

Financial Economics of Insurance Reinsurance¹

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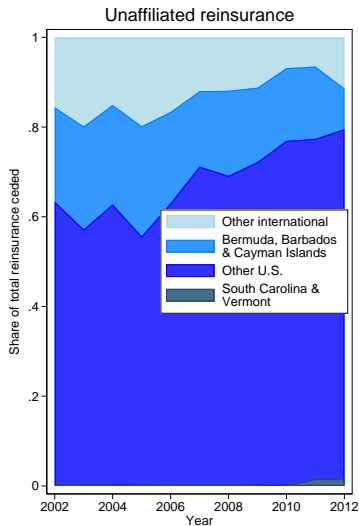
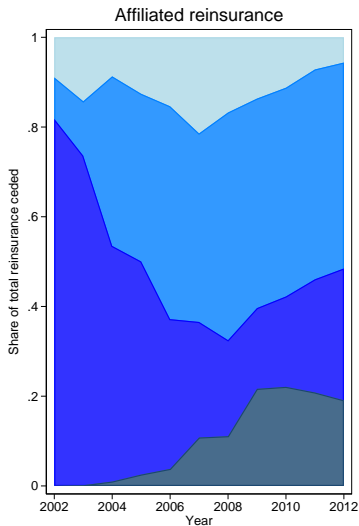
Shadow insurance

- ▶ Shadow insurance grew from 2002 to 2012.
 - ▶ \$11 billion \implies \$364 billion
(Compare with \$270 billion in unaffiliated reinsurance.)
 - ▶ \$0.02 \implies \$0.25 of every dollar insured
- ▶ Policy tradeoff. Shadow insurance
 - ▶ Increases risk and expected loss for the industry.
 - ▶ Lowers prices and increases size of the insurance industry.

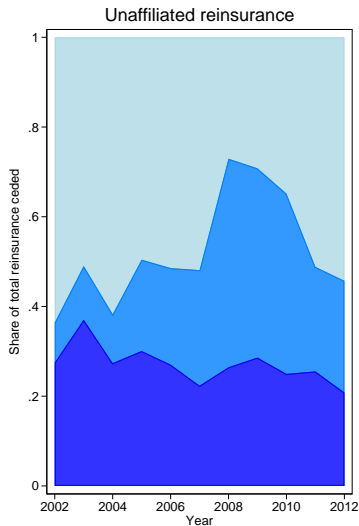
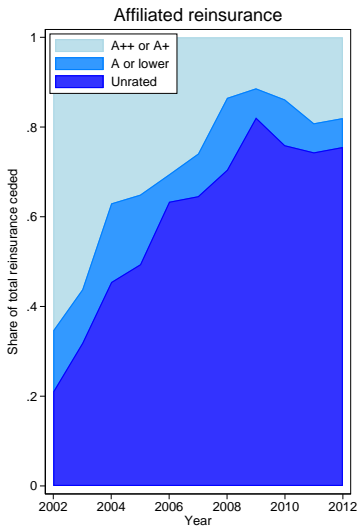
Data on life and annuity reinsurance

- ▶ NAIC financial statements from 2002 to 2012.
 - ▶ Schedule S reports all reinsurance agreements for authorized companies.
 - ▶ Not reported for unauthorized companies.
- ▶ **Shadow reinsurers** are
 1. Affiliated: Within same holding company.
 2. Unauthorized: Less regulated.
 3. Unrated by A.M. Best Company.
- ▶ Companies using shadow insurance:
 - ▶ Capture 48% of market share.
 - ▶ Mostly stock companies.
 - ▶ Larger, more leveraged, and more profitable.

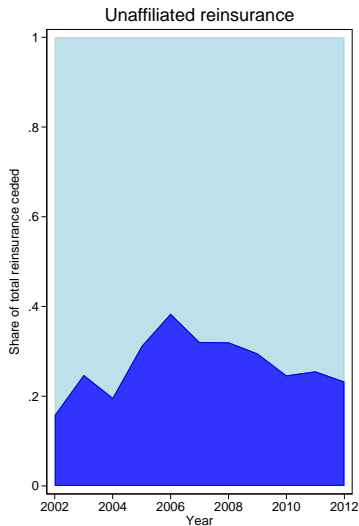
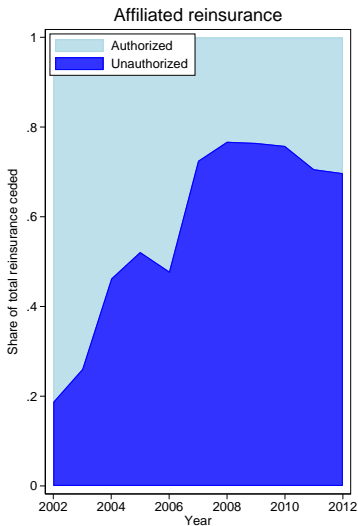
Reinsurance ceded by the reinsurer's domicile



Reinsurance ceded by rating of reinsurer



Reinsurance ceded to unauthorized reinsurers



Equity of Iowa captives

Captive	Iowa	Statutory
Cape Verity I	27	-432
Cape Verity II	140	-548
Cape Verity III	54	-169
MNL Reinsurance	118	118
Solberg Reinsurance	207	207
Symetra Reinsurance	20	-51
TLIC Riverwood Reinsurance	817	-1,113
TLIC Oakbrook Reinsurance	114	-675
Total	1,497	-2,663

Relation between ratings and shadow insurance

Variable	A.M. Best rating			Risk-based
	OLS		IV	capital
	(1)	(2)	(3)	(4)
Shadow insurance	0.03 (0.06)	0.00 (0.06)	0.25 (0.34)	-0.02 (0.05)
Log liabilities		0.17 (0.04)	0.13 (0.06)	0.15 (0.05)
Risk-based capital		0.13 (0.02)	0.15 (0.02)	
Leverage		-0.01 (0.03)	0.01 (0.03)	-0.46 (0.06)
Current liquidity		0.08 (0.02)	0.06 (0.02)	0.18 (0.04)
Return on equity		0.03 (0.02)	0.03 (0.02)	0.01 (0.02)
Stock company		0.05 (0.06)	0.02 (0.07)	0.12 (0.06)
R^2	0.60	0.62	0.63	0.33
Observations	6,641	6,641	6,351	6,641

- ▶ IV: Market share of term life insurance times dummy for stock company in 1999.

Balance sheets

Operating company		Shadow reinsurer	
Assets	Liabilities	Assets	Liabilities
A	L	\hat{A}	\hat{L}
	E		$\hat{E} = 0$

Assumptions:

1. Shadow reinsurers do not have equity, based on the evidence from Iowa captives.
2. Ratings do not incorporate shadow insurance, based on the rating regression.

Risk measures adjusted for shadow insurance

- ▶ Risk-based capital:

$$\text{RBC} = \frac{E}{\phi L} \implies \frac{E + \hat{E}}{\phi(L + \hat{L})} = \frac{\text{RBC} \times L}{L + \hat{L}}$$

- ▶ Use A.M. Best guideline to adjust rating and default probabilities.
- ▶ Leverage:

$$\frac{L}{A} \implies \frac{L + \hat{L}}{A + \hat{A}} = \frac{L + \hat{L}}{A + \hat{L}}$$

Risk measures adjusted for shadow insurance

- ▶ Adjusted risk measures in 2012.

Measure	Reported	Adjusted
Risk-based capital (%)	208	155
Rating	A	B+
10-year default probability (%)	0.9	3.0
Expected loss (billion \$)	4.9	14.4

- ▶ Expected loss of \$14.4 billion is 26% of capacity of state guaranty funds.

$$\sum_{m=1}^{15} \frac{\Pr(m|\text{Rating})\theta L}{(1 + y(m))^m}$$

Policy analysis

- ▶ Proposed policy reform.
 1. New York called for moratorium on shadow insurance in 2013.
 2. Designate some life insurers as “systemically important” and subject them to Fed supervision.

- ▶ How would policy reform affect pricing and size of the industry?
 1. Estimate a structural model of supply and demand.
 2. Counterfactual exercise: Shut down shadow insurance to estimate the impact on pricing and size of the industry.

Modeling supply in the life insurance industry

- ▶ Holding company consists of
 1. Operating company that sells policies.
 2. Affiliated reinsurer (captive or SPV).
- ▶ Choice variables
 1. P_t : Insurance price, facing demand $Q_t(P)$.
 2. B_t : Reinsurance ceded to the affiliated reinsurer.
- ▶ Actuarial value of V_t .
- ▶ Profit is

$$D_t = (P_t - V_t)Q_t$$

Maximization problem

- ▶ Holding company maximizes

$$J_t = D_t - C_t$$

- ▶ Regulatory and financial frictions ($\phi > \hat{\phi}$):

$$C_t = C(K_t, \hat{K}_t)$$

- ▶ Operating company: $K_t = A_t - (1 + \phi)L_t$
- ▶ Affiliated reinsurer: $\hat{K}_t = \hat{A}_t - (1 + \hat{\phi})\hat{L}_t$
- ▶ Marginal cost of capital:

$$c_t = - \frac{\partial C_t}{\partial K_t}$$

$$\hat{c}_t = - \frac{\partial C_t}{\partial \hat{K}_t}$$

Optimal insurance pricing and reinsurance

1. Insurance price:

$$P_t = \left(1 - \frac{1}{\epsilon_t}\right)^{-1} \underbrace{\frac{(1 + (1 + \phi)c_t)V_t}{1 + c_t}}_{MC}$$

- ▶ $\partial MC / \partial B < 0$: Affiliated reinsurance lowers marginal cost.

2. Affiliated reinsurance:

$$\underbrace{\phi c_t}_{\text{operating company}} = \underbrace{\widehat{\phi} \widehat{c}_t}_{\text{affiliated reinsurer}}$$

Modeling demand for life insurance

- ▶ Random coefficients logit model of demand:

$$Q_{n,t} = \int \frac{\exp(\alpha P_{n,t} + \beta' \mathbf{x}_{n,t} + \xi_{n,t})}{1 + \sum_{m=1}^N \exp(\alpha P_{m,t} + \beta' \mathbf{x}_{m,t} + \xi_{m,t})} dF(\alpha, \beta)$$

- ▶ Market shares of life insurance at the company level.
- ▶ Representative price: 10-year term life insurance premiums from COMPULIFE.
- ▶ Outside asset: Savings deposits, money market funds, and mutual funds.

Empirical specification for marginal cost

- ▶ Supply:

$$P_{n,t} = \left(1 - \frac{1}{\epsilon_{n,t}}\right)^{-1} MC_{n,t}$$

$$MC_{n,t} = \exp(\delta SI_{n,t} + \mathbf{\Gamma}'\mathbf{x}_{n,t} + \gamma'\mathbf{1}_t + \nu_{n,t})$$

- ▶ Identifying assumption: Shadow insurance enters supply, but not demand directly.

Estimated model of the life insurance market

Variable	Demand		Marginal cost
	Mean	Standard deviation	
Price	-1.33 (0.50)		
Shadow insurance			-0.13 (0.03)
Log liabilities	2.71 (0.05)	0.24 (0.11)	0.02 (0.01)
A.M. Best rating	0.13 (0.08)	0.12 (0.58)	-0.07 (0.03)
Risk-based capital	-0.07 (0.07)		0.01 (0.02)
Leverage	0.11 (0.09)	0.33 (0.15)	-0.04 (0.02)
Current liquidity	0.09 (0.06)		0.00 (0.01)
Return on equity	-0.21 (0.03)		0.04 (0.02)
Stock company	0.07 (0.10)		0.01 (0.03)
Observations	1,711		

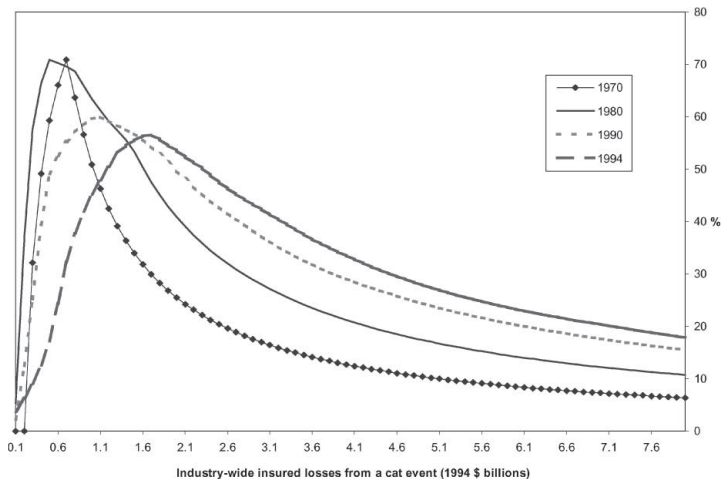
Impact of eliminating shadow insurance

- ▶ Counterfactual exercise: Shut down shadow insurance and solve for new equilibrium.
- ▶ For companies using shadow insurance:
 - ▶ Marginal cost rises by 27%.
 - ▶ Raise prices by 21%.
- ▶ Change in annual life insurance underwritten:
 - ▶ $-\$15.8$ billion for companies using shadow insurance.
 - ▶ $+\$0.9$ billion for the other companies.
 - ▶ $-\$14.9$ billion (-16%) for the industry.

Property-casualty reinsurers

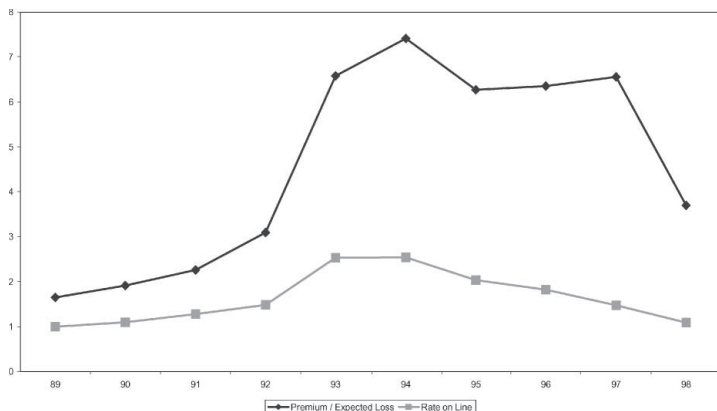
- ▶ For life insurance, risks are highly predictable and small, so the primary purpose of reinsurance is capital and tax management.
- ▶ For catastrophe insurance, risks are unpredictable and large, so reinsurance across insurers and lines of business have potential benefits.
- ▶ LLN implies increasing returns: Want a large reinsurer to aggregate all risks (but need some competition to offset market power).
- ▶ Reinsurers have limited risk bearing capacity due to value-at-risk constraints.
- ▶ Underwriting cycles (Gron 1994, Froot and O'Connell 1999).
 - ▶ A large loss wipes out internal capital, and external capital does not flow in immediately.

Percentage of exposure reinsured



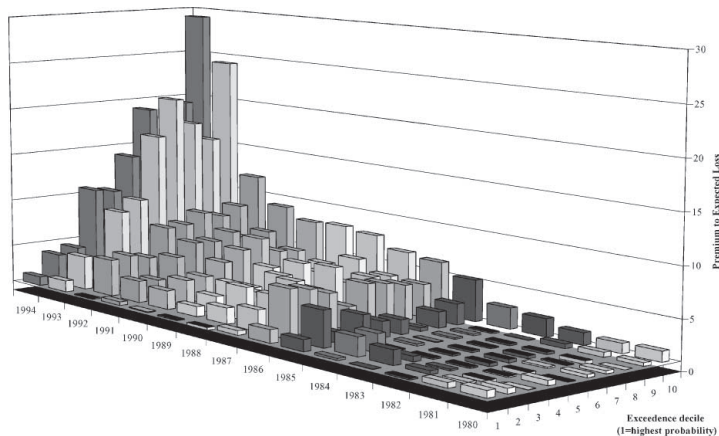
Source: Froot (2001, Figure 2)

Premium relative to expected loss and coverage limit



Source: Froot (2001, Figure 3)

Premium relative to expected loss by exceedence probability and year



Source: Froot (2001, Figure 4)

Summary of the facts

- ▶ Economic theory predicts that largest losses should be insured first. Yet low coverage of largest losses, consistent with value-at-risk constraints.
 - ▶ Also markups are highest on the largest losses.
- ▶ Large increases in premiums after shocks (Hurricane Hugo in 1989 and Hurricane Andrew in 1992).
- ▶ Identification problem: Demand for reinsurance could go up in response to a shock.
- ▶ Froot and O'Connell (1999) examine unrelated risks.
 - ▶ Prices of other types of catastrophe insurance (earthquakes in CA or windstorms in TX) respond to hurricane losses in FL.
 - ▶ Can only work through capital constraint of reinsurer that insures all types of catastrophe risks.

Conclusion

- ▶ The canonical model of insurance explains both shadow insurance of life insurers and property-casualty reinsurance.
- ▶ Life insurers use shadow insurance to relax capital constraints in response to
 - ▶ Higher capital requirements for life insurance in 2000.
 - ▶ Sharp increase in variable annuity liabilities in 2008.
- ▶ Catastrophe reinsurers become constrained after shocks.
 - ▶ Higher prices and lower quantities.
 - ▶ Largest risks remain uninsured.
- ▶ Applies to other market with tail risk such as long-term care, climate, and cyber risks.