Shadow Insurance*

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Abstract

Liabilities ceded by life insurers to shadow reinsurers (i.e., affiliated and less regulated off-balance-sheet entities) grew from $11 billion in 2002 to $364 billion in 2012. Companies using shadow insurance, which capture half of the market share, ceded 25 cents of every dollar insured to shadow reinsurers in 2012, up from 2 cents in 2002. Our adjustment for shadow insurance reduces risk-based capital by 53 percentage points (or 3 rating notches) and raises impairment probabilities by a factor of four. We develop a structural model of the life insurance industry to estimate the impact of current policy proposals to curtail shadow insurance. Without shadow insurance, marginal cost would rise by 18 percent, and annual life insurance underwritten would fall by 23 percent. (*JEL* G22, G28, L11)

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Life insurance and annuity liabilities of U.S. life insurers were $4,068 billion in 2012, which is substantial even when compared with $6,979 billion in savings deposits at U.S. depository institutions (Board of Governors of the Federal Reserve System 2013). However, there is little research on life insurer liabilities, especially in comparison with the large banking literature. The reason, perhaps, is the traditional view that life insurer liabilities are safe (and boring) because they are more predictable, have a longer maturity, and are less vulnerable to runs. Hence, all of the interesting action is on the asset side, where life insurers take on some investment risk.

This paper shows that developments in the life insurance industry over the last decade shatter this traditional view. As a consequence of changes in regulation, life insurers are now using reinsurance to move liabilities from operating companies that sell policies to less regulated and unrated *shadow reinsurers*. These shadow reinsurers are captives or special purpose vehicles in U.S. states (e.g., South Carolina and Vermont) or offshore domiciles (e.g., Bermuda and Barbados) with more favorable capital regulation or tax laws. In contrast to traditional reinsurance with unaffiliated (i.e., third-party) reinsurers, these transactions do not transfer risk because the liabilities stay within the holding company.

Using new data on life and annuity reinsurance agreements in the United States, we map out the financial plumbing of life insurer liabilities, paying particular attention to the shadow insurance sector. We find that liabilities ceded to shadow reinsurers grew rapidly from $11 billion in 2002 to $364 billion in 2012. This activity now exceeds total unaffiliated reinsurance in the life insurance industry, which was $270 billion in 2012.[1] Operating companies using shadow insurance tend to be larger and capture 48 percent of the market share for both life insurance and annuities. These companies ceded 25 cents of every dollar insured to shadow reinsurers in 2012, significantly up from only 2 cents in 2002.

We find that shadow insurance adds significant financial risk for the companies involved, which is not reflected in their current ratings. Our adjustment for shadow insurance reduces risk-based capital by 53 percentage points and ratings by 3 notches for the average company. Furthermore, the adjusted ratings imply a 10-year impairment probability that is four times that implied by the reported ratings. We estimate an expected loss of $28.0 to $69.9 billion for the industry, depending on assumptions about loss conditional on impairment. The upper range of our estimates exceeds the current total capacity of state guaranty funds, which is $56.4 billion.

Shadow insurance clearly imposes costs on the operating companies not using shadow insurance and state taxpayers, through the state guaranty funds. However, its potential

[1] Similarly, total unaffiliated reinsurance in the property-casualty insurance industry was $155 billion in 2008 (Cummins and Weiss 2010, Table 5).

benefits are harder to measure. In theory, shadow insurance lowers the cost of financial and regulatory frictions for life insurers, which leads to lower marginal cost and more underwriting of insurance in the retail market. To estimate this potential benefit, we develop a structural model of the life insurance industry. Demand is determined by a standard discrete choice model of product differentiation, along both observable and unobservable company characteristics. Supply is determined by imperfectly competitive operating companies that sell policies and cede reinsurance to affiliated reinsurers for the purposes of capital management. We estimate the structural model by instrumental variables under the identifying assumption that shadow insurance lowers prices, but it does not affect demand directly.

We use the structural model to estimate the impact of current policy proposals to curtail shadow insurance. For example, the New York State Department of Financial Services has called for a national moratorium on further approval of shadow insurance (Lawsky 2013). The Financial Stability Oversight Council has designated some life insurers as "systemically important" and placed them under Federal Reserve supervision, which could curtail shadow insurance through new reporting and capital requirements. In the counterfactual equilibrium without shadow insurance, we find that marginal cost would rise by 17.7 percent for the average company. Higher prices mean that some potential customers would stay out of the life insurance market. Consequently, annual life insurance underwritten would fall by $21.4 billion from its current level of $91.5 billion.

Our work on life and annuity reinsurance is related to the literature on property and casualty reinsurance. This literature finds that property and casualty reinsurance is used for a variety of reasons, including risk transfer as well as capital and tax management (Mayers and Smith 1990, Adiel 1996). Froot (2001) finds evidence for limited transfer of catastrophe event risk, which highlights the importance of capital market frictions in the supply side of reinsurance markets. For life insurers, risk transfer has always been a less important motive because of the more predictable nature of their business, which explains why there is relatively little unaffiliated reinsurance. All of the growth in life and annuity reinsurance over the last decade is within the holding company, which points to capital and tax management as the primary motive for this activity.

Our work is also related to the literature on financial and regulatory frictions in the supply side of insurance markets. In particular, some recent papers show that capital regulation and accounting rules, when they interact with financial frictions, affect investment behavior on the asset side of the balance sheet.[2] Our work complements this literature by showing that a set of capital regulation and accounting rules, which is specific to the liability side,

[2] See Becker and Ivashina (2012), Ellul, Jotikasthira, Lundblad and Wang (2012), and Merrill, Nadauld, Stulz and Sherlund (2012).

has a profound impact on reinsurance and underwriting activity.

The remainder of the paper is organized as follows. Section 1 discusses the changes in life insurance regulation and new captive laws that preceded shadow insurance. Section 2 describes the data on life and annuity reinsurance. Section 3 documents the rapid growth of shadow insurance over the last decade. In Section 4, we estimate the impact of shadow insurance on financial risk of the companies involved and expected loss for the industry. In Section 5, we develop a model of optimal insurance pricing and reinsurance for a holding company. In Section 6, we estimate the structural model and the counterfactual equilibrium without shadow insurance. Section 7 concludes with broader implications of our findings.

1. Changes in Regulation that Preceded Shadow Insurance

The four basic motives of life and annuity reinsurance are risk transfer, underwriting assistance, capital management, and tax management (Tiller and Tiller 2009, Chapter 1). Over the last decade, the latter two motives have become increasingly important relative to the former two because of two related developments. On the one hand, changes in regulation after 2000 forced life insurers to hold more capital against life insurance liabilities, straining their capital positions. On the other hand, new state laws after 2002 allowed life insurers to establish captives to circumvent the new capital requirements. We now discuss these developments and related institutional background, to the extent that they are relevant for this paper.

1.1. Changes in Life Insurance Regulation

In January 2000, the National Association of Insurance Commissioners (NAIC) adopted Model Regulation 830, commonly referred to as Regulation XXX. This was followed by Actuarial Guideline 38 in January 2003, commonly referred to as Regulation AXXX. These changes in regulation forced life insurers to hold much higher statutory reserve on newly issued term life insurance and universal life insurance with secondary guarantees.

These changes in regulation are a matter of statutory accounting principles and do not apply to generally accepted accounting principles (GAAP). The reserve requirements under GAAP are much lower and closer to actuarial value. Therefore, an operating company that reports under statutory accounting principles can cede reinsurance to a reinsurer that reports under GAAP, thereby reducing overall reserves. In practice, however, unaffiliated reinsurance can be expensive because of the limited supply of capital for this purpose.

1.2. New Captive Laws

Starting in 2002, South Carolina introduced new laws that allow life insurers to establish captives, whose primary function is to assume reinsurance from affiliated companies for the purpose of reducing overall reserves. Captives are governed by state law that is different from the usual insurance regulation that applies to operating companies. A captive structure that has proven especially successful is the so-called special purpose financial captive, which is a type of special purpose vehicle that was introduced by South Carolina in 2004 and by Vermont in 2007. There are now 26 states that have adopted a version of the captive laws, eight of which have defined special purpose financial captives (Captives and Special Purpose Vehicle Use Subgroup 2013).

Captives usually have several advantages over traditional reinsurers. First, they allow life insurers to keep the underwriting profits within the holding company. Second, they can hold less capital because they report under GAAP or do not face risk-based capital regulation. Third, their financial statements are confidential to the public, and sometimes even to insurance regulators outside their domicile. Finally, they have a more flexible financial structure that allows them to fund transactions through letters of credit or securitization. In Appendix A, we provide stylized balance-sheet examples that illustrate these advantages of captive reinsurance.

Operating companies are ultimately responsible for all liabilities that they issue, even those that they cede to reinsurers. Combined with the fact that securitization is rare in practice (Stern, Rosenblatt, Nadell and Andruschak 2007), captives do not transfer risk outside the holding company and exist solely for the purpose of capital and tax management. Hence, captives have a function similar to asset-backed commercial paper conduits with explicit guarantees from the sponsoring bank, prior to the recent regulatory reform of shadow banking (Acharya, Schnabl and Suarez 2013).

U.S. tax laws disallow reinsurance for the primary purpose of reducing tax liabilities. However, it can be an important side benefit of captive reinsurance that motivates where a life insurer establishes its captive. Life insurance premiums are taxable at the state level, and the tax rates on premiums vary across states (Cole and McCullough 2008). In addition, profits are taxable at the federal level, so a life insurer could reduce its tax liabilities by ceding reinsurance to an offshore captive. Bermuda, Barbados, and the Cayman Islands are important captive domiciles for this purpose.

2. Data on Life and Annuity Reinsurance

2.1. Data Construction

We construct our sample of life and annuity reinsurance agreements for U.S. life insurers from the Schedule S filings for fiscal years 2002 to 2012 (A.M. Best Company 2003–2013b). These financial statements are annually reported to the NAIC according to statutory accounting principles, which are conveniently organized along with ratings information by A.M. Best Company. The relevant parts of Schedule S for our analysis are 1.1 (Reinsurance Assumed), 3.1 (Reinsurance Ceded), and 4 (Reinsurance Ceded to Unauthorized Companies).

The data contain all reinsurance agreements (both ceded and assumed) at each fiscal year-end for any operating company or authorized reinsurer that faces the same reporting and capital requirements as an operating company. In particular, the data contain reinsurance ceded by an operating company to an unauthorized reinsurer, such as a domestic captive or a foreign reinsurer. However, we do not observe reinsurance ceded by unauthorized reinsurers that do not report to the NAIC.

For each reinsurance agreement, we observe the identity of the reinsurer, the type of reinsurance, the effective date, reserve credit taken (or reserves held), and modified coinsurance reserve.[3] We know the identity of the reinsurer up to its name, domicile, whether it is affiliated with the ceding company, whether it is authorized in the domicile of the ceding company, and whether it is rated by A.M. Best Company. We define *shadow reinsurers* as affiliated and unauthorized reinsurers without an A.M. Best rating. Our definition is stricter than "captives" because some captives are actually authorized.

We merge the Schedule S data with the annual NAIC financial statements of the ceding companies (A.M. Best Company 2003–2013c). The relevant parts for our analysis are Liabilities, Surplus and Other Funds; Exhibit 5 (Aggregate Reserve for Life Contracts); Exhibit of Life Insurance; and Schedule S Part 6 (Restatement of Balance Sheet to Identify Net Credit for Ceded Reinsurance).

2.2. Description of the Sample

Table 1 reports summary statistics for our sample of life and annuity reinsurance agreements, by whether they were ceded to unaffiliated or affiliated reinsurers. The table also reports the same statistics for shadow reinsurers, which are a subset of affiliated reinsurers that are

[3] The types of life reinsurance agreements in the data are coinsurance, modified coinsurance, combination coinsurance, yearly renewable term, and accidental death benefit. The types of annuity reinsurance agreements are coinsurance, modified coinsurance, combination coinsurance, and guaranteed minimum death benefit.

unauthorized and do not have an A.M. Best rating.

Although there are fewer affiliated reinsurance agreements, the typical amount ceded is significantly higher than that for unaffiliated reinsurance. For example, there were 456 new unaffiliated reinsurance agreements in 2009. In comparison, there were only 120 new affiliated reinsurance agreements, 67 of which were ceded to shadow reinsurers. Average unaffiliated reinsurance ceded was $37 million, which is much lower than $1,199 million for affiliated reinsurance and $2,003 million for shadow insurance. The average shadow insurance agreement has generally grown from $60 million in 2002 to $502 million in 2012.

Table 2 describes the characteristics of the operating companies in our sample, by whether they were using shadow insurance. Most operating companies do not use shadow insurance. However, the ones that do tend to be larger, either by market share or total liabilities. In 2012, 78 companies used shadow insurance, while 443 companies did not. However, the operating companies using shadow insurance captured 48 percent of the market share for both life insurance and annuities, and their average liabilities were 317 percent higher.

Operating companies using shadow insurance are mostly stock companies, instead of mutual companies. They also tend to be more leveraged, have assets with lower liquidity, and have higher return on equity. In 2012, the average leverage ratio (i.e., total liabilities over total assets) was 89 percent for the operating companies using shadow insurance, compared with 72 percent for the other companies.

3. New Facts about Shadow Insurance

We now document the rapid growth of shadow insurance over the last decade, as a consequence of changes in life insurance regulation and new captive laws, discussed in Section 1. We start with a case study of the MetLife group, which is the largest insurance group in our sample by total assets. We then show that the rapid growth of affiliated reinsurance, especially with unrated and unauthorized reinsurers, stands in sharp contrast to the behavior of unaffiliated reinsurance over the same period.

3.1. A Case Study of the MetLife Group

Table 3 lists the U.S. operating companies of the MetLife group and their affiliated reinsurers in 2012. The operating companies all have an A.M. Best rating of A+ and cede reinsurance to the rest of the group. The reinsurers are all unrated and assume reinsurance from the rest of the group. The reinsurers are also unauthorized, except for MetLife Reinsurance of Delaware and MetLife Reinsurance of Charleston since 2009. Quite strikingly, the liabilities disappear from the balance sheets of operating companies that sell policies and end up in less regulated and nontransparent reinsurers.

Net reinsurance ceded by Metropolitan Life Insurance (the flagship operating company in New York) was $39.1 billion, which was nearly three times their capital and surplus. In the same year, net reinsurance assumed by Missouri Reinsurance (a captive in Barbados) was $28.4 billion. The sum of net reinsurance ceded across all companies in Table 3, which is total reinsurance ceded outside the MetLife group, was $5.5 billion. This shows that most of the reinsurance activity is within the MetLife group, rather than with unaffiliated reinsurers.

3.2. Growth of Affiliated Reinsurance

Figure 1 reports total reinsurance ceded by U.S. life insurers to affiliated and unaffiliated reinsurers. Affiliated reinsurance grew rapidly from $90 billion in 2002 to $572 billion in 2012. In contrast, unaffiliated reinsurance peaked at $287 billion in 2006 and has been flat since then. Affiliated reinsurance has exceeded unaffiliated reinsurance since 2007.

Figure 2 breaks down Figure 1 into life versus annuity reinsurance. Affiliated life reinsurance grew rapidly from $36 billion in 2002 to $375 billion in 2012. This trend is consistent with changes in life insurance regulation and new captive laws, as discussed in Section 1. In contrast, affiliated annuity reinsurance shows little growth prior to 2007. It then grew rapidly from $91 billion in 2007 to $197 billion in 2012. This timing is consistent with the hypothesis that life insurers faced capital constraints during the financial crisis and, therefore, used affiliated reinsurance to boost their capital positions (Koijen and Yogo 2012).

3.3. Geographic Concentration of Reinsurance

Figure 3 decomposes life and annuity reinsurance ceded by domicile of the reinsurer, separately for affiliated and unaffiliated reinsurance. As discussed in Section 1, South Carolina and Vermont are the most important domiciles for domestic captives because of their capital regulation. Bermuda, Barbados, and the Cayman Islands are the most important domiciles for offshore captives because of their capital regulation and tax laws.

The geography of affiliated reinsurance is characterized by increasing concentration, which is not present in unaffiliated reinsurance. The share of affiliated reinsurance ceded to South Carolina and Vermont grew rapidly from essentially none in 2002 to 19 percent in 2012. In contrast, the share of unaffiliated reinsurance ceded to these two states remained low throughout this period. Similarly, the share of affiliated reinsurance ceded to Bermuda, Barbados, and the Cayman Islands grew from 9 percent in 2002 to 46 percent in 2012. In contrast, the share of unaffiliated reinsurance ceded to these offshore domiciles shrank slightly during the same period.

3.4. Reinsurance with Unrated and Unauthorized Reinsurers

Figure 4 decomposes life and annuity reinsurance ceded by the A.M. Best rating of the reinsurer, separately for affiliated and unaffiliated reinsurance. The share of affiliated reinsurance ceded to unrated reinsurers grew rapidly from 21 percent in 2002 to 76 percent in 2012. In contrast, the share of unaffiliated reinsurance ceded to unrated reinsurers shrank slightly during the same period.

Figure 5 decomposes life and annuity reinsurance ceded by whether the reinsurer is authorized in the domicile of the ceding company, separately for affiliated and unaffiliated reinsurance. The share of affiliated reinsurance ceded to unauthorized reinsurers grew rapidly from 19 percent in 2002 to 70 percent in 2012. In contrast, the share of unaffiliated reinsurance ceded to unauthorized reinsurers has been relatively constant throughout this period.

3.5. Growth of Shadow Insurance

Figure 6 reports total reinsurance ceded by U.S. life insurers to shadow reinsurers. Shadow insurance grew rapidly from $11 billion in 2002 to $364 billion in 2012. In particular, growth accelerated during the financial crisis from 2006 to 2009. As a share of the capital and surplus of the ceding companies, shadow insurance grew from 0.22 in 2002 to 2.49 in 2012. This represents significant leverage in a less regulated and nontransparent part of the life insurance industry.

Figure 7 documents the rapid growth of shadow insurance from the perspective of retail customers that buy policies. As discussed in Section 2, operating companies using shadow insurance capture 48 percent of the market share for both life insurance and annuities. These companies ceded 25 cents of every dollar insured to shadow reinsurers in 2012, significantly up from only 2 cents in 2002.

4. Impact of Shadow Insurance on Financial Risk and Expected Loss

We now estimate the impact of shadow insurance on financial risk of the companies involved and expected loss for the industry. Before doing so, we first show that the A.M. Best rating is unrelated to shadow insurance, after controlling for the conventional determinants of ratings.

4.1. Relation between Ratings and Shadow Insurance

Reinsurance, even with affiliated reinsurers, has traditionally been viewed as risk transfer and credited as reduction in required capital. We suspect that the current rating methodology has not kept pace with recent developments in shadow insurance, which is economically different from traditional reinsurance. To verify this empirically, we first convert the A.M. Best rating to a numerical equivalent based on risk-based capital guidelines (A.M. Best Company 2011, p. 24). We then estimate the relation between the numerical rating and company characteristics, including a dummy for shadow insurance. The first column of Table 4 reports the estimated relation based on ordinary least squares.

The conventional determinants of ratings, as discussed in A.M. Best Company (2011), have the expected signs and are statistically significant. For example, ratings increase by 0.09 standard deviations per one standard deviation increase in risk-based capital. Similarly, ratings are positively related to the dummy for stock company, log liabilities, current liquidity, and return on equity and are negatively related to leverage. Ratings are essentially unrelated to shadow insurance, after controlling for these other characteristics. The coefficient on shadow insurance is economically small and statistically insignificant.

The coefficient on shadow insurance could be biased if there are omitted characteristics that are key determinants of ratings (e.g., soft information that is only available to A.M. Best Company). We address this concern by instrumental variables, where our instrument for shadow insurance is the market share for term life insurance in 1999, interacted with a dummy for stock company in 1999. The motivation for our instrument is that Regulation XXX had a stronger effect on operating companies with more presence in the term life insurance market. The interaction accounts for the fact that among those companies affected by Regulation XXX, the stock companies have a stronger incentive to take advantage of the captives laws after 2002. The market share in 1999 is plausibly exogenous because Regulation XXX applies only to new policies that are issued after 2000 and does not apply retroactively to existing liabilities.

Table 4 reports that the market share for term life insurance in 1999 is a significant predictor of whether an operating company uses shadow insurance. In the first stage of instrumental variables, the likelihood of shadow insurance increases by 5 percent per one standard deviation increase in the market share for term life insurance. The coefficient on shadow insurance in the second stage is 0.03, which is close to the ordinary least squares estimate of 0.05. That is, ratings remain unrelated to shadow insurance, even after addressing the concern of omitted variables bias.

4.2. Impact of Shadow Insurance on Financial Risk

We now estimate what would happen to risk-based capital and ratings if both the assets and liabilities on reinsurance ceded to shadow reinsurers were moved back on balance sheet. Our counterfactual exercise essentially applies the recent regulatory reform of shadow banking (Adrian and Ashcraft 2012) to analogous off-balance-sheet activity in the insurance sector.

We assume that capital and surplus does not change, but risk-based capital would fall because the capital required to support the additional liabilities (i.e., the denominator of the ratio) would rise. We also assume that the risk characteristics of reinsurance ceded are identical to existing life and annuity reserves on balance sheet, so that required capital rises proportionally. This is a conservative assumption because reinsurance ceded to shadow reinsurers is more likely riskier than the liabilities that remain on balance sheet. Our assumptions yield a simple adjustment to risk-based capital based on the reported data:

$$\text{Adjusted RBC} = \frac{\text{Reported RBC} \times \text{Reported reserves}}{\text{Reported reserves} + \text{Shadow insurance}}. \tag{1}$$

Table 5 reports that our adjustment reduces risk-based capital by 53 percentage points for the average company using shadow insurance in 2012. When we apply equation (1) to the numerical rating, instead of risk-based capital, the average rating drops by 3 notches from A to B+. We next match both the reported and adjusted ratings to the historical term structure of impairment probabilities by rating (A.M. Best Company 2013a). The adjusted ratings imply a 10-year impairment probability of 15.6 percent, which is four times that implied by the reported ratings.

4.3. Impact of Shadow Insurance on Expected Loss

We use the term structure of impairment probabilities to estimate the present value of expected loss for each company, which is then aggregated across the industry. We assume a 10 percent loss conditional on impairment in our baseline estimate, based on the typical historical experience (Gallanis 2009). In Table 6, the reported balance-sheet positions and impairment probabilities imply an expected loss of $8.9 billion in 2012. The expected loss rises to $28.0 billion when the balance-sheet positions and impairment probabilities are adjusted for shadow insurance. Since state guaranty funds ultimately pay off all liabilities by assessing the surviving companies, this expected loss is an externality to the operating companies not using shadow insurance. State taxpayers also bear a share of the cost because guaranty fund assessments are tax deductible.

Our baseline estimates in Table 6 are based on historical impairment probabilities and loss ratios, estimated from mostly idiosyncratic events of smaller life insurers. We expect the actual experience for larger life insurers using shadow insurance to be more systematic, leading to larger losses for the industry. To address this concern, we reestimate the expected loss under a 25 percent loss conditional on impairment, which is in the upper range of the historical experience (Gallanis 2009). The expected loss adjusted for shadow insurance rises to $69.9 billion in 2012.

To put these figures into perspective, we estimate the total capacity of state guaranty funds in the last column of Table 6. All states have a cap on annual guaranty fund assessments, typically 2 percent of recent life insurance and annuity premiums. Following Gallanis (2009), we estimate the total capacity of state guaranty funds as the maximum annual assessment in the current year aggregated across all states, projected to remain constant over the next 10 years. This calculation implies a total capacity of \$56.4 billion in 2012, which is already less than the upper range of our estimates for expected loss. If shadow insurance continues to grow, the life insurance industry could experience a painful collapse of demand due to debt overhang.

5. A Model of Insurance Pricing and Reinsurance

We now develop a model of an insurance holding company that consists of an operating company that sells policies to retail customers and an affiliated reinsurer (i.e., captive or special purpose vehicle) that faces looser capital regulation. The holding company uses affiliated reinsurance to move capital between the two companies to reduce the overall cost of financial frictions. In doing so, affiliated reinsurance lowers the operating company's marginal cost of issuing policies, raising its equilibrium supply in the retail market.

Our model has some elements that are familiar from existing models of reinsurance in the property and casualty literature. For example, Froot and O'Connell (2008) model the demand for unaffiliated reinsurance (with risk transfer) when insurance companies face capital market frictions and imperfect competition. In addition to these familiar elements, we add affiliated reinsurance (without risk transfer) as a powerful tool for capital management, which has become the predominant form of reinsurance for life insurers over the last decade. For simplicity, we ignore tax effects because they are difficult to model realistically and also measure. As discussed in Section 1, U.S. tax laws disallow reinsurance for the primary purpose of reducing tax liabilities.

5.1. An Insurance Holding Company's Maximization Problem

An insurance holding company consists of an operating company and an affiliated reinsurer. The operating company prices its policies, facing a downward-sloping demand curve. Let Q_t denote the quantity of policies sold in year t, and let

$$\epsilon_t = -\frac{\partial \log Q_t}{\partial \log P_t} > 1 \tag{2}$$

denote the elasticity of demand at price P_t. We normalize the actuarial value, or the frictionless marginal cost per policy, to one.

After the sale of policies, the operating company can cede reinsurance to the affiliated reinsurer. Let $B_t \geq 0$ denote the quantity of affiliated reinsurance ceded in year t. The operating company can also cede reinsurance to unaffiliated reinsurers outside the holding company. Let $D_t \geq 0$ denote the quantity of unaffiliated reinsurance ceded at an exogenously given price $P_{D,t}$.

The holding company's total profit in year t is

$$\Pi_t = (P_t - 1)Q_t - (P_{D,t} - 1)D_t. \tag{3}$$

Total profit is equal to the profit from the sale of policies minus the cost of unaffiliated reinsurance. Note that affiliated reinsurance nets out of total profit (in the absence of tax effects).

We now describe how the sale of policies and reinsurance affect the operating company's balance sheet. Let L_t be the operating company's reserves (i.e., liabilities) at the end of year t. For simplicity, we assume that the reserve value per policy is equal to the actuarial value (normalized to one). The change in reserves in year t is

$$\Delta L_t = Q_t - B_t - D_t. \tag{4}$$

Let A_t be the operating company's assets at the end of year t. The change in assets in year t is

$$\begin{aligned}\Delta A_t =& \Delta L_t + (P_t - 1)Q_t - (P_{D,t} - 1)D_t \\ =& P_t Q_t - B_t - P_{D,t} D_t.\end{aligned} \tag{5}$$

The change in assets is equal to the change in reserves, plus the profits from the sale of policies, minus the cost of unaffiliated reinsurance.

We define the operating company's statutory capital at the end of year t as

$$K_t = A_t - (1 + \rho)L_t. \tag{6}$$

Our formulation of statutory capital may be interpreted in two ways, both of which lead to equation (6). First, as discussed in Section 1, operating companies must hold additional reserves under Regulation (A)XXX. Under this interpretation, ρ is the difference between reserve and actuarial value. Second, operating companies that face risk-based capital regulation must hold additional capital to buffer shocks to their liabilities. Under this interpretation, ρ is the risk charge on reserves. Under both interpretations, a higher ρ implies tighter capital regulation. Equations (4) and (5) imply that the change in statutory capital in year t is

$$\Delta K_t = (P_t - (1+\rho))Q_t + \rho B_t - (P_{D,t} - (1+\rho))D_t. \tag{7}$$

The only function of the affiliated reinsurer is to assume reinsurance from the operating company. We define the affiliated reinsurer's statutory capital at the end of year t as

$$\widehat{K}_t = \widehat{A}_t - (1+\widehat{\rho})\widehat{L}_t. \tag{8}$$

We assume that $0 < \widehat{\rho} < \rho$, which means that the affiliated reinsurer faces looser capital regulation than the operating company. The change in statutory capital in year t is

$$\Delta \widehat{K}_t = -\widehat{\rho} B_t. \tag{9}$$

The holding company faces financial frictions, part of which arises from regulatory restrictions on the movement of capital within a holding company (National Association of Insurance Commissioners 2011, Appendix A-440). For example, moving capital through affiliated reinsurance can draw regulatory scrutiny. A simple way to model these frictions is a cost function that depends on the statutory capital of both companies:

$$C_t = C\left(K_t, \widehat{K}_t\right) \tag{10}$$

with negative first derivatives.

The holding company maximizes firm value, or the present value of profits minus the cost of financial frictions:

$$J_t = \Pi_t - C_t + \mathbf{E}_t[M_{t+1} J_{t+1}], \tag{11}$$

where M_{t+1} is the stochastic discount factor. Its choice variables are the insurance price P_t, affiliated reinsurance B_t, and unaffiliated reinsurance D_t.

To simplify exposition and notation, we refer to

$$c_t = -\frac{\partial C_t}{\partial K_t} + \mathbf{E}_t \left[M_{t+1} \frac{\partial J_{t+1}}{\partial K_t} \right], \tag{12}$$

$$\widehat{c}_t = -\frac{\partial C_t}{\partial \widehat{K}_t} + \mathbf{E}_t \left[M_{t+1} \frac{\partial J_{t+1}}{\partial \widehat{K}_t} \right] \tag{13}$$

as the shadow cost of capital for the operating company and the affiliated reinsurer, respectively. They measure the importance of financial frictions, either in the present or some future period.

5.2. *Optimal Insurance Pricing*

The first-order condition for the insurance price is

$$\begin{aligned} \frac{\partial J_t}{\partial P_t} =& \frac{\partial \Pi_t}{\partial P_t} + c_t \frac{\partial K_t}{\partial P_t} \\ =& Q_t + (P_t - 1)Q_t' + c_t[Q_t + (P_t - (1+\rho))Q_t'] = 0. \end{aligned} \tag{14}$$

Rearranging this equation, the optimal insurance price is

$$P_t = \left(1 - \frac{1}{\epsilon_t}\right)^{-1} \frac{1 + (1+\rho)c_t}{1 + c_t}. \tag{15}$$

The first term in this equation is the standard Bertrand pricing formula. The second term is the marginal cost of issuing policies, which arises from financial frictions. The marginal cost rises with the shadow cost of capital and tighter capital regulation (i.e., higher ρ).

5.3. *Optimal Affiliated Reinsurance*

Assuming an internal optimum, the first-order condition for affiliated reinsurance is

$$\begin{aligned} \frac{\partial J_t}{\partial B_t} =& c_t \frac{\partial K_t}{\partial B_t} + \widehat{c}_t \frac{\partial \widehat{K}_t}{\partial B_t} \\ =& c_t \rho - \widehat{c}_t \widehat{\rho} = 0. \end{aligned} \tag{16}$$

This implies that

$$\rho c_t = \widehat{\rho} \widehat{c}_t. \tag{17}$$

That is, the holding company equates the shadow cost of capital across the two companies, appropriately weighted by the tightness of capital regulation.

Equation (17) implies that the operating company generally cedes reinsurance to the affiliated reinsurer that faces looser capital regulation (i.e., $\widehat{\rho} < \rho$). To illustrate this point, suppose that the two companies have the same shadow cost of capital prior to affiliated reinsurance. The first-order condition (17) requires that $c_t < \widehat{c}_t$, which implies that the operating company's statutory capital must rise relative to the affiliated reinsurer's to reduce the overall cost of financial frictions.

The insurance price falls when the operating company cedes reinsurance to the affiliated reinsurer, raising its equilibrium supply in the retail market. To show this analytically, we make two simplifying assumptions for the moment. The first is a constant elasticity of demand. The second is a special case of the cost function (10) that is additively separable in changes in statutory capital:

$$C_t = C(\Delta K_t) + C\left(\Delta \widehat{K}_t\right) \tag{18}$$

with negative first derivatives and positive second derivatives. Differentiating the pricing equation (15) with respect to B_t through the implicit function theorem,

$$\frac{\partial P_t}{\partial B_t} = -\frac{\rho^2 P_t}{(1+c_t)(1+(1+\rho)c_t)} \frac{\partial^2 C_t}{\partial \Delta K_t^2} < 0. \tag{19}$$

5.4. Optimal Unaffiliated Reinsurance

The derivative of firm value with respect to unaffiliated reinsurance is

$$\begin{aligned}\frac{\partial J_t}{\partial D_t} =& \frac{\partial \Pi_t}{\partial D_t} + c_t \frac{\partial K_t}{\partial D_t} \\ =& -(P_{D,t} - 1) - c_t(P_{D,t} - (1+\rho)).\end{aligned} \tag{20}$$

This implies that the operating company cedes reinsurance to an unaffiliated reinsurer only if

$$\frac{\partial J_t}{\partial D_t} > 0 \iff P_{D,t} < \frac{1+(1+\rho)c_t}{1+c_t} \tag{21}$$

at $D_t = 0$. The right side of this equation can be interpreted as the effective marginal benefit of unaffiliated reinsurance. It can be higher than the marginal benefit of affiliated reinsurance because of additional benefits that may include risk transfer, underwriting assistance, or tax effects.

6. Impact of Eliminating Shadow Insurance

We now complete the model of the life insurance industry by introducing additional parametric assumptions about the demand curve and the shadow cost of capital. We then estimate the structural model under the identifying assumption that shadow insurance lowers prices, but it does not affect demand directly. Finally, we use the structural model to estimate the counterfactual equilibrium in the retail market without shadow insurance.

We estimate the structural model on the life insurance market, rather than the annuity market, for two reasons. First, as discussed in Section 3, life insurance accounts for a larger share of affiliated reinsurance than annuities because of Regulation (A)XXX. Second, variable annuities account for most of the annuity market, and data on their rider fees are not readily available. We focus on 10-year guaranteed level term life insurance for males aged 30 as representative of the life insurance market. Appendix B contains further details about the data on life insurance prices.

6.1. Identifying Assumptions

Operating companies compete in the life insurance market by setting prices, facing the multinomial logit model of demand (Anderson, de Palma and Thisse 1992, Chapter 2). Since all companies sell the same type of policy, product differentiation is along company characteristics. Life insurance is a type of intermediated savings, so we specify the outside good as household savings that are intermediated by financial institutions other than insurance companies. Specifically, we measure total annual saving by U.S. households in savings deposits, money market funds, and mutual funds (Board of Governors of the Federal Reserve System 2013, Table F.100).

Let S_t denote the demand for the outside good in year t, whose utility is normalized to zero. Let $Q_{n,t}$ denote the demand for life insurance sold by company n in year t. The logit model implies that the market share is

$$q_{n,t} = \frac{Q_{n,t}}{S_t + \sum_{m=1}^{N} Q_{m,t}} = \frac{\exp\{\alpha P_{n,t} + \beta' \mathbf{x}_{n,t} + u_{n,t}\}}{1 + \sum_{m=1}^{N} \exp\{\alpha P_{m,t} + \beta' \mathbf{x}_{m,t} + u_{m,t}\}}, \tag{22}$$

where $\alpha < 0$ and N is the total number of operating companies. The vector $\mathbf{x}_{n,t}$ includes a set of observable company characteristics that affect demand and year fixed effects. The term $u_{n,t}$ captures company characteristics that are unobservable to the econometrician, which could be correlated with the price.

We parameterize the shadow cost of capital in the pricing equation (15) as

$$c_{n,t} = \exp\{\gamma \mathrm{SI}_{n,t} + \delta' \mathbf{x}_{n,t} + e_{n,t}\}. \tag{23}$$

The shadow cost depends on a dummy for shadow insurance, where the coefficient $\gamma < 0$. The shadow cost also depends on observable company characteristics and an unobservable shock $e_{n,t}$. Our baseline specification assumes that the unobservable shock is uncorrelated with shadow insurance, but we relax this assumption in an alternative specification as discussed below.

Our identifying assumption is that shadow insurance lowers prices through supply (15), but it does not affect demand (22) directly. This exclusion restriction is plausible insofar as retail customers do not know about shadow insurance (at least prior to this paper). Alternatively, this exclusion restriction holds as long as retail customers do not care about shadow insurance because they expect the state guaranty funds to ultimately pay off their policies. Of course, shadow insurance could be correlated with other company characteristics that retail customers do care about, such as company size or the A.M. Best rating. Our model of demand (22) controls for these characteristics directly.

We estimate the structural model consistently through a two-step estimator (Berry 1994). We first transform equation (22) as

$$\log\left(\frac{Q_{n,t}}{S_t}\right) = \alpha P_{n,t} + \beta' \mathbf{x}_{n,t} + u_{n,t} \tag{24}$$

and estimate it by instrumental variables, using a dummy for shadow insurance as an instrument for price. We then calculate the elasticity of demand for each company as $\epsilon_{n,t} = -\alpha P_{n,t}(1 - q_{n,t})$, as implied by the logit model. We calibrate the higher reserve requirements for operating companies to $\rho = 2$, based on the industry estimates (Dieck, Erkis, Kaura, Kehrberg and Trivedi 2012, Table 5.2). We then invert the pricing equation (15) to obtain the shadow cost of capital for each company. Finally, we estimate the logarithm of equation (23) by ordinary least squares.

6.2. Estimates of the Structural Model

The first column of Table 7 reports our estimate of demand (22). Our estimate of the key determinant of the elasticity of demand is $\alpha = -4.28$ with a standard error of 0.93. This implies a relatively high demand elasticity of seven for the average company in 2012, which is justified by the fact that life insurance is a financial product. Company size is the most important characteristic for demand, which is also the only one that is statistically significant. Demand increases by 268 percent per one standard deviation increase in log liabilities.

The second column of Table 7 reports our estimate of the shadow cost of capital (23), which is a key determinant of marginal cost in the pricing equation (15). Shadow insurance reduces the shadow cost of capital by 33 percent with a standard error of 8 percent. The shadow cost is negatively related to the A.M. Best rating and leverage and positively related to return on equity. Among these company characteristics, the A.M. Best rating is the most important determinant of the shadow cost. The shadow cost decreases by 25 percent per one standard deviation increase in the A.M. Best rating.

The coefficient on shadow insurance could be biased if the unobservable shock in equation (23) is correlated with the dummy for shadow insurance. We address this concern by instrumental variables, where our instrument for shadow insurance is the market share for term life insurance in 1999, interacted with a dummy for stock company in 1999. As discussed in Section 4, our instrument is plausibly exogenous and also a significant predictor of shadow insurance. As reported in the last column of Table 7, the instrumental variables estimate of the coefficient on shadow insurance is -1.23, which is actually larger than the ordinary least squares estimate of -0.33. However, the standard error is sufficiently large to include the ordinary least squares estimate in the 95 percent confidence interval.

6.3. Retail Market without Shadow Insurance

We now use the structural model to estimate the counterfactual equilibrium in the retail market without shadow insurance. To do so, we first adjust the rating and leverage for shadow insurance, as described in Section 4. We then turn off the dummy for shadow insurance and plug in the adjusted rating and leverage in equation (23). This implies a counterfactual estimate of the shadow cost of capital and marginal cost of issuing policies. The first column of Table 8 reports that marginal cost would rise by 17.7 percent for the average company using shadow insurance in 2012.

We next plug in the adjusted rating and leverage in equation (22). We then solve for the new equilibrium that satisfies the equations for supply (15) and demand (22). Operating companies using shadow insurance lose market share as their marginal cost rises, while the other companies gain market share due to substitution effects. The second column of Table 8 reports that annual life insurance underwritten would fall by 54.4 percent for the average company using shadow insurance in 2012. At the same time, annual life insurance underwritten would rise by 2.6 percent for the other companies.

Higher prices mean that some potential customers would stay out of the life insurance market. The last column of Table 8 aggregates the dollar change in annual life insurance underwritten across the industry. Without shadow insurance, annual life insurance underwritten would fall by $21.4 billion in 2012 from its current level of $91.5 billion.

7. Conclusion

We find that shadow insurance significantly increases risk in the life insurance industry. The current size of the U.S. shadow insurance sector is $364 billion, which implies an expected loss of $28.0 to $69.9 billion for the industry. The upper range of our estimates exceeds the current total capacity of state guaranty funds, which is $56.4 billion. The actual cost of shadow insurance could be even higher than our estimate for two reasons. First, the lack of public disclosure by shadow reinsurers prevents accurate assessment of their investment risk and the fragility of their funding arrangements. Second, the U.S. shadow insurance sector could just be the tip of an iceberg, if there is additional activity in other countries.

Problems in the life insurance industry could have broader consequences for the economy. First, the financial crisis has shown that even relatively small shocks could amplify due to the interconnectedness of financial institutions and the endogeneity of asset prices. Second, life insurers are the most important institutional investors of corporate bonds, so problems in this industry could spill over to real investment and economic activity. Finally, the insurance industry diversifies the most important sources of idiosyncratic risk in the economy, so shocks to the supply of insurance could lead to large welfare losses for households (Koijen, Van Nieuwerburgh and Yogo 2011).

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Table 1: Summary Statistics for Reinsurance Agreements

This table reports summary statistics for life and annuity reinsurance agreements that originated within the previous year, by whether they were ceded to unaffiliated or affiliated reinsurers. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are affiliated and unauthorized reinsurers without an A.M. Best rating.

	Number of reinsurance agreements ceded to			Mean reinsurance ceded (million $)		
Year	Unaffiliated	Affiliated	Shadow	Unaffiliated	Affiliated	Shadow
2002	1,493	157	53	26	77	60
2003	960	119	70	26	116	59
2004	753	149	89	101	528	502
2005	824	182	110	28	211	163
2006	681	146	85	54	227	231
2007	599	114	65	39	345	451
2008	566	132	88	25	613	717
2009	456	120	67	37	1,199	2,003
2010	410	116	56	10	509	776
2011	310	110	49	56	626	640
2012	328	120	45	89	392	502

Table 2: Characteristics of Companies Using Shadow Insurance

This table reports summary statistics for operating companies in 2012, by whether they were using shadow insurance. The market shares are based on gross reserves held for life insurance and annuities, respectively. A.M. Best Company defines current liquidity as the ratio of unencumbered cash and unaffiliated investments to liabilities.

Statistic	Not using shadow insurance	Using shadow insurance
Number of companies	443	78
Market share (percent):		
Life insurance	52	48
Annuities	52	48
Stock company (percent)	91	99
Mean:		
Log liabilities	0.00	3.17
Risk-based capital (percent)	307	208
Leverage (percent)	72	89
Current liquidity (percent)	158	80
Return on equity (percent)	7	18

Table 3: Affiliated Reinsurance within the MetLife Group

This table lists the U.S. operating companies of the MetLife group and their affiliated reinsurers in 2012, whose net reinsurance ceded is greater than $0.1 billion in absolute value. Net reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded minus the sum of reserves held and modified coinsurance reserve assumed.

Company	Domicile	A.M. Best rating	Net reinsurance ceded (billion $)
Metropolitan Life Insurance	New York	A+	39.1
MetLife Investors USA Insurance	Delaware	A+	13.3
General American Life Insurance	Missouri	A+	3.9
MetLife Insurance of Connecticut	Connecticut	A+	3.6
MetLife Investors Insurance	Missouri	A+	2.6
First MetLife Investors Insurance	New York	A+	1.6
New England Life Insurance	Massachusetts	A+	1.0
Metropolitan Tower Life Insurance	Delaware	A+	0.8
MetLife Reinsurance of Delaware	Delaware		-0.4
MetLife Reinsurance of South Carolina	South Carolina		-3.1
Exeter Reassurance	Bermuda		-5.6
MetLife Reinsurance of Vermont	Vermont		-9.9
MetLife Reinsurance of Charleston	South Carolina		-12.9
Missouri Reinsurance	Barbados		-28.4
Total for the MetLife group			5.7

Table 4: Relation between Ratings and Shadow Insurance

This table reports the estimated relation between the A.M. Best rating and company characteristics, including a dummy for shadow insurance. Estimation is by ordinary least squares (OLS) and instrumental variables (IV), where the instrument for shadow insurance is the market share for term life insurance in 1999. The sample consists of operating companies between 2002 and 2012. The coefficients are standardized, and robust standard errors clustered by holding company are reported in parentheses. All specifications include year fixed effects, which are not reported for brevity.

		IV	
Variable	OLS	First stage	Second stage
Shadow insurance	0.05		0.03
	(0.08)		(0.31)
Term life in 1999		0.05	
		(0.01)	
Stock company	0.26	0.10	0.26
	(0.07)	(0.03)	(0.08)
Log liabilities	0.91	0.12	0.92
	(0.05)	(0.02)	(0.07)
Risk-based capital	0.09	-0.01	0.10
	(0.03)	(0.01)	(0.03)
Leverage	-0.33	-0.02	-0.31
	(0.04)	(0.01)	(0.04)
Current liquidity	0.14	0.01	0.12
	(0.02)	(0.01)	(0.03)
Return on equity	0.04	-0.01	0.04
	(0.02)	(0.01)	(0.02)
R^2	0.44	0.15	
Observations	6,643	6,353	6,353

Table 5: Measures of Financial Risk Adjusted for Shadow Insurance

This table reports the average risk-based capital, A.M. Best rating, and 10-year impairment probability for operating companies using shadow insurance. Our adjustment moves back on balance sheet both the assets and liabilities on reinsurance ceded to shadow reinsurers, so that capital and surplus does not change. The risk characteristics of reinsurance ceded are assumed to be identical to existing life and annuity reserves on balance sheet, so that required capital rises proportionally.

	Risk-based capital (percent)			Rating		10-year impairment probability (percent)		
Year	Reported	Adjusted	Difference	Reported	Adjusted	Reported	Adjusted	Ratio
2002	160	150	-10	A	A-	3.2	7.6	2.4
2003	170	156	-14	A	A-	3.0	7.6	2.5
2004	168	146	-22	A	A-	3.6	9.0	2.5
2005	197	166	-31	A	A-	4.1	9.9	2.4
2006	190	164	-25	A	A-	3.0	8.2	2.7
2007	199	171	-28	A	B++	4.4	11.4	2.6
2008	199	174	-25	A	B++	3.7	11.3	3.0
2009	227	182	-45	A	B+	4.0	13.5	3.4
2010	250	197	-53	A	B+	4.2	15.0	3.5
2011	238	194	-44	A-	B+	4.5	15.2	3.4
2012	208	155	-53	A	B+	3.9	15.6	4.0

Table 6: Expected Loss Adjusted for Shadow Insurance

This table reports the present value of expected loss, discounted by the Treasury yield curve. The reported expected loss and the lower estimate of adjusted expected loss are based on a 10 percent loss conditional on impairment. The higher estimate of adjusted expected loss is based on a 25 percent loss conditional on impairment. The total capacity of state guaranty funds is the maximum annual assessment in the current year aggregated across all states, projected to remain constant over the next 10 years (Gallanis 2009).

	Reported expected loss	Adjusted expected loss (billion $)		Guaranty funds
Year	(billion $)	Lower	Higher	(billion $)
2002	5.1	5.7	14.3	40.6
2003	4.7	5.9	14.8	38.0
2004	5.1	8.7	21.7	35.9
2005	5.2	8.8	22.0	33.4
2006	5.0	8.3	20.9	36.3
2007	5.7	13.1	32.8	38.7
2008	7.7	19.1	47.8	50.7
2009	6.8	23.3	58.2	47.6
2010	7.3	24.5	61.1	46.2
2011	8.6	26.7	66.9	49.2
2012	8.9	28.0	69.9	56.4

Table 7: Estimates of the Structural Model

This table reports estimates of the structural parameters in demand (22) and the shadow cost of capital (23). Estimation of equation (22) is by instrumental variables, where the instrument for price is shadow insurance. Estimation of equation (23) is by ordinary least squares (OLS) and instrumental variables (IV), where the instrument for shadow insurance is the market share for term life insurance in 1999. Annual life insurance underwritten is the change in gross life reserves, and log liabilities is the logarithm of gross life reserves. The sample consists of operating companies between 2002 and 2012, which are matched to term life insurance prices from Compulife Software. Heteroskedasticity-robust standard errors are reported in parentheses. All specifications include year fixed effects, which are not reported for brevity.

		Pricing	
Variable	Demand	OLS	IV
Price	-4.28		
	(0.93)		
Shadow insurance		-0.33	-1.23
		(0.08)	(0.51)
Stock company	-0.17	0.10	0.39
	(0.16)	(0.13)	(0.21)
Log liabilities	2.68	0.07	0.20
	(0.05)	(0.04)	(0.08)
A.M. Best rating	0.01	-0.25	-0.22
	(0.10)	(0.06)	(0.06)
Leverage	-0.16	-0.13	-0.04
	(0.10)	(0.06)	(0.06)
Current liquidity	0.06	0.01	0.06
	(0.07)	(0.04)	(0.04)
Return on equity	-0.07	0.17	0.16
	(0.06)	(0.03)	(0.03)
Observations	1,710	1,710	1,683

Table 8: Retail Market without Shadow Insurance

The structural model is used to estimate the counterfactual equilibrium without shadow insurance. This table reports the change in marginal cost for operating companies using shadow insurance as well as the change in annual life insurance underwritten for all companies. This table is based on the ordinary least squares estimates of equation (23) in Table 7.

	Change in	Change in quantity (percent) for companies		Total
Year	marginal cost (percent)	Using shadow insurance	Not using shadow insurance	change in quantity (billion $)
2002	8.5	-33.8	0.9	-3.1
2003	7.1	-27.6	1.0	-4.2
2004	9.8	-37.6	1.6	-9.0
2005	11.2	-43.0	1.6	-10.9
2006	13.1	-50.6	1.3	-10.5
2007	14.2	-52.5	2.7	-26.1
2008	15.8	-51.3	8.4	-30.0
2009	18.0	-50.7	11.3	-28.6
2010	18.2	-53.2	8.3	-16.2
2011	18.5	-57.3	3.1	-18.9
2012	17.7	-54.4	2.6	-21.4

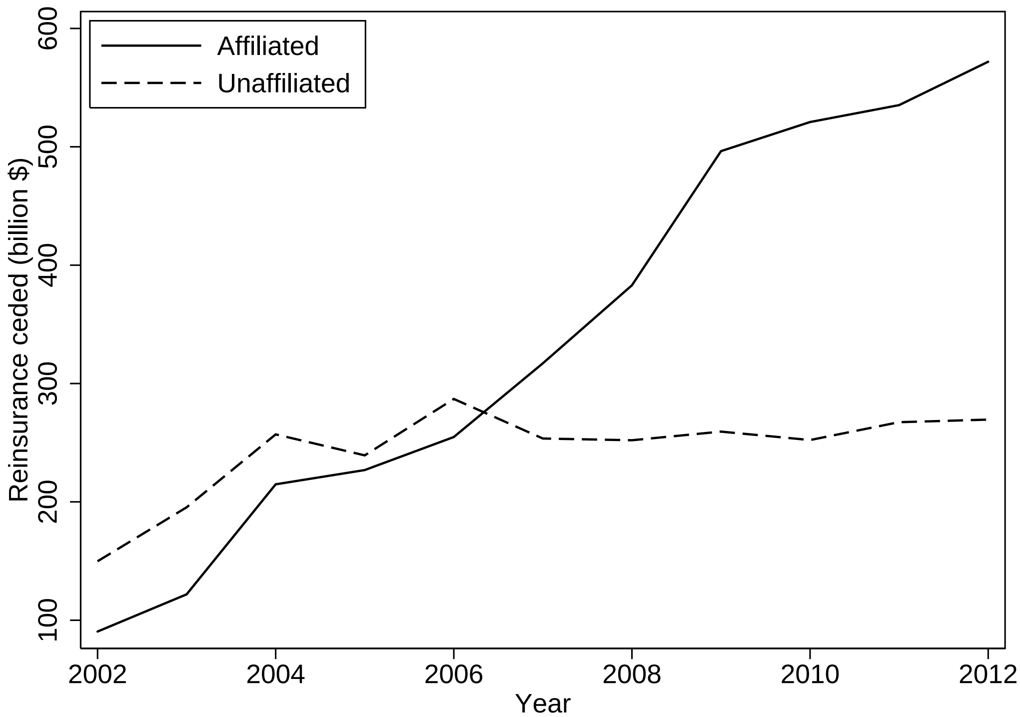

Figure 1: Reinsurance Ceded by U.S. Life Insurers
This figure reports life and annuity reinsurance ceded by U.S. life insurers to affiliated and unaffiliated reinsurers. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded.

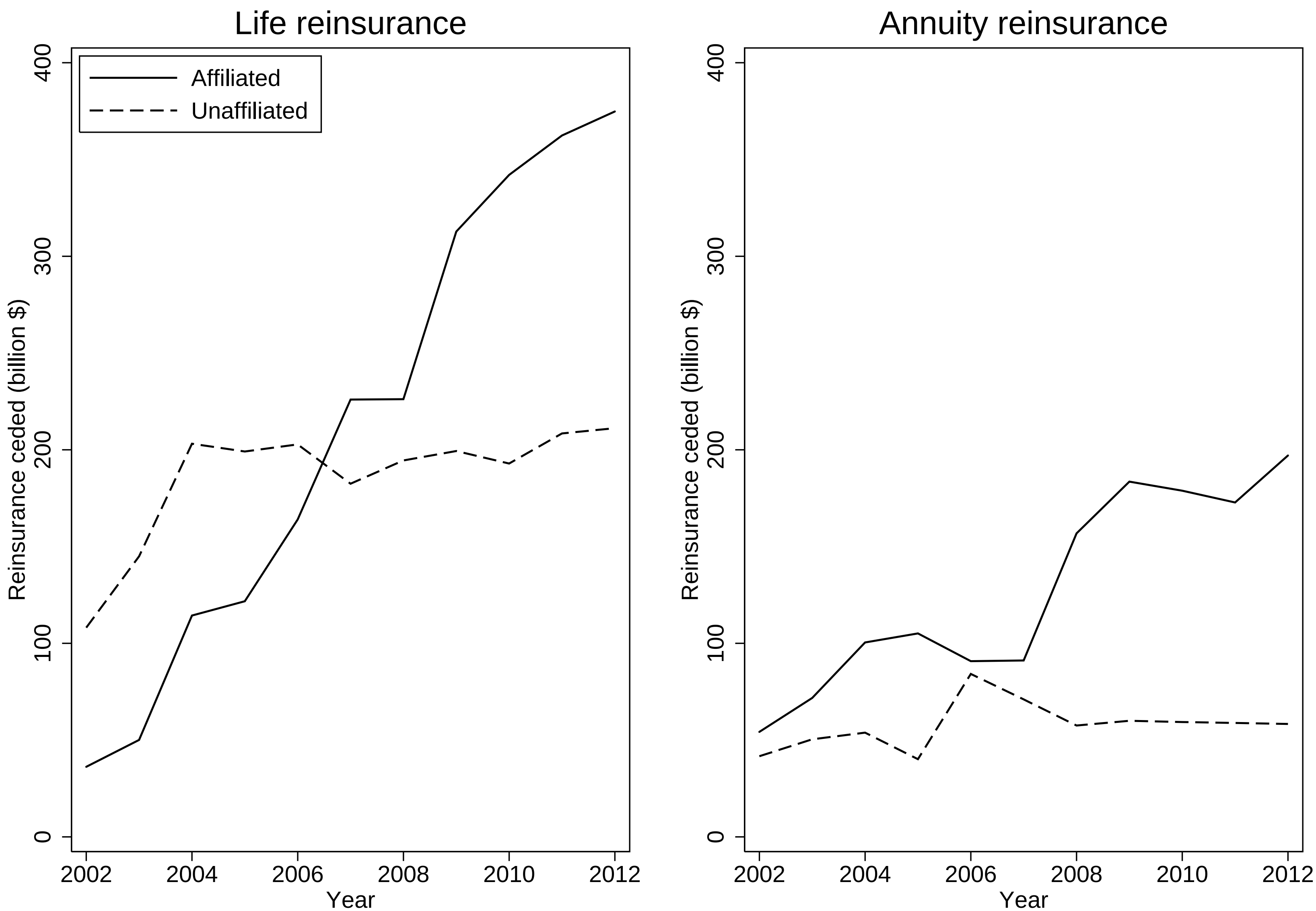

Figure 2: Life versus Annuity Reinsurance Ceded by U.S. Life Insurers
This figure reports reinsurance ceded by U.S. life insurers to affiliated and unaffiliated reinsurers, separately for life and annuity reinsurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded.

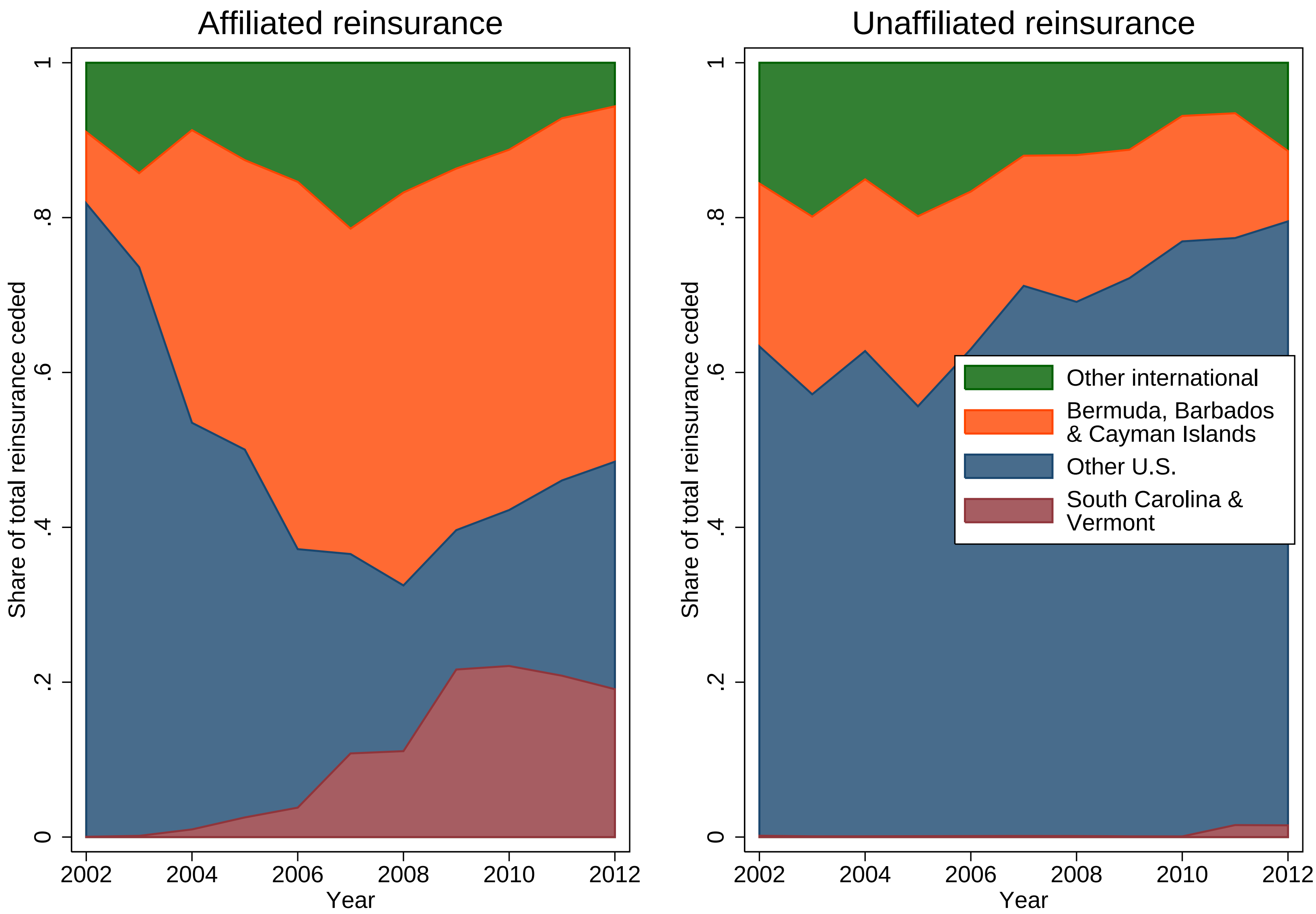

Figure 3: Reinsurance Ceded by Domicile of Reinsurer

This figure decomposes life and annuity reinsurance ceded by domicile of the reinsurer, separately for affiliated and unaffiliated reinsurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded.

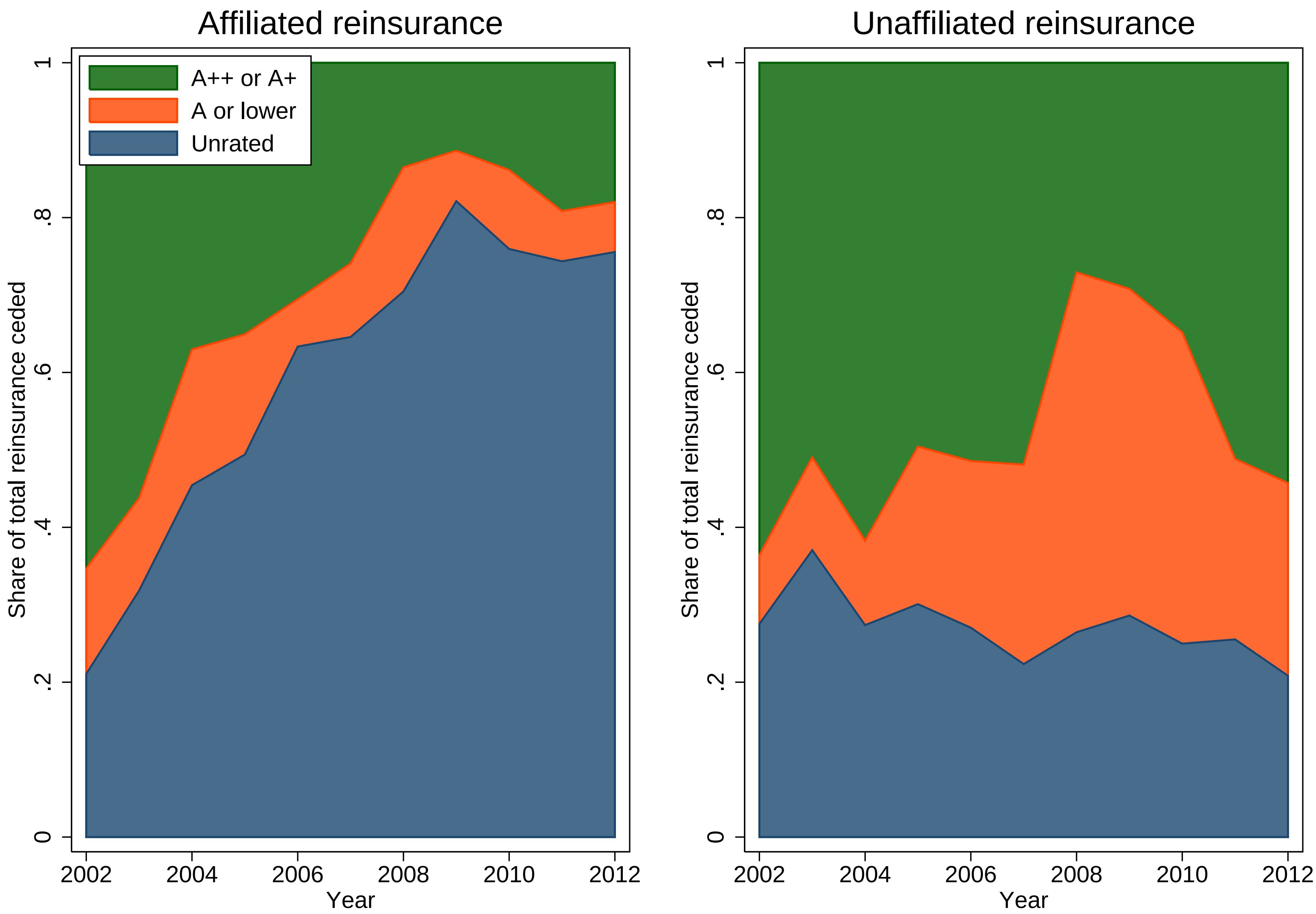

Figure 4: Reinsurance Ceded by Rating of Reinsurer

This figure decomposes life and annuity reinsurance ceded by the A.M. Best rating of the reinsurer, separately for affiliated and unaffiliated reinsurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded.

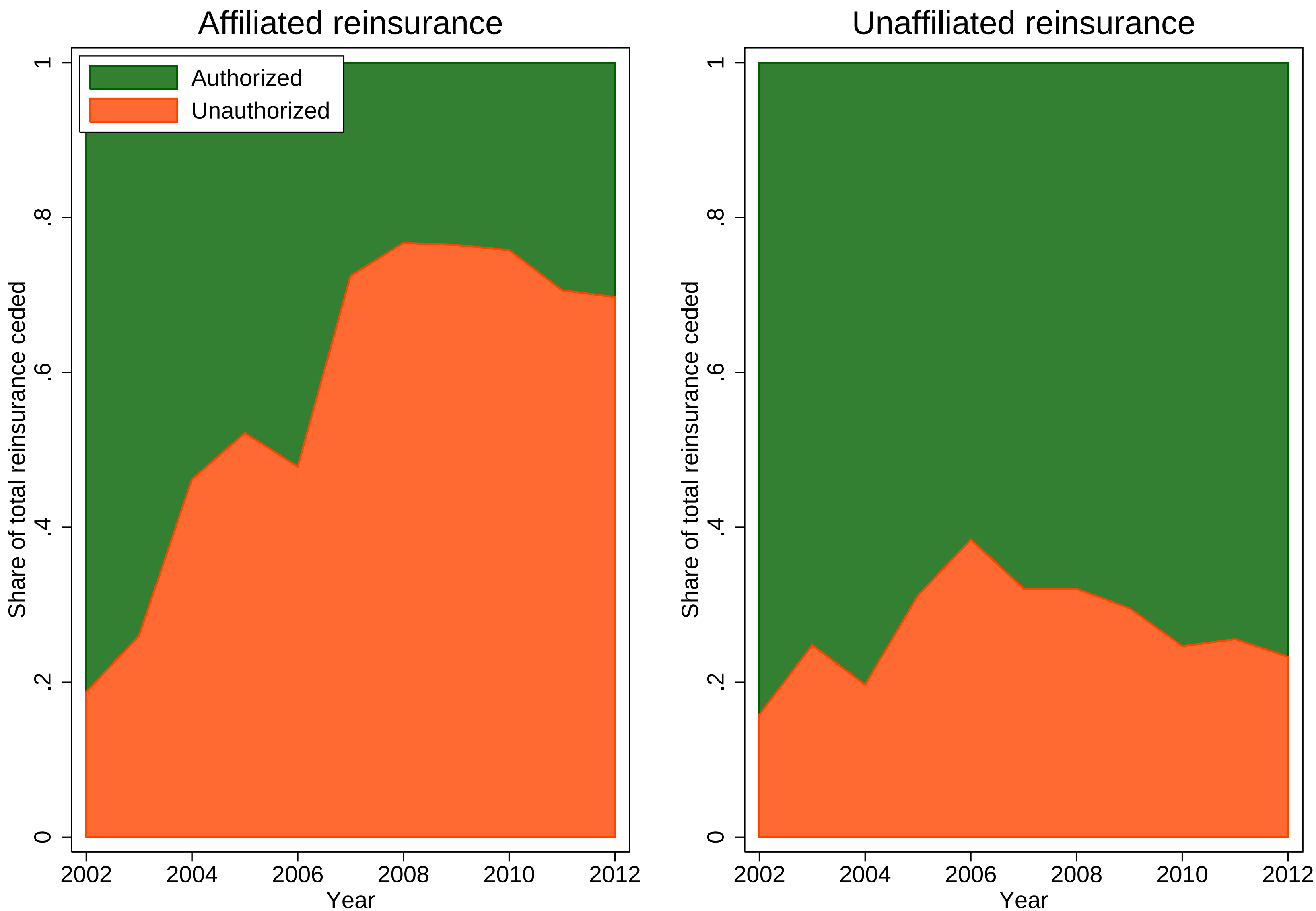

Figure 5: Reinsurance Ceded to Unauthorized Reinsurers
This figure decomposes life and annuity reinsurance ceded by whether the reinsurer is authorized in the domicile of the ceding company, separately for affiliated and unaffiliated reinsurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded.

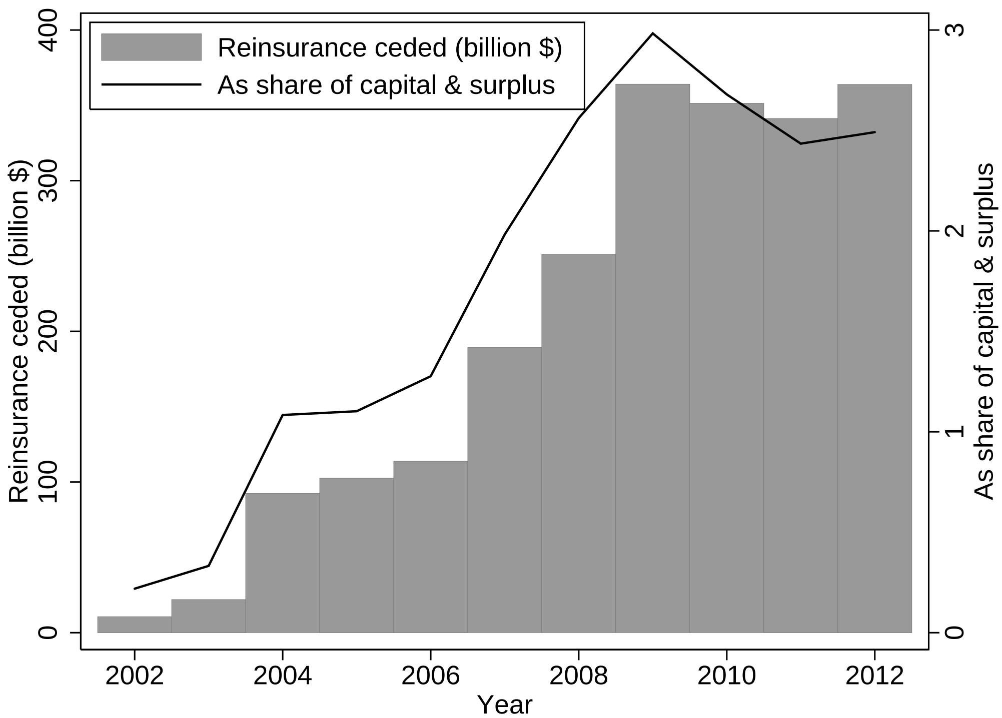

Figure 6: Reinsurance Ceded to Shadow Reinsurers

This figure reports life and annuity reinsurance ceded by U.S. life insurers to shadow reinsurers, both in total dollars and as a share of the capital and surplus of the ceding companies. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are affiliated and unauthorized reinsurers without an A.M. Best rating.

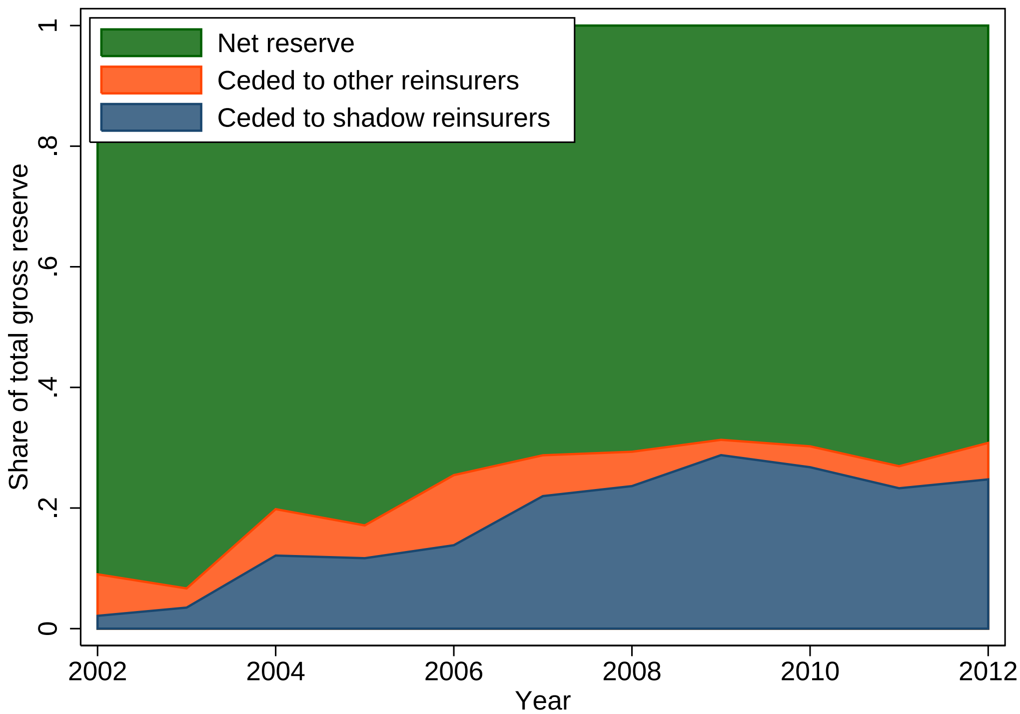

Figure 7: Decomposition of Gross Reserve for Companies Using Shadow Insurance
This figure decomposes gross life and annuity reserves into reinsurance ceded versus net reserves held for operating companies using shadow insurance. Reinsurance ceded is the sum of reserve credit taken and modified coinsurance reserve ceded. Shadow reinsurers are affiliated and unauthorized reinsurers without an A.M. Best rating.

Appendix

A. Stylized Examples of Captive Reinsurance

We illustrate the balance-sheet mechanics of how an operating company can free up capital by ceding reinsurance to an unauthorized captive. We offer three examples to illustrate the three main types of reinsurance: coinsurance, coinsurance with funds withheld, and modified coinsurance. The latter two types are different from coinsurance in that the ceding company retains control of the assets, so that the captive does not need to establish a trust fund. However, the examples show that all three types achieve the same economic outcomes. We refer to Loring and Higgins (1997) and Tiller and Tiller (2009, Chapters 4 and 5) for further details.

A.1. Coinsurance

In Table A1, the operating company starts with $10 in bonds and no liabilities, so that its equity is $10. For simplicity, the captive is initially a shell company with no assets. In the first step, the operating company sells term life insurance to retail customers for $100. The operating company must record a statutory reserve of $110, which is higher than the GAAP reserve of $90 because of Regulation XXX. Consequently, its equity is reduced to $0.

In the second step, the operating company cedes all policies to the captive, paying a reinsurance premium of $100. Reserve credit on reinsurance ceded to an unauthorized reinsurer requires collateral through a trust fund established in or an unconditional letter of credit from a qualified U.S. financial institution (National Association of Insurance Commissioners 2011, Appendix A-785). Hence, the captive establishes a trust fund with $90 in bonds and secures a letter of credit up to $20 to fund the difference between the statutory and GAAP reserves. For simplicity, our example ignores a small fee that the captive would pay to secure the letter of credit. On the liability side, the captive records a GAAP reserve of only $90 because it is not subject to Regulation XXX.[4]

As a consequence of captive reinsurance, the operating company's balance sheet is restored to its original position with $10 in equity. The captive ends up with an additional $10 in cash that it can use for various purposes, including a commission to the operating company or a dividend to the parent company.

[4]Our example assumes that the operating company's domicile does not require mirror reserving, and the captive's domicile does not count a letter of credit as an admitted asset. If we flip both of these assumptions, the economics of this example remains the same. The captive records the letter of credit as a $20 asset and holds a statutory reserve of $110, so that its equity remains $10.

A.2. Coinsurance with Funds Withheld

The first step in Table A2 is the same as in Table A1. In the second step, the operating company cedes all policies to the captive, paying a reinsurance premium of $10. The operating company withholds $90 in the transaction, investing it in bonds. The withheld assets are recorded as a "funds held" liability for the operating company and as a "funds deposited" asset for the captive. The captive secures a letter of credit up to $20 to fund the difference between the statutory and GAAP reserves. On the liability side, the captive records a GAAP reserve of only $90 because it is not subject to Regulation XXX.

A.3. Modified Coinsurance

The first step in Table A3 is the same as in Table A1. In the second step, the operating company cedes all policies to the captive, paying a reinsurance premium of $10. The operating company withholds $90 in the transaction, investing it in bonds. The withheld assets are recorded as a "modco reserve" liability for the operating company and as a "modco deposit" asset for the captive. The captive secures a letter of credit up to $20 to fund the difference between the statutory and GAAP reserves. On the liability side, the captive records a GAAP reserve of only $90 because it is not subject to Regulation XXX.

Table A1: A Stylized Example of Captive Reinsurance: Coinsurance

This example illustrates how coinsurance or yearly renewable term reinsurance affects the balance sheets of an operating company and an unauthorized captive, both of which are part of the same holding company. The operating company must hold a statutory reserve of $110, while the captive can hold a GAAP reserve of $90.

Operating company
(in domicile with tighter capital regulation)

Initial balance sheet:

A		L	
Bonds	$10		
		Equity	$10

⟹ *1. Sells insurance for $100. (Statutory reserve of $110 and GAAP reserve of $90.)*

A		L	
Bonds	$10		
Premium	$100	Reserve	$110
		Equity	$0

⟹ *2. Cedes reinsurance.*

A		L	
Bonds	$10		
		Equity	$10

Captive
(in domicile with looser capital regulation)

Initial balance sheet:

A		L	
		Equity	$0

⟹ *2. Assumes reinsurance. Establishes trust with $90 in bonds. Secures letter of credit up to $20.*

A		L	
Trust: Bonds	$90	Reserve	$90
Letter of credit			
Cash	$10		
		Equity	$10

Table A2: A Stylized Example of Captive Reinsurance: Coinsurance with Funds Withheld

This example illustrates how coinsurance with funds withheld affects the balance sheets of an operating company and an unauthorized captive, both of which are part of the same holding company. The operating company must hold a statutory reserve of $110, while the captive can hold a GAAP reserve of $90.

Operating company
(in domicile with tighter capital regulation)

A		L	
Bonds	$10		
		Equity	$10

⟹

1. Sells insurance for $100. (Statutory reserve of $110 and GAAP reserve of $90.)

A		L	
Bonds	$10		
Premium	$100	Reserve	$110
		Equity	$0

⟹

2. Cedes reinsurance, paying $10 premium. Invests $90 in bonds.

A		L	
Bonds	$100	Funds withheld	$90
		Equity	$10

Captive
(in domicile with looser capital regulation)

A		L	
		Equity	$0

⟹

2. Assumes reinsurance. Secures letter of credit up to $20.

A		L	
Funds deposited	$90	Reserve	$90
Letter of credit			
Cash	$10		
		Equity	$10

Table A3: A Stylized Example of Captive Reinsurance: Modified Coinsurance

This example illustrates how modified coinsurance affects the balance sheets of an operating company and an unauthorized captive, both of which are part of the same holding company. The operating company must hold a statutory reserve of $110, while the captive can hold a GAAP reserve of $90.

Operating company
(in domicile with tighter capital regulation)

Initial balance sheet:

A		L	
Bonds	$10		
		Equity	$10

⟹ *1. Sells insurance for $100. (Statutory reserve of $110 and GAAP reserve of $90.)*

A		L	
Bonds	$10		
Premium	$100	Reserve	$110
		Equity	$0

⟹ *2. Cedes reinsurance, paying $10 premium. Invests $90 in bonds.*

A		L	
Bonds	$100	Modco reserve	$90
		Equity	$10

Captive
(in domicile with looser capital regulation)

Initial balance sheet:

A		L	
		Equity	$0

⟹ *2. Assumes reinsurance. Secures letter of credit up to $20.*

A		L	
Modco deposit	$90	Reserve	$90
Letter of credit			
Cash	$10		
		Equity	$10

B. Data on Life Insurance Prices

Our sample of life insurance premiums is from Compulife Software (2002–2012), which is a computer-based quotation system for insurance agents. We focus on 10-year guaranteed level term life insurance for males aged 30 in the paper, but we have also examined 20-year policies and older age groups. We pull quotes for all U.S. states at the end of June in each year between 2002 and 2012, for the regular health category and a face amount of $1 million. We merge the financial statements with life insurance premiums by company name. Whenever the premium is not available for an operating company, we assign the average premium for its insurance group.

We normalize the premium by actuarial value. Let $R_t(m)$ denote the zero-coupon Treasury yield at maturity m and time t, and let p_n denote the one-year survival probability at age n. We define the actuarial value of 10-year term life insurance at age n per dollar of death benefit as

$$V_t(n) = \left(1 + \sum_{m=1}^{9} \frac{\prod_{l=0}^{m-1} p_{n+l}}{R_t(m)^m}\right)^{-1} \left(\sum_{m=1}^{10} \frac{\prod_{l=0}^{m-2} p_{n+l}(1 - p_{n+m-1})}{R_t(m)^m}\right). \quad \text{(B1)}$$

We calculate the actuarial value based on the appropriate mortality table from the American Society of Actuaries and the zero-coupon Treasury yield curve (Gürkaynak, Sack and Wright 2007). We use the 2001 Valuation Basic Table prior to January 2008 and the 2008 Valuation Basic Table since January 2008. These mortality tables are derived from the actual mortality experience of insured pools, so they account for potential adverse selection. We smooth the transition between the two vintages of the mortality tables by geometric averaging.