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RISK OF LIFE INSURERS: RECENT TRENDS AND TRANSMISSION MECHANISMS

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ABSTRACT

We summarize recent trends in risk exposure for U.S. life insurers from variable annuities, shadow insurance, securities lending, and derivatives. We discuss how these sources of risk could be amplified and transmitted to the rest of the financial sector and the real economy. More complete and transparent financial statements are necessary to accurately assess the overall risk mismatch in the insurance industry. We suggest ways to disclose relevant information and discuss some implications for insurance regulation.

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1. Introduction

The traditional sources of risk for life insurers are uncertainty in interest rates, aggregate longevity or mortality, and policyholder behavior. Life insurers manage interest-rate risk by investing a significant share of their assets in long-term bonds. They manage longevity or mortality risk by offsetting annuities with life insurance. Uncertainty in policyholder behavior may be more difficult to hedge, but life insurers have decades of experience to assess the policyholder risk of traditional annuities and life insurance. Finally, life insurers diversify these risks through unaffiliated (i.e., third-party) reinsurance.

Although modern life insurers are exposed to the traditional sources of risk, their risk profile has become increasingly complex and opaque over the last decade because of two developments. First, variable annuities with minimum-return guarantees, which are more difficult to value and hedge than traditional products, have grown to be a significant share of liabilities. Second, life insurers are now using sophisticated capital management tools such as shadow insurance, securities lending, and derivatives.[1]

Evidence from the 2008 financial crisis suggests that variable annuities and securities lending could cause significant risk mismatch. For example, the failure of AIG was not only due to their credit default swaps, but also due to securities lending in their insurance subsidiaries (McDonald and Paulson 2014; Peirce 2014). Like AIG, Hartford also received government support through the Troubled Asset Relief Program (TARP) because of significant losses on their variable annuity business. Other companies that were involved in variable annuities or securities lending (e.g., Allstate, Genworth Financial, and Prudential Financial) also applied for TARP but were ultimately rejected or withdrew their application. These examples refute the conventional wisdom that the insurance industry is immune from macroeconomic shocks.

Building on these examples, Section 2 of this chapter summarizes recent trends in risk

[1]Shadow insurance is affiliated reinsurance (within the same financial group) between an operating company (i.e., a regulated and rated company that sell policies) and a shadow reinsurer (i.e., a less regulated and unrated off-balance-sheet entity).

exposure from variable annuities, shadow insurance, securities lending, and derivatives. Our analysis is based on public financial statements for U.S. life insurers from 2002 to 2013 and captives domiciled in Iowa for 2014.[2] We see our analysis as a first step in identifying risks that are potentially important to guide the next generation of insurance regulation. A common theme that emerges from our analysis is *risk concentration*. That is, the aggregate size of a given activity (e.g., shadow insurance) is dominated by a few large players, although the composition of these players varies somewhat across activities. Another theme is that while it is possible to identify exposure to individual risks, it is difficult to assess how they aggregate to overall risk mismatch because of insufficient data.

Shadow insurance has grown from $11 billion in 2002 to $370 billion in 2013 (Koijen and Yogo 2016). Shadow reinsurers usually report their liabilities under more favorable accounting standards than operating companies from which they assume reinsurance, and moreover, they are not subject to risk-based capital regulation. Thus, shadow insurance potentially allows life insurers to reduce risk-based capital and increase leverage, which is an important amplification mechanism for any risk mismatch. In general, we cannot quantify the capital reduction that may arise from shadow insurance because the financial statements of captives are not publicly available. However, the Iowa Insurance Division (2014) recently released financial statements for captives in their domicile, and we find that they have significantly negative equity when valued under the same accounting standards as the operating companies.

Life insurers use derivatives to hedge risk mismatch between their investment assets and insurance liabilities, including that which arises from minimum-return guarantees in variable annuities. However, the use of derivatives could expose life insurers to basis risk because of imperfect hedging and counterparty risk. Overall, we find that derivatives have consistently reduced the volatility of accounting equity over the last decade. However, additional data are necessary to fully assess the economic effectiveness of the hedging programs.

[2]See Appendix A for a description of the data.

Section 3 discusses how risks in the insurance industry could be amplified and transmitted to the rest of the financial sector and the real economy. Banks are important counterparties in shadow insurance, securities lending, and derivatives transactions. In addition, risks in the insurance industry could be amplified and transmitted to other institutional investors through the corporate bond market. Finally, insurance demand and precautionary saving could endogenously respond to risks in the insurance industry, which has important implications for household welfare.

Section 4 suggests ways to disclose relevant information on variable annuities, interest-rate risk, captive reinsurance, derivatives, and international activity. We also discuss some implications for insurance regulation.

2. Recent Trends in Risk Exposure

Informational frictions, agency problems, and regulatory frictions could create incentives for life insurers to increase leverage, pay higher dividends, and take more risks. For example, the presence of state guaranty funds could lead to a moral hazard problem (Lee, Mayers, and Smith 1997). Shareholders may prefer dividends to retained earnings because portfolio decisions outside the insurance industry (e.g., in mutual funds) are not subject to risk-based capital regulation. These frictions could lead to a higher cost of external finance and introduce a role for capital management tools such as shadow insurance, securities lending, and derivatives (Froot 2007).

2.1. Variable Annuities

Variable annuities are long-term savings products whose underlying assets are invested in traditional mutual funds. In exchange for additional fees, life insurers guarantee a minimum rate of return on the mutual funds.[3] Partly because of the shift from defined-benefit to

[3]See Bauer, Kling, and Russ (2008) and Credit Suisse (2012, Appendix B) for an overview of the various types of variable annuity guarantees.

defined-contribution plans, there has been a growing demand for minimum-return guarantees. The total account value of U.S. variable annuities associated with guaranteed benefits grew from $875 billion in 2003 to $1.726 trillion in 2013.

The variable annuity market is highly concentrated. Table 1 reports the top ten life insurers by variable annuity account value associated with guaranteed benefits in 2007. These life insurers accounted for $991 billion of variables annuities in 2007, which is a significant share of $1.460 trillion for the industry.

The long-term nature of these guarantees presents significant challenges for both valuation and risk management. During the financial crisis, the variable annuity business experienced significant losses because of falling stock prices, high volatility, and low interest rates. The last column of Table 1 reports the net operating gain from individual annuities in 2008 as a share of capital and surplus (i.e., accounting equity) in 2007.[4] Hartford Life and Manulife Financial suffered the largest losses on the order of half of their capital and surplus. When aggregated over the industry, life insurers with variable annuity guarantees lost 9 percent of their capital and surplus from the individual annuity business, while those without guarantees gained 1 percent.

To put the 2008 losses into historical perspective, Figure 1 reports the time series of net operating gain from individual annuities, aggregated over life insurers with positive variable annuity account value associated with guaranteed benefits in the previous year. We report the net operating gain in total dollars and as a share of capital and surplus in the previous year. The −$24 billion loss in 2008 is certainly extraordinary in historical perspective. Although the profitability of individual annuities recovered after 2008, the experience illustrates the sensitivity of variable annuity guarantees to stock prices and volatility. An ongoing concern is whether further losses could yet occur, especially if interest rates remain low. An additional concern is that losses are not immediately transparent because variable annuity guarantees are not marked to market.

[4]Prior to the change in reporting requirements in 2010, life insurers reported the net operating gain for fixed and variable annuities combined, rather than separately.

As discussed in A.M. Best Company (2015), life insurers have responded to the 2008 experience by reducing the riskiness of variable annuity guarantees in various ways. Many companies have raised fees, reduced the generosity of guarantees (e.g., by limiting the investment options), or closed existing accounts to new investment. In particular, MetLife and Prudential Financial have reduced sales, while Hartford and John Hancock have exited from the market entirely.

In addition to financial market risks, variable annuities are exposed to uncertainty in policyholder behavior because of the various surrender and conversion options. Relative to traditional annuities, life insurers have less experience with policyholder behavior, especially since the product design of variable annuities has changed over the last decade. Furthermore, the risks associated with financial markets and policyholder behavior could interact in important ways. For example, lapse rates have fallen significantly since the financial crisis in a low interest-rate environment (Credit Suisse 2012).

The risks associated with minimum-return guarantees are not limited to the United States. For example, Equitable Life in the United Kingdom failed partly because of guarantees that were too generous (Roberts 2012). Perhaps more relevant to the current interest-rate environment, many Japanese life insurers experienced significant losses because of overly generous guarantees in the early 2000s (Kashyap 2002). The European Systemic Risk Board (2015) reports that guaranteed products represent a significant share of insurance liabilities in Austria, Germany, Netherlands, and Sweden. In these countries, the average duration of liabilities exceed that of assets by five to ten years, which implies significant losses if interest rates remain unexpectedly low (European Insurance and Occupational Pensions Authority 2014b; Domanski, Shin, and Sushko 2015).

The economics of minimum-return guarantees for life insurers are similar to those of defined-benefit pension guarantees, which have a longer history. Therefore, the widespread underfunding of both public and private pensions is a cautionary lesson for life insurers (Novy-Marx and Rauh 2011).

2.2. Shadow Insurance

Regulation XXX in 2000 and AXXX in 2003 forced life insurers to hold more capital on newly issued term life insurance and universal life insurance with secondary guarantees. These regulations are part of National Association of Insurance Commissioners' (NAIC) statutory accounting principles that apply to operating companies.

In response to the new capital requirements, 26 states have now passed a version of captive laws, starting with South Carolina in 2002 and Vermont in 2007 (Captives and Special Purpose Vehicle Use Subgroup 2013). These laws allow life insurers to establish captives for the exclusive purpose of assuming reinsurance from affiliated companies. Captives are not subject to Regulation XXX and AXXX and may record lower reserves for term life insurance and universal life insurance with secondary guarantees under generally accepted accounting principles (GAAP). Therefore, a life insurer could reduce accounting liabilities, and thereby increase accounting equity, by moving liabilities from operating companies to captives.

Because captives are subject to lower capital requirements than operating companies, the additional accounting equity that captive reinsurance generates could be paid back to the parent company (and eventually to shareholders). Because the financial statements of captives are not publicly available, we cannot generally tell how much equity they have. However, as we discuss later in this section, two case studies suggest that captives have much less equity than operating companies.

The potential risk of affiliated reinsurance depends on whether the reinsurer is subject to oversight by either state regulators or rating agencies. An authorized reinsurer is subject to the same reporting and capital requirements as an operating company in its state of domicile, whereas an unauthorized reinsurer is not. Even if an affiliated reinsurer is unauthorized, rating agencies could request financial statements and ensure that it has enough capital. Therefore, affiliated reinsurers with the least oversight are those that are unauthorized and unrated by A.M. Best Company, which we refer to as *shadow reinsurers*. Our definition of shadow reinsurers is more restrictive than "captives" because some captives are actually

authorized.

Like variable annuities, shadow insurance is highly concentrated. Life insurers using shadow insurance are on average larger and are mostly stock instead of mutual companies (Koijen and Yogo 2016). Table 2 reports the top ten life insurers by life and annuity reinsurance ceded to shadow reinsurers in 2013. These life insurers ceded $331 billion of liabilities in 2013, which is a significant share of $370 billion for the industry.

To summarize the recent trends in reinsurance, Figure 2 reports the time series of reinsurance ceded to affiliated, shadow, and unaffiliated reinsurers. Affiliated reinsurance grew from $90 billion in 2002 to $617 billion in 2013. The part of affiliated reinsurance that was ceded to shadow reinsurers grew from $11 billion to $370 billion during the same period. The growth of shadow insurance accelerated during the financial crisis from 2006 to 2009. Since shadow insurance effectively lowers capital requirements, this timing is consistent with the evidence that some life insurers were financially constrained during the financial crisis (Koijen and Yogo 2015).

The growth of shadow insurance has slowed since 2009, partly because of more regulatory scrutiny in states like California and New York. Interestingly, unaffiliated reinsurance grew from $270 billion in 2012 to $331 billion in 2013 after a long period of essentially no growth. Although it is premature to extrapolate these trends, there could be substitution from shadow insurance to other types of reinsurance due to changes in the regulatory environment.

Figure 3 decomposes the time series of shadow insurance in Figure 2 into life and annuity reinsurance. Since Regulation XXX and AXXX apply only to life insurance, the growth of annuity reinsurance implies that shadow insurance does not exist simply to circumvent these regulations. Curiously, annuity reinsurance grew from $134 billion in 2011 to $163 billion in 2013, while life reinsurance remained flat at $208 billion during the same period. In response, NAIC initiated a working group in 2015 to investigate why captive reinsurance is being used on variable annuities.

The usual reasons for captive reinsurance are more favorable capital regulation and tax

laws. In addition, a possible reason for captive reinsurance of variable annuities in particular is the volatility of reserves under statutory accounting principles (i.e., under Actuarial Guideline 43). Statutory accounting essentially forces life insurers to record variable annuity guarantees based on historical tail scenarios, while GAAP allows them to record reserves at market value. Therefore, the difference between statutory accounting and GAAP could increase after a period of high volatility. Related to this issue, a life insurer may not get proper credit for hedging variable annuity guarantees under statutory accounting, which provides an additional incentive to hedge these guarantees in a captive. Of course, the lack of transparency is a clear drawback of having variable annuity guarantees and corresponding hedging programs in captives.

Shadow insurance is a potential source of risk for three reasons (Koijen and Yogo 2016; Schwarcz 2015). First, a significant share of shadow insurance is funded through letters of credit, which have shorter maturity than the insurance liabilities. Therefore, shadow insurance exposes life insurers to liquidity risk. Second, shadow reinsurers could take more investment risk than operating companies, which exposes the life insurer to more risk mismatch. Finally, shadow reinsurers could reduce risk-based capital and increase leverage within the financial group. Of course, higher leverage amplifies any risk mismatch in the overall balance sheet.

In fact, two case studies suggest that captives have much less equity than operating companies. First, Lawsky (2013) finds that captives that assume reinsurance from operating companies in New York have less equity, especially in cases where letters of credit are conditional and are ultimately backed by the parent company instead of an unaffiliated bank. Moody's Investors Service shares a similar view that "because many companies' captives are capitalized at lower levels compared to flagship companies, the use of captives tends to weaken capital adequacy" (Robinson and Son 2013, p. 3).

Second, the Iowa Insurance Division (2014) recently released financial statements for captives in their domicile for 2013 and 2014. These financial statements report surplus (i.e.,

accounting equity) under both the permitted accounting practices of Iowa and statutory accounting principles. Table 3 summarizes these statements. Six of the eight captives would have significantly negative surplus under statutory accounting, while two of the captives voluntarily report under statutory accounting. When aggregated over the eight captives, total surplus under statutory accounting would be −$2.663 billion.

2.3. Securities Lending

The two sources of risk that we have discussed so far, variable annuities and shadow insurance, relate to the liabilities side of the balance sheet. The conventional wisdom is that risk exposure on the asset side is well regulated by risk-based capital regulation. However, the experience of securities lending during the financial crisis shows that there could be important gaps in the regulation. Prior to 2010, the reporting requirements for securities lending was sufficiently lax that life insurers left important details about their activity unreported, particularly regarding how the collateral was reinvested (National Association of Insurance Commissioners 2011).

In a securities lending transaction, a life insurer lends bonds in exchange for cash collateral with an agreement to return the collateral back for the bonds at some future date. The life insurer could reinvest the cash collateral to earn higher returns by taking on additional credit, interest-rate, or liquidity risk. Liquidity risk arises from the fact that the reinvested collateral has longer duration than the maturity of the lending agreement. If borrowers are unwilling to roll over the lending agreement in bad times, the life insurer may be forced to liquidate the investment at fire-sale prices. This is precisely what happened to AIG during the financial crisis, as they had reinvested their cash collateral in mortgage- and asset-backed securities. AIG lost at least $21 billion through securities lending, which is a similar order of magnitude to the $34 billion that they lost through credit default swaps (McDonald and Paulson 2014).

Securities lending by life insurers grew significantly prior to the financial crisis. The

amount of admitted assets subject to securities lending agreements grew from $49 billion in 2002 to $130 billion in 2007, then suddenly collapsed to $43 billion in 2008. After important changes to the reporting requirements in 2010, securities lending further dropped to $34 billion in 2011 and has remained low at $47 billion in 2013. Given the new reporting requirements and the smaller scale of activity, securities lending no longer appears to be an important source of risk. However, the experience during the financial crisis is a cautionary lesson that gaps in risk-based capital regulation could have significant consequences.

Like variable annuities and shadow insurance, securities lending is highly concentrated. Table 4 reports the top ten life insurers by the amount of admitted assets subject to securities lending agreements in 2007. These life insurers accounted for $115 billion of securities lending in 2007, which is a significant share of $128 billion for the industry. AIG Life alone accounted for $54 billion in securities lending.

The last column of Table 4 reports the total capital gain from investment activity in 2008 as a share of capital and surplus in 2007.[5] The capital loss for AIG Life in 2008 was 169 percent of its capital and surplus in 2007. When aggregated over the industry, life insurers with securities lending activity lost -39 percent of their capital and surplus, while those without securities lending activity lost -18 percent. To put the 2008 losses into historical perspective, Figure 4 reports the time series of capital gains, aggregated over life insurers with securities lending agreements in the previous year. The 2008 losses are extraordinary, both in total dollars and as a share of capital and surplus in the previous year.

An important question is whether other gaps remain in risk-based capital regulation that governs investment risk on the asset side of the balance sheet. This question is especially relevant in the current interest-rate environment as life insurers may reach for yield to earn higher returns. Three examples from the literature suggest that life insurers do take additional investment risk when risk-based capital regulation is not sufficiently sensitive to risk. Becker and Ivashina (2015) find that, within each of the NAIC bond classes defined by rat-

[5]Our conclusions remain the same if we add investment income (i.e., coupon and dividend payments) to the total capital gain.

ings, life insurers invest in corporate bonds with higher yields and risk as measured by credit default swap spreads. Becker and Opp (2013) find that life insurers increased the riskiness of their residential mortgage-back securities portfolio in response to a reduction in capital requirements. Finally, life insurers invest in high yield assets through special purpose vehicles that are funded by funding agreement-backed securities, which are exposed to liquidity risk that is similar to securities lending (Foley-Fisher, Narajabad, and Verani 2015).

2.4. Derivatives

Life insurers use derivatives to hedge interest-rate risk on their investment assets and insurance liabilities, including minimum-return guarantees on variable annuities. Berends and King (2015) report that the total notional amount of over-the-counter derivatives held by U.S. life insurers was $1.1 trillion in 2014. Although this amount may be small relative to the size of international derivatives markets, it is still an important share of life insurer assets, especially given the concentration in derivatives activity.

The use of derivatives could expose life insurers to basis risk for two reasons. First, variable annuity guarantees have much longer duration than the maturity of derivatives that are readily available. Second, life insurers may not want to hedge economic capital because they report and are regulated based on statutory capital. A hedging program that smoothes market equity may actually increase the volatility of accounting equity under statutory accounting principles or GAAP (Credit Suisse 2012). In addition to basis risk, derivatives could expose life insurers to counterparty risk. Although collateral could reduce counterparty risk, it potentially raises the cost of hedging programs (Berends and King 2015).

A basic question in understanding the role of derivatives is whether they indeed hedge, rather than amplify, balance sheet fluctuations. The answer is not as obvious it may seem because Begenau, Piazzesi, and Schneider (2015) find that in the case of banks, interest-rate derivatives actually amplify fluctuations in the overall balance sheet. Figure 5 reports the growth rate of capital and surplus with and without derivatives, aggregated over life insurers

with non-zero derivatives exposure. The figure shows that derivatives have consistently reduced the volatility of capital and surplus over the last decade. In 2008, capital and surplus fell by 6 percent, which would have been 15 percent without offsetting gains on derivatives.

Our preliminary analysis suggests that derivatives reduce balance-sheet fluctuations. However, additional data are necessary to fully assess the effectiveness of the hedging programs. In Schedule DB, life insurers currently report how derivatives are used to hedge broad categories of risk (e.g., variable annuities instead of the type of guaranteed benefit). The same schedule also reports "hedge effectiveness", which is difficult to interpret because it depends on statutory accounting principles for variable annuities. In Section 4, we suggest ways to disclose relevant information on variable annuities and derivatives.

3. Potential Transmission Mechanisms

We now discuss how risks in the insurance industry could be amplified and transmitted to the rest of the financial sector and the real economy. Our discussion will be qualitative because it is difficult to assess the quantitative importance of the transmission mechanisms, given the available data and our current state of knowledge. Based on the risks that we outline in this section, one could make a case that life insurers are systemically important (Acharya and Richardson 2014). However, we also acknowledge the counterargument that the risks are still isolated and may not be sufficiently large (Harrington 2009; Cummins and Weiss 2014).

3.1. Transmission to Banks

Life insurers are interconnected to banks through at least three channels. First, banks are counterparties in securities lending and derivatives transactions. The experience of AIG suggests that counterparty risk could be significant in bad times (McDonald and Paulson 2014; Peirce 2014). Second, life insurers provide an important source of funding for banks through

the corporate bond market. Any reduction in funding could lead to liquidity problems for banks, at least in the short run. Finally, banks fund a significant share of captive reinsurance through letters of credit. Therefore, a systematic shock to insurance liabilities (e.g., from equity risk in variable annuity guarantees) could trigger drawdowns of letters of credit, so that banks are exposed to both liquidity and counterparty risk.

3.2. Transmission through the Corporate Bond Market

Life insurers are among the largest institutional investors in the corporate bond market. Therefore, any shock to their balance sheets could interact with risk-based capital requirements to cause a significant shift in demand and price impact. Falling bond prices, potentially accompanied by a volatility spike, could cause value-at-risk constraints to bind for other institutional investors, forcing asset sales (Brunnermeier and Pedersen 2009). Thus, shocks to the insurance industry could be transmitted to other parts of the financial sector through fire-sale dynamics in asset markets. This ultimately matters for the real economy through higher borrowing costs for firms.

There is substantial evidence in the literature that shifts in bond demand, when life insurers become financially constrained, have price impact. Ellul, Jotikasthira, and Lundblad (2011) find that financially constrained life insurers sell downgraded corporate bonds to satisfy risk-based capital requirements, temporarily depressing prices. Merrill et al. (2012) find similar evidence for downgraded residential mortgage-back securities during the financial crisis. Ellul et al. (2015) find that financially constrained life insurers sell corporate bonds with the highest unrealized gains, carried at historical cost according to statutory accounting principles, to improve their capital positions.

These examples show that poorly designed accounting standards and risk-based capital regulation could have unintended consequences. Life insurers may have an incentive to sell bonds in depressed markets, even though they would be the natural long-term investors given their liability structure. Such incentives could exacerbate the transmission of shocks

through fire-sale dynamics.

3.3. Transmission to Households

Any shocks to life insurers could transmit to households through the insurance product market. For example, if households become concerned about the solvency of life insurers because of variable annuity guarantees or shadow insurance, demand could collapse because of a debt overhang problem. Instead of purchasing insurance products, households may self-insure idiosyncratic risk through precautionary saving. This could have a potentially important impact on household welfare and the real economy (Koijen, Van Nieuwerburgh, and Yogo 2016).

Koijen and Yogo (2015) find evidence for the transmission of shocks through annuity and life insurance markets. In ordinary times, life insurers earn an average markup of 6 to 10 percent on annuities and life insurance. During the financial crisis, life insurers reduced the markup to -19 percent for annuities and -57 percent for life insurance, when falling interest rates implied that they should have instead raised prices. In the cross-section of policies, the price reductions were larger for those policies with looser capital requirements. In the cross section of insurance companies, the price reductions were larger for those companies that suffered larger balance sheet shocks. Insurance companies that reduced prices sold more policies, consistent with a downward shift in the supply curve.

The example in Koijen and Yogo (2015) shows that poorly designed accounting standards and risk-based capital regulation could have unintended consequences. Life insurers may have an incentive to sell policies below actuarial value in order to boost their capital positions in the short run, hurting their solvency in the long run. This issue appears to be relevant to the "volatility adjustment" under Solvency II, under which regulators would adjust the risk-free term structure of interest rates depending on macroeconomic conditions (European Insurance and Occupational Pensions Authority 2014a). Such adjustments could distort product market outcomes and exacerbate the transmission of shocks to households.

4. Implications for Financial Disclosure and Insurance Regulation

The risk profile of life insurers has become increasingly complex and opaque over the last decade because of variable annuities, shadow insurance, securities lending, and derivatives. In this chapter, we have summarized recent trends in exposure to these sources of risk based on public financial statements. A number of potential reforms to financial disclosure could enhance understanding of how these sources of risk could lead to overall risk mismatch in the insurance industry.

1. Variable annuities: Life insurers could report the type and quantity of guaranteed benefits sold and outstanding for each variable annuity product, which would be useful for understanding potential risk mismatch that arises from equity and interest-rate risk in variables annuity guarantees. Under the current reporting requirements, we only know the aggregate account value associated with guaranteed benefits.

2. Interest-rate risk: Life insurers could report the market value and duration of liabilities (e.g., fixed annuities and life insurance), just as they already do for the asset side of the balance sheet. Such data would be useful for assessing the overall risk mismatch, particularly for interest-rate risk. This issue is especially important in the current interest-rate environment, in which there is significant uncertainty over how long interest rates will remain low.

3. Captive reinsurance: State regulators could release the financial statements of captives, following the lead of the Iowa Insurance Division. Furthermore, restated financial statements, in which the entire liability side is reported under statutory accounting principles, would be useful for assessing capital adequacy.

4. Derivatives: Life insurers could report their hedging programs in more detail, which would be useful for assessing their effectiveness. Under the current reporting requirements, we only know how derivatives are used to hedge broad categories of risk (e.g.,

variable annuities instead of the type of guaranteed benefit).

5. International activity: This chapter and most of the evidence that we cite is for the United States. The main reason is that financial statements at the same level of detail are not publicly available in Europe. Although transparency is expected to improve with Solvency II, we would like to see sufficient detail regarding guaranteed investment products, reinsurance, securities lending, and derivatives to be able to assess overall risk mismatch at the international level.

Recent research summarized in this chapter shows that regulation influences all important functions of the insurance industry including product design, pricing, reinsurance, investment activity, and risk management. Therefore, regulation is not only important for our understanding of insurance markets, but it must be properly designed to ensure both efficient function and future stability of the insurance industry. Yet, little research exists on optimal insurance regulation.

The fact that life insurers have a different liability structure than banks implies that their capital requirements must also be different. Life insurance liabilities are not prone to runs in most countries, so short-term risk constraints designed to prevent bank runs may not be appropriate for life insurers. In fact, short-term risk constraints can actually increase the long-term risk of life insurers if asset prices are mean reverting (Campbell and Shiller 1988). Therefore, long-term risk measures may provide more relevant information for life insurers that are analogous to short-term measures for banks.

Of course, measurement of long-term risk is challenging and potentially sensitive to reasonable variation in modeling assumptions. A fundamental problem with the insurance industry is that no one knows the market value of liabilities, and the data necessary for doing such calculations are far from complete in the public financial statements. We see the recent trend toward shadow insurance as an impedient to measuring liabilities. Complete and transparent financial statements are necessary to move forward the discussion on optimal insurance regulation.

References

Acharya, V. V., and M. Richardson. 2014. Is the insurance industry systemically risky? In J. H. Biggs and M. P. Richardson, eds., *Modernizing Insurance Regualation*, chap. 9, 151–79. Hoboken, NJ: John Wiley & Sons, Inc.

A.M. Best Company. 2003–2014a. *Best's Schedule S: Life/health, United States*. Oldwick, NJ: A.M. Best Company.

———. 2003–2014b. *Best's Statement File: Life/health, United States*. Oldwick, NJ: A.M. Best Company.

———. 2015. Variable annuities: Legacy blocks still represent tail risk. *A.M. Best Special Report* .

Bauer, D., A. Kling, and J. Russ. 2008. A universal pricing framework for guaranteed minimum benefits in variable annuities. *ASTIN Bulletin* 38:621–51.

Becker, B., and V. Ivashina. 2015. Reaching for yield in the bond market. *Journal of Finance* 70:1863–901.

Becker, B., and M. Opp. 2013. Regulatory reform and risk-taking: Replacing ratings. Working Paper No. 19257, NBER.

Begenau, J., M. Piazzesi, and M. Schneider. 2015. Banks' risk exposures. Working Paper No. 21334, NBER.

Berends, K., and T. B. King. 2015. Derivatives and collateral at U.S. life insurers. *Federal Reserve Bank of Chicago Economic Perspectives* 39:21–37.

Brunnermeier, M. K., and L. H. Pedersen. 2009. Market liquidity and funding liquidity. *Review of Financial Studies* 22:2201–38.

Campbell, J. Y., and R. J. Shiller. 1988. The dividend-price ratio and expectations of future dividends and discount factors. *Review of Financial Studies* 1:195–228.

Captives and Special Purpose Vehicle Use Subgroup. 2013. Captives and special purpose vehicles. Unpublished Manuscript, National Association of Insurance Commissioners.

Credit Suisse. 2012. US variable annuities. *Credit Suisse Connections Series* .

Cummins, J. D., and M. A. Weiss. 2014. Systemic risk and the U.S. insurance sector. *Journal of Risk and Insurance* 81:489–528.

Domanski, D., H. Shin, and V. Sushko. 2015. The hunt for yield: Not waving but drowning? Unpublished Manuscript, Bank for International Settlements.

Ellul, A., C. Jotikasthira, and C. T. Lundblad. 2011. Regulatory pressure and fire sales in the corporate bond market. *Journal of Financial Economics* 101:596–620.

Ellul, A., C. Jotikasthira, C. T. Lundblad, and Y. Wang. 2015. Is historical cost accounting a panacea? Market stress, incentive distortions, and gains trading. *Journal of Finance* 70:2489–538.

European Insurance and Occupational Pensions Authority. 2014a. Consultation paper on a technical document regarding the risk free interest rate term structure. Working Paper 14-042, EIOPA.

———. 2014b. EIOPA insurance stress test 2014. Working Paper 14-203, EIOPA.

European Systemic Risk Board. 2015. Issues note on risks and vulnerabilities in the EU financial system. Unpublished Manuscript, ESRB.

Foley-Fisher, N., B. Narajabad, and S. Verani. 2015. Self-fulfilling runs: Evidence from the U.S. life insurance industry. Unpublished Manuscript, Board of Governors of the Federal Reserve System.

Froot, K. A. 2007. Risk management, capital budgeting, and capital structure policy for insurers and reinsurers. *Journal of Risk and Insurance* 74:273–99.

Harrington, S. E. 2009. The financial crisis, systemic risk, and the future of insurance regulation. *Journal of Risk and Insurance* 76:785–819.

Iowa Insurance Division. 2014. Financial statements—single-state life or property. http://www.iid.state.ia.us/single_state_life_pc.

Kashyap, A. K. 2002. Sorting out Japan's financial crisis. *Federal Reserve Bank of Chicago Economic Perspectives* 26:42–55.

Koijen, R. S. J., S. Van Nieuwerburgh, and M. Yogo. 2016. Health and mortality delta: Assessing the welfare cost of household insurance choice. *Journal of Finance* 71:957–1010.

Koijen, R. S. J., and M. Yogo. 2015. The cost of financial frictions for life insurers. *American Economic Review* 105:445–75.

———. 2016. Shadow insurance. *Econometrica* 84:1265–87.

Lawsky, B. M. 2013. Shining a light on shadow insurance: A little-known loophole that puts insurance policyholders and taxpayers at greater risk. Unpublished Manuscript, New York State Department of Financial Services.

Lee, S.-J., D. Mayers, and C. W. Smith, Jr. 1997. Guaranty funds and risk-taking: Evidence from the insurance industry. *Journal of Financial Economics* 44:3–24.

McDonald, R. L., and A. Paulson. 2014. AIG in hindsight. *Journal of Economic Perspectives* 29:81–106.

Merrill, C. B., T. D. Nadauld, R. M. Stulz, and S. M. Sherlund. 2012. Did capital requirements and fair value accounting spark fire sales in distressed mortgage-backed securities? Working Paper No. 18270, NBER.

National Association of Insurance Commissioners. 2011. Securities lending in the insurance industry. *NAIC Capital Markets Special Report* .

Novy-Marx, R., and J. D. Rauh. 2011. Public pension promises: How big are they and what are they worth? *Journal of Finance* 66:1211–49.

Peirce, H. 2014. Securities lending and the untold story in the collapse of AIG. Unpublished Manuscript, George Mason University.

Roberts, R. 2012. Did anyone learn anything from the Equitable Life? Lessons and learning from financial crises. Unpublished Manuscript, King's College London.

Robinson, S., and M. Son. 2013. The captive triangle: Where life insurers' reserve and capital requirements disappear. Report 156495, Moody's Investors Service.

Schwarcz, D. 2015. The risks of shadow insurance. Unpublished Manuscript, University of Minnesota.

Table 1: Operating gain in 2008 for top ten life insurers by variable annuity account value

Financial group	Account value (billion $)	Operating gain (share of capital and surplus)
MetLife	143	-0.05
AXA Financial	139	-0.18
Hartford Life	119	-0.52
AIG Life	105	0.00
ING USA Life	98	-0.14
Lincoln Financial	97	-0.01
Manulife Financial	94	-0.46
Prudential of America	79	-0.28
Aegon USA	61	-0.26
Ameriprise Financial	57	-0.44
Total for life insurers		
with VA guarantees	1,460	-0.09
without VA guarantees	0	0.01

A.M. Best financial groups are ranked by variable annuity (VA) account value associated with guaranteed benefits in 2007. Net operating gain from individual annuities in 2008 is reported as a share of capital and surplus in 2007. The last two rows report the total for the insurance industry, separately for life insurers with and without VA guarantees in 2007.

Table 2: Top ten life insurers by shadow insurance

Financial group	Reinsurance ceded (billion $)
John Hancock Life Insurance	118
MetLife	45
Athene USA	40
Hartford Life	40
Aegon USA	30
Great-West Life	14
Voya Financial	13
AIG Life and Retirement	12
Global Atlantic	11
Lincoln Financial	7

A.M. Best financial groups are ranked by life and annuity reinsurance ceded to shadow reinsurers in 2013. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are a subset of affiliated reinsurers that are unauthorized and do not have an A.M. Best rating.

Table 3: Surplus of Iowa captives based on Iowa versus statutory accounting

Captive	Iowa	Statutory
Cape Verity I	27	-432
Cape Verity II	140	-548
Cape Verity III	54	-169
MNL Reinsurance	118	118
Solberg Reinsurance	207	207
Symetra Reinsurance	20	-51
TLIC Riverwood Reinsurance	817	-1,113
TLIC Oakbrook Reinsurance	114	-675
Total	1,497	-2,663

Surplus of Iowa captives in 2014 are reported on the basis of permitted accounting practices of the Iowa Insurance Division and statutory accounting principles. All amounts are in millions of dollars.

Table 4: Capital gain in 2008 for top ten life insurers by securities lending agreements

Financial group	Amount of assets (billion $)	Capital gain (share of capital and surplus)
AIG Life	54	-1.69
MetLife	38	-0.07
New York Life	6	-0.34
Prudential of America	5	-0.28
Northwestern Mutual	4	-0.52
Hartford Life	2	-0.07
Genworth Financial	2	0.12
Allstate Financial	2	-0.48
Manulife Financial	2	-0.07
Woodmen Life	1	-0.26
Total for life insurers		
with securities lending	128	-0.39
without securities lending	0	-0.18

A.M. Best financial groups are ranked by the amount of admitted assets subject to securities lending agreements in 2007. Total capital gain from investment activity in 2008 is reported as a share of capital and surplus in 2007. The last two rows report the total for the insurance industry, separately for life insurers with and without securities lending activity.

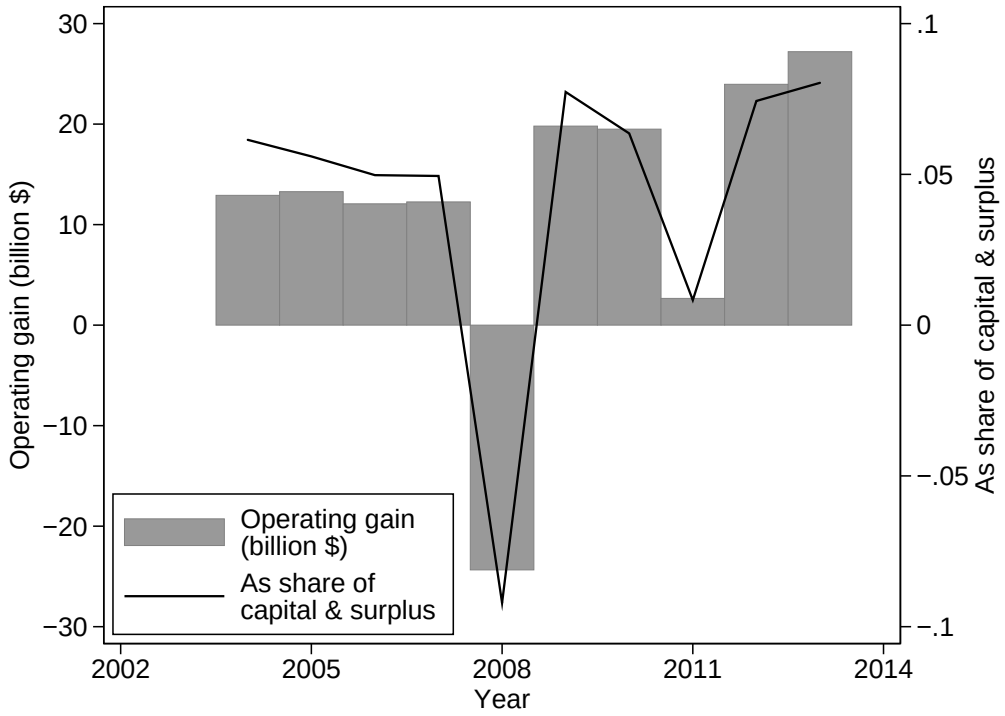

Figure 1: Operating gain from annuities for life insurers with variable annuity guarantees

Net operating gain from individual annuities is reported in total dollars and as a share of capital and surplus in the previous year. The sample consists of A.M. Best financial groups with positive variable annuity account value associated with guaranteed benefits in the previous year.

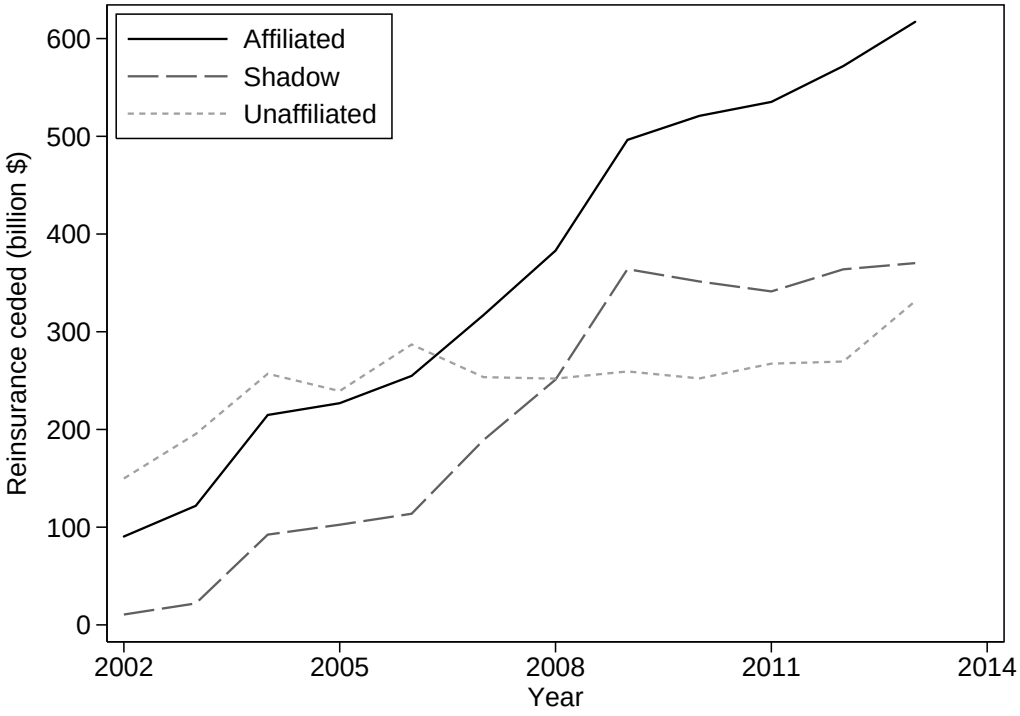

Figure 2: Reinsurance ceded to affiliated, shadow, and unaffiliated reinsurers
Life and annuity reinsurance ceded by U.S. life insurers to affiliated, shadow, and unaffiliated reinsurers is reported. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are a subset of affiliated reinsurers that are unauthorized and do not have an A.M. Best rating.

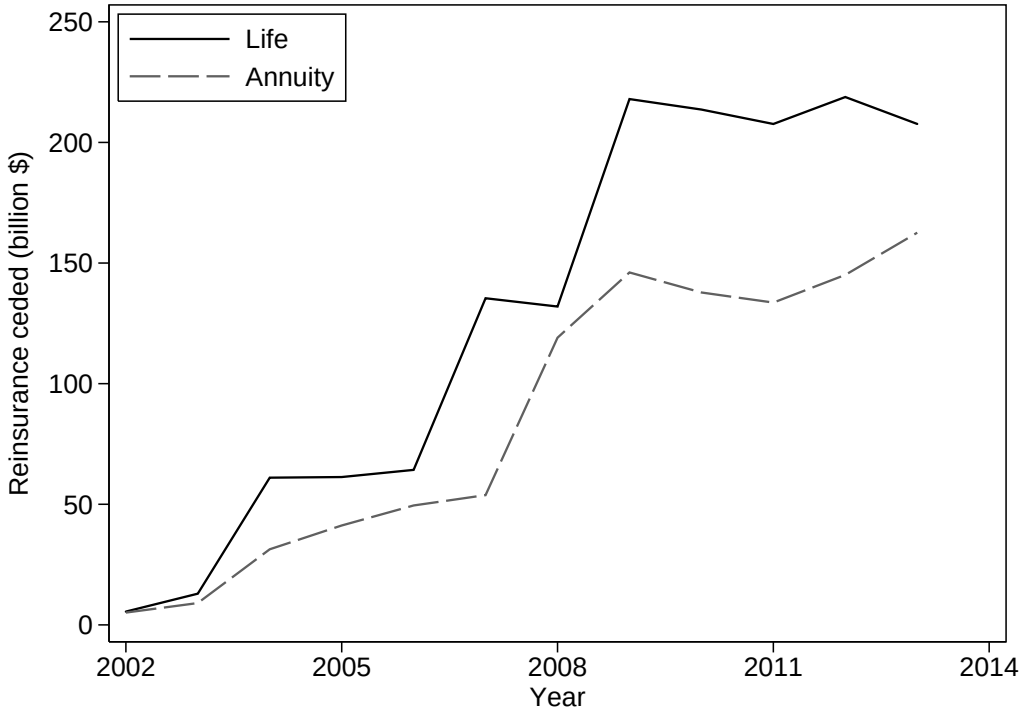

Figure 3: Life versus annuity reinsurance ceded to shadow reinsurers
Reinsurance ceded by U.S. life insurers to shadow reinsurers is reported, separately for life and annuity reinsurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are a subset of affiliated reinsurers that are unauthorized and do not have an A.M. Best rating.

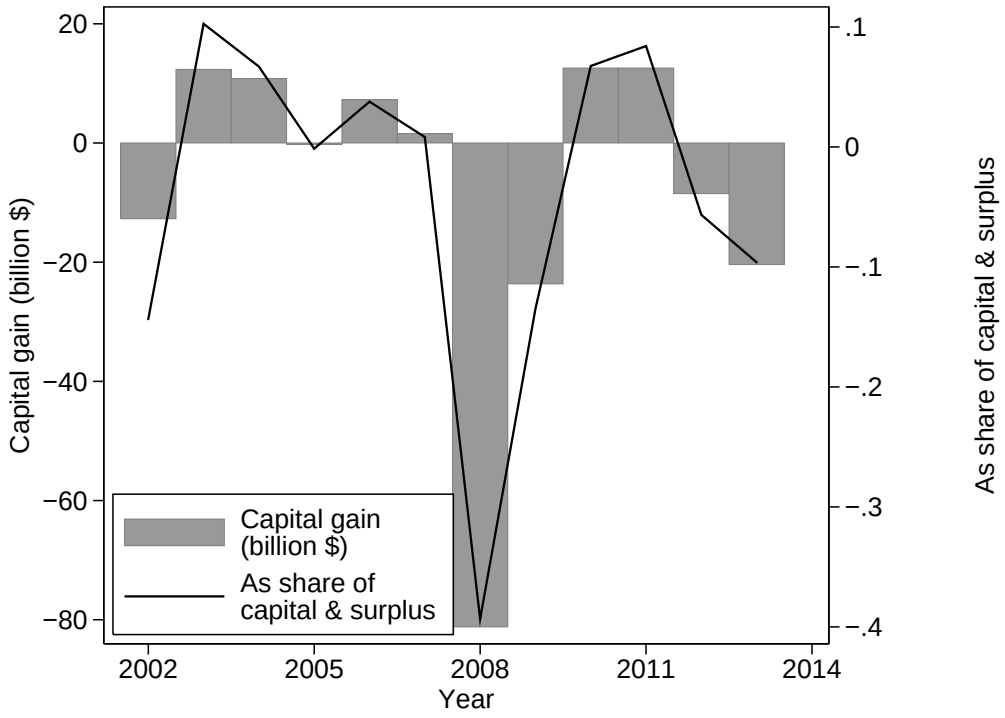

Figure 4: Capital gain for life insurers with securities lending agreements
Total capital gain from investment activity is reported in total dollars and as a share of capital and surplus in the previous year. The sample consists of A.M. Best financial groups with a positive amount of admitted assets subject to securities lending agreements in the previous year.

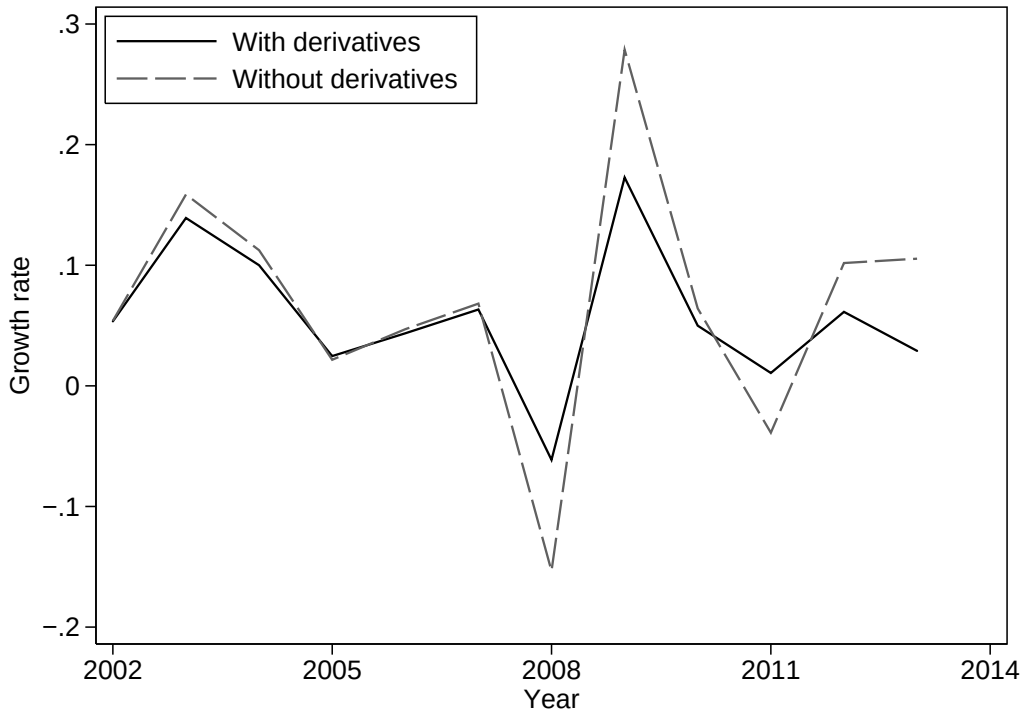

Figure 5: Growth rate of capital and surplus with and without derivatives
The growth rate of capital and surplus without derivatives is the growth rate of capital and surplus minus the sum of net investment income and total capital gain from derivatives. The sample consists of A.M. Best financial groups with non-zero derivatives exposure.

Appendix A. Data Construction

We construct our data from A.M. Best Company (2003–2014b). The relevant schedules and variables are as follows.

1. Summary of Operations:
   (a) Capital and surplus for December 31 of prior year.
   (b) Capital and surplus for December 31 of current year.
2. Analysis of Operations by Lines of Business:
   (a) Individual annuities: Net gain from operations before dividends and taxes.
3. Exhibits of Net Investment Income and Capital Gains (Losses):
   (a) Earned during year: Derivative instruments.
   (b) Realized gain (loss) on sales or maturity: Derivative instruments.
   (c) Realized gain (loss) on sales or maturity: Total capital gains.
   (d) Other realized adjustments: Derivative instruments.
   (e) Other realized adjustments: Total capital gains.
   (f) Change in unrealized capital gain (loss): Derivative instruments.
   (g) Change in unrealized capital gain (loss): Total capital gains.
   (h) Change in unrealized foreign exchange capital gain (loss): Derivative instruments.
   (i) Change in unrealized foreign exchange capital gain (loss): Total capital gains.
   (j) Unrealized increases (decreases) by adjustment: Derivative instruments.
   (k) Unrealized increases (decreases) by adjustment: Total capital gains.
   (l) Net gain (loss) from change in difference between basis: Derivative instruments.

(m) Net gain (loss) from change in difference between basis: Total capital gains.

4. General Interrogatories:

   (a) Guaranteed benefit: Total related account values.

5. Supplemental Investment Risks Interrogatories:

   (a) Admitted assets subject to agreement at year-end: Securities lending.

In Table 1 and Figure 1, variable annuity account value associated with guaranteed benefits is 4(a). Net operating gain from individual annuities is 2(a). In Table 4 and Figure 4, the amount of admitted assets subject to securities lending agreements is 5(a). Total capital gain from investment activity is 3(c)+3(e)+3(g)+3(i)+3(k)+3(m). In Figure 5, the change in capital and surplus with derivatives is 1(b)−1(a). The sum of net investment income and total capital gain from derivatives is 3(a)+3(b)+3(d)+3(f)+3(h)+3(j)+3(l).

In Table 2 and Figures 2 and 3, our data construction exactly follows Koijen and Yogo (2016), based on A.M. Best Company (2003–2014a).