Variable Annuities and Systemic Risk

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This chapter argues that variable annuities may cause systemic risk in the insurance sector. Life insurers, in particular in the US, have transformed their business by moving from largely diversifiable activities to taking on market risk. This exacerbated by the fact the variable annuities are typically supplemented with guarantees. Such guarantees are effectively put-options on the stock market and expose insurers to significant stock market risk. Although insurers hedge a large fraction of the guarantees, the hedging also causes insurers to shift their asset allocation towards illiquid bonds. This backfires in the event of a correlated shock, where collective fire-sales of illiquid bonds result. The implications for the capital of the US life insurance sector, and systemic risk, are significant.

Life insurance companies traditionally source risk that is largely diversifiable. However, as the U.S. retirement landscape has moved away from employer-sponsored defined benefit plans, insurers have significantly expanded their supply of variable annuities (VAs) [1]. Variable annuities are life insurance policies and their return is often linked to the stock market. Importantly, insurers typically offer guarantees on these products (Koijen and Yogo, 2017a, 2017b), for example taking the form of a minimum return. Given both the size and the nature of the arising commitments, VAs are attracting attention from policymakers as a potential source of risk. In particular, U.S. insurers have been implicated as a primary source of the market instability exhibited in February of 2018 (see, for example, *The Financial Times,* February 22, 2018 [2])

As Figure 1 shows, U.S. life insurers are now relatively less likely to be involved in the traditional insurance business, where an insurer underwrites idiosyncratic risks and invests in accordance with an asset-liability matching principle. Under this model, insurers can take a long-term investment perspective, and potentially act as asset insulators by providing liquidity during periods of market stress (Chodorow-Reich *et al.*, 2016; GA, 2015, 2016; Thimann, 2014).

In sharp contrast, with the significant emergence of VAs, insurers' asset allocations have become more procyclical, less diverse across insurers (Bank of England, 2014; ESRB 2015), and more exposed to overall equity market fluctuations. One major concern among regulators is that the overall insurance sector's exposure to aggregate risk, in particular duration risk/interest rate sensitivity, has been growing (EIOPA, 2017; GA, 2015; IMF, 2016). Finally, we also observe elevated stock price co-movement among insurers as a consequence of this evolution.

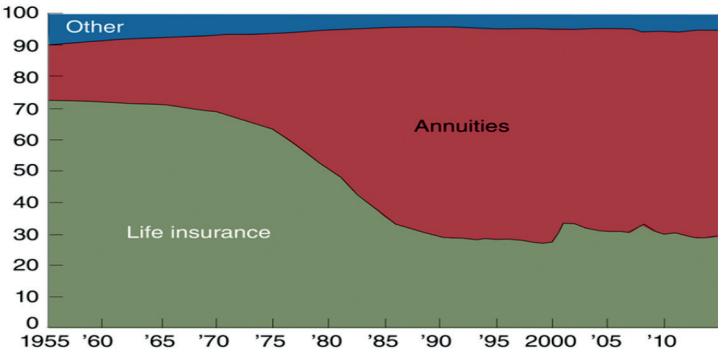

Figure 1: Life insurance product shares over the period 1955-2014 (source: American Council of Life Insurers, 2015 Life Insurers Fact Book, and Alejandro H. Drexler, Zain Mohey-Deen & Richard J. Rosen).

Systemic risk analysis has largely focused on the linkages among financial institutions' funding arrangements, and the increasing connections along these lines between insurers and the remainder of the financial system deserves appropriate scrutiny. However, commonality in financial institutions' assets is equally important. Yet, the asset-

(1) Annuity premia and deposits earned by the U.S. life insurance industry increased from $286 billion in 2010 to $353 billion in 2014, making them one of the fastest growing areas of policy generation, accounting for almost 35% of U.S. life insurers' liabilities in 2015.
(2) While insurers have increasingly turned to target volatility funds to help manage the risks associated with VA guarantees over the preceding several years, a significant component of market-wide selling pressure was attributed to the unintended consequence of their collective strategy overlap on realized market volatility.

side as a source of vulnerability has received relatively less attention, perhaps because of a lack of data availability and/or a proper environment to test this channel. The insurance sector data are excellent, and the risk implications of the evolution of insurers' asset allocations associated with their VA business are potentially important.

In a recent paper "Insurers as Asset Managers and Systemic Risk" we analyse this channel and show how systemic risk can originate from the insurers' business model in which they provide embedded equity-linked investment guarantees. We describe a mechanism that explains how financial institutions' exposures to financial guarantees on stock market performance create incentives to reach for yield by overweighting similar, illiquid assets. In the case of a period characterized by equity market stress, an individual insurance company may be forced to sell its assets to re-gain financial health and meet regulatory thresholds. Doing so, however, it will impose externalities on other institutions – not only insurers – holding similar assets. Contagion will result and systemic risk emerges.

Our main finding confirms the maintained hypothesis: insurers' collective allocation to illiquid bonds, exacerbated by the reaching for yield behaviour of the last decade characterized by low interest rates, amplifies system-wide fire-sales in the event of negative asset shocks. Under different scenarios, these dynamics can plausibly erase a large part of insurers' aggregate equity capital.

Guarantees expose insurers to market tail risk

From the perspective of an insurer, a VA policy is a combination of business lines related to asset management and life insurance. An insurer allocates policyholder savings to a separate account and acts as a delegated asset manager of policyholders' funds. Absent any guarantees, the separate account is a pass-through account in which a policyholder bears all investment risk. Once a policyholder reaches retirement age, she has an option to convert funds to an annuity which protects against outliving savings in retirement. This exposes the insurer to (traditional) longevity risk.

The presence of guarantees, however, turns VAs into stock market put option-like instruments. As a result, insurers now bear significant market tail risk. That is, exposures to guarantees are at their peak during a severe market downturn, exposing insurers to losses at the most turbulent times.

To safeguard annuity investors, capital regulation forces insurers to set aside reserves associated with any guarantees they have written. The size of the reserves associated with guarantees, now among the largest liabilities on insurers' balance sheets, fluctuates with stock market performance and interest rates. Figure 2 plots the evolution of the insurers' gross reserves to capital ratio for the period from 2004 to 2013. It reveals the high volatility of the ratio for insurers with high exposure to guarantees, with spikes around the global financial and European sovereign debt crises.

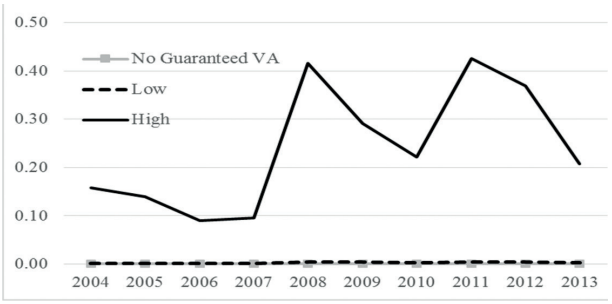

Figure 2: Exposure to Guaranteed Variable Annuities (VA) and Firm Performance. This figure plots the time series of the ratio of gross reserve to capital for the period from 2004 to 2013. Each year, life insurers with VA are divided into two groups by the ratio of gross reserve to capital. The "high" ("low") group includes life insurers with ratio of gross reserve to capital higher than (less than or equal to) the median. The annual averages across life insurers in each group are plotted – the solid (dashed) line representing the high (low) group. For comparison, the annual averages for life insurers without VA are also plotted (solid line with square markers). Only life insurers that have averaged total assets greater than the fifth percentile of the sample of life insurers with VA are included.

Hedging of guarantees

To reduce the exposure to guarantees and the associated fluctuations of reserves, insurers hedge their exposure to the stock market. As markets for long-term put options are incomplete, outright hedging of the exposures is not feasible. Instead, insurers employ delta-hedging, *i.e.* short selling of equities and investing the proceeds in bonds. Insurers, in practice, hedge a large part of their guarantee exposure using this method. This, however, does not imply that there are no systemic risk implications of guarantees.

Guarantees and reach-for-yield

Guarantee-writing may lead to reach-for-yield, taking the form of insurers increasing their allocation to illiquid bonds. The reason is the following. First, profitable guarantee-writing increases the regulatory capital of insurers, allowing it to expand its investment in illiquid assets. Second, hedging frees further capital, which can be used to allocate even more funds to the illiquid asset space. Insurers find such a shift in investments attractive, as regulation is likely to require insufficient levels of capital on illiquid bonds in the presence of systemic risk. This is because regulatory frameworks cannot easily account of the fire-sale dynamics that correlated sellings of illiquid bonds by insurers would encounter.

The net effect

The net effect of guarantee writing, and associated hedging, is driven by two factors. Guarantee-writing by itself requires additional capital, hence reducing the room for investing in illiquid bonds. The profits from guarantees, and the regulatory relief provided by hedging, however, mean extra capital for insurers. We show that, when insurers decide to hedge a large part of their guarantee exposures, the net effect is likely to be positive, that is, insurers will increase their allocation towards illiquid

bonds. The intuition for this is that insurers will find it only optimal to write guarantees if they are sufficiently profitable (relative to their required capital) and that a large degree of hedging will neutralize the effect of guarantees on capital requirements. Theoretically, we show that if insurers hedge a sufficiently large fraction of their guarantee exposures, reach-for-yield always increases. As in particular the large and sophisticated insurers hedge a large fraction of their guarantee exposures in practice, we would thus expect the overall reach-for-yield effect in the insurance sector to be positive.

The evidence confirms reach for yield prediction

Calibrating our model using the regulatory filings data collected by the National Association of Insurance Commissioners (NAIC) confirms this insight from theory. We find that insurers that underwrite a substantial amount of VAs with guarantees (and delta-hedge their exposures) disproportionately tilt their portfolios towards higher yielding illiquid bonds.

Hedging of guarantees prompts fire sales of illiquid assets during the market downturn

The portfolio overweight on riskier bonds then becomes problematic during a market downturn. Once guarantees become in-the-money, regulatory reserves spike and insurers need to shore up their capital positions. While issuing equity is a possibility, it is precisely in these moments that such an avenue becomes impractical. This calls for an alternative action: selling of the illiquid bonds in a regulatory-induced fire sale. Importantly, as all insurers writing guarantees are exposed to the stock market shock at the same time, the need to sell illiquid bonds is also correlated among insurers. A consequence is contagion to other insurance companies and to a broader financial system holding similar assets (*e.g.* Acharya and Yorulmazer, 2007, 2008; Wagner, 2011; Greenwood *et al.,* 2015).

The systemic consequences are large and mainly attributable to "reach-for-yield"

Assessing the quantitative impact of various market shocks on insurers, we demonstrate that a negative shock to the equity market of 19% would result in insurers selling $240 billion of illiquid bonds, with the corresponding system-wide fire sale costs representing 6% of insurers' total equity capital. If the stock market shock occurs simultaneously with shocks to illiquid bonds and the value of guarantees, as was the case during the financial crisis, the fire-sale costs will be amplified due to a fire-sale externality. A 48% shock to the equity market combined with an 8% shock to illiquid bonds and a 100% shock to guarantees (arising for example because higher volatility increases the value of the put), would generate fire sale costs that erase up to 97% of insurers' capital. Interestingly, we find that a main culprit of *ex post* systemic risk is the *ex ante* reaching for yield behaviour (besides the direct impact of net VA guarantees). The overweight towards illiquid assets in the bond portfolio is thus a central component of the story.

Implications for policy

The relevance of our results extends beyond the insurance sector. While the exact transmission mechanism will depend on institutional details, our analysis helps to shed light on the incentives and consequences of other guarantees that are pervasive throughout the financial system. For example, defined benefit pension funds also provide various guarantees and share a degree of under-fundedness, both of which provide incentives for these funds to reach for yield.

Insurance regulation has traditionally put little emphasis on systemic risk, consistent with the idiosyncratic nature of insurance liabilities. Following the expansion of the life insurance industry into asset management, insurers are now more likely to contribute to systemic risk through correlated fire-sales of illiquid bonds. It implies that regulators need to put more prominence on developing appropriate liquidity monitoring tools and liquidity regulation. Our study explains the transmission mechanism and develops practical tools to quantify the fire sale risk.

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