From Long to Short:

How Interest Rates Shape Life Insurance Markets

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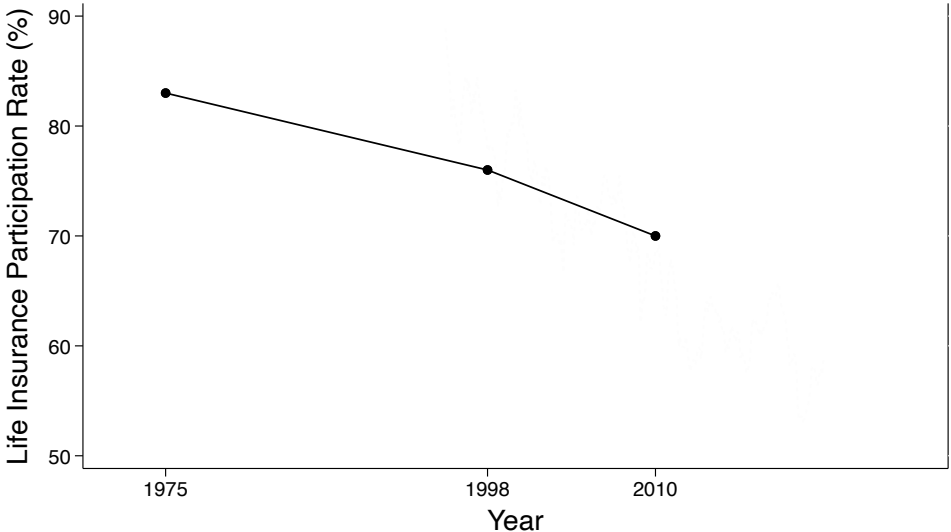
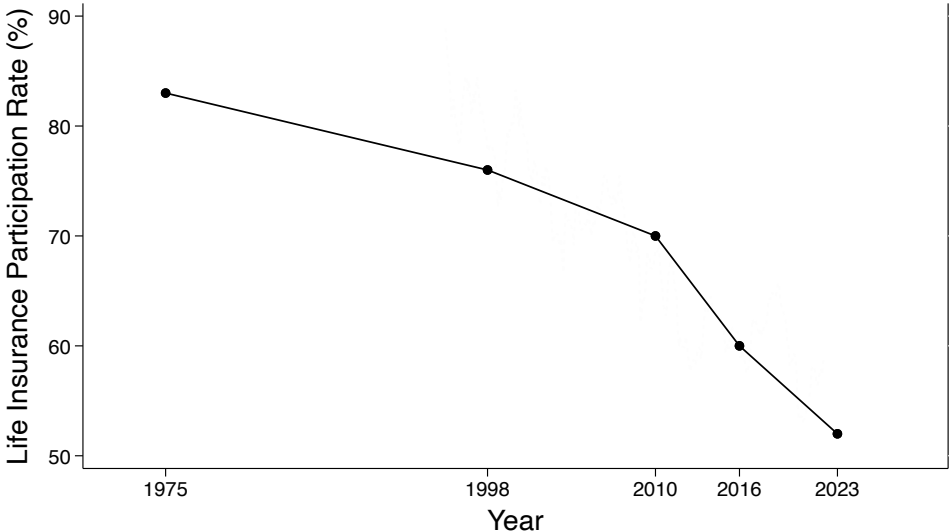


* Source: Guardian Life Insurance report, based on data from LIMRA



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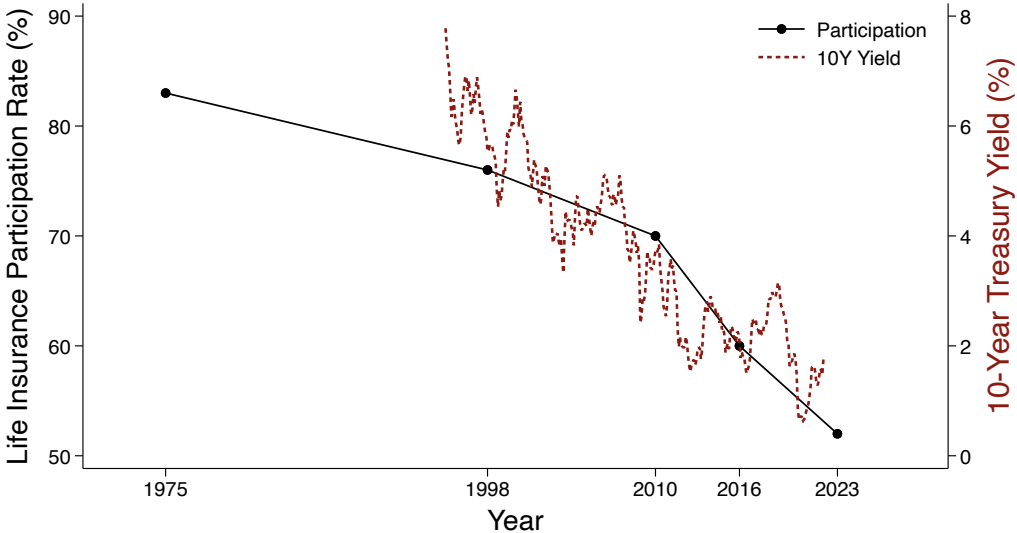

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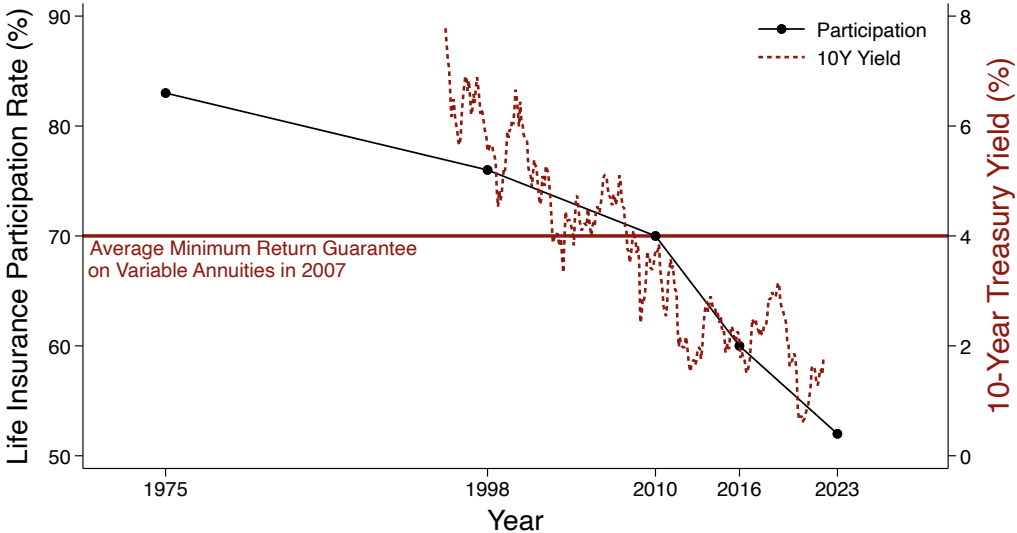

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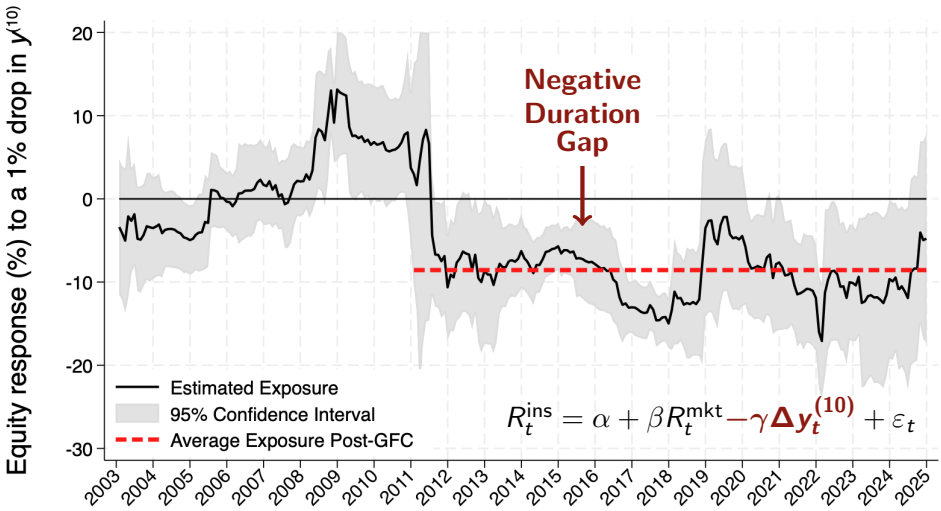
In-the-Money Guarantees → Elevated Interest Rate Risk Exposure



How can life insurers address duration mismatch?

- **Interest rate swaps**
  - Idea: swap duration with other institutions that would like to sell it
  - Limits: regulatory + accounting disincentives (Sen, 2023)

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- **This paper: liability rebalancing**
  - Idea: **shorten liability duration** to match asset duration

Today: A Theoretical Framework + Empirical Facts

- Build a simple model of insurance product markets
  - Key ingredient: life insurer risk aversion $\rightarrow$ **duration matching motive**
  - Interest rate risk exposure $\uparrow \rightarrow$ product market distortions $\uparrow$
- Take the model to the data using statutory filings + monthly pricing data
  - Contrast **VA issuers (exposed)** with **non-VA issuers (non-exposed)**
  - Focus on post-GFC period when duration mismatch is highest
- Document several novel findings consistent with our theory
  - **Prices and quantities** shift to favor short-term products $\rightarrow$ *liability rebalancing*
  - Aggregate issuance + in force life insurance shrinks relative to GDP

Literature

- **Insurers face interest rate risk, imperfectly hedge using assets and derivatives.**
  Berends et al., 2013 – Hartley et al., 2016 – Ozdagli & Wang, 2019 – Koijen & Yogo, 2021, 2022 – Huber, 2022 – Ellul et. al, 2022 – Sen, 2023 – Barbu & Sen, 2024 – Kirti & Singh, 2024 – Li, 2024
  This paper: Insurers also rebalance their liabilities to hedge their duration mismatch.

- **Insurers' financial health affects their product characteristics.**
  Gron, 1994 – Froot, 2001 – Zanjani, 2002 – Koijen & Yogo, 2015 – Ge, 2022 – Ellul et al., 2022 – Knox & Sorensen, 2024 – Verani & Yu, 2024 – Barbu et al., 2024
  This paper: Insurers distort prices on the maturity margin when exposed to interest rate risk.

- **(The decline in) life insurance participation is largely demand driven.**
  Koijen et al., 2016 – Hartley et al., 2017 – Rampini & Vishwanathan, 2022
  This paper: Insurers offer less accessible coverage as a byproduct of interest rate risk, reducing participation.

Theory

Broad Layout of the Model

- Set of insurers (j) that sell products ($i \in \{s, \ell\}$) over time ($t \in \mathbb{N}$)
  - Note: paper generalizes to any number of insurers and products

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- **Insurers' Legacy Balance Sheets:** $K_{jt} = A_{jt} - L_{jt}$
  - Asset returns: $R^A_{jt} = \overline{R}^A_{jt} - \boldsymbol{D^A_{jt} \Delta R_t}$
  - Liability returns: $R^L_{jt} = \overline{R}^L_{jt} - \boldsymbol{D^L_{jt} \Delta R_t}$

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- Add to their capital by issuing new policies — premiums $P_{ijt}Q_{ijt}$, reserves $V_{ijt}Q_{ijt}$
  - Premium revenues invested at return R^A_{jt}
  - Reserves grow according to $R_{it} = \overline{R}_{it} - \boldsymbol{D_{it} \Delta R_t}$
  - Note: paper also adds extensive margin using commissions/agent-based distribution

Insurers' Objectives: Profits + Risk Management

$$\max_{\{P_{ijt}\}} \underbrace{\sum_i (P_{ijt} - V_{ijt}) Q_{ijt}(P_{ijt})}_{\text{new capital from issuance}} + \underbrace{\mathbb{E}_t\left[\Lambda_{jt}\left(R_{jt}^K - \mathbb{E}_t\left[R_{jt}^K\right]\right)\right]}_{\text{expected value of risk management}}$$

- Risk management function $\Lambda(\cdot)$ increasing and concave (think mean-variance pref's)

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- Risk management function $\Lambda(\cdot)$ increasing and concave (think mean-variance pref's)
- Work with first-order approximation around legacy returns, $R^K_{jt} = \widetilde{R}^K_{jt}$:

$$\Lambda_{jt}(\cdot) \approx \lambda_{jt}(\cdot)\underbrace{\left[\sum_i (D^A_{jt} P_{ijt} - D_{it} V_{it}) Q_{ijt}\right]}_{\text{contribution of new product issuance to firm's interest rate risk}} \Delta R_t + \text{constant}$$

Risk Management Motives Affects Optimal Price Setting

- Optimal markup over reserve value can be (approximately) written

$$\log \frac{P_{ijt}}{V_{it}} \approx \underbrace{\log \mu_{it}}_{\substack{\text{product-specific} \\ \text{markup}}} + \underbrace{\bar{\lambda}'_{jt}\sigma^2_{t+1}\overbrace{D^K_{jt}}^{\text{duration gap, } \leq 0} \times (D_{it} - D^A_{jt})}_{\substack{\text{risk management} \\ \text{markup/discount}} \equiv \mathcal{M}_{ijt}}$$

Intuition:

If $D^K_{jt} = 0$, no need for risk management

If $D^K_{jt} < 0$, mark up long duration policies, discount short duration policies

Liability Rebalancing: $D^K_{jt} \downarrow$ implies $Q_{sjt} \uparrow$ and $Q_{\ell jt} \downarrow$

Broad Changes in Net Duration Can Expand or Contract Product Markets

- With logit demand, (new customer) participation rate for product i is

$$\mathcal{P}_{it} = \frac{\sum_j \alpha_{jt} \mu_{jt}^{1-\varepsilon_{it}} \mathcal{M}_{ijt}^{1-\varepsilon_{it}}}{\alpha_{it}^0 + \sum_j \alpha_{jt} \mu_{jt}^{1-\varepsilon_{it}} \mathcal{M}_{ijt}^{1-\varepsilon_{it}}}$$

Implication:

If $D_{jt}^K \downarrow$ (weakly) for all insurers, participation rate $\mathcal{P}_{st}^0 \uparrow$ and $\mathcal{P}_{\ell t}^0 \downarrow$

(*Total* participation depends on relative market sizes, distribution costs, etc.)

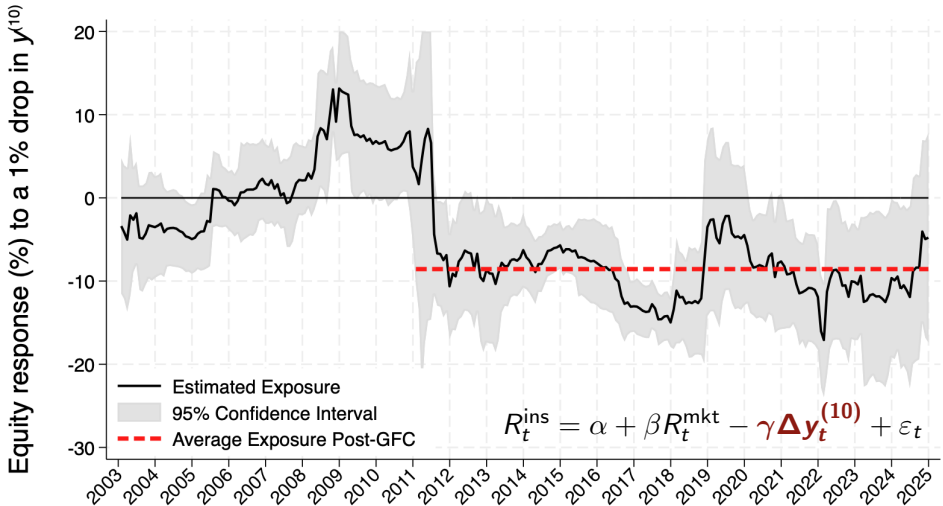
Data and Empirical Facts

Data Sources

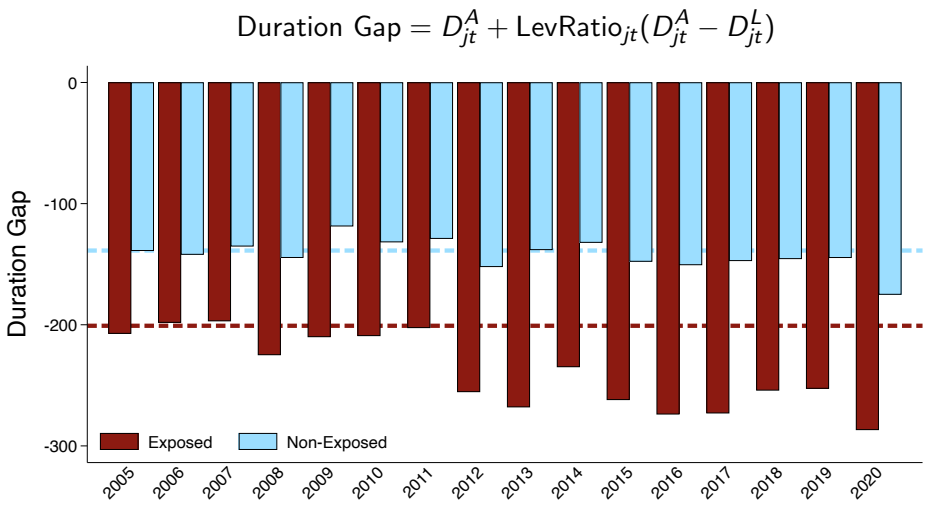
- **Statutory Filings** — regulatory reports filed annually
  - Products: insurance/policies issued and in force, gross reserves, commissions
  - Balance Sheet: assets, liabilities, leverage
  - Asset/Liability duration: bond-level holdings + Huber (2022) liability duration estimates
- **Compulife** — agent software with life insurance quotes
  - 10, 15, 20, and 30 year term life prices
  - $\sim$ 39 insurers per month
- **CRSP** — insurer + market monthly stock returns
- **Exposed Insurers:** top 10% of (relative) variable annuity liabilities pre-GFC
  - Relatively large (assets \$95B vs. \$8.3B) and levered (19.62 vs. 6.56)
  - Similar market shares across products (43% vs. 54%)

▸ Summary Statistics

Life Insurers Had Negative Net Duration After the GFC



Duration Gaps were Exacerbated Only for Exposed Insurers



How Does Duration Mismatch Affect Product Pricing?

- Our theory admits the following (approximate) expression

$$\mathbb{E}_{\text{Ex}}\left[\log \frac{P_{\ell jt}/V_{\ell t}}{P_{sjt}/V_{st}}\right] - \mathbb{E}_{\text{NonEx}}\left[\log \frac{P_{\ell jt}/V_{\ell t}}{P_{sjt}/V_{st}}\right]$$

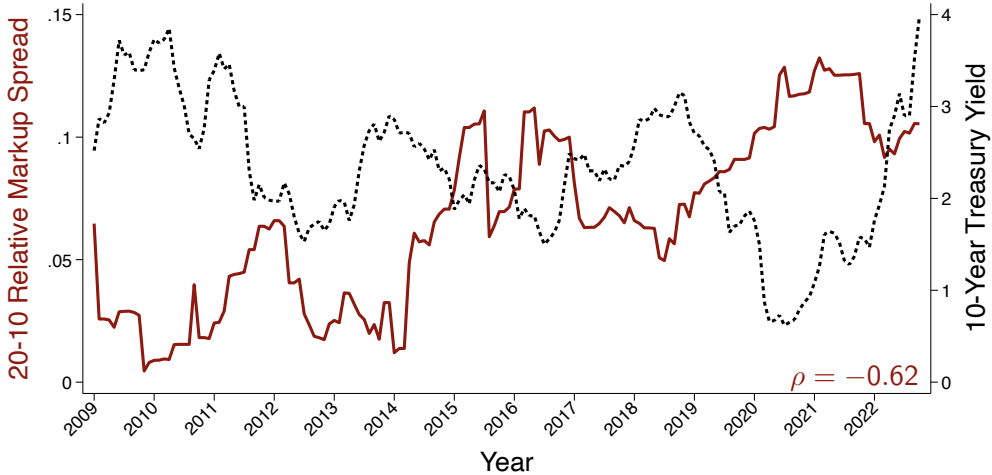
$$\approx \sigma^2_{t+1} \times \underbrace{\left(\mathbb{E}_{\text{Ex}}\left[\bar{\lambda}'_{jt} D^K_{jt}\right] - \mathbb{E}_{\text{NonEx}}\left[\bar{\lambda}'_{jt} D^K_{jt}\right]\right)}_{\geq 0,\ \text{increases when interest rates fall}} \times \underbrace{(D_{\ell t} - D_{st})}_{>0}$$

- **Idea:** Exposed insurer duration gaps ↑ relative to non-exposed when yields ↓

  → **Relative maturity spreads** should widen when yields ↓

  (**Note**: Double differencing nets out firm-specific components, e.g. RBC treatments)

Relative Maturity Spreads Negatively Correlate with Long Rates



▸ Adjust for Volatility

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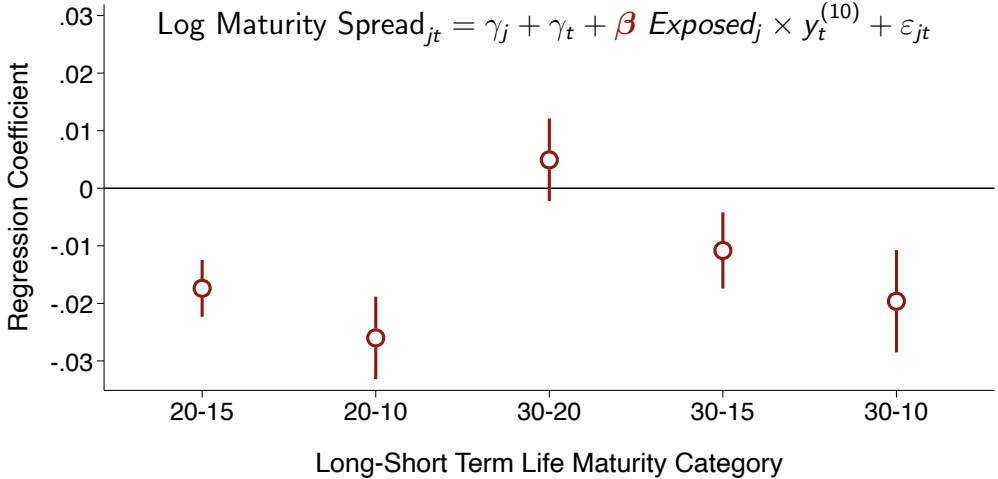

▸ Regression Table

How Do Pricing Distortions Affect Quantities?

- **Ordinary Life:** long term (term or whole life), accessible through agents
  - Interest sensitive due to whole life guarantees, surrender/lapsation risk

- **Group Life:** yearly renewable, accessible through employers
  - No dynamic component $\rightarrow$ little to no duration

▸ Reserve Values

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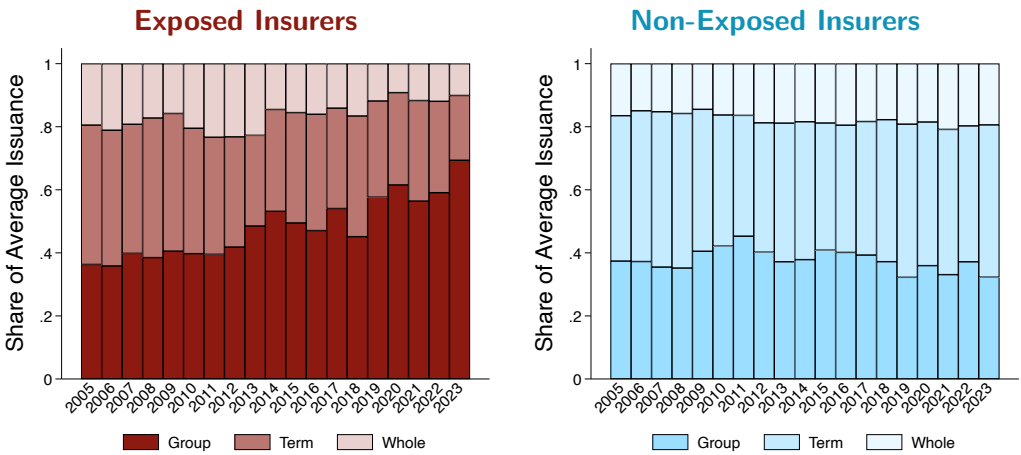
Theory: Exposed insurer duration gaps $\uparrow \rightarrow Q_{jt}^{\text{group}} \uparrow$ while $Q_{jt}^{\text{ordinary}} \downarrow$

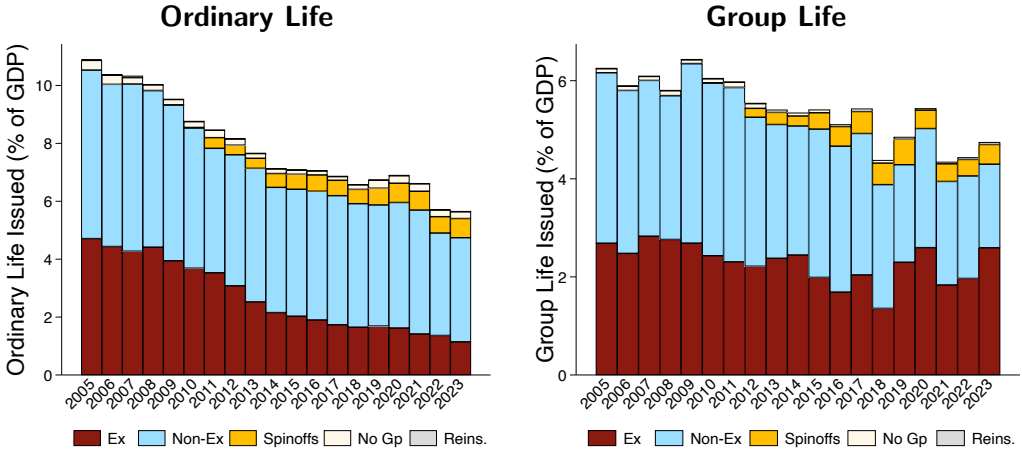
▸ Reserve Values

Exposed Insurers Transition to Short Term Group Policies



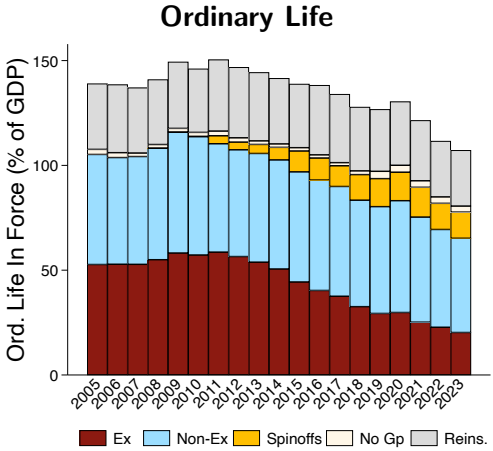
▸ Levels

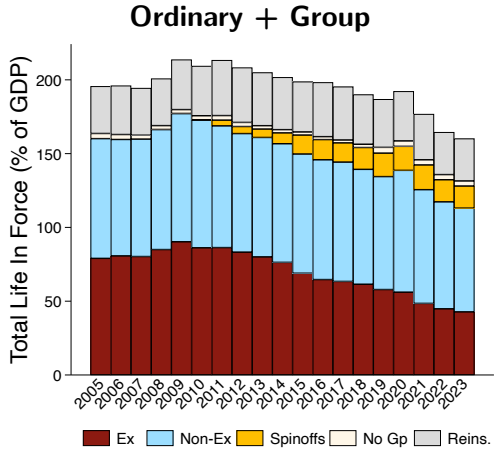
Exposed Insurers were Responsible for the Aggregate Decline in Issuance



- Nominal
- # of Policies

As a Result, The Life Insurance Market Has Shrunk Relative to GDP





▸ Group Only

Conclusion

Interest Rate Risk Matters for Product Markets

- **Today** — Large swings in product issuance and distortions due to IRR
  - Large consequences for products with different maturities!

- **Coming Up**
  - Continue tightening evidence, ruling out other potential stories (e.g. RBC concerns)
  - Structural estimation + counterfactuals
    1. Decomposition of market size into demand + supply characteristics
    2. How would market look today if duration gaps never opened up?

Appendix

Summary Statistics for Statutory Filings Data

	Exposed Insurers		Non-Exposed Insurers	
	2005-2008	2009-2023	2005-2008	2009-2023
Number of Groups	26	25	239	198
Assets	94.68	100.30	8.31	14.57
Surplus	5.09	5.39	0.67	1.25
Leverage Ratio	19.62	19.17	6.56	8.97
VA Liability Share	0.57	0.50	0.01	0.01
IS Reserve Share	0.67	0.65	0.24	0.25
Issuance Market Share				
Ordinary	0.43	0.29	0.54	0.61
Group	0.45	0.42	0.54	0.51
In Force Market Share				
Ordinary	0.38	0.29	0.37	0.39
Group	0.48	0.44	0.49	0.47

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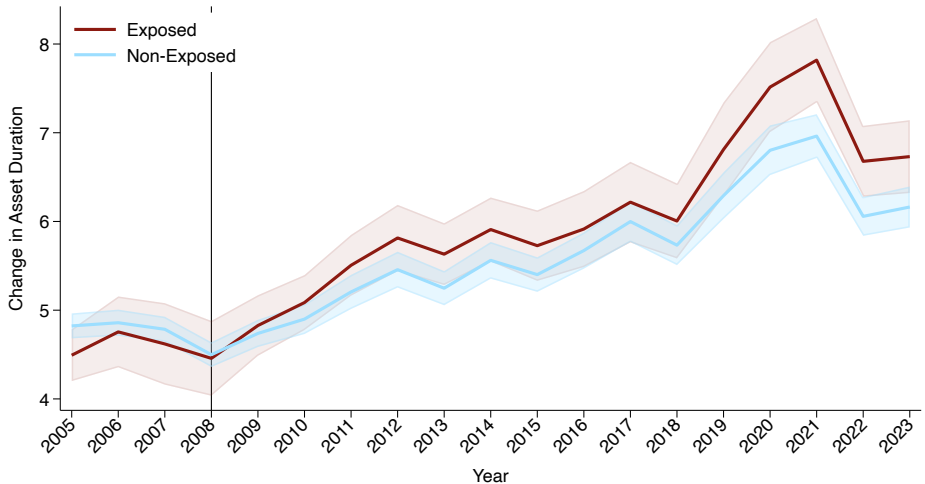
Exposed Insurers Reach for Duration More After the GFC



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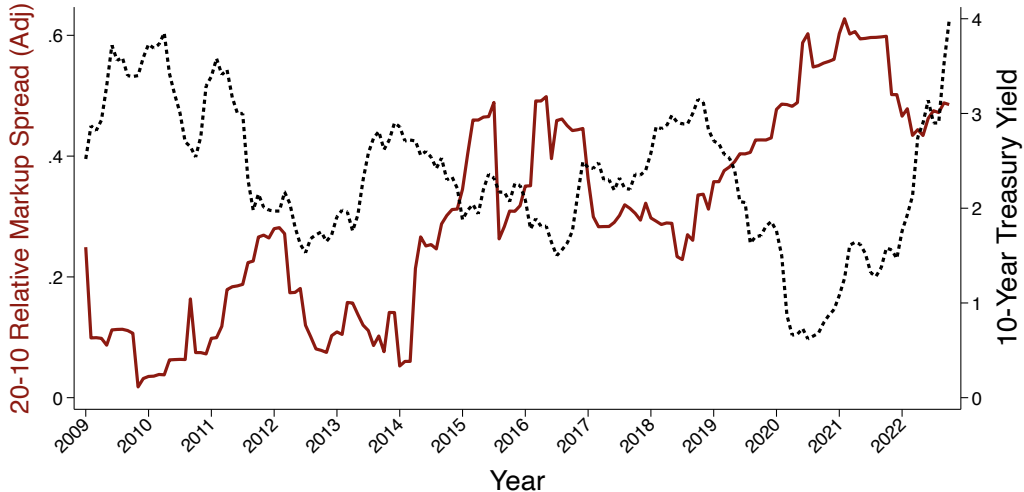
Relative Markups Negatively Correlate with Long Rates (Adjusted)



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Relative Maturity Spreads Negatively Correlate with Long Rates

$$\text{Markup Spread}_{jt} = \gamma_j + \gamma_t + \beta \; \textit{Exposed}_j \times y_t^{(10)} + \varepsilon_{jt}$$

	Long-Short Category			
	$20-15$	$20-10$	$30-15$	$30-10$
$\textit{Exposed}_j \times y_t^{(10)}$	-0.017^{***}	-0.026^{***}	-0.011^{***}	-0.020^{***}
	(0.003)	(0.004)	(0.003)	(0.005)
Month FE	✓	✓	✓	✓
Group FE	✓	✓	✓	✓
Obs.	5399	5915	4639	4756
Within-R^2	0.020	0.020	0.000	0.010

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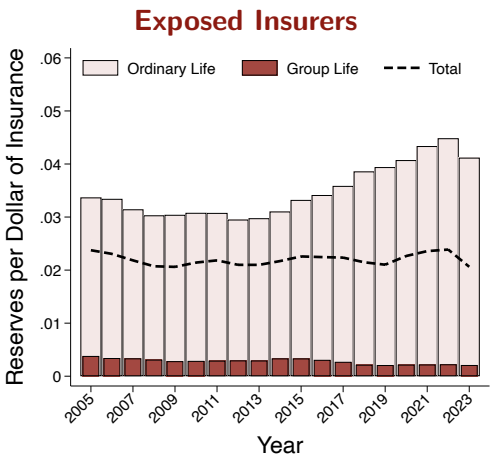
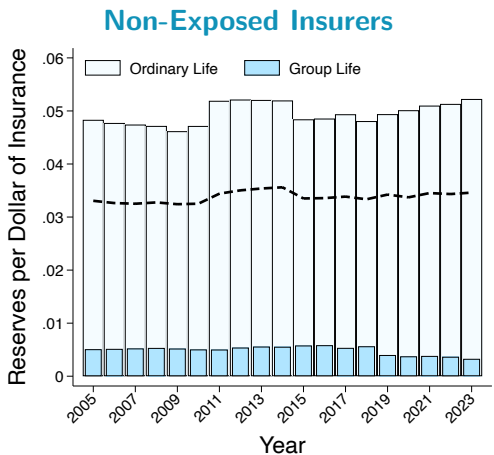
Ordinary life reserves are larger and more interest sensitive than Group





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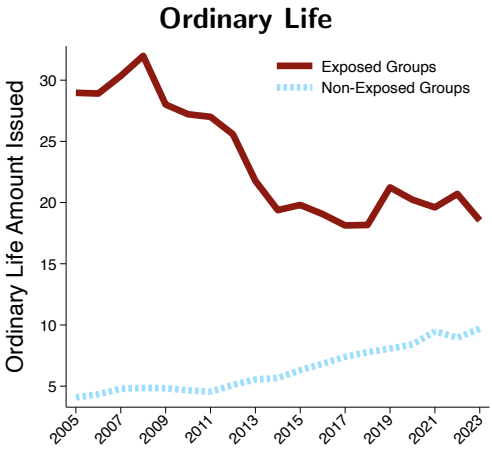
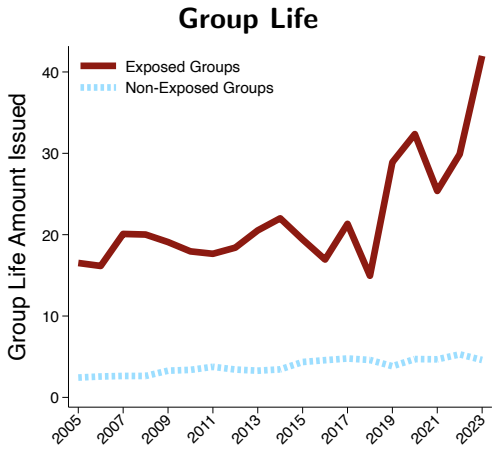
Average Ordinary Issuance Declined (Group Increased) For Exposed Groups





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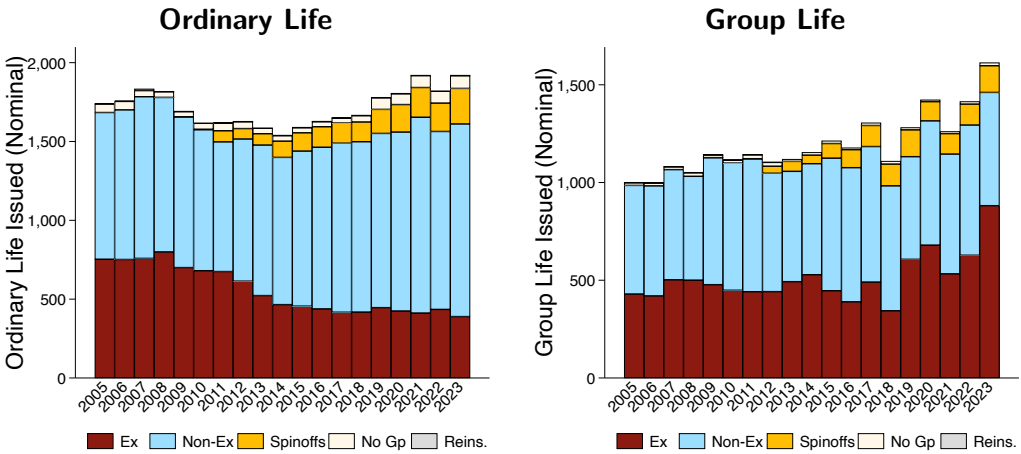
Nominal Ordinary Issuance Steady While Group Life Increases



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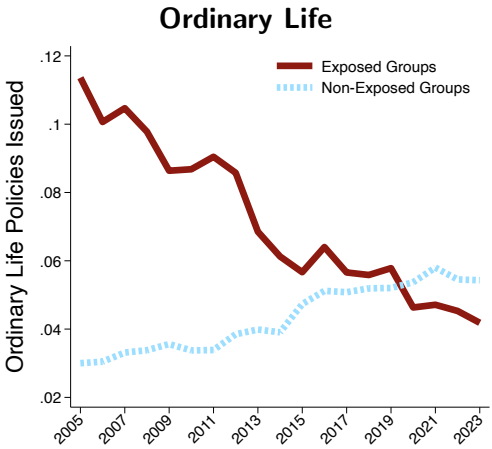
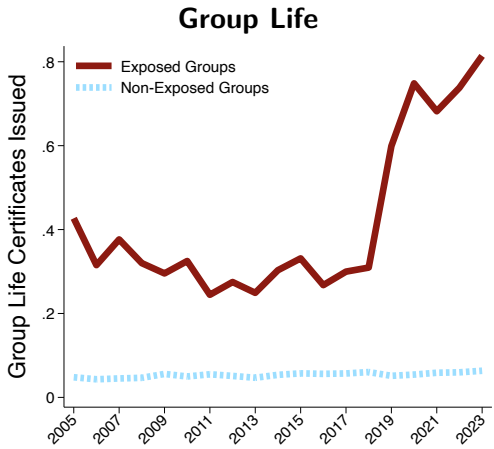
Policy Issuance Followed the Same Trends as Amounts





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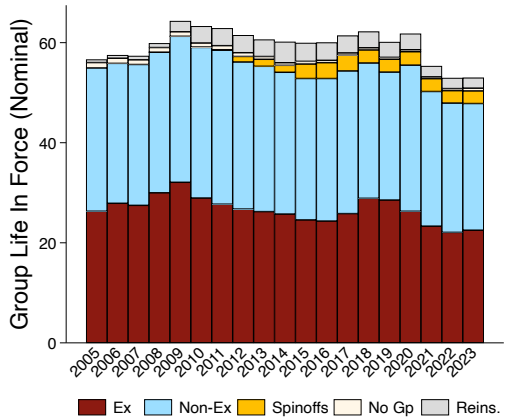
Group Life In Force As a Share of GDP



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