Final Demand for Structured Finance Securities

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Abstract

Structured finance boomed during the run-up to the Financial Crisis. Highly rated, structured securities offered higher yield than other similarly rated bonds due to their concentration of systematic risk, but regulatory capital requirements did not account for this risk. As a result, regulated entities facing capital constraints had an incentive to invest in them. 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, consistent with regulatory arbitrage distorting the demand to hold these assets.

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Introduction

According to Flow of Funds (Federal Reserve), private-label (non-agency) structured finance securities (alphabet soup: ABS, RMBS, CLOs, CDOs, CBOs; we will refer to these bonds generically as "non-Agency ABS") increased from an outstanding balance of $2.2 trillion in 2003 to $4.2 trillion in 2007, an increase of 94%. No other fixed income security class grew as rapidly. Why were investors willing to absorb such an increase? Popular narratives of the Financial Crisis often ignore the role of final demand for these securities. Yet, without demand from final investors, it is difficult to imagine the supply of private-label securities would have increased so dramatically between 2003 and 2007.

We argue that final demand for private-label finance securities was distorted by a regulatory arbitrage that encouraged financial institutions to purchase high-yielding assets that carried low regulatory capital costs. The structured finance boom followed a period of declining interest rates.[1] Firms exposed to losses when interest rates fall have an incentive to reach for yield. Highly rated, structured securities offered higher yield than other similarly rated bonds due to their concentration of systematic risk. Regulatory capital requirements did not account for or "price" systematic risk, creating an incentive for firms in need of yield to satisfy that demand in the form of regulatory capital-efficient, high-yielding, non-Agency ABS.

Unfortunately, lack of consistent data have thus far limited studies of the demand to hold non-Agency ABS.[2] The primary exception is insurance, where regulators require companies to

[1] Rajan (2005) argues that a sustained period of low interest rates fueled a speculative boom. More broadly, Aliber and Kindleberger (1978) show that financial crises tend to be preceded by periods of sustained loose monetary policy.

[2] While the Flow of Funds characterizes suppliers of these securities, including issuance of private-label securities, they do not characterize demanders. For example, in the balance sheet tables of potential purchasers (banks, insurance companies, pension funds, mutual funds, and endowments), non-Agency ABS are grouped with traditional corporate bonds. Moreover, data on security-level investments are not available for most of the major market participants.

report their securities holdings. While we believe the economics described in this paper provide a plausible explanation for the purchasing behavior of most regulated financial institutions, we examine insurance company demand as a laboratory for the broader forces at work in the structured finance market. We show that insurance company demand during the boom was increased, and distorted, by a regulatory arbitrage that encouraged capital-constrained firms to purchase highly rated non-Agency ABS in a low interest rate environment. We find that certain firms account for a disproportionate share of the industry's increased holdings. In fact, life insurers with the strongest incentive to invest in non-Agency ABS almost tripled their holdings over our sample period, compared to a two-fold increase in issuance of non-Agency ABS.

Our empirical set up focuses on insurance companies for the sake of data and identification. Deferred annuities with embedded interest rate guarantees (hereafter, guaranteed annuities) differentially expose insurance companies to unrealized losses in a low-rate environment. We exploit this fact to generate cross-sectional variation in negative shocks to capital. Declines in capital both move companies closer to ratings downgrades, or regulatory minimums, and increase 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 return vs. risk. Regulatory capital depends on credit ratings which, as Coval, Jurek and Stafford (2009) argue, are insufficient for pricing; ratings account only for physical default, but prices depend also on the value of claims in states of default. Thus, regulated insurance companies with incentives to deliver yield (i.e., those with high exposure to guaranteed annuities) ought to reach by investing where yields are high but capital requirements are low (e.g., in highly rated non-Agency ABS securities).[3]

[3] The challenge facing writers of fixed deferred annuities was well known, as illustrated by this quote from the December 2002 Wall Street Journal article entitled, "Insurers Find It Hard to Guarantee 3% Return," "With record-

To test this idea, we first document that yields on highly rated non-Agency ABS securities exceeded those of 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 non-Agency ABS offer yield spreads about 25-75 basis points higher than similarly rated bonds, with the difference concentrated between 2003 and 2005.[4] The result also extends that of Pennacchi and Iannotta (2012), who shows that systematic risk affects 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 non-Agency 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, 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).

Our data come from holdings of more than 130,000 securities, representing an aggregate principal balance of almost $500 billion (by 2007) across more than 700 insurance companies. In this sample we find, first, that insurance companies increased non-Agency ABS from an average of 6.4% (8.4%) of total assets (total fixed income holdings) in 2003 to an average of 7.5% (10.4%)

low interest rates and slumping stock prices, insurers say it's getting hard to provide the minimum guaranteed return on fixed annuities, which is set by law in many states at 3%. Every drop in interest rates, such as November's half-point cut by the Federal Reserve, makes fixed annuities even more attractive to customers – … and more difficult for insurers to finance."

[4] 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 non-Agency ABS and thus lowered their yield relative to what would be expected in an undistorted market.

of total assets (total fixed income holdings) in 2007. This increase crowded out holdings primarily of corporate bonds, as well as municipal bonds and agency securities to a smaller extent. Second, increased holdings were concentrated among insurers with large annuities exposure. Thus, demand was distorted across insurance companies and a subset of insurers absorbed a disproportionate share of non-Agency ABS. To understand magnitudes, firms that had one-standard deviation larger annuities liabilities as of 2003 increased their subsequent holdings of non-Agency ABS by an average of 1 percentage point of total assets between 2003 and 2007. Third, the positive relationship between ex ante annuities issuance and subsequent investment in non-Agency ABS is evident *only* in the highly rated segment (AAA, AA and A-rated), the segment where capital requirements are lowest.

Though the aggregate increase in holdings may appear as though insurers merely absorbed their pro-rata share of ABS, our results are concentrated among insurers most exposed to interest rate declines via the annuity channel. Concentrated increases in holdings within the cross-section of insurers underscores a central contribution of this paper, which is to describe the potential distortionary impact credit-ratings-based capital requirements can have on financial institutions. While our data force us to analyze insurance companies, similar economics could be at work with other financial institutions with capital adequacy requirements.

An identification strategy that relies solely on *ex ante* annuity exposure is limited. Although interest rate shocks create plausibly exogenous unexpected losses, exposure to those shocks may not be exogenous. For example, unobservable firm attributes – managerial risk appetite, for example – could be correlated with both the purchase of highly-rated non-Agency ABS and exposure to annuities. To address potential omitted variables, we exploit a 2004 regulatory change that lowered the minimum guaranteed interest rate for subsequently issued annuities, but kept the

minimum guaranteed interest rate in force for existing policies. With this change, we can compare the effect of annuity sales made under the pre-2004 high minimum guaranteed interest rate on subsequent non-Agency ABS purchases with that of annuity sales made in the lower rate guarantee environment. We find that annuities sold under the higher guaranteed rate predict subsequent non-Agency ABS purchases, but incremental annuities sold in the lower rate guarantee environment do not. These difference-in-difference patterns are hard to explain with omitted variables that might drive both liability (annuity issuance) and asset (non-Agency ABS investment) risk taking.

Though our identification strategy attempts to rule out alternative explanations for increased ABS, at least two alternatives warrant consideration. First, the increased supply of ABS implies that investors seeking to hold the market portfolio would increase their portfolio weight in ABS. While true for all insurers, our empirical strategy investigates *cross-sectional* differences in ABS holdings. We show that cross-sectional differences can be explained by ex-ante high vs. low exposure to guaranteed annuities. A second possibility, even within the cross-section, is that insurers used ABS as a hedge against duration risk. Yet ABS are ill-suited for this task, particularly for insurers facing interest rate guarantees, because ABS have negative convexity at low interest rates (due to pre-payment risk). Interest rate derivative offer a means to hedge duration risk, but we find that only about 10% of the insurers in our sample report using them.

Our results complement those of Becker and Ivashina (2013), who study corporate bond holdings (as opposed to non-Agency ABS) and find that insurance companies engaged in more '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. Yet, Becker and Ivashina (2013) do not uniquely predict demand sufficient for the explosion of non-Agency ABS. We contribute to this literature by documenting the advantages of non-Agency ABS over corporate bonds in

reaching for yield. Further, we can exploit cross-section variation in exposure to a declining interest rate environment to identify regulatory arbitrage as a motivating force. We find that greater exposure to the shock was followed by an increase in investment in the non-Agency ABS market, where yields were high and capital requirements insufficient relative to the underlying systematic risk.

Our analysis sheds light on policies and investment decisions that helped fuel a potential misallocation of credit (see Diamond and Rajan (2009)). As we will describe, most of the existing literature on structured finance has focused on the supply side. Issuers of non-Agency 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. Because credit originators expected to securitize assets, their incentives to engage in careful due diligence declined, resulting in a rapid expansion of credit that helped fuel the housing boom. A complete explanation of the explosion in structured finance, however, requires understanding not only the supply side but also the demand side. Our results suggest that two policy decisions distorted demand for non-Agency ABS. The first distortion came from capital regulations 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. 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.

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

2. Demand for Non-Agency ABS

Analyzing final demand for non-Agency ABS (as well as GSE-backed securitized assets) is complex because there are (at least) three market segments. 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 an explanation of which of these three segments 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 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 non-Agency ABS securities can be viewed as expressing supply, and the investors who purchase the securities (among whom are insurance companies) can be viewed as expressing demand.

Most of the extant research has focused on supply. At the heart of the supply-driven view: 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), 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 building non-Agency ABS 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 (2013) show that the explosive growth of the asset-backed commercial paper market followed a regulatory decision that allowed banks to reduce required capital to nearly zero without moving the risks to other investors ('securitization without risk transfer'). Gorton and Metrick (2012) 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 is that securitization is a rational response to mispricing in the underlying fundamentals (Shleifer and Vishny, 2010).

The rapid expansion of non-Agency ABS also weakened incentives for lenders to screen and monitor borrowers and for credit rating agencies to 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, Quan and Strahan (2012) provide evidence that ratings were less trusted by investors (i.e. more inflated) for securities

originated by large issuers. Moreover, Piskorski, Seru, and Witkin (2013) and Griffin and Maturana (2016) 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 non-Agency ABS 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 subprime mortgage market. Loutskina and Strahan (2015) show that financial integration facilitated by the growth of non-Agency ABS 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 non-Agency ABS issuance and expanded the supply of credit to primary-market borrowers. Naturally investors must purchase non-Agency ABS supplied, but until recently the literature has remained quiet regarding factors that drive purchasing patterns of investors. In a contemporaneous paper, Chernenko, Hanson, and Sunderam (2016) 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 our 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 non-Agency ABS.

3. Theoretical Underpinnings of Regulatory Capital Arbitrage

In a frictionless world with financial intermediaries making asset allocation decisions for investors, asset managers would simply maximize return subject to a given tolerance for risk (e.g. based on clientele preferences). In practice, at least two salient frictions exist in a regulated financial intermediary, such as insurance, that could distort this choice and give rise to investment behavior that could be described as regulatory arbitrage. The first friction is a risk-shifting motive in the spirit of Jensen and Meckling (1976), and the second friction arises due to the effects of risk-based capital requirements in the presence of equity issuance costs.

In the presence of an expected (but not yet realized) liability, a financial intermediary would anticipate that regulatory capital rules will require equity issuance when losses are realized. Given costs of raising equity, a financial intermediary may choose to invest in securities with promised yields that are high relative to expected returns (i.e. chase yield by tilting to high-risk bonds), thus potentially reducing the need to issue equity in the future. High return realizations would alleviate the future declines in regulatory capital, whereas with limited liability low realized returns would harm creditors rather than shareholders (this is the risk-shifting effect of Jensen and Meckling, 1976). But with risk-based capital requirements, chasing yield may also bring an immediate increase in regulatory capital. The desire to reduce both the immediate amount of capital tied up in these requirements and future equity issuance costs will lead an intermediary to choose capital efficient portfolios that still deliver high yield.[6] In the presence of unrealized losses,

[6] It is worth noting that the same incentive to raise capital that applies to low levels of RBC in the absolute level also apply to RBC levels that would trigger a ratings downgrade (see Merrill, Nadauld, Stulz and Sherlund, 2015). Thus, negative capital shocks may induce even high RBC companies to reach for yield if a ratings downgrade might be triggered by the capital shock. The incentive to reach for yield, though, should be greater, in general, for lower RBC levels.

financial intermediaries address expected capital deficiencies by substituting for the expected costs of equity issuance with higher current yields using regulatory capital-efficient securities.

Regulation encourages yield chasing in non-Agency ABS because 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. For example, Pennacchi and Iannotta (2012) show that a financial intermediary subject to regulatory capital requirements based on credit risk may overinvest in securities with high systematic risk. 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 an immediate 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 issuing equity is costly, the latter choice will be taken. As Coval, Jurek, and Staffrd (2009) show, highly rated non-Agency ABS are designed specifically to achieve the maximum credit rating relative to their systematic 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'.[7]

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).[8] The first step in the RBC ratio calculation is to multiply the face value of each bond by its "RBC net factor," which depends on the bond's credit rating. Bonds

[7] In addition to catastrophe risk, Hurst et al (2015) provide evidence that the non-agency RMBS market may have priced regional mortgage-default risk. If regional default risks were not properly incorporated into credit ratings, regional default risk would be an example of an additional source of yield in RMBS that would not impact capital requirements.

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

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 more for each credit quality rating level as bond credit quality declines. Regulated intermediaries thus would be expected to tilt toward the purchase of highly rated non-Agency ABS securities, where yields are highest relative to required capital.

Becker and Ivashina (2015) 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 non-Agency ABS because these products are designed specifically to achieve the highest yield relative to their rating. In addition, we are able to offer insight into which insurance companies, in the cross section, will have a greater incentive to reach for yield beyond a correlation with low RBC levels. Conditional, then, on non-Agency ABS delivering higher yields for a given regulatory capital bucket, insurance companies (as regulated intermediaries) ought to have reallocated away from traditional debt securities and into non-Agency ABS. Moreover, this effect should have been strongest for those companies experiencing unexpected shocks that pushed capital toward regulatory minimums.

4. Empirical Framework

4.1 Testing how capital requirements distort demand for non-Agency ABS

We have argued that non-agency ABS securities were attractive in light of a regulatory capital framework based on credit ratings, whereas the market yields of non-Agency ABS incorporated the full price of systematic risk. The ideal experiment would consist of unexpected and randomly assigned shocks to insurers' capital levels. Then, one could observe the subsequent investment decisions of the shocked firms, with a prediction that those firms suffering unexpected shocks to capital would be more likely to tilt their portfolios towards securities with higher yield per unit of regulatory capital.

In the absence of a controlled experiment, we consider the next best alternative. Life insurers sell a mix of products but focus primarily on life insurance and deferred, fixed-rate annuities. These annuities offer minimum interest rate guarantees to their annuitants. A guaranteed rate may not be changed once a policy is issued. Two types of rate guarantees exist. One is a contractual guarantee offered by the company, and the second is a regulatory floor on annuity surrender value that is calculated based on a minimum guaranteed interest rate. Both guarantees represent a claim on the issuing company's assets. Thus, guaranteed minimum 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. As a result, unexpected declines in market interest rates would lead to declines in company earnings over the life of the contract.

As an example, consider a fixed-rate deferred annuity with a ten-year maturity and a 3% guaranteed minimum interest rate sold in the year 2000 when Treasury yields with duration similar to the annuity hovered around 6.5%. By the year 2003, Treasury yields had fallen to 2.5%, below

the minimum guaranteed crediting rate of 3%.[9] The unexpected decline in interest rates creates an unrealized liability, because contracts are held at book value, which will continue to grow through time if market interest rates remain at low levels. Thus, the insurance company experiences an unexpected shock to their capital levels as they are forced to commit their capital to meet the obligations of the annuity.

A few additional institutional features serve to buttress the quasi-experimental setting described above. First, the regulatory minimum guaranteed rate on surrender values was set at 3% until 2004. As a result, all annuities issued prior to 2004 in our sample were subject to regulatory minimum guaranteed interest rates of 3%. Additionally, in 2004, due to the pressure of declining market rates, the regulatory rate on newly issued annuities was allowed to drop as low as 1% – an institutional feature that we exploit for identification in subsequent specifications.

A second institutional feature addresses the obvious question of whether insurance companies simply hedged this risk. Surprisingly, the data indicate that only about 10% of the insurers in our sample held any interest rate derivative positions. 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 straight bond when rates fall. 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 (mortgage refinancing speeds up when rates fall). These securities actually have

[9] The interest rate threshold for losing money on an annuity with a guaranteed minimum rate is actually above the level of the guaranteed minimum interest rate because the insurance company must also cover the expenses associated with managing the annuity. The expense spread can be in excess of 150 basis points.

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.

To better understand the sensitivity of annuity values to declines in interest rates, 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.

As a summary of the quasi-experiment, guaranteed interest rates on annuities create a risk for the insurance companies that market rates may decline, which would force 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 could thus lead to declines in company earnings over the life of the contract. Meeting the cash flow burden implied by these guarantees, if a low-rate environment were realized, would require such firms either to increase yield (risk) on their assets, or liquidate assets to generate cash. Thus, given the low interest rate environment that did occur, it is reasonable to conclude that insurance companies with larger exposure to guaranteed annuity contracts had both a stronger incentive to reach for yield *and* to alter their portfolio holdings to avoid binding regulatory capital constraints.

4.2 Empirical specification

Variation in the exposure of life insurance companies to minimum interest rate guarantees provides an empirical framework to evaluate the impact of the regulatory capital framework on holdings of non-Agency ABS. Consider a simple, linear specification of the following form:

$$\Delta\left(\frac{Struct\ ABS\ Holdings_{i,2003\rightarrow2007}}{Total\ Assets_{i,2003\rightarrow2007}}\right) = \alpha + \beta_1 \frac{Annuities_{i,2003}}{Liabilities_{i,2003}} + \gamma X_i + \varepsilon_i. \quad (1)$$

This specification proposes a cross-sectional regression where the change in the portfolio weight of investments in non-agency ABS between 2003 and 2007 depends on annuities exposure as of 2003. Subscript *i* represents life insurance company *i*. No time subscripts are required because it is a cross-sectional regression estimated as of 2007. Annuities/Liabilities, our proxy for shocks to life insurance capital, is measured as of 2003 because the level of annuities as of 2003 should capture annuity originations that occurred during years prior to the decline in rates. For example, 5-year Treasury rates fell from more than 6.5% to below 2.5% between 2000 and 2003. We also control for a set of firm-level and investment-account controls (X_i in equation 1).[10] Firm-level controls include the level of non-Agency 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 of 2003 and the change in the size of the total investment account bond portfolio over the sample period.[11]

[10] 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.

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

4.3 Evaluating the relevance of annuities exposure

Our identification strategy assumes that guaranteed annuities as of the end of 2003 exposed firms to future accounting losses (and thus pressure on capital ratios). To validate this notion, we compare 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.[12] 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. Because we want to validate the level of 2003 annuities exposure, we evaluate returns over the annuities build-up period rather than a traditional regression where annuities exposure predicts future returns. Given that the average deferred annuity maturity is five years, or more, market returns over the 1998-2003 time period should reflect the market's view of the exposure created by the issuance of new annuities over this period. Thus, the level of annuities holdings as of 2003 should capture the aggregate build-up of annuities over the years prior to 2003.

Figure 2 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)

[12] 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.

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.

To further validate our measure, we briefly compare annuities exposure to the results of Koijen and Yogo (2014), who measure the shadow cost of regulatory capital for 45 large life insurers. Under our hypothesis, high levels of annuity sales created subsequent capital constraints. Under the Koijen/Yogo hypothesis, capital constrained firms were more likely to sell products at a loss during the financial crisis to obtain regulatory capital relief. As such, we would expect to find some correlation between the two measures. 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. Thus, we simply compute the correlation of their measure of the shadow cost of capital with our measure of annuity exposure. We are able to match our non-Agency 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.

4.4 Evaluating omitted variables

We now turn our attention to the consideration of omitted variables. We argue that our setting represents a quasi-experiment because the decline in interest rates that occurred between the years 2000-2003 created an unexpected future liability to insurers that had built up large annuities exposure. While the decline in interest rates could be considered exogenous, firm's exposure to that decline, i.e. the decision to sell large quantities of fixed-rate annuities with

minimum interest rate guarantees, may not be. That decision could be correlated with a host of unobserved firm-level, or management-level characteristics.

In order to rule out potential omitted variables, we exploit one additional institutional feature: A regulatory change implemented in 2004 allowed for a one-time lowering of the minimum guaranteed interest rate embedded in 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 non-Agency 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 non-Agency ABS, we should see *changes* in annuities exposure between 2002 and 2003 impact the subsequent demand for non-Agency ABS. 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 non-Agency 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.

5. Data and Summary Statistics

5.1. Constructing the sample

We begin with securities holdings data of life insurance companies. 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, ABS 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 non-Agency ABS 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 data on each of the variables we include in our regressions.

5.2 Summary statistics

Table 1 reports summary statistics on securities holdings by security type. Panel A tabulates securities holdings as a fraction of the total assets, while Panel B reports holdings scaled by total bond holdings. Average firm-level holdings of non-Agency ABS scaled by assets was

7.5% in 2007, up from 6.4% in 2003. It is important to note that life insurance assets grew substantially over this time period. A 1.1 percentage point increase in non-agency ABS holdings as a fraction of assets represents an impressive 55% increase in aggregate holdings, from $301 B in 2003 to $469 B in 2007 (see Table 2). Although average holdings per firm increased from $403 M to $628 M, the aggregate increases in holdings were not spread uniformly across insurers. Rather, increases in holdings were most concentrated among firms with the largest incentives to reach for yield, a result we highlight in Table 5.

In comparison, corporate bond holdings dropped as a percentage of total assets, falling from an average of 28.5% in 2003 to an average of 26.4% in 2007, as reported in Table 2. Holdings in municipal bonds also declined slightly. U.S. Treasuries remained stable as did holdings of Agency securities. 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. The results in Table 2, Panel B confirm that patterns in holdings are consistent when scaled by assets or the total size of the bond portfolio.

Table 3 reports trends on holdings of various asset classes. Panel A, along with Figure 4, documents a naïve version of our core result. We sort firms based on their level of annuity exposure as of 2003. The cells report how ABS holdings evolve from 2000 to 2007. These simple comparisons show pre-event trends (2000-2003) that, if anything, strengthen our findings. From 2000 to 2003, holdings of non-Agency ABS for firms with above-median annuities *fall* by 0.6 percentage points; in contrast, holdings for firms with below-median annuities *rise* by 0.4 percentage points. Post-2003, these trends shift: above-median annuities firms *grow* their non-Agency ABS holdings by nearly 3 percentage points, as compared to just one percentage point for below-median annuities firms over the same period. Figure 4 characterizes this result graphically.

We plot the change in the ABS share between 2000 and 2007, normalized by the level observed in 2003. Non-Agency ABS investments rise by more for firms more exposed to annuities. In fact, the differential trends after 2003 are larger when we compare top-quartile with bottom-quartile annuity firms. While these patterns suggest that high exposure to annuities encouraged firms to invest in non-Agency ABS bonds, they do not control for possibly confounding factors. So, below we present results from regressions explaining the growth of non-Agency ABS holdings from 2003 to 2007 among a cross-section of life insurance companies.

Table 3, Panels B, C, and D report holdings of non-agency ABS, Corporate bonds, and Municipal bonds, respectively, as a function of credit quality. The patterns documented in these panels also demonstrate, though crudely, an important result of the paper – increases in highly-rated (NAIC level 1 – AAA, AA, and A ratings) non-agency ABS securities are concentrated in the highly-rated sample. This result is consistent with highly-rated non-Agency ABS securities delivering higher yields than corporate bonds, a result we document below. Holdings of lower rated (NAIC level 2-6, < A ratings) non-agency ABS securities decrease through time. Corporate or Municipal bond holdings either remain steady, or decline in each ratings category.

6. Do Non-Agency ABS Deliver Higher Yields than Corporate Bonds?

We have argued that highly rated non-Agency ABS delivered more yield than other similarly rated securities by concentrating systematic 'catastrophe' risk. In this section, we compare yields on non-Agency ABS with those of similarly rated corporate bonds. We first identify all non-Agency ABS 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 non-Agency ABS depends on the seniority of the security within the issuance. We use Bloomberg's estimate of weighted average maturity for both non-Agency ABS and corporate bonds. Our measure of yield is the yield spread, calculated as the reported yield-to-maturity at acquisition minus the yield on Treasuries with comparable maturity. We remove any convertible bonds from the sample.

We begin by reporting simple summary statistics on the yield-spread of highly rated structured securities and corporate bonds over various maturity horizons. The average yield spreads tabulated in 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 38 basis point higher yields than corporate bonds, while at the longest end of the yield curve the yield difference was 10 basis points. Yield-spread premiums for structured securities persist over most maturity horizons.

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 deliver higher yields than AA or AAA-rated securities (Becker and Ivashina (2015)).[13] However, the evidence provided in the lower portion of Table 4 suggest that AAA-rated structured securities were associated with higher average yields than A-rated corporate bonds during our sample period.

Figure 5 compares the yield spreads on non-Agency ABS and corporate bonds over time. These figures suggest that yield spreads tended to be highest during the early years of the non-Agency ABS boom (2003-2005). We see smaller differences in 2006. Then, in 2007 – when the

[13] 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.

risks of non-Agency ABS started to come to fruition – the differences grow quite large. The results on yield differences have important implications. First, they indicate that AAA-rated structured securities were a capital efficient means of delivering high yield. Second, market participants appeared to price some of the systemic risk inherent in structured securities, despite their reported credit ratings. Third, the pricing of the systematic risk declines over time, as strong demand for non-Agency ABS drove down yields.

7. Explaining Growth in Holdings of Non-Agency ABS

As we have argued, the urgency to deliver yield, subject to capital requirements, increased demand for non-Agency ABS. Our proxy for cross-sectional differences in demand for non-Agency ABS is the amount of outstanding guaranteed annuities as a fraction of total liabilities as of 2003. 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. non-Agency ABS).

Table 5 tabulates the results of cross-sectional regressions. In column (1), we model the change in non-Agency ABS portfolio weights from 2003 through 2007 with limited control variables - just the level of non-Agency ABS holdings as of 2003 (to address the fact that annuities exposure as of 2003 is likely to be correlated with the pre-treatment level of non-Agency ABS holdings). We find a positive and statistically significant relationship between outstanding annuities as of 2003 and subsequent changes in holdings of non-Agency ABS. In column (2), we

re-estimate the model when controlling for a host of firm attributes measured as of 2003. The estimated coefficient of 0.033 suggests that a one-standard deviation increase in annuities (=29%) is associated with a one percentage point increase in the ratio of non-Agency ABS holdings to total assets. Given the increase in average asset size, a one percentage point increase in ABS holdings scaled by assets corresponds roughly to a $200 Million increase in ABS holdings for the average firm, a relative increase in the dollar amount of holdings of almost 50%.

To more fully appreciate the economic magnitude of the results presented in columns 1 and 2, it is important to note that our estimates are cross-sectional, thus limiting our ability to fully explain aggregate increases in ABS holdings. The results do, however, highlight the fact that each and every insurer in our sample did not simply soak up their pro-rata share of supplied ABS. For example, firms in the top decile of annuity exposure increased their structured holdings as a fraction of assets by an average of 1.5 percentage points over our sample period, while the top 25 annuity issuing insurers increasing holdings by 3 percentage points. In comparison, firms in the bottom decile, those with no annuity exposure, showed little increase in structured holdings. Although in aggregate, the insurance industry appears to have absorbed its pro-rata share, growth in ABS holdings were concentrated among insurers with the strongest incentives to reach for yield. Many of the firms in our sample did not report any outstanding annuities as of 2003, and are thus categorized as holding zero annuities. One concern with this assumption is that our results could be biased by fundamental but unobserved differences between annuity and non-annuity writing firms. In column (3), we estimate the model in a sample of non-zero annuity writing firms and include the standard set of firm-level controls included in column (2). The estimated coefficient is 0.043 and remains statistically significant, indicating that differences in 2003 annuity levels within annuity-active firms is a meaningful predictor of subsequent ABS growth. A different concern,

even among annuity-active firms is that our size control does not adequately address how differences in size could drive both annuity issuance and ABS growth. In column (4), we estimate the model with only above-median sized firms within the sub-sample of positive annuity writers. The estimated coefficient remains economically large (0.053) and statistically significant (t-stat=2.78), indicating that even within the largest firms, differences in annuity exposure as of 2003 predicts substantial differences in subsequent ABS investment.

7.1 Do the portfolios of high annuities insurers differ along other observable dimensions?

The models estimated in columns (1)-(4) could produce biased estimates of the effect of annuities on structured non-Agency ABS holdings for at least two immediately obvious reasons. The first possibility is selection bias. High annuity firms could differ along a host of observable dimensions because the accumulation of annuities exposure by an insurer is not random (though, we argue, the consequence of high annuities exposure to unexpected interest rate changes is random). Second, unobserved firm attributes such as managerial risk appetite or management quality could jointly impact annuities exposure and the decision to overinvest in structured non-Agency ABS. In this section we consider the robustness of our results to a selection critique. In the next section we consider the possibility of omitted variables.

We first consider a set of placebo tests. In column (5) of Table 5 we model whether high annuities insurers increased the risk profile of their holdings over the years 2003-2007. We calculate the change in the fraction of insurer's portfolios held in NAIC level 1 securities (AAA, AA, and A-rated) and regress the change variable on 2003 annuities exposure. Importantly, we control for the level of NAIC 1 securities as of 2003. The insignificant estimate indicates that annuities exposure is not associated with overall increases in portfolio risk. In Column (6) we evaluate whether annuities exposure is associated with changes in the maturity of portfolios. The dependent variable

is measured as the change from 2003-2007 in the fraction of bonds in insurers' portfolios with maturity over 20 years. The estimates indicate no association between annuities exposure and changes in portfolios maturity. In unreported results, we also confirm that the growth in holdings of non-Agency ABS of high and low annuities firms (as of 2003) followed parallel trends over the years 2000-2003 (consistent with the simple comparisons in Table 3).

7.2 Evaluating the potential impact of unobserved firm or managerial attributes

The previous results have focused on the outstanding level of annuities as of 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. To rule out omitted variables, we exploit time series changes in annuities holdings to explain changes in non-Agency ABS holdings. The identification assumption in the time series test is that any unobserved, endogenous variable plaguing our estimates 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.

A regulatory change allowed for a one-time lowering of the minimum guaranteed interest rate offered on newly-issued annuities; importantly, the guaranteed rates on existing policies <u>were not affected</u> by this regulatory change.[14] The 2004 change in the Standard Nonforfeiture Law allows us to compare how incremental changes in annuities affect non-Agency ABS demand relative to annuity exposures written prior to the change.[15] If annuities written in a relatively high-

[14] There are, potentially, two guaranteed rates on deferred annuities. The first is the rate applied to the nonforfeiture calculation of guaranteed minimum cash value in a policy. The second type may be offered by a company when they guarantee a minimum crediting rate that may be applied to a policy. Neither may be changed after a policy is issued. These are contractual guarantees and are binding on the company for the life of the issued policy.

[15] The NAIC changed the Standard Nonforfeiture Law to lower guaranteed rates in 2004. As members of the NAIC, each state had to adopt the model law change, and it was generally in force by the end of 2004. Sixteen states reduced the guaranteed rate associated with the Standard Nonforfeiture Law on new policies sold in the year prior to the formal change by the NAIC.

guaranteed-rate environment create incentive to hold non-Agency ABS, we should see *changes* in annuities exposure between 2002 and 2003 impact the subsequent demand for non-Agency ABS. 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 non-Agency 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.

Table 6 reports the results of this test. Changes in holdings of non-Agency 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 non-Agency ABS holdings from 2003 through 2007, columns (2)-(4) measure changes in holdings from 2004 through 2007, and columns (5)-(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 non-Agency 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 non-Agency 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 non-Agency ABS holdings. Columns (2) and (4) indicate that changes in annuities exposure prior to the rule change also explain changes in non-Agency 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 crediting 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 non-Agency 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 non-Agency 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 non-Agency 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 non-Agency 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 non-Agency 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 non-Agency ABS.

Section 8. Robustness Tests.

Section 8.1. Structured holdings, Hedging, and Required Capital

The large and unexpected drop in interest rates negatively shocked the capital of firms heavily exposed to annuities; because 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 non-Agency ABS. Many have argued that this market boomed because of an agency conflict between asset managers who faced contractual incentives to purchase AAA-rated non-Agency 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 time series results presented in Table 6. Agency explanations would most

likely be time invariant; yet, we find interesting time series variation in our results surrounding a plausibly exogenous (to managerial agency conflicts) policy change. Moreover, Table 7 indicates our main result is concentrated 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.

8.2 Structured holdings and asset quality

As we have argued, the regulatory arbitrage argument suggests that firms expecting declines in regulatory capital (i.e. those with high levels of guaranteed annuities) ought to invest most heavily in highly rated non-Agency ABS. The yield advantage for non-Agency ABS over similarly rated corporate debt is strongest in the highest rated tranches. This is also consistent with theory, as the highly rated tranches concentrate systematic risk and thus have the highest yield per unit of physical default risk. For lower-rated non-Agency ABS, there is no capital advantage relative to investments in other bonds with similar ratings, such as corporate bonds. As such, highly rated non-Agency 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 non-Agency ABS holdings as a function of annuities exposure is concentrated in the highly rated segments (AAA, AA or A). Consistent with this notion, columns (1) and (2) of Table 8 show that annuity exposure *only* predicts increases in investment in the highly rated non-Agency ABS (coefficient = 0.038), whereas its effect on investment in lower-rated non-Agency ABS is approximately zero (coefficient = -0.005).

Columns (3) and (4) of Table 8 replace non-Agency ABS securities with corporate bonds. This approach allows us to compare investment 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 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. Instead, they moved *into* highly rated non-Agency ABS securities (column 1) and *out of* corporate bonds generally (columns 3 and 4).

8.3 Yield reaching in general

A regulatory arbitrage hypothesis predicts that insurance companies that are exposed to a capital shock will search for assets with high yields but low capital requirements. More generally, capital constrained insurers could search for high yielding assets across all asset types, as in Jensen and Meckling (1976). In this section we test this more general prediction.

Table 9 reports results of regressions that estimate whether insurers with high annuities as of 2003 invested in securities that increased the average yield in their portfolio. The dependent variable in column (1) measures the weighted average yield spread of all newly purchased securities in the insurer's portfolio between the years 2004 and 2007.[16] We control for the average maturity of the securities as of 2003, the level of portfolio yield spread as of 2003 and the same set of as-of-2003 firm-level controls included in previous regressions. We also restrict the sample of securities to only include NAIC level 1 (AAA, AA, or A-rating) securities because all NAIC level 1 securities have the same regulatory capital charge. We lose 58 observations from the sample of 747 due to missing yield data on newly purchased securities.

[16] The 2004-2007 portfolio yields are weighted by par value. We also note that we mean-adjust yield spreads against the average within-security average yield in a given year. This is akin to including year-security type fixed effects were the estimation to be performed in panel data. Because we estimate cross-sectional regressions we remove the effects of year-security type trends using the within year, within security mean-adjusted approach.

Column (1) indicates that firms with higher annuities exposure as of 2003 increased their investment across all security types that delivered higher average yield spreads over the years between 2004 and 2007. A one-standard deviation larger annuities exposure translates into weighted-average portfolio yields that are 36 basis points higher. This result is consistent with a more general prediction of the regulatory arbitrage hypothesis, namely, that capital constrained firms should seek for yield in any capital-efficient (NAIC level 1) asset class that delivers yield.

Previously presented results indicate that non-agency ABS offered higher yields than corporate bonds during our sample period (Figure 5 and Table 4), and that high annuities predict increased investment in non-agency ABS (Tables 5-8). If annuities exposure coupled with declining interest rates did increase incentives to reach for yield, than in general we could expect to see high annuity firms reaching for yield in asset classes other than non-agency ABS. After all, non-agency ABS do not represent the only asset class where extra yield could be obtained. Given that column (1) yields include non-agency ABS (shown to have higher yields), we test the effect of annuities exposure on asset classes outside of non-agency ABS by restricting the dependent variable in column (2) to only include the weighted-average yield spreads of security types excluding non-Agency ABS. The positive and statistically significant coefficient on annuities exposure of 0.11 indicates that the reaching for yield behavior of high annuity firms is also manifest in non-Agency ABS securities.

We interpret these results as being consistent with results presented throughout the paper. While a regulatory arbitrage hypothesis does not uniquely predict overinvestment in non-Agency ABS, the data indicate that non-Agency ABS represented the asset class that provided the most opportunity to reach for yield conditional on low regulatory capital charges.

Section 9. Conclusion

The explosion in issuance of non-Agency ABS over a short time period represents a puzzle for financial economists. Supply-side explanations for the growth in ABS include innovations in securitization fueled by regulatory changes (Acharya, Schnabl, Suarez (2013), Loutskina and Strahan (2009), Acharya and Richardson (2009)), misrepresentation in asset quality (Piskorski, Seru, Witkin (2013), Griffin and Maturana (2016), and screening failures (Keys, et al. (2010) or Keys, Seru and Vig (2012)). The proposed supply-side explanations require an environment where sufficient demand for securitized assets would exist. On the demand side, there is reason to believe that the factors influencing investors to reach-for-yield in the corporate bond market (as in Becker and Ivashina, 2015) might also be at work in the non-agency ABS market. Chernenko et al (forthcoming) offer another demand side explanation focusing on investor experience.

We focus on the holdings of life insurance companies, who represent a large class of investors 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 non-Agency ABS 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 non-Agency ABS. Moreover, the patterns are driven by companies with low levels of ex ante capital.

While our primary contribution has been to document economic forces that create incentives to hold non-Agency ABS, one remaining question is how the economics described in this paper speak to the dramatic increase in issuance of non-Agency ABS. An alternative explanation to our final demand hypothesis is that institutions simply soaked up their pro-rata share of non-agency ABS issuance, and that issuance spiked for reasons outside of final demand. Flow of Funds data, as well as aggregated holdings data from regulated financial institutions, show that regulated institutions in the U.S. increased their holdings of non-Agency ABS more than their proportionate share. Aggregate issuance of non-agency ABS increased from $2.18 Trillion in 2003 to $4.22 Trillion by 2007, an increase of 94%. In comparison, holdings of non-agency ABS among U.S. bank holding companies and U.S. life insurers increased from $477 Billion in 2003 to $995 Billion in 2007, an increase of 108%.[17] In addition to aggregate holding amounts, our paper documents cross-sectional distortion in demand, caused by incentives to reach for yield that motivated a subset of insurance firms to hold well more than their pro-rata share of non-Agency ABS. To illustrate the impact of the cross-sectional distortion in demand, Figure 6 plots the actual dollar change in non-Agency ABS holdings for insurance companies with top-decile annuity exposure compared to what top-decile annuity firms *would have* held based on the growth in the overall non-Agency ABS market if they had only held their pro-rata share of total issuance. These comparisons are striking. The overall holdings for top decile annuity writers increased from about $40 to $130 billion by 2007 (more than 3X), compared to hypothetical total holdings in the amount of $80 billion by 2007 based on growth in the market (2X).[18] Hence, insurance companies with

[17] Data on aggregate holdings of non-agency ABS for U.S. bank holding companies comes from Erel, Nadauld, and Stulz (2014).

[18] Flow of funds data indicate that over our sample period, non-Agency ABS issuance increased from $2.2 Trillion to $4.2 Trillion (a 1.94X increase).

the most pronounced yield-seeking incentives increased their non-Agency ABS holdings significantly above the rate of market issuance.

Although our results are specific to insurance, the economic forces likely extend to other regulated entities such as banks. Consistent with our findings, Effing (2014) demonstrates that German banks subject to capital requirements bought non-Agency ABS with the highest yield spreads, with effects most pronounced for banks with low regulatory capital.[19] Much of the existing explanations for the explosive growth of the non-Agency 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.

[19] Reaching for yield explanations are not mutually exclusive to other possible explanations for non-Agency ABS demand. Erel, Nadauld, and Stulz (2014) document that non-Agency ABS holdings among U.S. bank holding companies was concentrated among banks most active in securitization. Securitization itself can be viewed as a form of regulatory arbitrage. Erel, Nadauld, and Stulz (2014) were unable to evaluate the specific predictions of a reaching for yield hypothesis because they did not have securities level data.

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

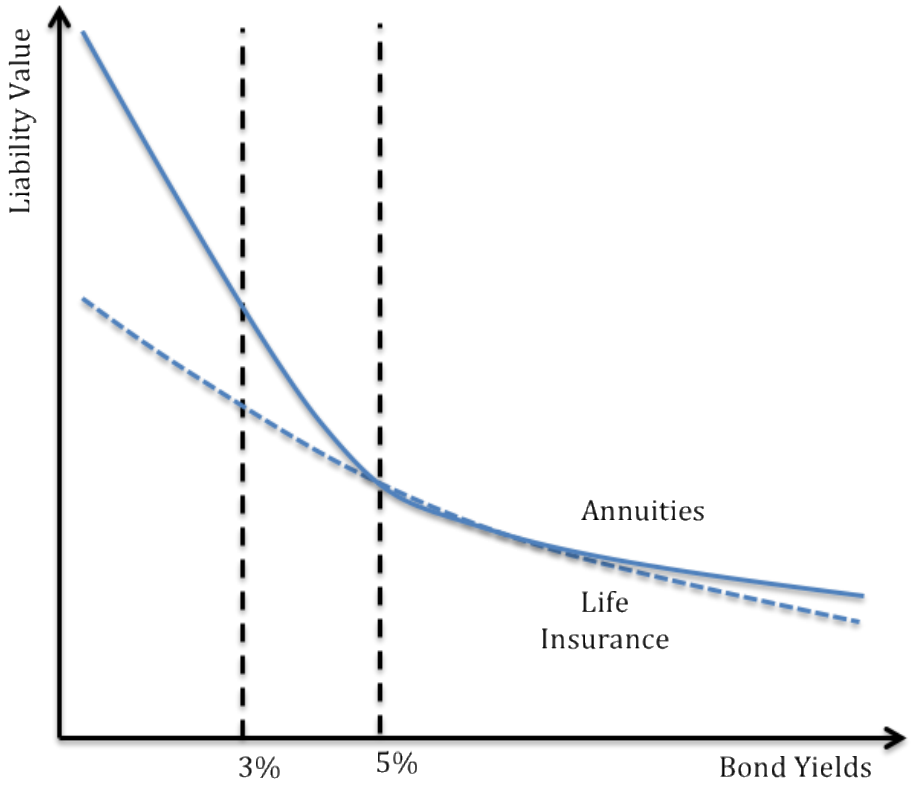


Figure 2. Life Insurance Company Abnormal Returns and Exposure to Annuities

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 taken 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.

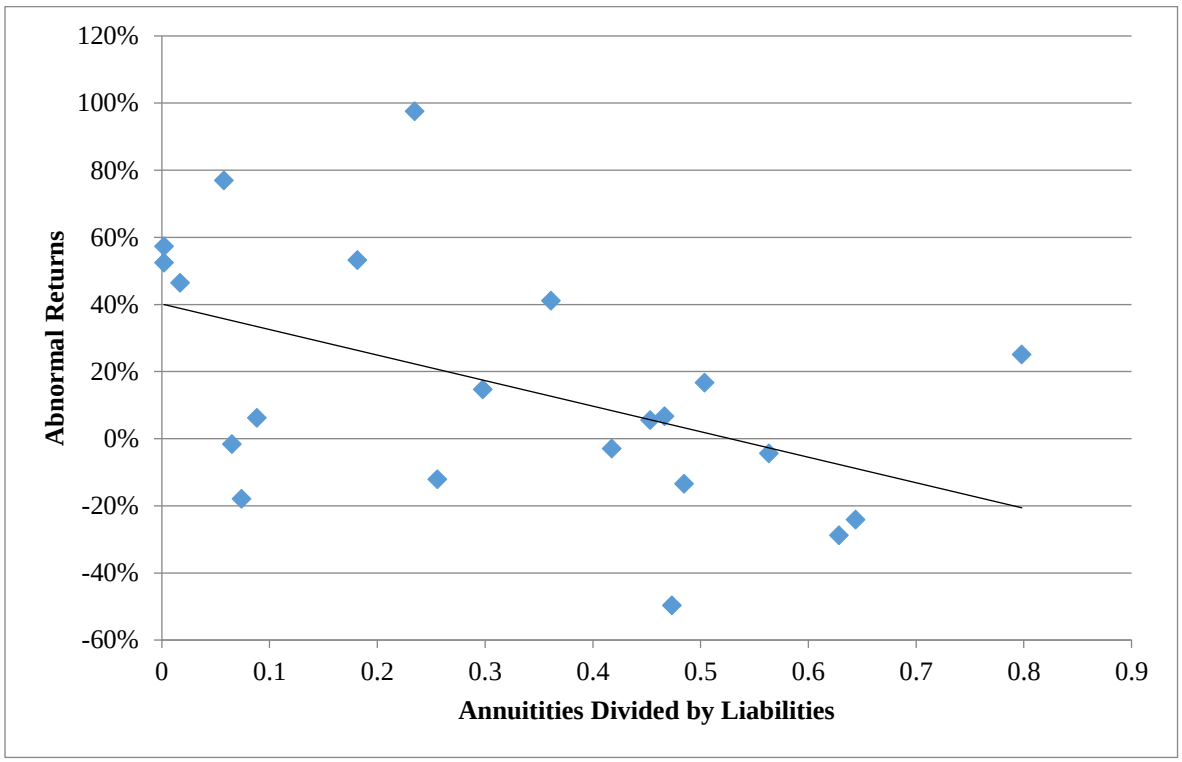


Figure 3. Annuity Exposure and the Koijen/Yogo Estimates of the Shadow Cost of Capital

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 for which Koijen/Yogo also produce an estimate of the shadow cost of regulatory capital. 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.

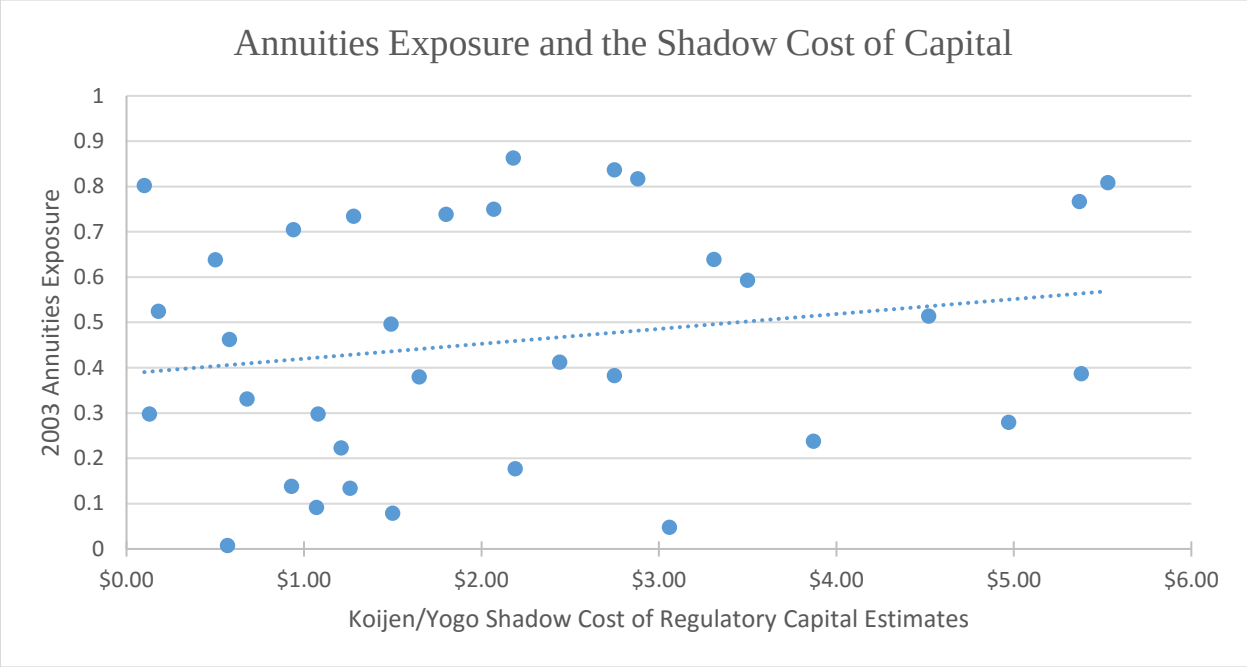
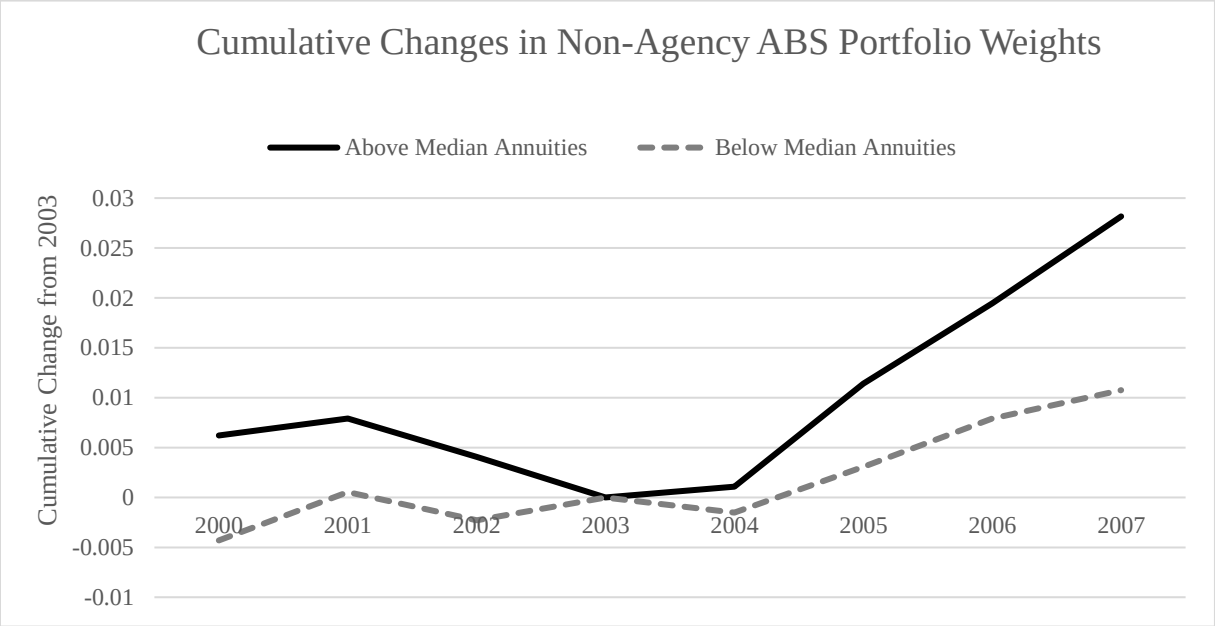


Figure 4. Changes in Non-Agency ABS Portfolio Weights as a Function of Annuities Holdings

These figures plot the cumulative changes in holdings of non-Agency ABS securities. Non-Agency ABS holdings are plotted separately for firms with high and low annuity holdings in 2003, where annuity holdings are calculated as a fraction of total liabilities. The plots are normalized by the ABS share in 2003. Data used in these plots are tabulated in Table 3, Panel A.



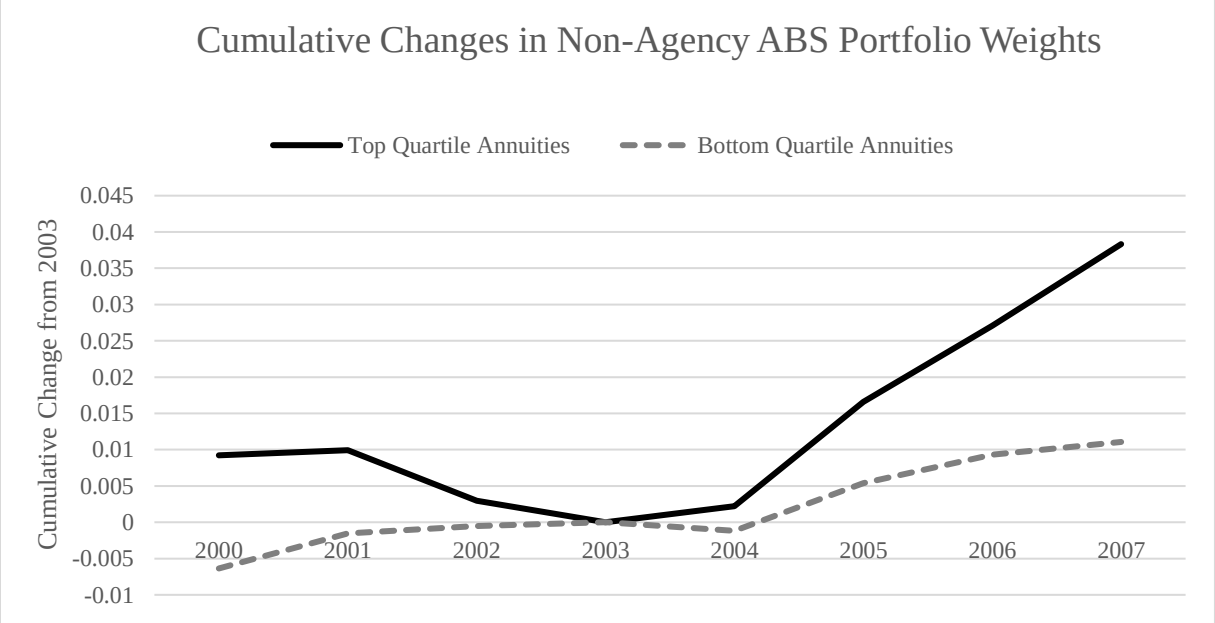
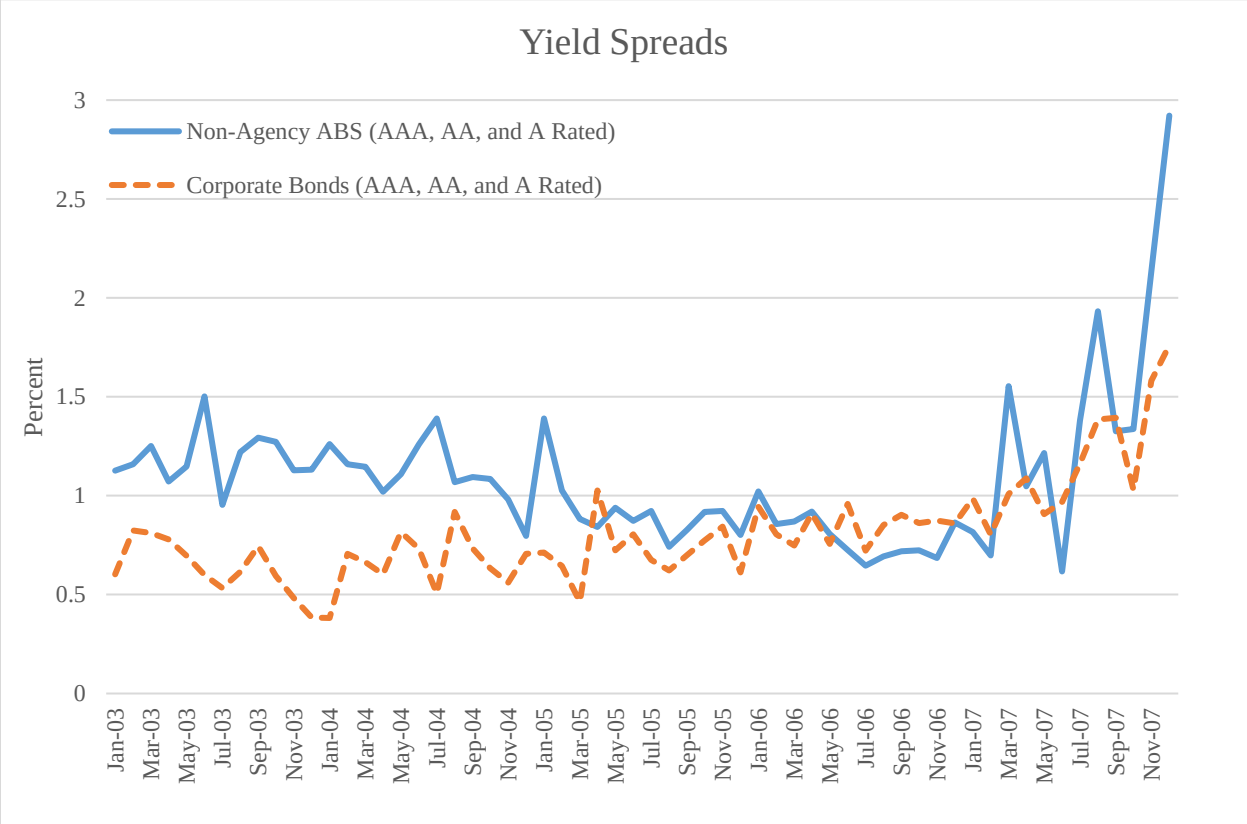


Figure 5. Bond and ABS Yield Spreads over Time

These figures plot the monthly average yield-spread of bonds held by life insurance companies at the time of purchase. Yields are reported by insurance companies in regulatory filings to the NAIC. Estimates of maturity are provided by Bloomberg. The risk-free reference rate used to calculate the yield spread is matched to bonds based on maturity. *Panel A* plots yield spreads for all NAIC 1 rated non-Agency ABS and Corporate Bonds. *Panel B* plots yield spreads for only AAA rated non-Agency ABS and A rated Corporate Bonds.

Panel A. Yield Spreads on all NAIC 1 non-Agency ABS and Corporate Bonds



Panel B. Yield Spreads on AAA-Rated non-Agency ABS and A-Rated Corporate Bonds

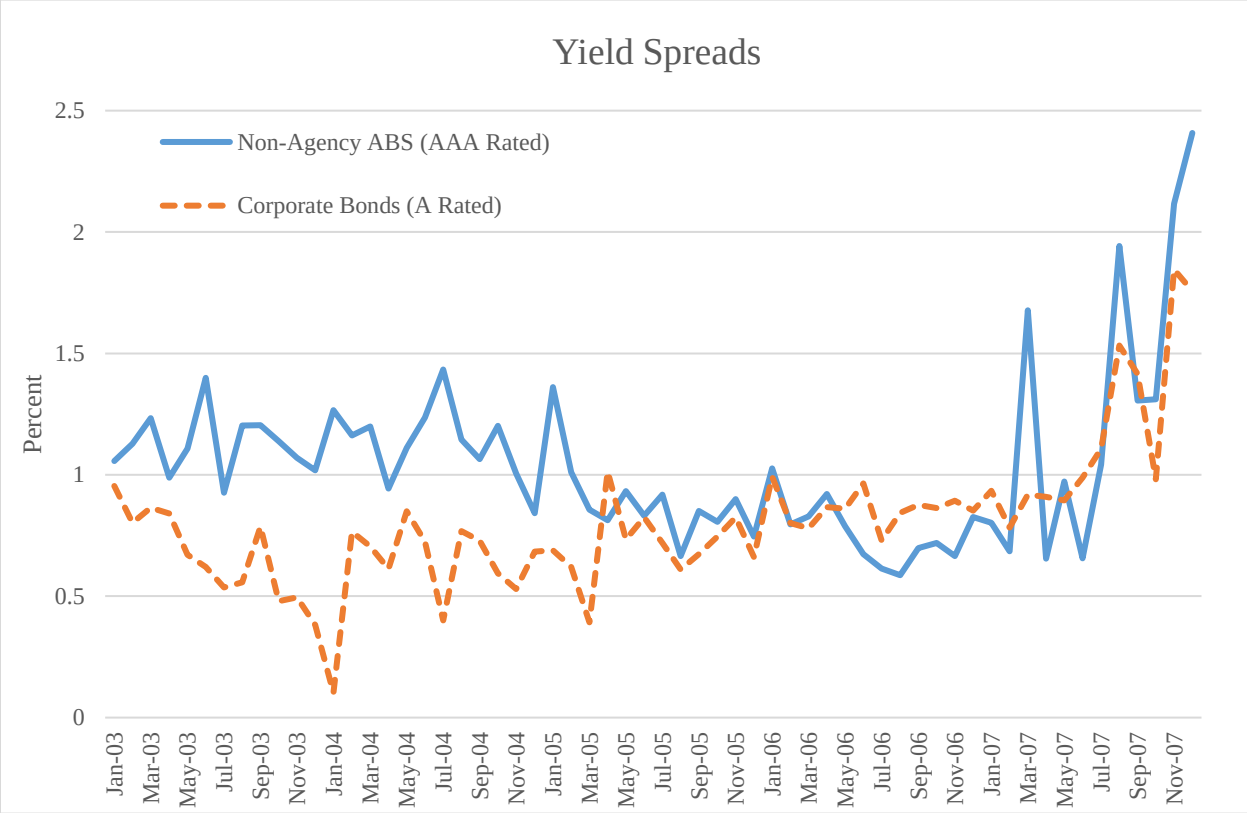


Figure 6. Aggregate Holdings of Non-Agency ABS Securities Among Financial Intermediaries

In this figure we consider a subset of firms that have attributes such that their predicted growth in non-Agency ABS holdings places them in the top decile of all life insurers in our sample (i.e. we sort firms into deciles based on their predicted growth in non-Agency ABS holdings based on the set of control variables included in Table 5, column (2)). The dotted line plots the 2003 holdings of these firms as if they grew at the same rate as the growth in total market issuance of non-Agency ABS. The solid line represents the actual growth in total holdings for the top decile firms.

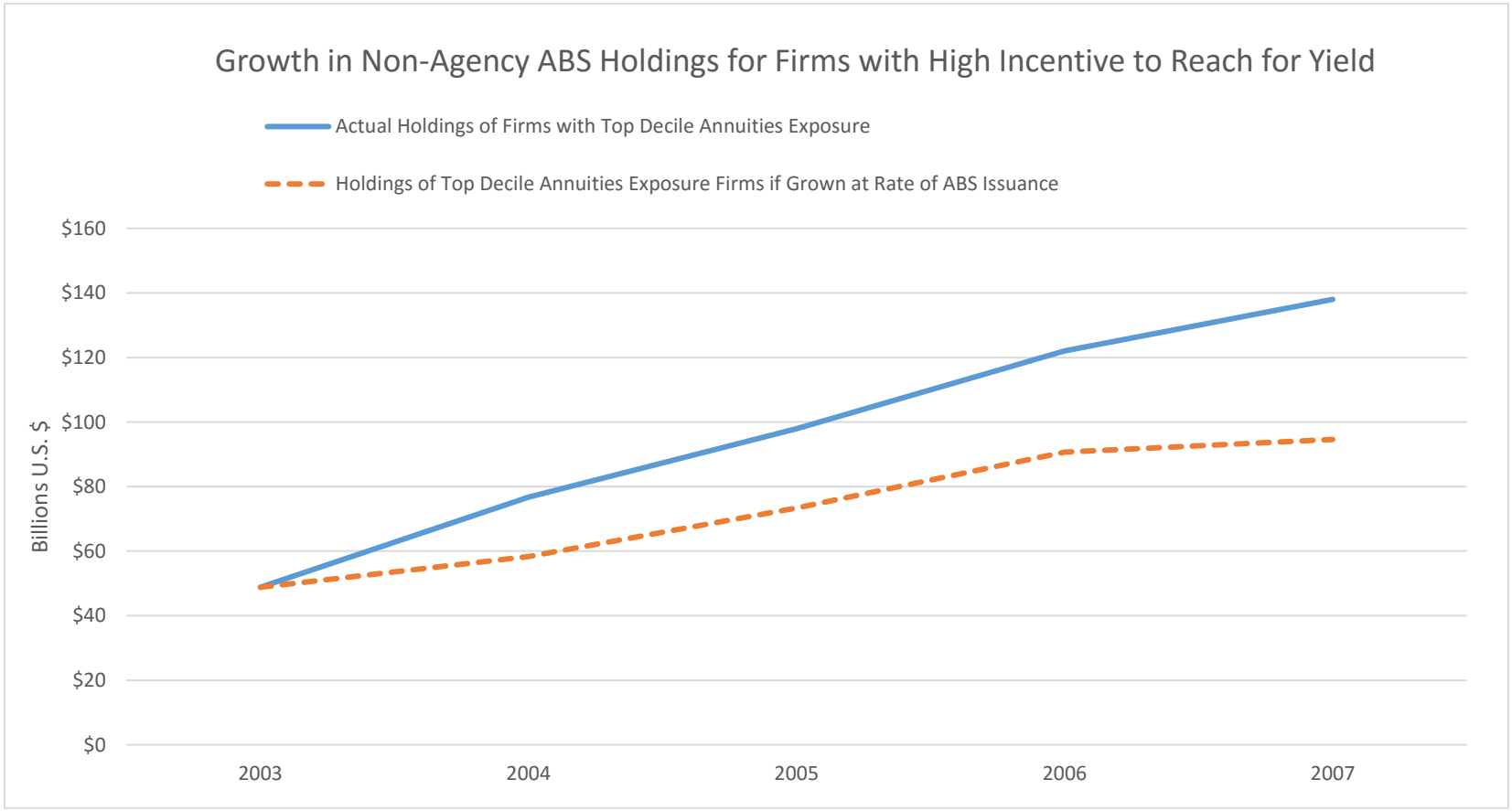


Table 1. Summary Statistics on Life Insurance Company Securities Holdings by Security Type

This table documents the aggregate holdings of life insurance companies between 2003 and 2007. Holdings are scaled by total assets. Panel A tabulates holdings for all insurance companies in our sample. Non-Agency 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 ABS	Corporate Bonds	Agency Securities	U.S. Treasuries	Municipal Bonds	Foreign Bonds	Other Bonds
2003	747	6.4%	28.5%	9.9%	16.4%	9.0%	0.4%	0.4%
2004	747	6.6%	28.9%	10.1%	16.7%	8.6%	0.5%	0.4%
2005	747	7.4%	27.7%	10.4%	17.7%	8.6%	0.5%	0.4%
2006	747	7.2%	26.1%	9.5%	17.8%	8.1%	0.6%	0.4%
2007	747	7.5%	26.4%	9.9%	16.3%	8.2%	0.4%	0.5%

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

Year	Sample Size	non-Agency Structured ABS	Corporate Bonds	Agency Securities	U.S. Treasuries	Municipal Bonds	Foreign Bonds	Other Bonds
2003	747	8.4%	39.4%	13.6%	24.5%	12.9%	0.6%	1.2%
2004	747	8.5%	39.8%	13.6%	24.8%	11.9%	0.6%	1.1%
2005	747	9.2%	37.7%	13.7%	26.0%	11.9%	0.7%	1.1%
2006	747	9.9%	37.0%	13.5%	26.4%	11.8%	0.8%	1.3%
2007	747	10.4%	37.2%	13.9%	25.3%	12.0%	0.6%	1.3%

Table 2. Summary Statistics on the Attributes of Life Insurance Companies in the Sample.

Total holdings of non-Agency 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. Average asset size is the average size of total assets for insurance firms in the sample. Total annuities liabilities are scaled by total liabilities. Risk-based capital (RBC) ratio is calculated as the ratio of total adjusted capital to total control level capital.

Panel A. Insurance Company Summary Statistics

Year	Sample Size	Total Holdings of non-Agency ABS ($ Million)	Average Holdings of non-Agency 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

Table 3. Holdings by Security Type and Ratings Category.

This table documents the time series patterns in the holdings of three types of securities: non-Agency ABS, corporate bonds, and municipal bonds. We report total holdings for all firms. Holdings in Panel A are scaled by total bond holdings. Securities rated either AAA, AA, or A are considered NAIC Level 1 securities and receive identical regulatory capital treatment. Holdings in Panels B, C, and D, are scaled by total assets.

Panel A. Non-Agency ABS Holdings

Year	Sample Size	Above-Median Annuities	Below-Median Annuities	Top Quartile Annuities	Bottom Quartile Annuities
2000	747	11.03%	5.16%	12.77%	3.94%
2001	747	11.19%	5.65%	12.85%	4.42%
2002	747	10.81%	5.37%	12.15%	4.52%
2003	747	10.40%	5.59%	11.85%	4.57%
2004	747	10.51%	5.44%	12.08%	4.45%
2005	747	11.54%	5.90%	13.51%	5.11%
2006	747	12.35%	6.38%	14.56%	5.50%
2007	747	13.22%	6.67%	15.69%	5.68%

Panel B. Non-Agency ABS Holdings

Year	Sample Size	NAIC Level 1	NAIC Level 2-6
2003	747	5.7%	0.66%
2004	747	5.9%	0.65%
2005	747	6.9%	0.48%
2006	747	6.7%	0.42%
2007	747	7.1%	0.42%

Panel C. Corporate Bond Holdings

Year	Sample Size	NAIC Level 1	NAIC Level 2-6
2003	747	16.4%	12.1%
2004	747	17.6%	11.3%
2005	747	17.1%	10.5%
2006	747	16.7%	9.3%
2007	747	16.5%	9.8%

Panel D. Municipal Bond Holdings

Year	Sample Size	NAIC Level 1	NAIC Level 2-6
2003	747	6.9%	2.0%
2004	747	6.7%	1.8%
2005	747	6.7%	1.9%
2006	747	6.3%	1.7%
2007	747	6.4%	1.7%

Table 4. Comparing Yield Spreads on Non-Agency ABS Relative to Corporate Bonds.

Panel A computes the average yield-spread of bonds held by life insurance companies at the time of purchase for which maturity estimates are available from Bloomberg. The yield-to-maturity for bonds at the time of purchase is reported by insurance companies in regulatory filings to the NAIC. Estimates of maturity are provided by Bloomberg. Reference treasury rates for given maturities are provided by the Federal Reserve.

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 non-Agency ABS	1.03%	1.27%	1.22%	0.95%	0.87%
AAA, AA, A Rated Corporate Bonds	0.65%	0.79%	0.89%	0.99%	0.77%
Difference (non-Agency ABS minus Corporate Bonds)	0.38%	0.48%	0.33%	-0.05%	0.10%
AAA Rated non-Agency ABS	1.02%	1.28%	1.08%	0.92%	0.83%
A Rated Corporate Bonds	0.69%	0.83%	0.86%	1.01%	0.75%
Difference (non-Agency ABS minus Corporate Bonds)	0.33%	0.46%	0.22%	-0.09%	0.07%

Table 5. Explaining Growth in Non-Agency ABS Holdings.

This table reports results of regressions where the sample is the cross-section of life insurance companies as of 2007. The dependent variable in Columns (1) and (2) is the change in the non-Agency ABS portfolio weight between 2003 and 2007. The dependent variable in Column (3) is the change in the portfolio weight of assets in NAIC class 1 (credit ratings of AAA, AA, or A). The dependent variable in Column (4) measures the change in the fraction of the portfolio that is invested in bonds with maturity over 20 years. Portfolio weights are constructed as holdings scaled by total assets. The key explanatory variable, *(annuities/liabilities) as of 2003* measures outstanding annuity liabilities as of 2003 scaled by total liabilities as of 2003. Control variables include the level of holdings of the dependent variable as of 2003. We also control for 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 Holdings, 2003-2007					
	non-Agency ABS	non-Agency ABS	non-Agency ABS	non-Agency ABS	NAIC Class 1	Maturity Over 20 Years
	(1)	(2)	(3)	(4)	(5)	(6)
(Annuities/Liabilities) as of 2003	0.052***	0.033***	0.043***	0.055***	0.033	-0.013
	(4.211)	(2.740)	(3.256)	(2.782)	(0.998)	(-0.555)
Level of Dep. Var. Holdings Measure as of 2003	-0.425***	-0.460***	-0.471***	-0.434***	-0.234***	-0.123
	(-7.365)	(-7.828)	(-6.896)	(-4.318)	(-2.815)	(-1.114)
Total Bond Portfolio/Liabilities as of 2003		-0.000	0.001	-0.008	-0.003***	-0.000
		(-1.576)	(0.127)	(-0.753)	(-2.954)	(-0.486)
Growth in Total Bond Portfolio, 2003-2007		0.004	0.003	0.000	0.029***	0.010**
		(1.490)	(1.020)	(0.096)	(3.257)	(2.127)
Hedging Indicator		-0.003	0.002	0.005	-0.033	-0.029
		(-0.297)	(0.193)	(0.371)	(-1.393)	(-1.608)
Log Risk Based Capital Ratio (RBC) as of 2003		0.001	0.001	-0.008	0.000	0.005
		(0.597)	(0.137)	(-1.015)	(0.050)	(1.251)
Log Total Assets as of 2003		0.006***	0.005**	0.000	-0.005	0.007**
		(3.799)	(2.200)	(0.027)	(-0.943)	(2.311)
Growth in Total Assets, 2003-2007		0.020***	0.024**	0.031	-0.024	0.036***
		(2.740)	(2.204)	(1.619)	(-0.990)	(3.124)
Log Surplus as of 2003		0.001	0.001	0.002	0.005	0.000
		(1.239)	(0.733)	(0.855)	(0.953)	(0.159)
Growth in Total Surplus, 2003-2007		-0.008	-0.008	-0.023**	-0.023*	-0.025**
		(-1.262)	(-1.226)	(-2.065)	(-1.760)	(-2.539)
Constant	0.028***	-0.149***	-0.125**	0.002	0.160	-0.157***
	(7.583)	(-4.820)	(-2.498)	(0.017)	(1.538)	(-2.588)
Observations	747	747	468	228	747	747
Adj R2	0.181	0.241	0.285	0.261	0.201	0.088

Table 6. Explaining Growth in non-Agency ABS Holdings Based on *Changes* in Annuities Exposure

This table reports regressions of changes in non-Agency ABS holdings on changes in annuities exposure. Portfolio weights are constructed as holdings scaled by assets. The regressions are estimated separately within the cross-section of firms over different time horizons. We calculate changes in non-Agency 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 non-Agency 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 non-Agency ABS holdings as of the base year of the non-Agency ABS growth-in-holdings-calculation. For example, when the dependent variable is measured as non-Agency ABS growth from 2003-2007, we control for the level of non-Agency 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 non-Agency ABS holdings measure. For example, when non-Agency 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 ABS						
	non-Agency ABS Growth '03-'07	non-Agency ABS Growth '04-'07	non-Agency ABS Growth '04-'07	non-Agency ABS Growth '04-'07	non-Agency ABS Growth '05-'07	non-Agency ABS Growth '05-'07	non-Agency 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

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

This table reports cross-sectional regressions designed to explain variation in the growth of non-Agency ABS holdings for life insurance companies over the 2003 to 2007 time period. The sample is the cross-section of life insurance companies as of 2007. The dependent variable in Columns (1) and (2) is the change in the non-Agency ABS portfolio weight between 2003 and 2007. Portfolio weights are constructed as holdings scaled by assets. *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, (*annuities/liabilities)* is a measure of outstanding annuity liabilities as of 2003 scaled by total liabilities as of 2003. We also create an interaction term of annuities with the above-median capital and hedging indicators. Control variables include the level of non-Agency 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. We report *t*-statistics associated with heteroskedasticity-robust standard errors.

	Dependent Variable: Change in Portfolio Weight in non-Agency ABS Holdings, 2003-2007	
	Sample: Full Sample	
	(1)	(2)
Above Median Capital * (Annuities/Liabilities) as of 2003	-0.051**	
	(-2.311)	
Above Median Capital	0.013*	
	(1.887)	
Hedging Indicator * (Annuities/Liabilities) as of 2003		0.040
		(1.100)
Hedging Indicator	-0.007	-0.019
	(-0.637)	(-1.073)
(Annuities/Liabilities) as of 2003	0.054***	0.028**
	(3.568)	(2.200)
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 ABS Holdings, By Rating.

This table reports cross-sectional regressions designed to explain variation in the growth of non-Agency ABS and corporate bond holdings for life insurance companies over the 2003 to 2007 time period. The estimation sample is the cross-section of life insurance companies with necessary data as of 2007. The dependent variable in Columns (1) and (2) is the change in the non-Agency ABS portfolio weight of a given credit rating (as specified in the column heading) between 2003 and 2007. The dependent variable in Columns (3) and (4) is the change in the corporate bond portfolio weight of a given credit rating (as specified in the column heading) between 2003 and 2007. Portfolio weights are constructed as holdings scaled by assets. The key explanatory variable, (*annuities/liabilities)* is the measure of outstanding annuity liabilities as of 2003 scaled by total liabilities as of 2003. Control variables include the level of non-Agency ABS holdings as of 2003 (Columns (1) and (2)), the level of Corporate bond holdings as of 2003 (Columns (3) and (4)), 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 ABS Holdings, 2003-2007		Dependent Variable: Change in Portfolio Weight in Corporate Bond Holdings, 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)
(Annuities/Liabilities) as of 2003	0.038***	-0.005	-0.024*	-0.021**
	(3.193)	(-1.634)	(-1.760)	(-2.452)
ABS Portfolio Weight as of 2003	-0.423***	-0.037***		
	(-7.281)	(-2.757)		
Corporate Bond Holdings as of 2003			-0.077***	-0.093***
			(-4.570)	(-7.608)
Total Bond Portfolio/Liabilities as of 2003	-0.0002	-0.0001	0.0003	-0.001***
	(-1.453)	(-1.618)	(0.694)	(-2.604)
Growth in Total Bond Portfolio, 2003-2007	0.004	-0.000	0.010***	0.001
	(1.512)	(-0.261)	(2.857)	(0.317)
Hedging Indicator	-0.002	-0.001	-0.006	0.003
	(-0.235)	(-0.313)	(-0.568)	(0.410)
Log RBC as of 2003	0.001	0.001***	-0.002	-0.001
	(0.324)	(2.637)	(-0.447)	(-0.485)
Log Total Assets	0.006***	-0.000	0.008***	-0.000
	(4.183)	(-0.253)	(3.388)	(-0.071)
Growth in Total Assets, 2003-2007	0.018**	0.002*	0.006	0.027***
	(2.553)	(1.668)	(0.497)	(3.747)
Log Surplus	0.001	0.000	0.000	0.001
	(0.788)	(1.314)	(0.013)	(0.938)
Growth in Total Surplus, 2003-2007	-0.006	-0.001	-0.013	-0.009**
	(-1.210)	(-0.973)	(-1.534)	(-2.250)
Constant	-0.142***	-0.007	-0.177***	0.004
	(-4.850)	(-1.057)	(-3.872)	(0.162)
Observations	747	747	747	747
Adj R2	0.229	0.065	0.085	0.180

Table 9. Reaching for Yield.

This table reports cross-sectional regressions designed to explain variation in *changes* in the weighted average yield spread of portfolio holdings of insurance companies from 2003 to 2007. The sample includes yields on NAIC Level 1 bonds (i.e. credit ratings = AAA, AA, or A) in the year in which they were purchased. The dependent variable measures average yield spreads at the company level and within bond type. Yield spreads for each individual bond held by an insurer are calculated as the difference between the reported yield on the day of purchase and the relevant treasury rate for a given maturity bond. The key explanatory variable, (*annuities/liabilities)* is the measure of outstanding annuity liabilities as of 2003 scaled by total liabilities as of 2003. *Log average maturity* measures the average maturity of bonds in the portfolio. *Level of Yield* is the level of portfolio yield spread as of 2003, either for the total portfolio, or within a given asset class, depending on which model is being estimated. *Hedging indicator* is equal to one for life insurance companies with non-zero levels of outstanding derivatives exposure. Control variables include 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: Weighted Average Yield of All Purchases in 2004 through 2007	
	All Securities	All Securities excl. Non-Agency ABS
	(1)	(2)
(General Account Annuities/Liabilities) as of 2003	0.126**	0.117**
	(2.575)	(2.227)
Level of Yield as of 2003	0.096***	0.082***
	(2.750)	(3.324)
Level of Maturity as of 2003	0.024***	0.022***
	(11.020)	(9.351)
Total Bond Portfolio/Liabilities as of 2003	-0.004***	-0.004***
	(-2.941)	(-2.986)
Hedging Indicator	0.051	0.061*
	(1.577)	(1.731)
Log Risk Based Capital Ratio (RBC) as of 2003	0.019	0.019
	(1.344)	(1.301)
Log Total Assets as of 2003	-0.034**	-0.031*
	(-2.157)	(-1.878)
Log Surplus as of 2003	0.029*	0.027
	(1.722)	(1.531)
Constant	-0.321*	-0.343**
	(-1.939)	(-2.087)
Observations	689	689
Adj R2	0.289	0.222