Financial Economics of Insurance
Risks in the Insurance Sector[1]

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Traditional risks in the insurance sector

- Traditional risks:
  1. Interest rates.
  2. Aggregate longevity or mortality.
  3. Policyholder behavior (lapsation, surrender, and withdrawal).
- These risks are relatively easy to manage.
  1. Duration matching of assets and liabilities.
  2. Offset longevity risk (annuities) with mortality risk (life insurance).
  3. Fees to discourage early surrenders and withdrawals.
- Strong prior in the academic literature.
  - Insurance is stable and boring.
  - If there is any risk, credit or equity risk on the asset side from investment in corporate bonds and equities.
- Good description up to 1990s.

Risks in the modern insurance sector

- Sources of risk:
  1. Variable annuities (minimum return guarantees).
  2. Derivatives.
  3. Interest risk mismatch (in a low interest rate environment).
  4. Shadow insurance.
  5. Securities lending.
- Unlike traditional liabilities, variable annuities are exposed to systematic risk.
- Larger balance sheets were safer with traditional liabilities, but may be riskier when liabilities are exposed systematic risk.
- Derivatives, shadow insurance, and securities lending
  - Used for more efficient capital management.
  - But could increase leverage and risk exposure.

Life insurers during the global financial crisis

- AIG lost $21 billion from securities lending, compared with $34 billion from CDS (McDonald and Paulson 2015).
- Hartford bailed out by TARP because of variable annuity losses.
- Others involved in variable annuities or securities lending applied for TARP: Allstate, Genworth, and Prudential.

Why are variable annuities risky?

- Variable annuity = Mutual fund + Long-dated put option
- Completes a missing market for minimum return guarantees over long horizons.
- A private solution to the secular decline of defined benefit plans and Social Security.
- Difficult to hedge because traded options have short maturity.
- Dynamic hedging: Model uncertainty exposes insurers to basis risk.

Summary of the variable annuity market

	VA liabilities			
Year	Billion $	% of total liabilities	Number of insurers	Reserve valuation (%)
2005	1,071	35	45	0.9
2006	1,276	38	47	0.8
2007	1,435	41	46	0.8
2008	1,068	34	44	4.1
2009	1,195	35	43	3.4
2010	1,344	36	43	2.5
2011	1,358	35	42	4.9
2012	1,434	36	39	3.9
2013	1,606	37	40	1.8
2014	1,599	37	38	2.3
2015	1,499	35	38	2.9

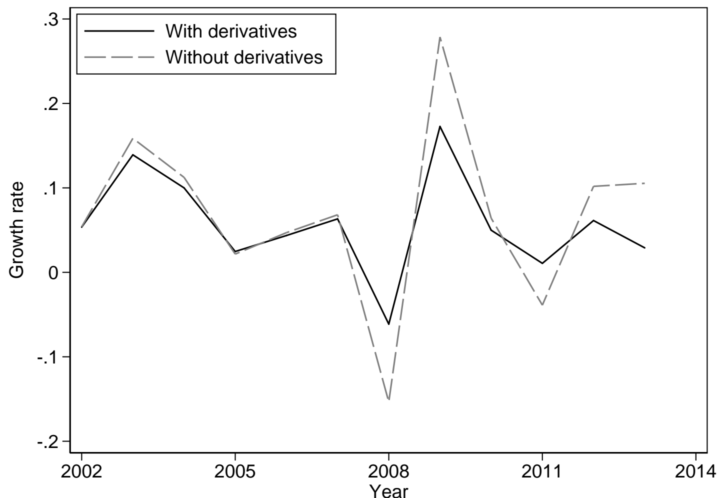
Top insurers by variable annuity liabilities

Insurer	VA liabilities in 2007 (billion $)	Change from 2007 to 2008: Reserve valuation (%)	Change from 2007 to 2008: Reserves (% of equity)
AXA	140	7.6	125
Metropolitan Life	129	2.9	6
Prudential	122	1.4	13
Voya	121	4.2	42
Hartford	120	2.9	13
AIG	99	0.8	2
Lincoln	97	1.3	15
John Hancock	95	1.8	27
Ameriprise	81	1.0	13
Aegon	63	7.3	29
Pacific Life	56	1.5	13
Nationwide	46	1.7	18
Jackson National	33	3.6	13
Delaware Life	24	3.7	44
Allianz	23	5.3	35
New York Life	19	2.2	2
Genworth	17	0.5	1
Northwestern	12	0.2	0
Ohio National Life	11	2.2	22
Fidelity Investments	10	1.0	8
Security Benefit	10	1.3	12
MassMutual	6	1.7	0
Thrivent Financial	3	0.4	0

Do derivatives hedge volatility?

- US life insurers held $1.1 trillion in notional amount of OTC derivatives in 2014 (Berends and King 2015).
- Analysis of Schedule DB shows that insurers do not fully hedge variable annuity risk (Drexler et al. 2017, Ellul et al. 2018, and Sen 2019).
- More generally, do derivatives hedge or amplify volatility?
  - Derivatives amplify volatility for banks (Begenau et al. 2015).

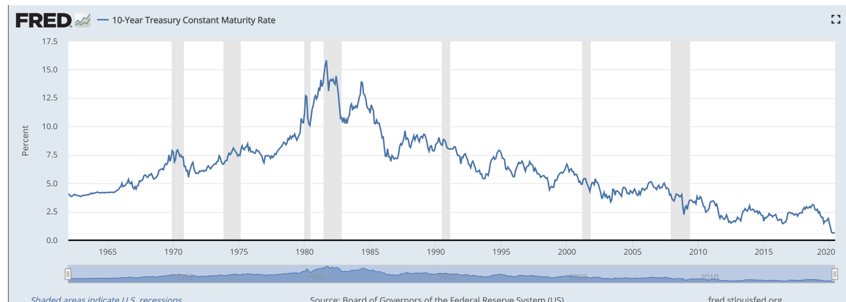
Impact of derivatives on the equity growth rate



Why do insurers not fully hedge variable annuity risk?

1. Insurers may not want to hedge.
   - Risk shifting under limited liability and guaranty funds.
   - Hedge positions differ depending on whether insurer targets economic, statutory, or GAAP capital.
   - Regulation may disincentivize hedging (Sen 2019).
2. Insurers cannot hedge perfectly because of model uncertainty.
3. Limited supply of long-dated puts.
   - Someone has to hold aggregate risk, and insurers may have comparative advantage over other institutions.

10-year Treasury yields



- Overall balance sheet has negative duration and convexity because of variable annuities. Thus, a low interest rate environment is challenging.

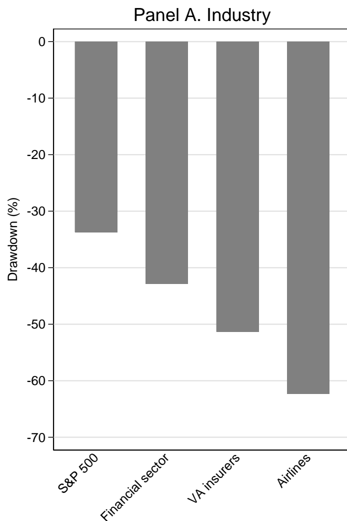
Risk exposure of variable annuity insurers

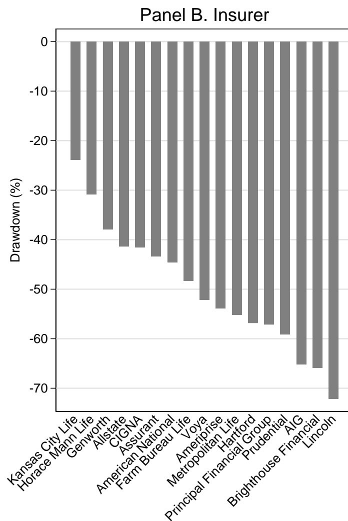
		By subsample		
Factor		1999–2007	2008–2009	2010–2017
Stock market return	1.36	0.56	2.56	1.11
	(0.19)	(0.15)	(0.22)	(0.08)
10-year bond return	−0.01	−0.38	1.14	−1.28
	(0.32)	(0.29)	(0.66)	(0.16)
Alpha (%)	−0.22	0.35	−1.14	0.41
	(0.46)	(0.47)	(1.70)	(0.29)
Observations	228	108	24	96

SRISK of US financial institutions

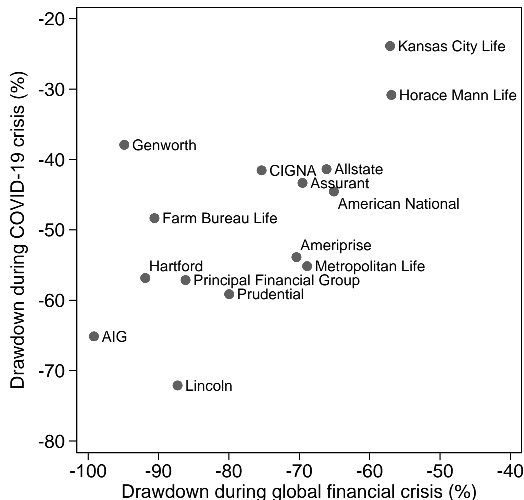
Institution	% of total SRISK	SRISK (million $)
Citigroup	19.0	61,197
Prudential Financial	11.2	36,178
Goldman Sachs Group	9.7	31,043
Morgan Stanley	9.6	30,889
Bank of America	7.5	24,096
MetLife	6.9	22,216
Wells Fargo	5.1	16,448
Lincoln National	4.0	12,913
Brighthouse Financial	3.1	9,799
AIG	2.7	8,537

Equity drawdowns during the COVID-19 crisis





Comparison of equity drawdowns across crises



Changing role of reinsurance

- Traditional reinsurance: Transfer risk to third-party reinsurers.
- Modern reinsurance: Transfer liabilities to off-balance-sheet entities.
- Due to changes in regulation.
  1. Higher capital requirements for life insurance after 2000.
     - Regulation XXX and AXXX.
     - Applies to operating companies under statutory accounting, but not necessarily to reinsurers under GAAP.
  2. New state laws allowed creation of captives and SPVs in South Carolina, Vermont, etc.
     - Less capital: GAAP accounting and no RBC regulation.
     - Confidentiality of financial statements.
     - More flexible financial structure: Funding through letters of credit and securitization.

Traditional versus modern insurance company

Traditional insurance company | **Modern insurance company**

Customer pays premium of $100. (Actuarial value of $90.)

⇓ $100

Traditional insurance company

Operating company in NY

A		L	
Premium	$100	Reserve	$110

Modern insurance company

Operating company in NY

A	L

⇓ $100

Captive in SC

A		L	
Premium	$90	Reserve	$90

⇓ $10

Holding company

What is shadow insurance?

- Shadow insurance: Affiliated reinsurance with an unauthorized and unrated reinsurer.
- Potential risks.
  1. Liquidity risk from mismatch between letters of credit and insurance liabilities.
  2. More investment risk?
  3. Less equity and higher leverage?
     - Lawsky (2013): Conditional LOC and naked parental guarantees.
     - Iowa released financial statements for 8 captives in 2014. Under statutory accounting, surplus would be −$2.663 billion (instead of $1.497 billion).

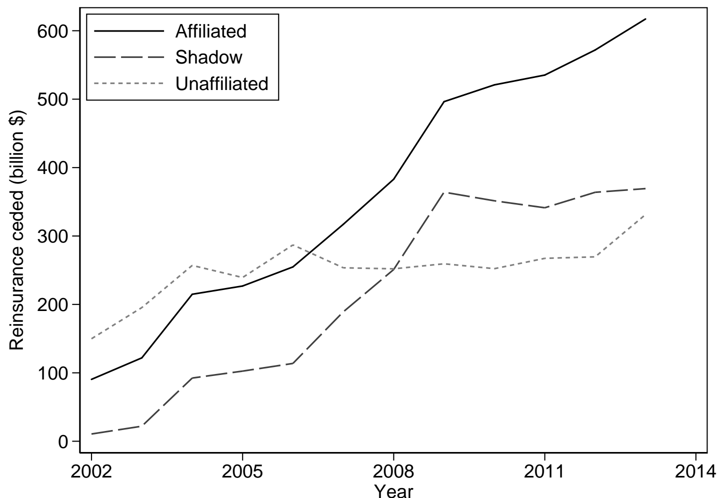
Affiliated reinsurance within the MetLife

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

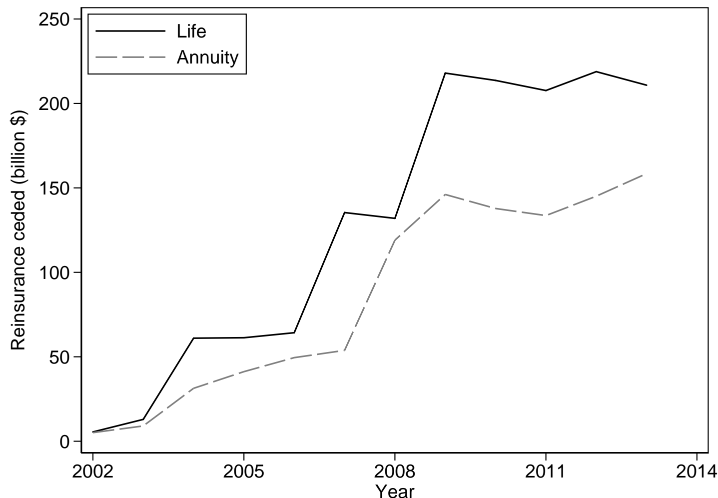
Top 10 insurers by shadow insurance

Insurer	Reinsurance ceded (billion $)
John Hancock	118
MetLife	45
Athene	40
Hartford	40
Aegon	26
Great-West Life	14
Voya Financial	13
AIG	12
Global Atlantic	11
Lincoln Financial	7

Reinsurance ceded by reinsurance type



Life versus annuity reinsurance ceded to shadow reinsurers



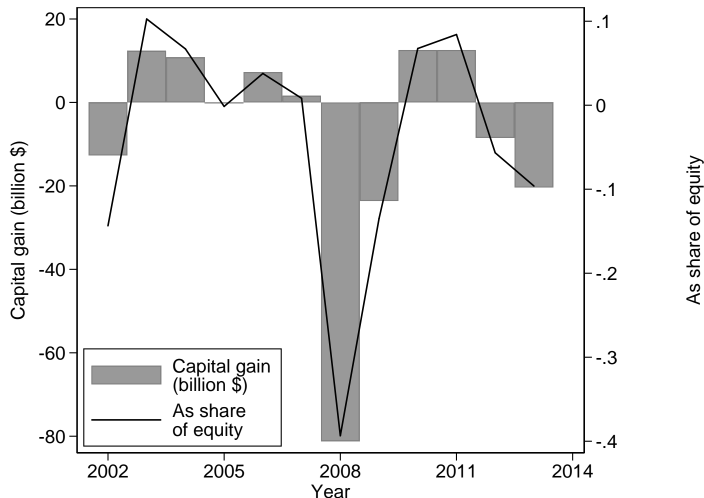
What is securities lending?

- Insurer lends bonds in exchange for cash collateral with an agreement to exchange back at some future date.
- Insurer could reinvest the cash collateral in riskier securities.
- Gap in regulation: Prior to 2010, insurers were not required to report how collateral was reinvested.
- Liquidity risk: Lending agreements have short maturity, so insurer may be forced to liquidate the risky investment if borrowers are unwilling to roll over the lending agreement.
- AIG had reinvested in MBS and ABS, losing at least $21 billion during the financial crisis.

Top insurers by securities lending agreements

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

Capital gain for insurers with securities lending agreements



Lessons

- Gaps in regulation lead to risk taking (e.g., shadow insurance and securities lending).
- Risk concentration: Aggregate activity for sector mostly due to top 10 insurers.
- Insurance underwriting works in conjunction with capital management. For example, sell variable annuities and move them off balance sheet through shadow insurance.
- Two sides of every activity: Efficiency versus risk.
  - Shadow insurance useful for avoiding (unnecessary) regulation and taxes.
  - But could also increase leverage and risk.

Potential transmission of risks

1. Corporate bond market.
   - Fire-sale dynamics (Ellul et al. 2011, Ellul et al. 2022).
   - Higher borrowing costs for firms.
2. Households.
   - Solvency concerns could lead to debt overhang and collapse in demand.
   - Increase in precautionary saving and welfare loss.
3. Banks.
   - Counterparties in securities lending and derivatives.
   - Funding through corporate bonds.
   - Shadow insurance funded by letters of credit.