplus as of 2003	0.001	0.001
	(1.478)	(1.131)
Growth in Total Surplus, 2003-2007	-0.008	-0.008
	(-1.327)	(-1.263)
Constant	-0.155***	-0.152***
	(-4.746)	(-4.864)
Observations	747	747
Adj R2	0.246	0.241

Table 8. Explaining Growth in Non-agency Structured ABS Holdings, By Rating.

This table reports cross-sectional regressions explaining variation in the change in ABS holdings for life insurance companies over the 2003 to 2007 time period, by rating. The dependent variable in Columns (1) and (2) is the change in the structured ABS portfolio weight of a given credit rating (as specified in the column heading) between 2003 and 2007. The key explanatory variable, (*general account annuities/liabilities)* is the measure of outstanding General Account annuity liabilities as of 2003 scaled by total liabilities as of 2003. *Above median capital* is an indicator variable for life insurance companies with above-median levels of risk-based capital (RBC) in the year 2003. Control variables include the level of General Account structured ABS holdings as of 2003, the size of the bond portfolio as a fraction of total liabilities as of 2003, and the growth in the size of the total bond portfolio over the sample period. Additional control variables include the log of the risk-based capital ratio as of 2003, log assets as of 2003, change in asset size over the sample period, log surplus as of 2003, and the change in surplus over the sample period. *Hedging indicator* is equal to one for life insurance companies with non-zero levels of outstanding derivatives exposure. We report t-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight in Non-Agency Structured ABS Holdings in the General Account, 2003-2007			
	AAA, AA, or A-Rated Sample	Non AAA, AA, or A-Rated Sample	AAA, AA, or A-Rated Sample	Non AAA, AA, or A-Rated Sample
	(1)	(2)	(3)	(4)
Above Median Capital * (General Account Annuities/Liabilities) as of 2003			-0.059***	0.007
			(-2.688)	(1.262)
Above Median Capital			0.012*	0.001
			(1.828)	(0.837)
(General Account Annuities/Liabilities) as of 2003	0.038***	-0.005	0.062***	-0.008**
	(3.193)	(-1.634)	(4.119)	(-2.016)
General Account ABS Portfolio Weight as of 2003	-0.423***	-0.037***	-0.428***	-0.035***
	(-7.281)	(-2.757)	(-7.451)	(-2.661)
Total Bond Portfolio/Liabilities as of 2003	-0.0002	-0.0001	-0.0004*	-0.000
	(-1.453)	(-1.618)	(-1.949)	(-0.843)
Growth in Total Bond Portfolio, 2003-2007	0.004	-0.000	0.004	-0.000
	(1.512)	(-0.261)	(1.496)	(-0.288)
Hedging Indicator	-0.002	-0.001	-0.007	-0.000
	(-0.235)	(-0.313)	(-0.649)	(-0.052)
Log RBC as of 2003	0.001	0.001***		
	(0.324)	(2.637)		
Log Total Assets	0.006***	-0.000	0.006***	0.000
	(4.183)	(-0.253)	(3.908)	(0.002)
Growth in Total Assets, 2003-2007	0.018**	0.002*	0.019***	0.002*
	(2.553)	(1.668)	(2.689)	(1.675)
Log Surplus	0.001	0.000	0.001	0.000
	(0.788)	(1.314)	(1.145)	(1.336)
Growth in Total Surplus, 2003-2007	-0.006	-0.001	-0.007	-0.001
	(-1.210)	(-0.973)	(-1.308)	(-0.885)
Constant	-0.142***	-0.007	-0.146***	-0.008
	(-4.850)	(-1.057)	(-4.787)	(-1.143)
Observations	747	747	747	747
Adj R2	0.229	0.065	0.237	0.070

Table 9. Explaining Growth in Non-agency Structured Corporate Bond Holdings, By Rating.

This table reports cross-sectional regressions designed to explain variation in the growth of corporate bond holdings for life insurance companies over the 2003 to 2007 time period. The dependent variable in Columns (1) and (2) is the change in the corporate bond portfolio weight of a given credit rating (as specified in the column heading) between 2003 and 2007. The key explanatory variable, (*general account annuities/liabilities)* is the measure of outstanding General Account annuity liabilities as of 2003 scaled by total liabilities as of 2003. *Above median capital* is an indicator variable for life insurance companies with above-median levels of risk-based capital (RBC) in the year 2003. Control variables include the level of General Account corporate bond holdings as of 2003, the size of the bond portfolio as a fraction of total liabilities as of 2003, and the growth in the size of the total bond portfolio over the sample period. Additional control variables include the *log of the risk-based capital ratio as of 2003*, log assets as of 2003, change in asset size over the sample period, log surplus as of 2003, and the change in surplus over the sample period. Hedging indicator is equal to one for life insurance companies with non-zero levels of outstanding derivatives exposure. We report t-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight in Corporate Bond Holdings in the General Account, 2003-2007			
	AAA, AA, or A-Rated Sample	Non AAA, AA, or A-Rated Sample	AAA, AA, or A-Rated Sample	Non AAA, AA, or A-Rated Sample
	(1)	(2)	(3)	(4)
Above Median Capital * (General Account Annuities/Liabilities) as of 2003			-0.040*	0.013
			(-1.677)	(0.792)
Above Median Capital			0.009	-0.007
			(0.940)	(-1.154)
(General Account Annuities/Liabilities) as of 2003	-0.024*	-0.021**	-0.008	-0.026**
	(-1.760)	(-2.452)	(-0.508)	(-2.327)
General Account Corporate Bond Portfolio Weight as of 2003	-0.077***	-0.093***	-0.075***	-0.094***
	(-4.570)	(-7.608)	(-4.456)	(-7.616)
Total Bond Portfolio/Liabilities as of 2003	0.0003	-0.001***	0.000	-0.001**
	(0.694)	(-2.604)	(0.574)	(-2.531)
Growth in Total Bond Portfolio, 2003-2007	0.010***	0.001	0.010***	0.001
	(2.857)	(0.317)	(2.850)	(0.311)
Hedging Indicator	-0.006	0.003	-0.009	0.004
	(-0.568)	(0.410)	(-0.829)	(0.488)
Log RBC as of 2003	-0.002	-0.001	-0.002	0.000
	(-0.447)	(-0.485)	(-0.551)	(0.069)
Log Total Assets	0.008***	-0.000	0.008***	-0.000
	(3.388)	(-0.071)	(3.369)	(-0.194)
Growth in Total Assets, 2003-2007	0.006	0.027***	0.006	0.027***
	(0.497)	(3.747)	(0.538)	(3.748)
Log Surplus	0.000	0.001	0.000	0.001
	(0.013)	(0.938)	(0.103)	(0.874)
Growth in Total Surplus, 2003-2007	-0.013	-0.009**	-0.013	-0.010**
	(-1.534)	(-2.250)	(-1.523)	(-2.298)
Constant	-0.177***	0.004	-0.179***	0.010
	(-3.872)	(0.162)	(-4.032)	(0.388)
Observations	747	747	747	747
Adj R2	0.085	0.180	0.086	0.179

Table 10. Explaining Growth in Structured ABS Holdings Based on *Changes* in Annuities Exposure

This table reports regressions of changes in ABS holdings on changes in annuities exposure. We calculate changes in structured ABS holdings over three separate time periods: 2003-2007, 2004-2007, and 2005-2007. We also calculate changes in annuities exposure over three separate time periods: 2002-2003, 2003-2004, and 2004-2005. In each regression we control for the level of outstanding annuities scaled by liabilities as of 2002. The dependent variables measure changes in the ABS portfolio over different time horizons. The key independent variables measure changes in annuities exposure measured over different time horizons. The regressions include control variables that are measured as of different time periods depending on the regression specification. We control for the level of ABS holdings as of the base year of the ABS growth-in-holdings-calculation. For example, when the dependent variable is measured as ABS growth from 2003-2007, we control for the level of ABS holdings as of 2003. We follow a similar convention for the other control variables that are also measured in levels. This includes the size of the total bond portfolio scaled by total liabilities, log RBC, log assets, and log surplus. Our specification also controls for changes in some control variables. The changes are measured over the same time period as the change in ABS holdings measure. For example, when ABS growth is measured from 2003-2007, we measure the change in the size of the total bond portfolio over the 2003-2007 time period. We follow a similar convention for the change in total assets and the change in surplus. The hedging control is an indicator variable equal to one for insurance companies that report non-zero derivatives holdings. We report t-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight of Non-Agency Structured ABS in the General Account						
	ABS Growth '03-'07	ABS Growth '04-'07	ABS Growth '04-'07	ABS Growth '04-'07	ABS Growth '05-'07	ABS Growth '05-'07	ABS Growth '05-'07
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Growth in Annuities, 2002 through 2003	0.054*	0.054*		0.047*	0.030		0.030
	(1.747)	(1.963)		(1.774)	(1.371)		(1.375)
Growth in Annuities, 2003 through 2004			-0.045	-0.036			
			(-1.288)	(-1.094)			
Growth in Annuities, 2004 through 2005						-0.011	-0.011
						(-0.421)	(-0.427)
(General Account Annuities/Liabilities) as of 2002	0.030**	0.034***	0.030**	0.032**	0.016	0.015	0.016
	(2.047)	(2.592)	(2.300)	(2.466)	(1.506)	(1.365)	(1.460)
Level of ABS Holdings	-0.414***	-0.279***	-0.274***	-0.277***	-0.214***	-0.212***	-0.214***
	(-7.044)	(-4.157)	(-4.175)	(-4.199)	(-3.024)	(-3.009)	(-3.022)
Total Bond Portfolio/Liabilities	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.277)	(-0.748)	(-0.760)	(-0.742)	(-0.666)	(-0.704)	(-0.706)
Growth in Total Bond Portfolio	0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(1.011)	(1.512)	(1.575)	(1.526)	(-0.039)	(-0.057)	(-0.074)
Hedging Indicator	-0.010	-0.014	-0.015	-0.015	0.000	0.000	0.000
	(-0.874)	(-1.389)	(-1.507)	(-1.443)	(0.055)	(0.005)	(0.057)
Log RBC	0.003	0.005	0.005	0.005	0.007*	0.007*	0.007*
	(0.701)	(1.206)	(1.305)	(1.223)	(1.771)	(1.797)	(1.752)
Log Total Assets	0.008*	0.006*	0.007**	0.006*	0.006**	0.006**	0.006**
	(1.949)	(1.799)	(2.092)	(1.845)	(2.308)	(2.499)	(2.312)
Growth in Total Assets	0.033***	0.036***	0.036***	0.036***	0.023*	0.023*	0.023*
	(4.151)	(3.554)	(3.531)	(3.538)	(1.794)	(1.787)	(1.792)
Log Surplus	-0.001	-0.001	-0.002	-0.002	-0.003	-0.004	-0.003
	(-0.341)	(-0.396)	(-0.653)	(-0.450)	(-1.195)	(-1.368)	(-1.202)
Growth in Total Surplus	-0.015	-0.015*	-0.015*	-0.015*	-0.007	-0.007	-0.007
	(-1.642)	(-1.843)	(-1.906)	(-1.872)	(-0.875)	(-0.904)	(-0.887)
Constant	-0.151***	-0.111***	-0.115***	-0.111***	-0.072***	-0.074***	-0.072**
	(-4.098)	(-3.243)	(-3.360)	(-3.263)	(-2.588)	(-2.647)	(-2.582)
Observations	683	683	683	683	683	683	683
Adj R2	0.203	0.153	0.152	0.153	0.108	0.107	0.107

Appendix: Institutional Features of the Insurance and Annuity Market

Life insurance companies write mortality contingent liabilities as well as some health insurance and deposit contracts. Mortality contingent contracts make up the vast majority of the liabilities of life insurance companies. We will focus on two broad categories of mortality contingent products: life insurance and annuity policies.

In addition to simple annual term life insurance, there are four broad categories of long-term life insurance policies: whole life, universal life, variable life and guaranteed term (possibly convertible) life insurance. Term insurance, whether annual or guaranteed term, has no cash value accumulation and is priced based upon the cost of mortality and annual expense loadings. Whole, universal, and variable life policies have a cash value accumulation. They are priced based upon the cost of mortality over the insured's remaining life, annual expense loadings, and assumptions about asset yields over the life of the policy.

With a whole life policy the insurance company sets the annual premium and bears all of the investment risk associated with the long-term nature of the contract. In contrast, a variable life policy offers a variety of accounts that are like mutual funds, for the policyholder to choose among for the cash value accumulation of the policy. The policyholder bears the investment risk in a variable life policy. The annual premium may increase or decrease depending upon asset yields over the life of the policy. Universal life is between whole life and universal life in terms of risk. The policyholder does not direct the investment of the cash value account. But, the rates credited to the cash value may vary with market bond yields. And, if yields are low there may be an increase in premium required to keep the policy in force.

In general, the less asset price risk that is borne by the policyholder, the greater the risk borne by the insurance company. In fact, when the insurance company bears the risk they are providing implicit, or explicit, performance guarantees to the policyholder. For example, with

whole life insurance, the company guarantees to provide lifetime coverage regardless of whether market asset yields fall well below initial assumptions at the time the policy was sold. In the worst cases, the company would be required to commit its own capital to make good on its obligations. It is this risk that motivates regulation and capital requirements.

As with life insurance, there are a variety of annuity products that are sold by life insurance companies. The simplest product is a fixed-term single-premium immediate annuity. With this product, a policyholder pays a one-time lump sum premium in return for the immediate inception of a fixed nominal, or real, payment stream for a pre-specified term. The insurance company bears the risk that asset yields may change during the life of the annuity.

Other annuity products can be understood as variations on the fixed-term single-premium immediate annuity. For example, a single-premium immediate life annuity still involves the payment of a one-time lump sum premium in return for the immediate inception of a fixed nominal, or real, stream of cash flows. In this case, though, the cash flow stream will continue until the death of the insured. More complex life annuities may be purchased with a guaranteed period of payments plus continuation for the life of the insured and/or the spouse.

Another common annuity product is the deferred annuity. As with the immediate annuity, the purchaser may receive a fixed nominal, or real, stream of cash flows. But, in this case the inception of the cash flow stream is delayed. Thus, there is an accumulation period, during which the premium may be invested, prior to the payment period. In addition, these deferred annuities often allow for a choice of a lump-sum payment rather than receiving periodic payments. The lump-sum payout is selected in a vast majority of cases when the choice is offered. The payout is often guaranteed to be *at least* some amount, in either lump sum or as a periodic payment, depending upon market conditions during the accumulation period.

Deferred annuities offer a variety of accumulation alternatives. Fixed deferred annuities offer an initial fixed interest rate (guaranteed for one, or more, years) and then the declared interest rate for subsequent years may vary depending upon the company's investment and expense experience during the accumulation period. Fixed deferred annuities usually have a guaranteed minimum interest rate.[17] A guaranteed rate is in force for the life of the policy and may not be changed once a policy is issued. Thus, guaranteed interest rates create a risk for the insurance companies that market rates may decline and that they may be required to commit their own capital to make good on their liabilities. This has, in fact, happened often during interest rate declines over the past decade.

Another broad class of deferred annuity is the fixed-indexed annuity. This product offers the policyholder a choice between a declared interest rate account, similar to the one described above for the fixed deferred annuity, and one or more accounts that are indexed to broad equity market indices. The equity indexed accounts typically offer no negative returns along with fractional participation in upward movements in the index and/or caps on positive index returns. These policies also create a risk to the insurance companies. When equity indices increase, creating increases in annuity account value, and then decline for extended periods, the insurance company is still obligated to protect the policyholder with only non-negative credits to the annuity. Thus, equity market declines may decrease the insurance company's assets while the liability under the annuity contract does not decline.

One last broad category of annuity products is the variable annuity. This is a deferred annuity contract where the policyholder directs the investment of the premium and accumulation

[17] In addition to any contractually specified minimum guaranteed interest rate, regulators impose "non-forfeiture requirements" that specify the minimum cash value that an annuity may return to a policyholder. Prior to 2004, this was 87.5 percent of premium accumulated at an annual rate of 3%. In more recent years the interest rate may be as low as 1% and is tied to Treasury rates.

value among several included alternatives that are like mutual funds. In this case the policyholder bears the market risk during the accumulation period. These also offer lump-sum and fixed-payment options at the end of the accumulation period.

For any of these life insurance or annuity products where the insurance company bears risk associated with guaranteed performance and asset yields, the product is issued as a claim on the insurance company's general account. There is no unique investment account for each policyholder. Rather, the insurance company collects premiums, aggregates them into the general account, invests in assets, and makes payments as required by the contracts. Profit is made when aggregate premiums and investment earnings, less expenses, exceed liability payments. When needed, the company contributes its own capital to make good on the obligations and suffers a loss on the product.

For products where the investment risk is passed through to the policyholder, primarily variable life or variable annuity products, the policyholder's premium is placed in a separate account and the premium and investment returns are tracked on a policy-by-policy basis.

Important to this paper is a key difference between general and separate accounts. Because the general account supports (potentially guaranteed) payments to policyholders, it is subject to capital requirements. In fact, the general account is the key reporting unit for statutory accounting purposes. The separate account is not subject to capital requirements because asset price risk is passed through to the policyholder. Both general and separate accounts are subject to policy form regulations.