Life Insurance and Annuity Pricing during the Financial Crisis, Revisited

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We reexamine life insurance and annuity pricing during the 2008 financial crisis. In contrast with previous research, we find that insurers sold the policies at significantly elevated markups over their fundamental values during the crisis months and, moreover, that statutory accounting pressures had the effect of increasing rather than decreasing prices. We show that the experience in 2008 was not extraordinary but instead mirrored earlier episodes where corporate borrowing rates rose quickly, such as 1994 and 1999.

In a provocative paper, Koijen and Yogo (2015) study life insurance and annuity pricing during the 2007-2008 financial crisis. They document "extraordinary" pricing behavior, arguing that insurers cut prices dramatically on annuities and life insurance during late 2008 and early 2009, with markups on some guaranteed universal life policies in particular falling by nearly 60%. They attribute the pricing to the combination of 1) insurer need to rebuild balance sheets adversely affected by the crisis, and 2) statutory accounting rules that permitted insurers to record liabilities far below their fundamental values, thereby enabling insurers to build statutory capital by selling deeply discounted contracts. They ultimately find that companies were, on average, willing to sacrifice 96 cents of economic value for each dollar of statutory capital earned through selling insurance at the climax of the crisis.

In this paper, we reexamine Koijen and Yogo's data, consider additional data, and ultimately come to strikingly different conclusions.

First, we find little evidence of price cutting. Nominal quotes deviated little from pre-crisis trends, and annuity quotes in particular rose after November of 2008. Markups relative to appropriately defined financial value *increased*.

Second, we find that the behavior was not extraordinary but in fact broadly consistent with the historical patterns connecting prices with reserve values. The annuity pricing experience of 2008-2009 resembled previous episodes in 1994 and in 1999, when investment grade yields rose sharply and quickly.

Third, we find that accounting rules did not provide incentives for insurers to discount policies in order to improve their balance sheets. Instead, the rules

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acted in the opposite way. Since statutory discount rates are based on medium term averages of corporate yields, when corporate yields rise sharply a disconnect emerges between the reserve value and the risk-adjusted value of the contract. The burden of the excessive reserve can cause markups over risk-adjusted values to reach unusually high levels, as they did in 1994, 2000, and 2008. Moreover, actual pricing behavior was inconsistent with accounting arbitrage: During the climax of the crisis—in an echo of these previous episodes—a number of long-term contracts were quoted at levels below the statutory reserve values, meaning that statutory capital could not possibly have been increased by their sale.

Finally, we confirm that insurer cost of capital rose significantly during the crisis. However, in contrast to Koijen and Yogo's argument, we find that the increase in the cost of capital was reflected in higher rather than lower prices. That is, insurance policies were priced to produce unusually high rates of return on invested capital—well above the rates of return associated with policies sold in the years leading up to the crisis. Again, this mirrored the historical patterns when statutory reserve values exceeded risk-adjusted financial values.

Getting the story right is important for at least two reasons. First, from a purely academic perspective, a "fire sale" of insurance contracts during the crisis would challenge standard supply-side theories on financial product pricing in the presence of financial frictions, which generally predict higher prices after industry-level or firm-level shocks. For example, the capacity shock wrought by plunging asset prices would produce rising markups in equilibrium models such as Winter (1994), whose insight is often applied to the surge in insurance prices after natural catastrophes. Micro-level motivations, on the other hand, flow from Froot and Stein (1998), where a shock to firm level capital increases effective risk aversion and project hurdle rates. Koijen and Yogo's model, though seemingly grounded in a foundation similar to many models, produces contrary results by drawing a distinction between economic and statutory capital, and making the latter the critical determinant of consumer demand and capacity. In this setting, the paradox of insurers selling policies at a discount to fundamental values becomes theoretically possible. However, as we argue in more detail below, this did not actually happen during 2008 and 2009.

Second, an accurate understanding of what happened and why is critically important, as the lessons of the crisis are continually being used to reshape regulatory frameworks. The results of Koijen and Yogo are now widely accepted and cited in various literatures as evidence of systemic risks in and vulnerability of the life insurance industry (He and Krishnamurthy 2018; Kartasheva 2014; Weiß and Mühlnickel 2014). Our findings show that product underpricing was not a contributor to any solvency concerns in the industry during the crisis months. This is not to say that there are no risks in the industry, nor to say that the statutory accounting system could not create perverse incentives at some point in the future. Indeed, in our concluding section, we point out some market scenarios (that, coincidentally, are not so far from current market conditions at the time of this writing) under which statutory reserves could be significantly understated in relation to financial values. However, such conditions were not present in 2008 and 2009.

In what follows, we reexamine the course of pricing before, during, and after the crisis (Section I). We then move on to investigate statutory accounting rules, and the nature of the pressures that they imposed on insurers during the crisis (Section II). We evaluate the profitability of annuity contracts in Section III. We then explore the relationship between company risk and pricing decisions (Section IV). Section V concludes.

I. An Overview of Contract Pricing and Valuation

We start with the same data as Koijen and Yogo (2015), with annuity prices pulled from Comparative Annuity Reports and the Annuity Shopper. Quotes for annuities are for the January 1989 to July 2011 period, with frequency being monthly or semiannual, depending on the contract. Term annuities are semi-annual quotes starting in May 1998, except for 5-year and 10-year term annuities, which start in December 1992 and January 1989, respectively. Life annuities are monthly quotes starting in January 1989. Life annuities with 10-year guarantees are monthly quotes starting in May 1998, while life annuities with 20-year guarantees are semi-annual starting in May 1998.

The source for life insurance prices is the Compulife Quoting Software. Life insurance price quotes are monthly from January 2005 to July 2011. Koijen and Yogo focus on guaranteed universal life (GUL) policies. GUL policies are universal life policies with secondary no-lapse guarantees. They claim that these contracts facilitate price comparisons due to the absence of renewal and conversion options present in, for example, term life insurance contracts (see their Footnote 1). However, it is important to flag that GULs require discipline by the policyholder. The secondary guarantees are only valid if the minimum premiums are paid consistently and if there are no withdrawals of account value, which is at odds with the "flexible" nature of the underlying universal policy. Indeed, a report by the actuarial consulting firm Milliman (Dall, Megregian, and Stone 2007) points to "aggressive assumption setting from a lapse and mortality standpoint" relative to other life insurance products and various adjustments to reserve requirements between 2005 and 2010—that are not reflected in Koijen and Yogo's calculations.

Figure 1, panels a and c, show the average quoted premiums for a representative selection of term annuities and life annuities for the 1990-2011 and 1998-2011 periods, respectively. Figure 1 panel e shows the average annual premiums for a representative GUL policy over the 2005-2011 period. In the figures, the black dots indicate quotes before September of 2008, and the white circles indicate quotes from that month forward.

The right-hand panels plot corresponding percentage premium changes for term annuities (panel b), life annuities (panel d), and life insurance (panel f). More precisely, we determine the period percentage changes across all considered products in the respective category, and display the mean (grey dots), median (solid black line), upper and bottom quartiles (solid green lines), and upper and bottom vigintiles (red dotted line). The grey shaded area in all panels is the financial crisis period.

Viewed from this perspective, the crisis no longer stands out as a period of selloff. Life insurance contract quotes deviated little from their pre-crisis paths, while annuity quotes continued a downward trend dating from the mid-2000's before reversing shortly after the critical months in the fall of 2008. Indeed, relative to other types of corporate debt, the nominal price changes during the crisis period seem remarkably tame. For example, between July and October of 2008, investment grade yields rose by about 200 basis points before retreating 50 basis points in November.[1] The corresponding increase for the implied yield-to-maturity on term annuities between July and November was about 20 basis points. For life annuities, the changes were even smaller. Moreover, the overall distribution of premium changes during the crisis period does not look unusual in the context of the longer history. For the life insurance contracts in particular, sample average monthly changes are almost always within the range of plus or minus 1 percent, with the median company leaving its price unchanged.

The foregoing assessment addresses nominal price quotes. Koijen and Yogo, however, focus on "markups," which they calculate based on the ratio of the "quoted price" to the "actuarial value." The latter value is estimated as a discounted present value of benefits using a mortality curve and the Treasury spot rate curve. To justify the choice of the Treasury curve, they argue (p. 448):

> *An insurance company that issues a term annuity must buy a portfolio of Treasury bonds to replicate its future cash flows. A portfolio of corporate bonds, for example, does not replicate the cash flows because of default risk. Thus, the law of one price implies that the Treasury yield curve is the appropriate cost of capital for the valuation of term annuities.*

As we will discuss in more detail in Section IV, estimating the value of a long-term insurance contract to the insurer is a complicated exercise requiring contemplation of many factors beyond simply discounting the benefit payments. Taxes, expenses, and allocated capital all come into play. However, even if we accept the approach of comparing the premium to the present discounted value of benefits as a useful shorthand approximation to the profitability of the contract, the use of the Treasury curve for discounting stands out as a critical assumption. As shown in Figure 2a, Treasury yields plummeted during the crisis months. The present value of benefits when using a Treasury-based discount rate thus soared, so that the Koijen-Yogo markups dropped with Treasury yields even though quoted premiums moved little during late 2008 and, in the case of annuities, rose in early

1. We measure investment grade yields here by the 10-year HQM par yield as reported in the Federal Research Economic Database (`https://fred.stlouisfed.org`).

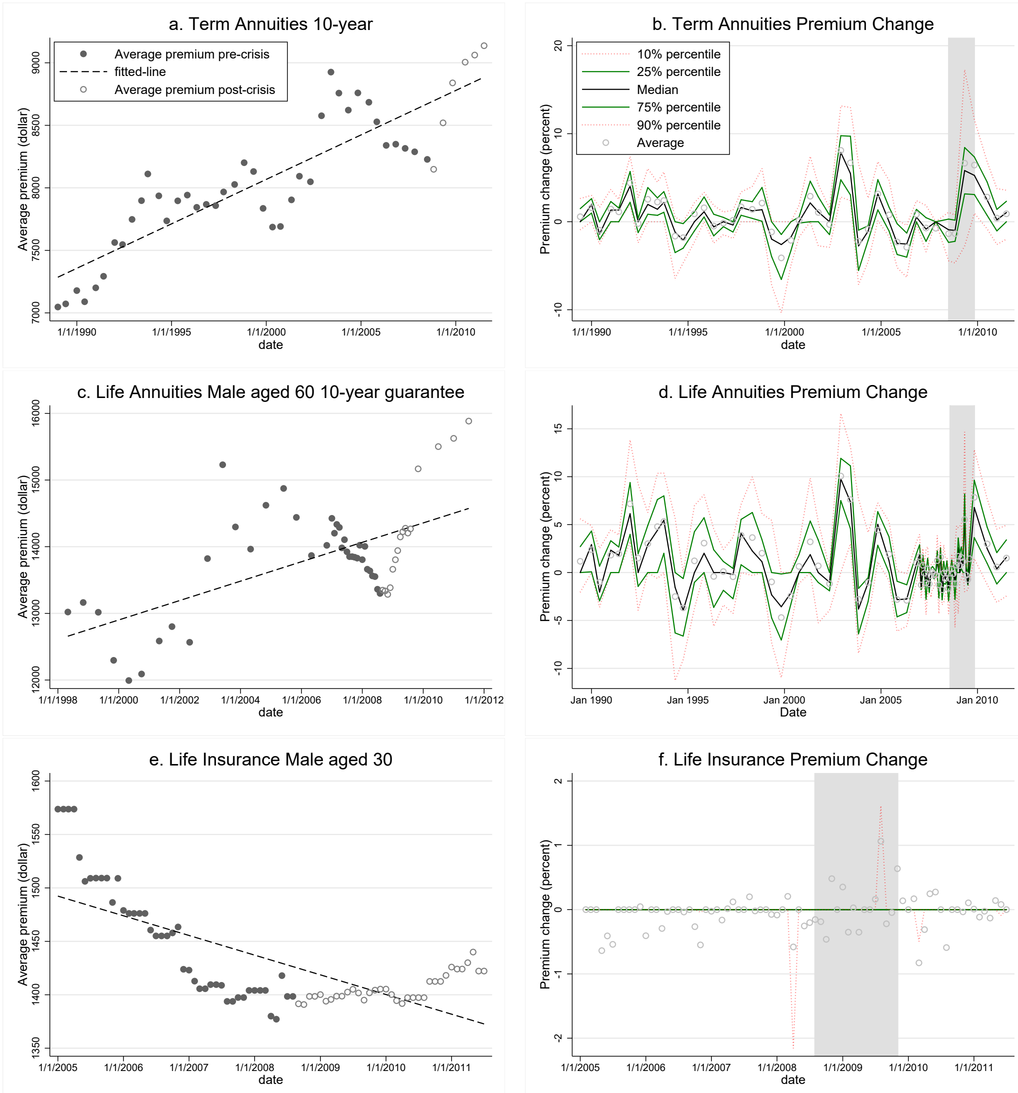

Figure 1. : Annuity and life insurance quoted premiums over time.

Note: This figure reports average premium level and change. The left-hand side panels show average quotes in the market for representative contract categories, and the right-hand side panels show the distribution of percentage changes relative to the previous period for term annuities, life annuities, and guaranteed universal life contracts, respectively.

2009.

How *should* one calculate the present value of benefit payments? Koijen and Yogo's replication claim shouldn't be taken literally as a description of industry

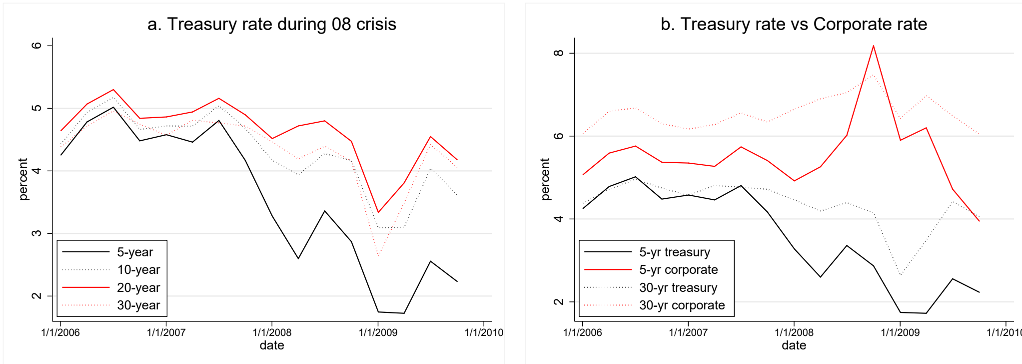

Figure 2. : Interest Rate Comparison.

Note: This figure illustrates the difference between Treasury and Corporate rates during the financial crisis years. We use treasury constant maturity rates and and High Quality Market (HQM) corporate interest rates as reported in FRED.

practice because Treasury securities comprise a relatively small portion of the industry investment portfolio. Moreover, fundamental finance theory tells us that the appropriate discount rate for valuation should account for default risk, a point stressed by Brown and Pennacchi (2015). Even default risk, though, varies with perspective. All U.S. states have guaranty associations responsible for covering the obligations of failed insurers, subject to limits. At the time of the crisis, the typical limit of coverage was $300,000 for a life insurance death benefit and $100,000 for cash values and individual annuities. Because insurers typically do not pay for this protection in an *ex ante* sense,[2] guaranty associations introduce a wedge between the value of the contract to the buyer and the value of the contract to the seller. The seller retains a valuable option to default, but the buyer does not suffer the full consequences of a seller default because of the guaranty association. Thus, in the presence of this guaranty fund protection, the usual no-arbitrage approach does not give a unique answer on contract value, even if one were committed to applying the approach in the context of highly illiquid insurance and annuity contracts.[3]

The relevance of the guaranty fund issue is moot for the annuity data, where the quotes are for monthly income per $1,000 of premium and thus are not limited to a particular contract size. For life insurance, however, Koijen and Yogo studied a $250,000 contract size, which is below the typical limit of guaranty fund coverage

2. Typical guaranty association financing is based on post-insolvency assessments of surviving insurers, with insurers recouping assessments through offsets to premium taxes (Brewer III, Mondschean, and Strahan 1997).

3. Generally it is difficult or even impossible to sell life insurance or annuity coverage to exploit arbitrage opportunities. While a small secondary market exists for life insurance policies, the size is minuscule relative to the primary life insurance market and transaction costs are very large (Bauer, Russ, and Zhu 2020).

for death claims at the time of the crisis. Later in this section, we also consider the same type of life insurance contract, but for a $3 million contract size—which is well above the typical guaranty fund coverage.

Given the presence of default risk and other features of the contract (e.g., illiquidity), we consider the impact of switching to a risk-adjusted discount curve. We use the Corporate High Quality Market (HQM) spot curve published by the U.S. Treasury.[4] The point here is not to debate discount rates, but instead to offer a visually simple depiction of the impact of risk adjusted value from the seller's perspective that offers a direct comparison with the dramatic figures of Koijen and Yogo.

Often, the discount rate choice does not make much difference. Some previous papers addressing the money's worth of annuities have presented calculations using both risk-free and corporate discount rates. And although the corporate discount rates obviously reduce estimated values, the qualitative conclusions are unaffected by the choice of discount rate (Mitchell et al. 1999; Finkelstein and Poterba 2002).

In this case, however, changing discount rates has a profound effect. During the crisis, Treasury yields plummeted while corporate yields soared, with investment grade spreads reaching unprecedented levels. Given that actual quoted premiums did not change substantially during the crisis, the divergence in yields translates into a complete reversal of perspective on pricing. When using a Treasury curve, the estimated value of the underlying obligations rises sharply, and one is faced with the question of why contract prices did not follow Treasury prices up. When using a corporate curve, the estimated value of the underlying obligations falls sharply, and one is faced with the question of why contract prices did not fall with corporate bond prices.

As shown in Figure 2b, corporate yields diverged from Treasury yields during the crisis, the latter soaring as the former plunged. The predictable consequences appear in Figure 3, which shows the Koijen-Yogo markups for term annuities (replicated using Treasury spot curves) alongside markups recalculated using HQM corporate bond spot curves.[5] We refer to their paper for the calculation details. The story inverts completely: When using a risky discount rate based on the investment grade yield curve, markups rise rather than fall during the crisis. A similar story emerges in Figure 4, which reports the markups on life annuities.

For purposes of comparison, we replicate the life insurance pricing and markup calculations for the same contract type (guaranteed universal life) analyzed by Koijen and Yogo, but include results for a $3,000,000 face value instead of a $250,000 face value. This $3,000,000 contract value substantially exceeds the guaranty fund coverage limit in every state, so in theory it should, unambiguously, be valued by all parties as a corporate obligation subject to default risk. As shown

4. See `www.treasury.gov/resource-center/economic-policy/corp-bond-yield`.
5. These curves are available at `www.treasury.gov`.

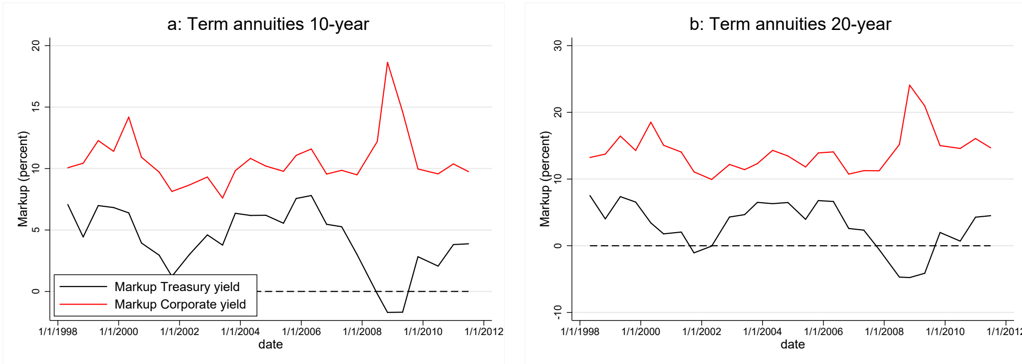

Figure 3. : Average Markup on Term Annuities.

Note: This figure reports the average markup for representative Term Annuity contracts. The markup is calculated as the ratio of "quoted price" to "actuarial value" minus 1. The black curves replicate the results from Koijen and Yogo using the Treasury spot curves. The red curves follow the same calculations but use the HQM corporate curve for the relevant rates.

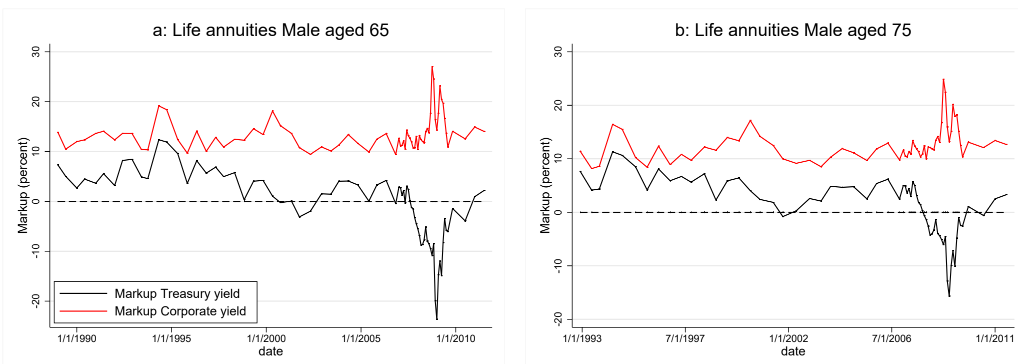

Figure 4. : Average Markup on Life Annuities.

Note: This figure reports the average markup for representative Life Annuity contracts. The markup is calculated as the ratio of "quoted price" to "actuarial value" minus 1. The black curves replicate the results from Koijen and Yogo using the Treasury spot curves. The red curves follow the same calculations but use the HQM corporate curve for the relevant rates.

in Figure 5, the pricing on the $3,000,000 contract is virtually indistinguishable from the pricing on the $250,000 contract, both in terms of the level of the markup and in terms of how the markup varies over time.[6]

Thus, while it is theoretically conceivable that insurers could draw distinc-

6. Again, we refer to Koijen and Yogo's paper for details on the calculation, noting that the valuation ignores lapse rates so that the *absolute* level of the markup should be interpreted with care.

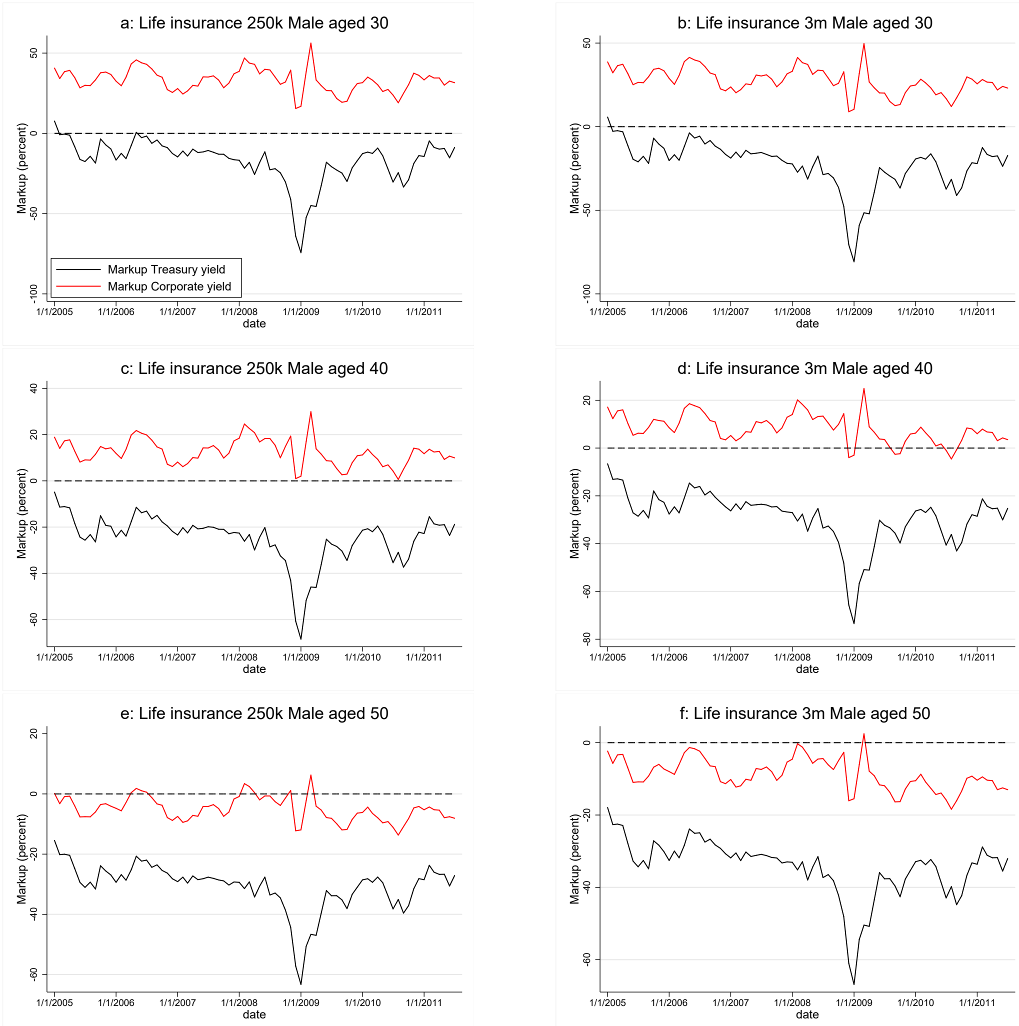

Figure 5. : Average markup on life insurance contracts.

Note: This figure presents the comparison of average markup across contract sizes for representative Life Insurance policies. The markup is calculated as the ratio of "quoted price" to "actuarial value" minus 1. The left-hand side panels show markups for \$250,000 face-value policies, whereas the righ-hand side panels show markups for \$3 million face-value policy. The black curves replicate the results from Koijen and Yogo using the Treasury spot curves. The red curves follow the same calculations but use the HQM corporate curve for the relevant rates.

tions between guaranteed and non-guaranteed obligations—leveraging association guarantees to extract additional rents on guaranteed contracts by pricing them as risk-free equivalents—this does not appear to happen in practice, at least not with these particular life insurance contracts.[7] Nor is it possible to detect a guaranty fund effect in annuity data, which, again, feature prices per unit that do not vary with contract size.

Were prices during the crisis best interpreted as marked down (relative to the present value of liabilities estimated using a Treasury curve) or marked up (relative to the present value estimated using a corporate curve)? The choice speaks to the deeper question of whether these contracts were profitable or unprofitable, with Koijen and Yogo arguing for the latter because of perverse accounting incentives. Specifically, they claim that contracts were sold at significantly unprofitable levels, but that the statutory reserve was even lower than the discounted price, so that insurers were gaining statutory capital with their sale.

In the sections that follow, we reexamine pricing in relation to the statutory reserve (Section II) and dive more deeply into the question of profitability (Section III).

II. Accounting Incentives, Revisited

Here, we focus our attention on annuities for several reasons. Universal life insurance features long streams of premium and benefit flows, both of which are reflected in the reserve. Hence, potential withdrawals, policy surrenders, and other options cloud the picture, particularly considering that the quotes Koijen and Yogo use are not for Whole Life products but for (flexible) Universal Life contracts with (less flexible) secondary guarantees, as we discussed in the previous section. More importantly, with the first year premium being a relatively small part of the picture, it seems highly unlikely that the sale of a universal life policy would have any substantial positive impact on the statutory capital position of the insurer, especially after considering acquisition expenses (underwriting costs, commissions, etc.).

With immediate annuities, the insurer receives the money up front, so it is theoretically conceivable that the sale of the contract could involve a cash inflow that substantially exceeds the reserve. Moreover, the assessment of contract value and reserve is simplified. For example, there is no need to reserve for future premium flows nor any concerns about how lapsation might affect the economic value of the contract. Term annuities in particular feature payments that are noncontingent, so there are no concerns about differing views on mortality.

In Figures 6 and 7, we plot the average markup of the actual price over the statutory reserve alongside the markup (or markdown) of the economic value in relation to the reserve. The economic value is calculated both ways—using the Treasury spot curve and using the corporate HQM spot curve. Figure 6 displays the results for term annuities and Figure 7 for life annuities.

When interpreting these figures, it is important to understand how the statutory reserve is calculated. There are two critical inputs to the reserve calcula-

7. We suspect that this is a general phenomenon. Our interviews with practitioners produced no reports of explicit reflection of guaranty fund coverage in contract pricing.

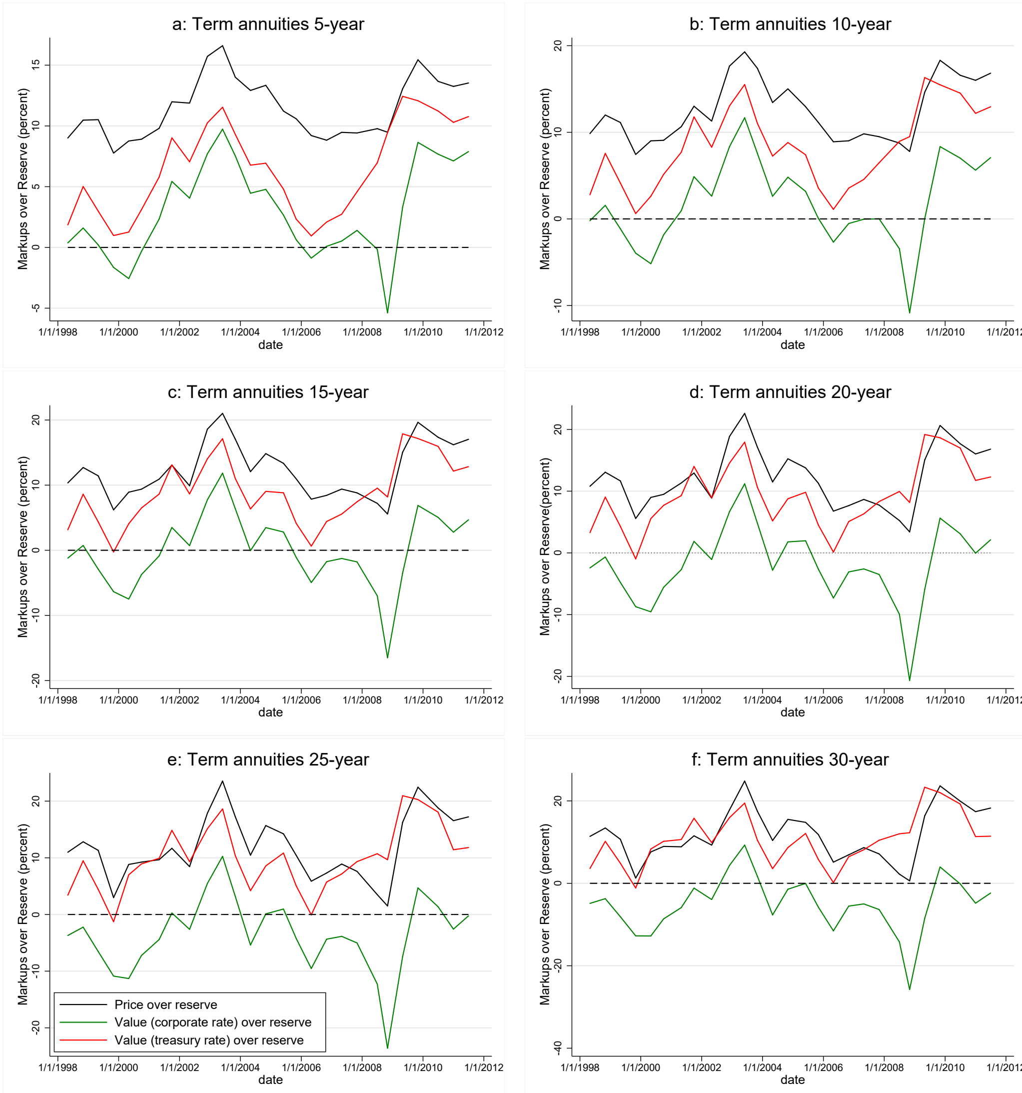

Figure 6. : Term annuities Average Markup over Reserve.

Note: This figure reports the average markup over statutory reserve for Term Annuity contracts. The markup is calculated as the ratio of "quoted price" or "actuarial value" to "statutory reserve" minus 1. The black curves plot the markup of "quoted price" over "reserve" that is calculated following Standard valuation law. The red curves plot the markup of Koijen and Yogo's version of "actuarial value" over "reserve" and the green curves plot the markup of "actuarial value" calculated using the HQM corporate curve over "reserve".

tion. First, for contracts with mortality contingent payments, the NAIC's Model Standard valuation law requires the statutory reserve to be calculated using the

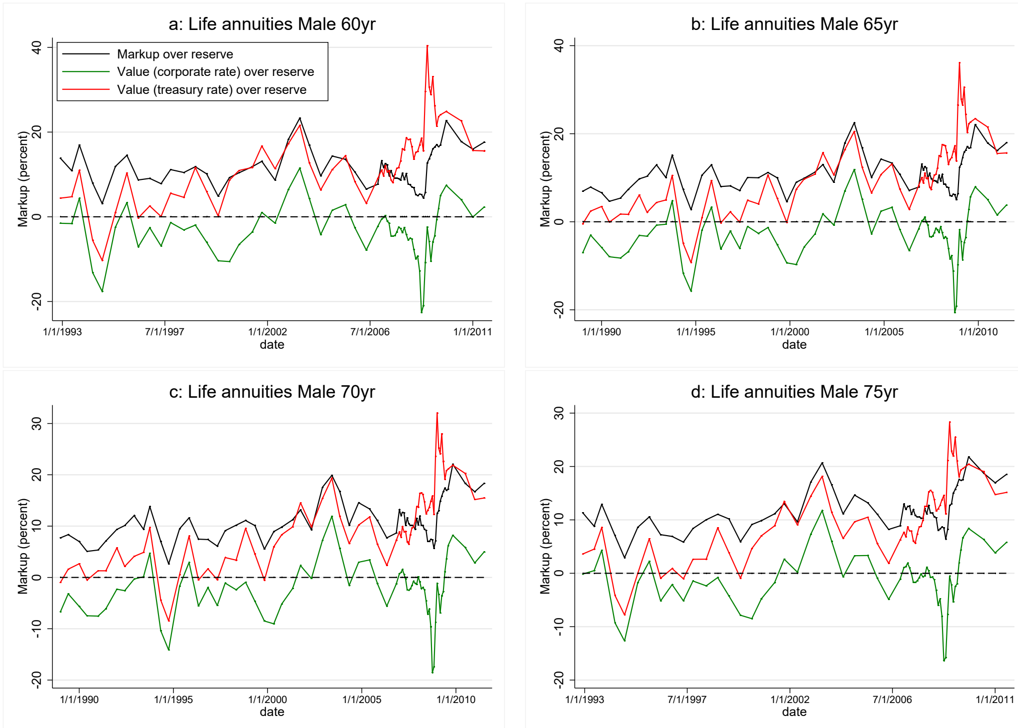

Figure 7. : Life annuities Average Markup over Reserve.

Note: This figure reports the average markup over statutory reserve for Life Annuity contracts. The markup is calculated as the ratio of "quoted price" or "actuarial value" to "statutory reserve" minus 1. The black curves plot the markup of "quoted price" over "reserve" that is calculated following Standard valuation law. The red curves plot the markup of Koijen and Yogo's version of "actuarial value" over "reserve" and the green curves plot the markup of "actuarial value" calculated using HQM corporate curve over "reserve".

"loaded" versions of mortality tables, which underestimate the mortality rates.[8] The second critical input is the discount rate. During the sample period, the statutory reserve from the NAIC's Model Standard Valuation Law for a single premium immediate annuity was calculated using a discount rate based on the 12 month average of Moody's composite yield on seasoned corporate bonds, y_t, according to the formula:

$$3\% + 0.8 \times (y_t - 3\%) \tag{1}$$

Thus, the formula effectively amounts to a weighted average of the Moody's yield and 3%. The rate is then set for the coming calendar year based on the average

8. See www.naic.org/store/free/MDL-820.pdf.

through June 30 of the preceding year. This approach has at least two important implications.

First, the lag embedded in the formula means that the statutory valuation can be "stale" in relation to market valuations when interest rates are moving rapidly. Examples of this can be found in 1994 and 1999 when rates rose rapidly during the year, with the result that economic valuations dropped significantly in relation to statutory valuations. Actual pricing tracked with economic valuations, falling in relation to the reserve during both episodes.

Second, the blending of the corporate yield with 3% meant that the statutory rate was often below the corporate yield during this sample period, because the corporate yield was typically above 3%. Thus, it was not uncommon during the sample for risk-adjusted economic valuations calculated under the corporate spot curve to be below the statutory reserve, particularly for contracts with longer terms. The gap was particularly acute during the crisis, when risk-adjusted economic values were significantly below the reserve.

Could insurers really sell policies at discounts to economic value and improve their balance sheets? Not surprisingly, the answer hinges on the choice of the discount rate used for economic valuation. Koijen and Yogo, when using the Treasury spot curve for valuation, find that a 30-year term annuity sold in January of 2009 would have produced, before expenses, 27 cents of accounting equity for each dollar of consideration received. On the other hand, when using the risk-adjusted corporate curve, the corresponding figure would be a loss of 6 cents on the dollar. In November of 2008, the same annuity sold at the risk-adjusted value would have produced an even greater accounting loss of 22 cents on the dollar.[9]

The foregoing assessments are based on different views about economic values. Figures 6 and 7 also show that when measured in relation to the reserve, actual prices generally tracked the movements of the risk-adjusted corporate-based values. Actual prices often tracked with Treasury-based valuations as well, with some exceptions such as the divergence during the crisis period. Pricing over the statutory reserve reached peaks in 2003 and late 2009 for many contracts, and troughs in relation to the statutory reserve appeared in 1994, 1999-2000, and 2008. However, it is important to note that these troughs always occurred when the risk-adjusted economic value was well below the statutory value, so the actual markup over the risk-adjusted economic value was typically quite high, as can be seen in Figures 3 and 4.

For longer term contracts, actual pricing during the critical months was very close to reserve levels—so close, in fact, that a benefit to statutory surplus is implausible after accounting for expenses. For example, the average price in the

9. Although we follow Koijen and Yogo by focusing on the impact of product sales on statutory capital, we note here that the question of whether such sales would actually help the insurer in terms of its assessed financial strength is a more complicated question. Both regulators and rating agencies rely on various assessments, including risk-based capital formulas, which would not necessarily reward insurers for product sales even if those sales improved statutory capital. Variable production expenses such as commissions also affect the accounting calculus.

sample for 30-year term annuities was only 0.7% above the statutory reserve in November of 2008. More to the point, *one-third* of the individual price quotes were below the statutory reserve values.

Such pricing behavior had precedent. Figure 8 shows that similar patterns occurred in 1994 and 1999. Firms who priced these contracts aggressively during these times evidently were not getting an accounting benefit for doing so. In fact, for a number of the contracts, there were accounting penalties. These penalties appeared in periods when corporate bond yields had risen quickly—as they did in late 2008.

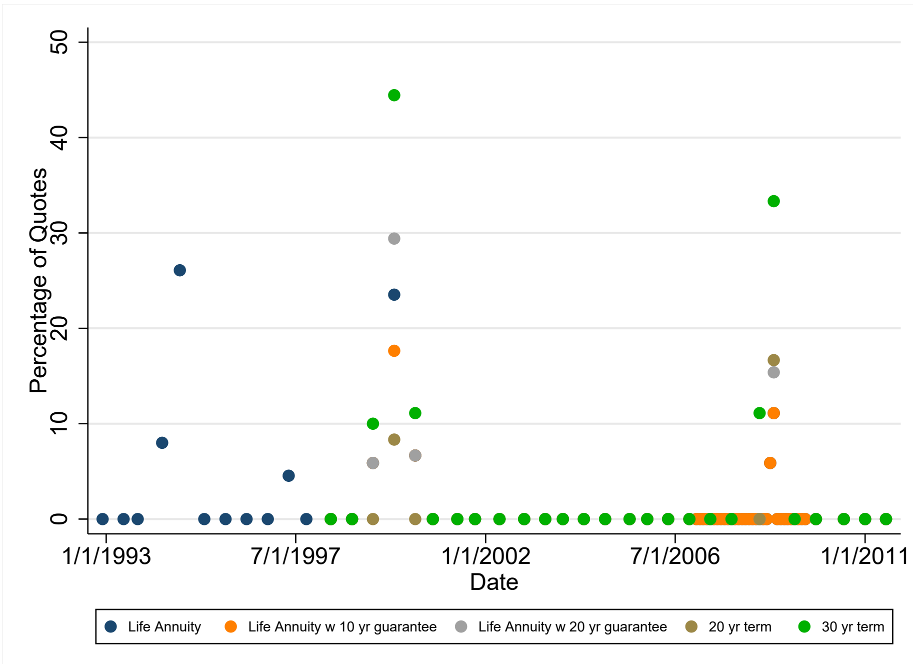

Figure 8. : Percentage of Quotes Below Statutory Reserve Values.

Note: This figure reports the percentage of representative annuity-contract quotes that were below statutory reserve levels during times of financial market stress, namely around 1994, 2000 and 2008.

III. Contract Profitability and the Cost of Capital

Comparison of price to the discounted present value of benefits may be a useful shorthand indicator of whether a contract is profitable. However, as noted above, evaluating the profit in an annuity contract is a complex exercise requiring the consideration of premium, expense, tax, benefit, and reserve flows over the life of the contract. In this section, we pursue this exercise and estimate the implied rate of return on capital embedded in the contracts in the sample. Insurers estimate the rate of return on capital supporting an insurance contract through internal rate of return models (IRR) and embedded value models such as those described by Feldblum (1992), Atkinson and Dallas (2000), and Dickson et al. (2013). These models boil the policy down to a sequence of cash flows:

p_t: premium/consideration received at time t,
i_t: investment income received at time t,
b_t: benefit paid at time t,
e_t: expenses paid at time t
τ_t: federal tax paid at time t,
Δs_t: change in statutory reserve at time t, and
Δk_t: change in allocated capital at time t.

Thus, the net flow to the capital provider in time t can be expressed as:

$$n_t = p_t + i_t + b_t + e_t + \tau_t + \Delta s_t + \Delta k_t$$

The initial flow at the inception of the contract will often be negative in the case of annuities: the premium comes in a lump sum at the beginning, but this is offset by significant acquisition expenses and the posting of the statutory reserve and supporting capital. The flow would then reverse, with investment income and reductions in the reserve and allocated surplus offsetting benefit payments.

The implied rate of return r to the capital provider, i.e. the cost of capital, solves:

$$0 = \sum_{t=0}^{\infty} \frac{n_t}{(1+r)^t} \tag{2}$$

We start by applying the model to our term annuity data. Because term annuities feature noncontingent payments, we do not have to make any conjectures about company views on mortality. The initial premium and monthly benefit flows are determined by the contract under consideration.

The expenses are based on the Society of Actuaries Individual Life and Annuity Expense Study for the years 2001 to 2010.[10] We take a straight average over the 10 years of the fixed expense components as well as the variable percentages from these studies. The fixed expense components are then scaled by the ratio of the average reserve disclosed in the study to that of the contract under consideration. This data provides us with an estimate of initial expenses as well as ongoing monthly maintenance expenses for each policy. Taxes are based on federal income tax rules and rates for insurance companies at the time (Burstein 2007) but are assumed, for simplicity, to be paid monthly as they are incurred. It is realistic to scale the expenses according to contract length, since commission schedules typically feature higher commissions for longer term contracts. Given the average

10. See `https://www.soa.org/research/topics/indiv-expense-exp-study-list/`.

commission of 2.7% in the studies, we use 3% for contracts with terms over 10 years, 2.5% for a 10 year term, and 2% for terms below 10 years.

Investment income is earned on the assets that are held to cover the statutory reserve and allocated capital. We base investment income on the assumption of a mix of high quality corporate bonds and Treasury securities. We use the HQM spot rate curve for the corporate bond yields and the Treasury spot curve as estimated by Gürkaynak, Sack, and Wright (2019) for the Treasury yields; we use the curves for the month in which the contract is assumed to have been sold. We use a split of 80% corporate and 20% Treasuries. We use this approach for two reasons. First, the split is representative of the industry's asset portfolio: Treasury bonds typically accounted for less than 10% of the industry's cash and invested assets during this time, with corporate bonds accounting for about 50%. Significant allocations were also made to mortgage loans and agency securities (about 10% apiece), with the remainder scattered among stock, preferred stock, and other assets. Second, the spot curves allow us to cash flow match the asset portfolio with the portfolio of obligations assumed with the sale of the contract.

The statutory reserve is calculated using the appropriate statutory interest rate for the year of the contract sale.

Capital is allocated based on the observed ratio to reserves. During this time period, total industry statutory surplus averaged around 11% of total contract reserves. We present results using a slightly higher figure of 12% to account for the differences between statutory capital and economic capital: For example, statutory rules do not recognize certain assets and also value most bonds at amortized cost rather than market value.

We calculate implied costs of capital for 5-year, 10-year, 20-year, and 30-year term annuities. The results for the average of these four contracts are shown in Figure 9.

Importantly, the crisis period stands out in terms of sporting a significantly higher implied return on capital than the surrounding months. The peak implied return in November 2008 stands out as the highest over the entire 1999-2011 period. A previous noteworthy peak also appears May of 2000, a time, as can be seen in Figure 6, when risk-adjusted economic values were also well below the statutory reserve.

We also calculate implied rate of return for life annuities. Life annuities feature payments conditioned on being alive, so both the reserve and the actual benefit flows must account for mortality. The structure of the model for life annuities is exactly the same as that for term annuities, except that we need to calculate the probability of the policyholder being alive at certain times in the future. For the actual benefit flow calculation we use "basic" version mortality tables. For the reserve calculation we use the "loaded" version mortality tables. We also use "Mortality Improvement Projection Scale G" ("Projection G" onward), published by the Society of Actuaries, to adjust mortality tables year by year to account for the improvement of life expectancy due to improvements in medical

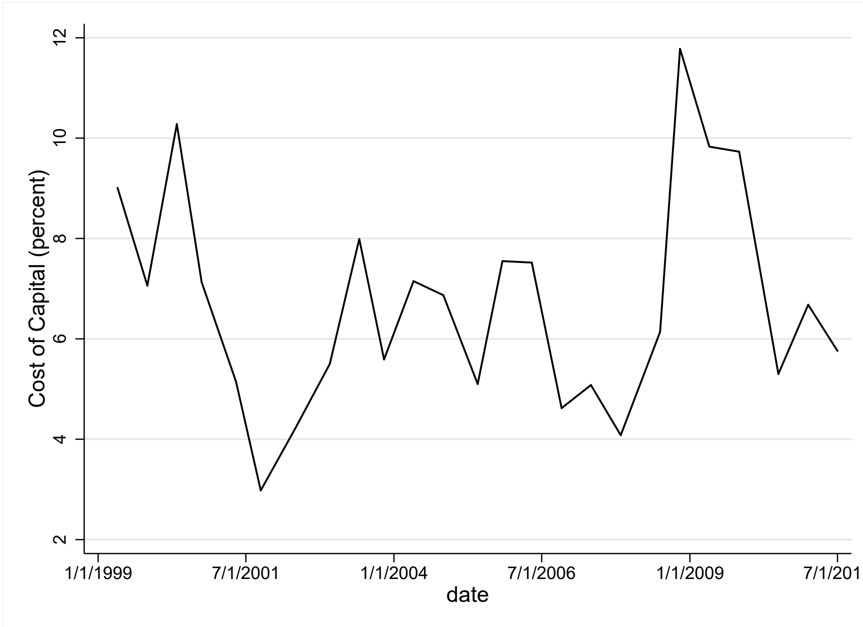

Figure 9. : Average Implied Cost of Capital for Term Annuities, 1999-2011.

Note: This figure reports the average implied cost of capital for Term Annuities over the 1999 to 2011 period. We use an internal rate of return model and the closest possible cash flow estimates (as described in Section III) for the calculation.

technology over time. Our sample period is from 1989 to 2011. During that time, the mortality table updated twice and the "Projection G" updated once. Because we are doing this calculation to estimate the actual return of insurance companies, we use the most up to date versions of mortality table and "Projection G" combination possible. This cuts our sample into three time periods: 1989-2000; 2001-2011; and 2012 onward. For payments happening in the 1989-2000 period, we use the 1983 version mortality tables with 1983 version of "Projection G." For payments happening in the 2001-2011 period, we use the 2000 version of mortality tables with the 1983 version of "Projection G." Finally, for payments happening in 2012 and onward, we use the 2012 version mortality tables with the 2012 version "Projection G2." The results for a straight life annuity for a 60 year old male are shown in Figure 10.

In broad terms, the results for life annuities track with those for term annuities over the 1999 to 2011 period, as can be seen in Figure 11. The higher frequency data for the life annuities reveals additional detail during the crisis period, with the implied cost of capital surging to a peak in November of 2008, dipping in December of 2008 and January 2009, and then rebounding through the spring of 2009. As suggested by Figure 1, the dip starting in December of 2008 was not

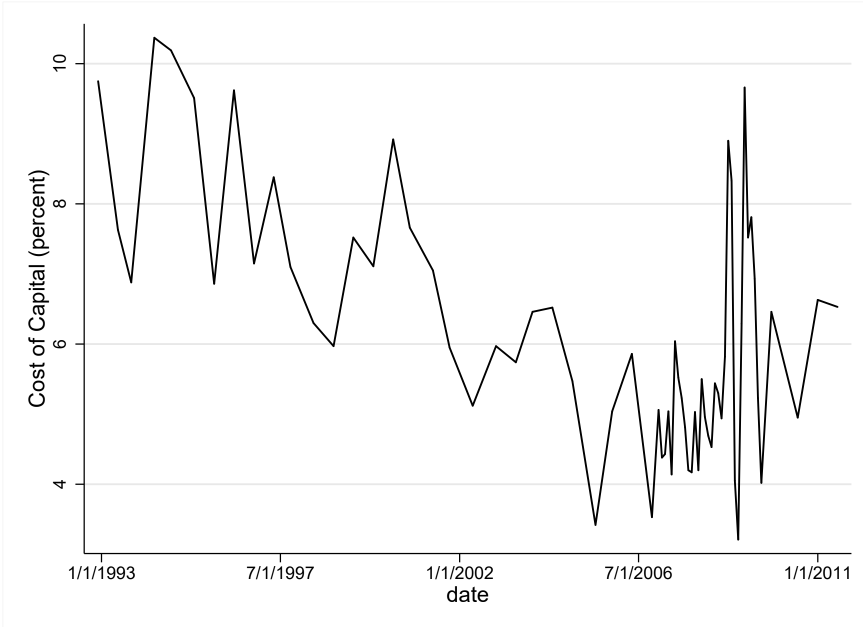

Figure 10. : Implied Cost of Capital, Life Annuity for 60 year-old male.

Note: This figure reports the implied cost of capital for a Life Annuity contract for a 60 year old male without any guarantee over the 1993 to 2011 period. We use an internal rate of return model and the closest possible cash flow estimates (as described in Section III) for the calculation.

driven by declines in the quoted premiums: Instead, this was driven by the drop in corporate spot rates, which retreated after the initial surge in the fall of 2008 before rising again in February 2009.

Figure 10 supplies further confirmation of the connection between risk-adjusted economic values being below the statutory reserve and high implied rates of return on capital. In addition to local peaks during 2008-2009 and in 2000, we also see a peak after the "bond market massacre" of 1994, when a sudden rise in corporate yields pushed risk-adjusted economic values well below their statutory counterparts.

The results are of course sensitive to calibration, particularly to surplus leverage. We also analyzed results for the individual contracts at capital leverage assumptions running from 10% to 14%. The implied costs are generally lower for the shorter term contracts—perhaps due to difficulties in fully calibrating expense differences across maturities—and the levels for any given contract vary significantly with leverage. However, the relative values over time, even if overstated or understated, generally rise and fall according to the pattern shown in Figures 9 and 10.

Nissim (2013) estimates the implied cost of equity capital for insurers using

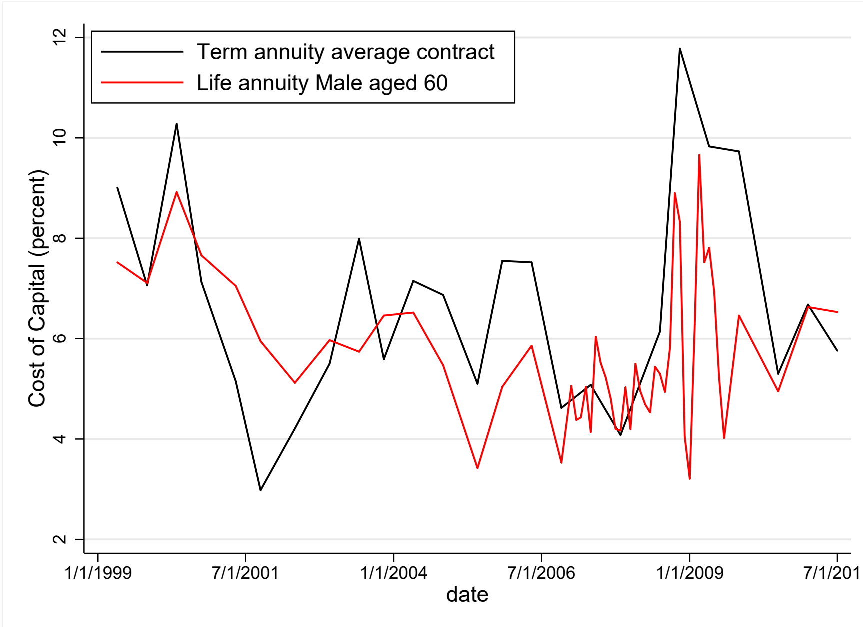

Figure 11. : Implied Cost of Capital, Life Annuity vs Term Annuity.

Note: This figure shows the implied cost of capital for a Life Annuity contract for a 60 year old male without any guarantee over the 1999 to 2011 period (a subperiod from Figure 10), along with the average term annuity implied cost of capital over the same time period from Figure 9. We use an internal rate of return model and the closest possible cash flow estimates (as described in Section III) for the calculation.

traditional "top down" methods and finds a roughly similar pattern in the time series, with the cost of equity peaking in early 2000 before retreating and recovering several years later, peaking again around the time of the financial crisis. Many of our estimates are also in the same ballpark, though our figures could arguably be interpreted as estimates of the weighted average cost of capital rather than the cost of equity capital alone, and if so should be lower.

It is important to contrast our findings and those of Nissim with those of Koijen and Yogo on this point. Koijen and Yogo argue that insurers priced policies at significant economic losses during the crisis in order to gain statutory capital, and thus were willing to accept a negative return on economic capital in order to gain statutory capital—with the implied cost of statutory capital being 96%. They acknowledge the paradoxical nature of this result when compared with previous empirical findings for the property-casualty insurance industry (Gron 1994; Froot and O'Connell 1999), arguing that statutory accounting is to blame for the different experience of the life industry.

However, our findings here and in the previous section suggest that the pricing actions of the life industry during the crisis were entirely consistent with existing theory and empirical evidence. Both macro-level theory on insurance capacity shocks (Winter 1994) and micro-level theories on capital shocks to individual firms (Froot and Stein 1998) predict that hurdle rates will rise in response to capacity shocks caused by underwriting or investment losses, and this appears to have happened in 2008 and 2009—just as it has been shown to do in the aftermath of natural catastrophes in the property-casualty industry.

IV. Company Risk and Pricing in the Cross Section

The discussion above raises interesting questions about the cross-sectional pattern of insurance pricing. Koijen and Yogo offer some descriptive evidence on the point of pricing during the crisis, suggesting that the weakest insurers cut prices the most. In what follows, we delve deeper by analyzing pricing over a longer period of time, including previous episodes with features similar to the financial crisis. In particular, the critical months of the financial crisis coincided with a time when risk-adjusted economic values were far below statutory reserve values. As noted above, this pattern occurred previously in 2000 and 1994, when corporate interest rates rose quickly. We also consider the reverse situation—periods when falling corporate rates pushed risk-adjusted economic values well above statutory reserve values. This latter phenomenon was most pronounced during 2003 and late 2009.

Table 1 summarizes prices and price changes by financial strength rating level for 5 different episodes for a representative contract—a life annuity for a female aged 60.

During the periods when risk-adjusted economic values were significantly below statutory reserve values, stronger companies (as measured by A.M. Best ratings) had lower price levels than weaker competitors and, moreover, the stronger firms discounted their prices more aggressively over the past 12 to 18 months to get to those levels. In contrast, periods when risk-adjusted economic values were significantly above statutory reserve values were characterized by stronger companies having, on average, higher prices than their weaker competitors and, on average, having raised prices more aggressively than their weaker competitors over the past 12 to 18 months.

There are two potential forces that may explain these results. The first is leverage. In general, within the supply-side model of Section III, smaller price changes are needed to maintain a given return on capital when leverage is higher. If weaker companies are more highly levered, ceteris paribus, they will need smaller adjustments to reach a target rate of return. In this light, it is not surprising that their pricing changes are less dramatic than those of their stronger competitors in all five of the episodes listed in Table 1. Second, periods of sharply rising interest rates may also coincide with increasing credit spreads (as we observe in the data for May 2000 and November 2008), which would indicate a relative increase in the cost of capital for weaker firms. Such a change could increase the gap between the hurdle rates of weak and strong firms, thus providing an additional influence

Table 1—: Average Prices and Price Changes for a Representative Contract, Selected Months.

		A and Above	A- and Below	A+ and Above	A and Below
October 1994					
	Average Price	12445	12737	12310	12718
	Average 1 Year Price Change	-9%	-5%	-11%	-6%
	Average 18 month Price Change	-1%	0%	-2%	0%
May 2000					
	Average Price	12491	12976	12588	12773
	Average 1 Year Price Change	-9%	-6%	-8%	-7%
	Average 18 month Price Change	-11%	-9%	-11%	-10%
November 2008					
	Average Price	13712	14294	13764	13836
	Average 1 Year Price Change	-4%	0%	-3%	-3%
	Average 18 month Price Change	-5%	1%	-4%	-5%
June 2003					
	Average Price	16073	14908	16254	15081
	Average 1 Year Price Change	25%	19%	26%	19%
	Average 18 month Price Change	23%	21%	24%	18%
November 2009					
	Average Price	15851	15084	15869	15568
	Average 1 Year Price Change	17%	6%	17%	13%
	Average 18 month Price Change	13%	6%	12%	11%

Note: This table shows average prices and price changes for a life annuity with no guarantee for a 60 year old female at different A.M. Best rating levels for five different months. The top panel covers three months—October 1994, May 2000, and November 2008—when risk-adjusted economic values had bottomed at levels well below statutory reserve values. The bottom panel covers two months—June 2003 and November 2009—when risk-adjusted economic values had peaked at leavels well above statutory reserve values. Averages are taken across company groups within each rating category, with the average group price and price change used when a group has more than one company in the rating category.

to drive pricing of weaker firms higher in relation to stronger ones. The opposite characterization applies to the falling interest rate environments of 2003 and late 2009, which also coincided with decreases in credit spreads.

Whatever the reasons, the important point is that the pricing behavior of late 2008 was not unusual given the confluence of circumstances and was in fact similar to previous episodes. Thus, our findings again sharply contrast with the cross-sectional characterization offered by Koijen and Yogo, who argued that the weakest insurers—driven by a need for statutory capital—discounted prices most heavily during the crisis. As we have shown, the accounting incentive was not actually present during the critical crisis months. But, in any case, the cross-sectional data actually suggest a paradoxically positive relationship between company risk and prices during the crisis period—as well as in several other periods when statutory reserve values were far above risk-adjusted economic values.

We explore the relation between firms' risk levels and prices more systematically in what follows. We use panel data sets with one observation for each combination of firm (i), contract (j), and time (t). The frequency may be semiannual or monthly depending on the data set. We estimate regressions that are variants of:

$$
\begin{aligned}
(3)\quad Price_{i,j,t} \; = \; & \alpha + \beta_1 \times Risk_{i,t} + \beta_2 \times ValuePremium^{HQM}_{i,j,t} \\
& + \beta_3 \times Risk_{i,t} \times ValuePremium^{HQM}_{i,j,t} \\
& + \beta_4 \times Value_{i,j,t} + ContractFE + \varepsilon_{i,j,t}
\end{aligned}
$$

$Price_{i,j,t}$, is the natural log of the quoted premium of contract j from firm i at time t. $Value_{i,j,t}$ is the the natural log of the statutory reserve value (following the Standard Valuation Law (SVL)) of contract j from firm i at time t. The details of the SVL reserve calculation are described in Section III. $ValuePremium_{i,j,t}$ is the difference between the natural log of the risk-adjusted economic value (calculated using HQM spot rates) and the natural log of the statutory reserve value, which represents how far the economic value deviates from the reserve in percentage terms.

Table 2—: Regression Results for Price on Risk and Reserves.

	$Log(price)_t$ (term annuity)		$Log(price)_t$ (life annuity)		$Log(price)_t$ (GULs)	
	(1)	(2)	(3)	(4)	(5)	(6)
$Risk$	0.01	-0.00	0.01**	-0.00***	0.01	0.03
	(1.49)	(-1.26)	(2.02)	(-2.96)	(1.51)	(1.51)
$Risk \times Value$	-0.03***	-0.05***	-0.04***	-0.05***	-0.00	-0.01
$Premium$	(-3.09)	(-3.08)	(-3.58)	(-4.41)	(-0.18)	(-0.45)
$ValuePremium$	0.72***	0.78***	0.62***	0.67***	0.10**	0.28**
	(13.22)	(14.34)	(12.29)	(14.00)	(2.20)	(2.17)
$Value$	1.12***	1.11***	1.00***	0.94***	-0.42	-1.56***
	(13.87)	(13.16)	(24.36)	(20.15)	(-1.67)	(-3.57)
$ContractFE$	Yes	Yes	Yes	Yes	Yes	Yes
$FirmFE$	Yes	No	Yes	No	Yes	No
N	2552	2552	30357	30357	13013	13013
adj. R-sq	0.993	0.991	0.970	0.956	0.993	0.976

t statistics in parentheses. * p<0.10, ** p<0.05, *** p<0.010.

Note: This table reports the results of regressions investigating the relationship between insurance pricing and firms' risk level. We estimate the regression:

$$
\begin{aligned}
Price_{i,j,t} = \alpha + \beta_1 \times Risk_{i,t} + \beta_2 \times ValuePremium^{HQM}_{i,j,t} + \beta_3 \times Risk_{i,t} \times ValuePremium^{HQM}_{i,j,t} \\
+ \beta_4 \times Value_{i,j,t} + ContractFE + \varepsilon_{i,j,t}
\end{aligned}
$$

In this equation, i index firm, j index contract, and t index time. $Price$ is the log of the premium. $Risk$ is defined as 10-year net impairment. $Value$ is the log statutory reserve. And $ValuePremium$ is the log difference between the risk-adjusted economic value and the statutory reserve. Contract fixed effects are included in all specifications. Columns (1) and (2) are results for term annuities, Columns (3) and (4) are results for life annuities, and Columns (5) and (6) are results for life insurance.

$Risk_{i,t}$ is the 10-year net impairment rate associated with the firm's A.M. Best rating in year t. The impairment rate is calculated as the total impairments that happened in the previous 10 years less the total number of impaired companies whose ratings were withdrawn prior to impairment, divided by the total number of insurers in consideration.[11] This term serves to quantify differences in default risk. It is inversely related to company rating, i.e. the higher the rating the smaller the impairment rate.

The interaction term between $Risk_{i,t}$ and $ValuePremium_{i,j,t}$ allows the relation between price and rating to vary with premium of economic value to reserve value. This is our main coefficient of interest, as it captures how the pricing response to changes in the value premium varies by the risk of the insurer. For example, a negative coefficient means that firms with lower ratings charge relatively higher prices when economic values are below reserve values but lower prices when economic values are above reserve values. This might happen, for example, if poorly rated firms value statutory capital more highly than strongly rated firms do.

Contract fixed effects are always included. In all specifications, the standard errors are clustered at the firm level.

We estimate regression (3) with and without firm fixed effects in three datasets (term annuity, life annuity, and life insurance). In general and as expected, there is a strong positive connection between pricing and the statutory reserve value ($Value$) for the annuity contracts; the risk-adjusted economic value as reflected in $ValuePremium$ also exhibits a strong connection with pricing of annuities. The results for life insurance are weaker and contrary in the case of the statutory reserve—the latter result may be a consequence of the secular decline in the pricing of these contracts as assumptions around lapsation have become more aggressive over time despite the falling interest rate environment. As for the risk effects, the overall connection appears, though not always strongly in a statistical sense, in the specifications with fixed effects.

Importantly, as we can see in Table 2, in all columns, the coefficients of the cross term between $Risk_{i,t}$ and $ValuePremium_{i,j,t}$ are negative. The results are significant at the 1% level for term annuities and for life annuities. This overall result is consistent with weaker firms pricing relatively more aggressively during periods when economic values are above statutory values and relatively more conservatively when economic values are below statutory values. For example, a negative coefficient and a negative value premium means, all else equal, the higher the rating the lower the price. When the risk-adjusted economic value is above the SVL reserve, firms with higher ratings would charge a higher price.

In Table 3, we separate the variable $ValuePremium_{i,j,t}$ into two variables $ValuePremium_{i,j,t}(+)$ and $ValuePremium_{i,j,t}(-)$. $ValuePremium_{i,j,t}(+)$ equals to $ValuePremium_{i,j,t}$ when $ValuePremium_{i,j,t}$ is positive and equals to zero otherwise. Similarly $ValuePremium_{i,j,t}(-)$ equals to $ValuePremium_{i,j,t}$ when $ValuePremium_{i,j,t}$ is negative and zero otherwise. We then interact $Risk_{i,t}$ with

11. An insurer is designated as a Financially Impaired Company (FIC) as of the first official regulatory action taken by an insurance department, which include capital or surplus inadequacy, general financial conditions that triggered regulatory concern and etc. See `www.ambest.com/webinars/info/AMBImpairmentRateTransitionStudy.pdf`.

Table 3—: Regression Results for Price on Risk and Reserves, Differentiated.

	$Log(price)_t$ (term annuity)		$Log(price)_t$ (life annuity)		$Log(price)_t$ (GULs)	
	(1)	(2)	(3)	(4)	(5)	(6)
$Risk$	0.00	-0.00	0.01**	-0.00*	0.02**	0.05*
	(1.00)	(-1.02)	(2.06)	(-1.85)	(2.66)	(1.89)
$Risk \times Value$	0.00	-0.02	-0.03	-0.05	-0.04*	-0.06*
$Premium_t(+)$	(0.19)	(-0.61)	(-1.07)	(-0.78)	(-1.80)	(-1.91)
$ValuePremium_t(+)$	0.85***	0.90***	1.13***	1.12***	0.13	0.56*
	(10.95)	(10.89)	(11.85)	(8.00)	(0.87)	(1.85)
$Risk_t \times Value$	-0.05***	-0.06***	-0.04***	-0.05***	0.03	0.03
$Premium(-)$	(-3.11)	(-3.99)	(-3.22)	(-3.78)	(1.09)	(1.17)
$ValuePremium(-)$	0.65***	0.70***	0.56***	0.61***	0.05	0.19
	(8.39)	(9.34)	(10.67)	(12.02)	(0.79)	(1.43)
$Value$	1.15***	1.11***	1.01***	0.94***	-0.41	-1.56***
	(14.91)	(13.09)	(25.90)	(20.08)	(-1.63)	(-3.53)
$ContractFE$	Yes	Yes	Yes	Yes	Yes	Yes
$FirmFE$	Yes	No	Yes	No	Yes	No
N	2552	2552	30357	30357	13013	13013
adj. R-sq	0.994	0.991	0.970	0.957	0.993	0.976

t statistics in parentheses. * p<0.10, ** p<0.05, *** p<0.010.

Note: This table reports the results of regressions investigating the relationship between insurance pricing and firms' risk level. We estimate the regression:

$$Price_{i,j,t} = \alpha + \beta_1 \times Risk_{i,t} + \beta_2 \times ValuePremium(+)^{HQM}_{i,j,t} + \beta_3 \times Risk_{i,t} \times ValuePremium(+)^{HQM}_{i,j,t} + \beta_4 \times ValuePremium(-)^{HQM}_{i,j,t} + \beta_5 \times Risk_{i,t} \times ValuePremium(-)^{HQM}_{i,j,t} + \beta_6 \times Value_{i,j,t} + ContractFE + \varepsilon_{i,j,t}$$

In this equation, i index firm, j index contract, and t index time. $Price$ is the log of the premium. $Risk$ is defined as 10-year net impairment. $Value$ is the log statutory reserve. And $ValuePremium$ is the log difference between the risk-adjusted economic value and the statutory reserve. $ValuePremium(+)$ is defined equal to $ValuePremium$ when positive and equal to zero otherwise; $ValuePremium(-)$ is defined equal to $ValuePremium$ when negative and equal to zero otherwise. Contract fixed effects are included in all specifications. Columns (1) and (2) are results for term annuities, Columns (3) and (4) are results for life annuities, and Columns (5) and (6) are results for life insurance.

these two new variables, respectively. The result is consistent with that in Table 2. The coefficients of interaction terms are generally negative, with the interaction of $Risk_{i,t}$ and $ValuePremium_{i,j,t}(-)$ being significant at levels of 1% for term annuities and life annuities. The coefficients for the interaction terms of $Risk_{i,t}$ and $ValuePremium_{i,j,t}(+)$ are negative and significant for life contracts.

V. Concluding Remarks

Ultimately, our interpretation of life insurance and annuity pricing is contrary to that offered by Koijen and Yogo. We argue that the modest adjustments to quoted prices during the crisis effectively amounted to pricing increases relative to fair value rather than discounts, and that regulatory frictions had an effect opposite to that identified by Koijen and Yogo. Specifically, accounting rules, if anything, penalized insurers for lowering their prices to reflect economic values and created incentives to keep prices above those suggested by analogous securities, or combinations of securities, in the capital markets. The patterns seen in the crisis were echoes of past episodes when risk-adjusted economic values fell below statutory values.

Koijen and Yogo's findings are cited as evidence of instability in the insurance industry, used in particular to support arguments for systemic regulation of insurance companies. While we do not take a position in this paper as to whether such regulation is warranted, we do argue that the evidence on product market pricing in this case has been misinterpreted.

We do, however, agree with Koijen and Yogo's emphasis on the importance of frictional costs for understanding insurance pricing behavior, as well as the importance of statutory accounting rules. Potential risks embedded in statutory accounting rules are evident.

For example, the rules for determining the interest rate to be used in life insurance reserve calculations 1) reference a moving average of historical interest rates and 2) establish a baseline, consistent with longstanding practice, of three percent—around which deviations are mitigated. In a declining interest rate environment, the industry will thus be keying reserve discounting to an average that is higher than current market rates. This has not been an acute problem in the U.S.; given that medium and long-term corporate yields have typically been above 3%, the mitigation embedded in the statutory formula has offset the effects of the declining average. However, should corporate yields fall below 3% and continue to fall, both of these problems—the mitigation and the averaging—will reinforce each other in keeping discount rates above actual market rates. This type of risk may fit more in the realm of the "slow burn" rather than the "fire sale" but it is important nonetheless.

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