INSURERS AS ASSET MANAGERS AND SYSTEMIC RISK

Andrew Ellul Anastasia Kartasheva Pab Jotikasthira
Christian Lundblad Wolf Wagner

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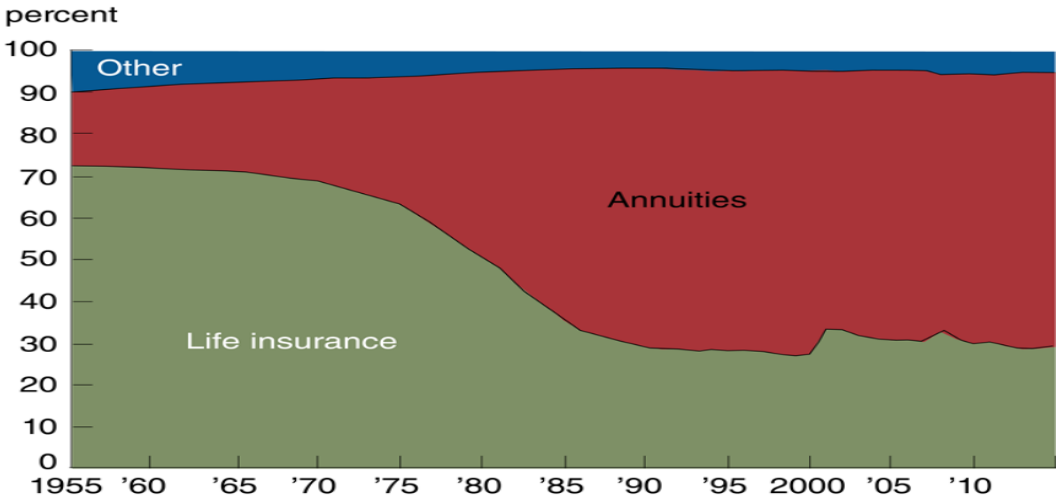
Research Motivation

- Systemic risk can arise from interconnectedness of institutions
  - Lots of evidence of the impact from interconnectedness on the liability/ funding side (mostly from banking literature)
  - Scarce evidence on impacts of interconnectedness arising from the asset side
    - Acharya and Yorulmazer (2007, 2008): "Too many to fail" guarantees leading to herding
    - Greenwood et al. (2015): Fire sales spreading contagion across banks holding same assets
- **This paper**: Proposes a new mechanism through which financial institutions' off-balance sheet commitments induce (a) reaching for yield, and (b) asset interconnectedness, leading to potential systemic risk
  - New mechanism: shared business model

Research Motivation II

- **Our laboratory**: **U.S. life insurers writing Variable Annuities (VAs)** = similar to asset managers

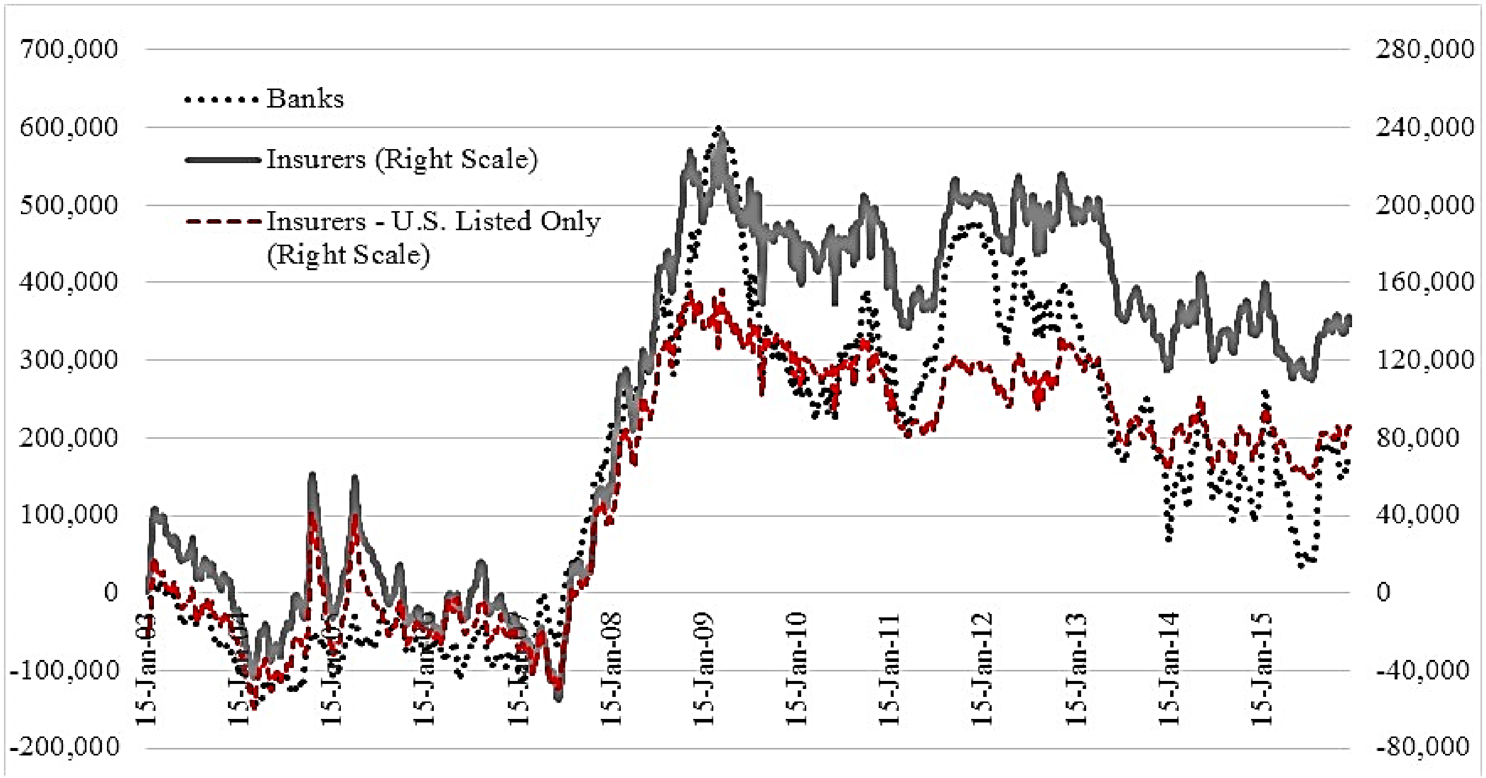


Sources: American Council of Life Insurers, *2015 Life Insurers Fact Book*, and authors' calculations.

- VAs embed **guarantees**, exposing insurers to **common, undiversifiable shocks**. Hedging the guarantees leads to **correlated asset portfolios**
- Guarantees are common for financial institutions, e.g. Defined Benefit pension plans, Banks' securitization arrangements

Insurers' Systemic Risk

Banks' systemic risk seems to have decreased for individual banks and the industry…but remains high for some insurers



Variable Annuities

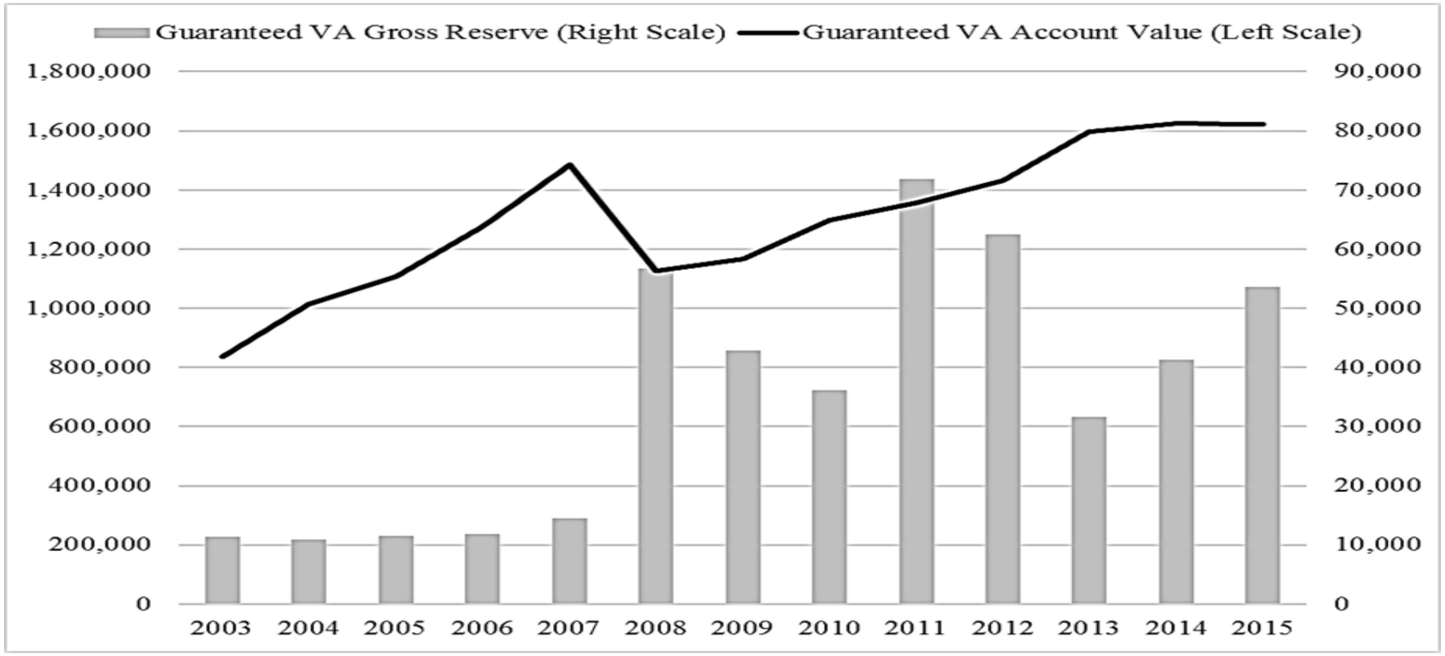
- A **Variable Annuity** is a long-term retirement saving contract between an insurer and a policyholder.
  - The fund is invested in stocks (> 70%), bonds, and money markets.

- An insurer allocates policyholder savings to a **separate account** and acts as a delegated asset manager of policyholder's funds.
  - Just like mutual funds, policyholder bears the market risk.

- **To reduce market risk** and compete with other savings alternatives, insurers offer **a host of guarantees**.
  - An assurance the policyholder's savings and annuity payments are protected from adverse market conditions, e.g. Guaranteed minimum income benefit.

Guarantees and Insurer's Capital

- **Guarantees** = **Put options.** Insurers are required to hold:
  - **Statutory reserve** to ensure promised payments.
  - Plus, additional **Risk-Based Capital (RBC)** to absorb extreme losses.
- Both reserves and RBC spike during stress periods.



Managing Reserve Fluctuations

- The two most important factors that influence reserves are **equity prices** and **interest rates**

- To mitigate the fluctuation of reserves associated with guarantees, insurers need to raise additional capital
  - Reserve additions are harmful to insurers: they increase the need for funding during market distress periods
  - Demand for capital is now synchronized among insurers offering guarantees, and capital can be costly during the market downturn

- As an alternative, insurers partially hedge their stock market exposure with derivatives and/or invest in riskier, less liquid assets
  - Delta hedging or options (the latter are not frequently used)

Our Thesis: Guarantee → Systemic Risk?

- Traditional life policies expose insurers to "diversifiable" risk, while VAs expose them to "systematic" risk.
  - The two most important factors that influence VA-related reserves are **stock prices (and volatilities)** and **interest rates.**

- To mitigate the risk and to avoid having to raise capital during market downturn, insurers **hedge their market exposures** using both comprehensive hedging (options) and **delta hedging programs**.

- However, hedging is costly. Insurers **only partially hedge** and engage in "**reaching for yield**" to offset the hedging costs and make up the increase in reserve.
  - Reaching for yield often involve **illiquid assets**, which may propagate shocks across the financial system through **fire sales**.

Framework of Analysis

- Step I: Model to analyze the mechanism through which VAs with guarantees
  - engender correlated investment decisions across life insurers during non-stress periods
  - propagate correlated liquidation during stress periods to meet the funding requirements on reserves

- Step II: Calibrate the model to U.S. life insurance data and obtain estimates of correlated investments in (a) liquid bonds, (b) illiquid bonds, and (c) equity, and price impacts due to liquidation during distress periods (fire sales and contagion)

Model: Key Elements

- Three dates
  - Date 0: insurer decides portfolio allocation using funds A
  - Date 1: with some probability, a shock occurs, forcing the insurer to liquidate part of its portfolio
  - Date 2: assets pay out their respective returns

- Insurer can use funds to invest in three assets: stocks, illiquid bond, and liquid bond

- Returns on stocks higher than those of illiquid bonds ($r^S > r^I$); returns on liquid bonds normalized to zero

Model: Key Elements

- Consider the portfolio optimization problem of an insurer who has written guarantees g>0
- Insurer can allocate funds between stocks (S), illiquid bond (I) and liquid bond (L)

- Insurer faces two constraints
  - Risk-sensitive capital requirements
    - Fair capital charges but do not take into account illiquidity risk
    - Must keep its RBC ratio of at least ρ.

  - Hedging constraint arising from the guarantee
    - Hedges a fraction h of its stock market exposure induced by the guarantee

Hedging Constraint

- Insurer hedges proportion h of the guarantee exposure by delta hedging
- The option delta of the guarantee (i.e, the sensitivity of value of guarantee to stock market) is $|\delta|$
- In order to hedge proportion h, insurer sells shorts $h \cdot |\delta| g$ units of the stock market and invests $h \cdot |\delta| g$ into bonds
- Hedging amounts to a constraint on bond holdings $\alpha_L + \alpha_I \geq h \cdot |\delta| g.$

Impact of VAs on Portfolio Choice

Main Result: Higher guarantees g increase the holdings of illiquid bonds α_I

Intuition

- A higher guarantee (higher delta-hedging) means that insurer shifts portfolio allocation from stocks to bonds (hedging constraint tightens)
- Relaxation of the regulatory constraint, allowing insurer to take more risk
- Higher risk has to be taken in the bond portfolio (because of the hedging constraint), leading to more investment in illiquid bonds

Link to Empirical Analysis

- The sensitivity of bond holdings to guarantees:

$$\frac{\partial \alpha_I^*}{\partial |\delta| g} = h \frac{\gamma_S}{\gamma_I}$$

where γ_S and γ_I are (regulatory) risk-weights

- Data on insurers' portfolio allocations and guarantee exposure (estimated from reserves), can estimate these sensitivities
  - Calculate the impact of guarantees on (joint) holdings of illiquid bonds

- Final step: analyse how this leads to fire-sales

Impact of VAs on Portfolio Choice

- A higher amount of guarantees, pushes insurers to engage in more delta hedge, leading to:
  - Lower stock market exposure (because of (imperfect) hedging)
  - Holding more bonds

- Insurers' regulatory risk will decline and thus have room to pursue returns, especially important when insurers have promised guaranteed returns
  - It cannot scale down its overall bond holdings; it has to take the risk within the bond portfolio
  - Invest more in higher yielding illiquid bonds

Insurer-level Data

- NAIC data obtained through SNL Financial
- 176 Life insurers (groups and stand-alone insurers) in 2004-2015
  - Insurers with positive VA guarantees reserves, 82 entities
  - Top 5% by asset size of insurers without VAs

- VA information: account values, gross reserves, reinsurance credits
- Balance Sheet information: portfolio year-end positions (corporate bonds, ABSs, mortgages etc.), and trading activities
- ABS-level data from S&P Rating Inquiry, corporate bond level-data from Mergent FISD
- NAIC Schedule DB for derivative positions

Overview of Empirical Analysis

- Portfolio allocation The higher the sensitivity of the reserves to the underlying asset values, the higher the incentive to invest in illiquid bonds with higher returns
  - We look at different types of illiquid bonds
    - Junk Bonds, Private label ABS classified as Class 1 (higher than BBB), Class 2 (BBB) and Class 3 (lower than BBB), Mortgage loans, Other bond-like assets (private equity etc.)

- Fire sales induced by herding Following a shock, insurers need to liquidate their assets to fulfil the capital requirement
  - Categorical shock, shock to illiquid bonds, shock to effective guarantee exposure

Preliminary Evidence - I

- Both groups of insurers that underwrite guaranteed VAs have significantly lower liquid bond allocations (about 8%) than insurers with no VAs
- The differences are driven by cash and agency ABS in NAIC class 1 but are partially offset by synthetic cash from selling stock futures

	[1] High			[2] Low			[3] No Guarantee			[1] - [2]	[1] - [3]
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Mean	Mean
Panel B: Asset Allocation											
Liquid bonds	0.653	0.115	0.634	0.657	0.135	0.655	0.737	0.138	0.753	-0.004	-0.084***
Cash	0.035	0.036	0.025	0.024	0.025	0.018	0.050	0.081	0.028	0.010***	-0.015**
Synthetic cash	0.032	0.048	0.003	0.006	0.027	0.000	0.000	0.000	0.000	0.025***	0.032***
Bonds in NAIC 1	0.297	0.127	0.274	0.282	0.204	0.279	0.350	0.261	0.378	0.015	-0.053*
Bonds in NAIC 2	0.208	0.064	0.212	0.228	0.111	0.207	0.205	0.139	0.193	-0.020	0.003
Agency ABS in NAIC 1	0.081	0.066	0.066	0.116	0.086	0.106	0.131	0.129	0.104	-0.035**	-0.050***
Agency ABS in NAIC 2	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Preliminary Evidence - II

- Insurers with high VA exposures have a significantly higher allocation to illiquid bonds than do both insurers with low or no VA exposures

	[1] High			[2] Low			[3] No Guarantee			[1] - [2]	[1] - [3]
	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Mean	Std. Dev.	Median	Mean	Mean
Illiquid bonds	0.326	0.113	0.347	0.288	0.120	0.289	0.195	0.126	0.178	0.038*	0.131***
Long-term assets	0.024	0.021	0.020	0.021	0.022	0.012	0.012	0.018	0.004	0.003	0.013***
Bonds in NAIC 3-6	0.034	0.018	0.032	0.032	0.020	0.032	0.028	0.032	0.019	0.002	0.006
Agency ABS in NAIC 3-6	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Private ABS in NAIC 1	0.108	0.060	0.106	0.104	0.083	0.096	0.078	0.090	0.045	0.004	0.031***
Private ABS in NAIC 2	0.011	0.011	0.009	0.008	0.012	0.004	0.007	0.012	0.002	0.002	0.004***
Private ABS in NAIC 3-6	0.008	0.008	0.006	0.005	0.006	0.003	0.004	0.008	0.001	0.003***	0.004***
Mortgages	0.087	0.062	0.097	0.077	0.059	0.087	0.041	0.065	0.005	0.010	0.046***
Loans	0.045	0.047	0.030	0.036	0.031	0.024	0.025	0.031	0.014	0.009	0.021**
Derivatives for income gen.	0.008	0.013	0.003	0.005	0.010	0.000	0.001	0.003	0.000	0.004*	0.008***
Common stock exposures	0.000	0.051	0.010	0.041	0.058	0.026	0.046	0.063	0.021	-0.040***	-0.045***

VAs and Portfolio Allocation

A one standard deviation increase in normalized delta is associated with:

(i) increase in illiquid bond allocation of 9%

(ii) decrease in liquid bond allocation of 5.6%

(iii) decrease of common stock allocation of 3.3%

Panel A: Equation by Equation OLS

	Asset Allocations			
	Liquid Bonds (1)	Illiquid Bonds (2)	Common Stocks (3)	Others (4)
Delta/Assets	-1.194***	1.857***	-0.667***	[illegible]
	(0.349)	(0.340)	(0.221)	[illegible]
RBC ratio	0.003***	-0.002***	-0.000	-0.000**
	(0.001)	(0.001)	(0.000)	(0.000)
Year fixed effects	YES	YES	YES	YES
Observations	1,071	1,071	1,071	1,071
R-squared	0.038	0.043	0.018	0.057

Implied delta hedge ratio

Hedging Coverage

- Insurers hedge overall about 75% of their guarantee exposure, of which 70% is delta hedging and 5% is options
- Given capital requirement of 0.30 for common stock, the estimated capital requirement for illiquid bonds is 11.3%

	Data			Estimation		
	Mean	Std. Dev.	Median	Mean	PCT5	PCT95
Comprehensive hedging - effective	0.000	0.000	0.000	-	-	-
Comprehensive hedging - others	0.052	0.121	0.000	-	-	-
Delta hedging	-	-	-	0.690	0.658	0.721
RBC requirement for illiquid bonds	0.060	0.020	0.058	0.113	0.049	0.177

Counterfactual Portfolios

- Portfolio allocation is driven by two factors
  - Hedging of guarantee exposure: tilt the allocation to bonds
  - Reaching for yield: tilt the bond allocation to illiquid (riskier) bonds

- **Hypothetical Portfolio 1**: Actual – Port 1 = "reaching for yield"
  - Keep total bond allocation the same as actual, but…
  - …"re-allocate between" liquid and illiquid bonds such that the ratio of their allocations is as if the insurer had no VAs

- **Hypothetical Portfolio 2**: Port 1 – Port 2 = "partially exposure to guarantees"
  - Set the normalized delta to zero (= no VA exposure and no hedging)

Fire-sales and Systemic Risk

- What is the impact of a shock on fire-sales and systemic risk?
  - Categorical asset shock A reduction in the value of all assets proportional to their risk-weights
  - Shock to illiquid bonds, but other assets and the value of the guarantee unchanged
  - Shock to the guarantee, e.g. increase in the stock market volatility
- A shock reduces capital by lowering asset values and increasing the guarantee liability
  - Insurers restore capital by deleveraging, by selling assets proportionally as in Greenwood et al 2015
  - Stocks and liquid bonds are sold at fair value; illiquid bonds are traded at a discount of $c_0 S$, where S are total sales of illiquid bonds

Stock Market Shock

- Stock market shocks 10-40% → insurers selling $114-458 billion of illiquid bonds → fire-sale costs = $2-39 billion = 1-21% of insurers' capital
- Without VAs, the sale amount =$50-201 billion → fire-sale costs = $0.5-7.5 billion

	Fire-Sale Amount ($ Million)				Decomposition of Fire-Sale Amount ($ Million)		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
10%	114,387	63,792	96,153	50,343	50,595	-32,361	45,810
20%	228,775	127,584	192,306	100,685	101,191	-64,722	91,620
30%	343,162	191,376	288,459	151,028	151,786	-97,083	137,431
40%	457,549	255,168	384,611	201,370	202,382	-129,444	183,241
	Fire-Sale Costs ($ Million)				**Decomposition of Fire-Sale Costs ($ Million)**		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
10%	2,434	757	1,720	471	1,677	-963	1,248
20%	9,735	3,028	6,879	1,886	6,707	-3,851	4,993
30%	21,903	6,812	15,477	4,243	15,091	-8,665	11,234
40%	38,939	12,111	27,514	7,542	26,829	-15,404	19,972

Shock to Illiquid Bonds

- Shocks to illiquid bonds of 2-8% (proportional to capital requirement, relative to stock market shocks of 10-40%) would result in actual insurers selling $107-$431 billion of illiquid bonds.
- The fire-sale costs are 1%-19% of insurers' total capital

	Fire-Sale Amount ($ Million)				Decomposition of Fire-Sale Amount ($ Million)		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
2%	107,805	59,493	52,898	52,898	48,312	6,595	0
4%	215,610	118,986	105,797	105,797	96,624	13,189	0
6%	323,415	178,479	158,695	158,695	144,936	19,784	0
8%	431,220	237,972	211,594	211,594	193,248	26,378	0
	Fire-Sale Costs ($ Million)				Decomposition of Fire-Sale Costs ($ Million)		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
2%	2,162	658	520	520	1,503	138	0
4%	8,647	2,633	2,082	2,082	6,013	551	0
6%	19,455	5,925	4,684	4,684	13,530	1,241	0
8%	34,587	10,533	8,328	8,328	24,054	2,206	0

Categorical Shock

- Categorical shocks to all assets would result in insurers selling $236-$943 billion of illiquid bonds, more than the sum of each shock due to externality
- The fire-sale costs potentially catastrophic [similar to the financial crisis]

	Fire-Sale Amount ($ Million)				Decomposition of Fire-Sale Amount ($ Million)		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
10%	235,653	130,617	155,472	109,662	105,035	-24,855	45,810
20%	471,306	261,235	310,945	219,324	210,071	-49,710	91,620
30%	706,959	391,852	466,417	328,987	315,106	-74,565	137,431
40%	942,612	522,470	621,890	438,649	420,142	-99,420	183,241

	Fire-Sale Costs ($ Million)				Decomposition of Fire-Sale Costs ($ Million)		
Magnitude of Shock	Actual Portfolio + VAs	Portfolio 1 + Actual VAs	Portfolio 2 + Actual VAs	Portfolio 2 + No VAs	Reaching for Yield	Hedging Guarantee Exposure	Gross Guarantee Exposure
10%	10,329	3,173	4,496	2,237	7,156	-1,323	2,259
20%	41,316	12,693	17,984	8,947	28,623	-5,290	9,037
30%	92,961	28,560	40,463	20,131	64,401	-11,903	20,332
40%	165,264	50,773	71,935	35,789	114,491	-21,162	36,146

Conclusions

- How systemic risk may arise from the inter-connectedness of the asset side of financial institutions' balance sheets?
- Propose an innovative mechanism: an incentive that arises from the financial institutions' business model
- Herding in illiquid assets emerges in equilibrium, increasing the likelihood of fire sales in the event of common shocks

- Our paper: the transformation of the life insurance industry has made these institutions less likely to behave as asset insulators
- More importantly, they are now more likely to contribute to systemic risk through correlated regulatory-induced fire-sales