Life insurance convexity

Christian Kubitza[1], Nicolaus Grochola[2], Helmut Gründl[2]

[1]University of Bonn, [2]Goethe-University Frankfurt & ICIR

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Life insurers are important

- 6 trn EUR invested in financial assets
  → significant **price impact** (Ellul et al. (2011))
- 40% of households' net worth
  → long-term savings policies with
  guaranteed minimum payout & **early withdrawal ("surrender") option**
  → liquidity risk: annual surrender payments > 300 bn EUR

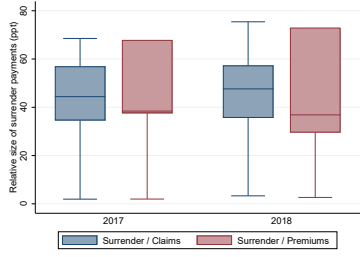

Figure: Annual surrender payments / cash flows (across European countries).

This paper: interest rates → surrender activity → asset sales

(I) **Empirics:** market interest rate↑ → surrender activity↑
⇒ $\frac{\partial \text{duration(life insurance policy)}}{\partial \text{interest rate}} < 0$ ⇒ convexity (Hanson (2014))

(II) **Model:** surrender activity → forced asset sales
⇒ price impact (≈ 1%↓) & costs (15bps of insurer equity capital p.a.)

Contribution:

(A) Financial fragility of insurers
traditionally: non-insurance business & asset side (e.g., Foley-Fisher et al. (2016, 2018))
recently: insurance business (Ellul et al. (2020), Koijen and Yogo (2015, 2016, 2020))
here: life insurance business → liquidity risk ↔ interest rates

(B) Surrender options in life insurance
traditionally: interest rate hypothesis (e.g., Kuo et al. (2003), Eling and Kiesenbauer (2014))
recently: collective run when PV(insurer's assets) ≤ guaranteed payout (Förstemann (2019))
here: causal identification & calibrated model with cash flows

Overview

Interest rates and surrender rates

Hypothesis: Surrender if cash value $\cdot \underbrace{\frac{\mathbb{E}[1 + r_{policy}]}{1 + \mathbf{r_f}}}_{\text{benefit of staying}} <$ cash value

(1) cash value $\perp r_f$ (in short/medium run)

(2) insurer's long-term investments insulate r_{policy}: $r_f \uparrow \Rightarrow \frac{\mathbb{E}[1+r_{policy}]}{1+r_f} \downarrow \Rightarrow$ surrender incentive $\uparrow$

Data: German insurer-year panel, 1996-2019, 163 life insurers
Source: Federal Supervisor (BaFin)'s insurance statistics

Surrender rate = % life insurance surrendered annually (mean: 4.9%)
Interest rate (r_f) = 10-year German government bond rate (mean: 3.1%)

Empirical results: OLS

Dependent variable:	(1)	(2)	(3)	(4)	(5)
			Surrender rate		
Interest rate$_t$	0.354***			0.308***	
	(0.000)			(0.005)	
Interest rate$_{t-1}$		0.366***	0.254***		
		(0.000)	(0.001)		
Interest rate$_t$ × Exc. Guaranteed return$_{t-1}$				-0.109**	
				(0.037)	
Interest rate$_t$ × Exc. Guaranteed return$_{t-1}$ × New business$_{t-1}$					-0.015***
					(0.002)
Insurer FE	Yes	Yes	Yes	Yes	Yes
Year FE	No	No	No	No	Yes
Macro controls	Yes	Yes	Yes	Yes	No
Controls for aggregate new business	No	No	**Yes**	Yes	No
Inv return$_{t-1}$ & New business$_{t-1}$	No	No	**Yes**	Yes	Yes
Exc. Guaranteed return$_{t-1}$	No	No	No	Yes	No
Interest rate$_t$ × New business$_{t-1}$	No	No	No	No	Yes
Exc. Guaranteed return$_{t-1}$ × New business$_{t-1}$	No	No	No	No	Yes
No. of obs.	2,263	2,255	2,232	2,232	2,232
R^2 within	0.224	0.220	0.216	0.223	0.067

Standard errors clustered at year and insurer level. p-values in parentheses. ***, **, * are significance at 1%, 5% and 10% levels.

Economically significant: 1sd interest rate ↑ ↔ 0.3sd surrender rate ↑ (≈ 4bn EUR)

Identification challenge: surrender → asset sales → prices → interest rate

Empirical results: OLS

Dependent variable:	(1)	(2)	(3)	(4)	(5)
	Surrender rate				
Interest rate$_t$	0.354***			0.308***	
	(0.000)			(0.005)	
Interest rate$_{t-1}$		0.366***	0.254***		
		(0.000)	(0.001)		
Interest rate$_t$ × Exc. Guaranteed return$_{t-1}$				-0.109**	
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Mechanism: interest rate-sensitivity smaller when guaranteed policy return larger
⇒ consistent with yield-oriented policyholders

Empirical results: IV

Instrument for German government bond rate: US federal funds rate (FFR)

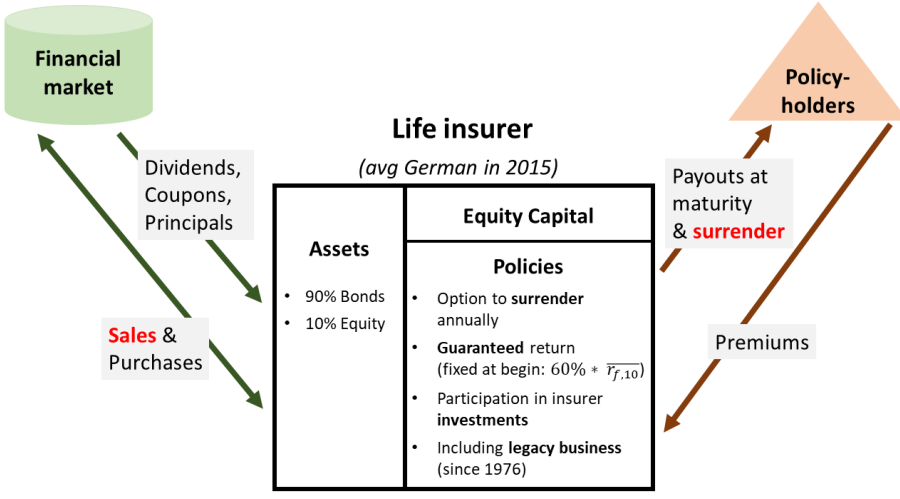
- FFR↑ → US bond rates↑ → DE bond rates↑
- DE insurers ↛ US monetary policy (< 1% of US treasuries held by DE life insurers)

Dependent variable:	(1)	(2)	(3)	(4)
	Surrender rate			
Interest rate$_t$	0.351***			0.427*
	(0.000)			(0.071)
Interest rate$_{t-1}$		0.362***	0.256**	
		(0.000)	(0.036)	
Interest rate$_t$ × Exc. Guaranteed return$_{t-1}$				-0.236*
				(0.065)
Insurer FE	Yes	Yes	Yes	Yes
Year FE	No	No	No	No
Macro controls	Yes	Yes	Yes	Yes
Controls for aggregate new business	No	No	Yes	Yes
Inv return$_{t-1}$ & New business$_{t-1}$	No	No	Yes	Yes
Exc. Guaranteed return$_{t-1}$	No	No	No	Yes
FFR$_t$ (1st stage)	0.680***	0.620***	0.349***	0.282**
	(0.000)	(0.000)	(0.000)	(0.013)
FFR$_t$ × Exc. Guaranteed return$_{t-1}$ (1st stage)				0.424***
				(0.002)
No. of obs.	2,263	2,255	2,232	2,232

Standard errors clustered at year and insurer level. p-values in parentheses. ***, **, * are significance at 1%, 5% and 10% levels.

Overview

Model: Key ingredients



Model: Surrender decision

Policyholder surrenders if

$$\text{cash value}_t \cdot \underbrace{\frac{1 + r_{policy,t}}{1 + r_{f,T-t}}}_{\text{benefit of staying}} < \text{cash value}_t \cdot (1 - \text{net costs})$$

with net costs $\sim F(c_0, \mu, \sigma^2)$ across policyholders.

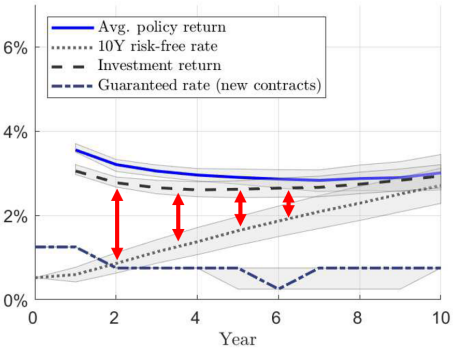
Calibration (2015):

- yield curve $r_{f,T-t}$ and policy return $r_{policy,t}$: dynamic financial market model and balance sheet
- costs (c_0, μ, σ^2): matching model-implied surrender rate to BaFin data

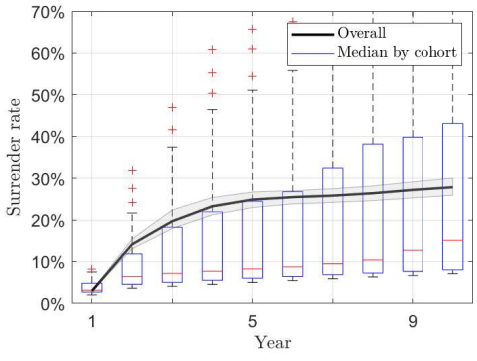
Simulation: interest rate rise by $\approx$ 20bps/year

Simulation: Interest and surrender rates

Long-term assets ⇒ investment return insulated from interest rate changes
⇒ (policy return - interest rate) ↓ ⇒ surrender more attractive:



(a) Interest rates and returns.

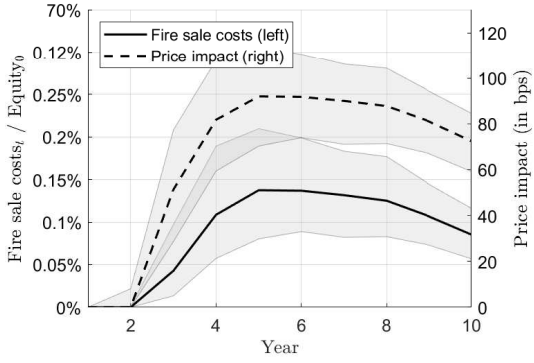


(b) % policies surrendered.

Simulation: Fire sales

Large surrender payouts ⇒ insurers forced to sell assets

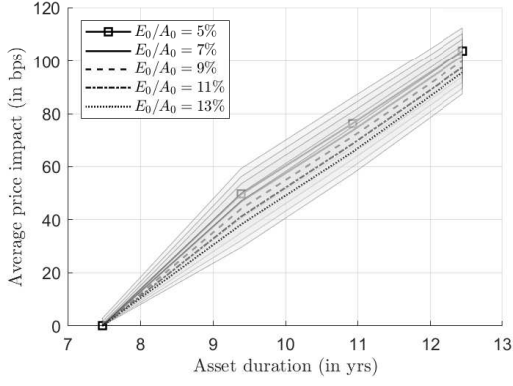
Using size of similar European insurance business (5trn EUR) and Greenwood et al. (2015)'s ∂price:
→ price impact: 80 − 100bps



Sensitivity

Long-term investments drive fire sales:

longer asset duration → policy return more insulated
→ more surrender activity → larger price impact



Conclusion

- Guaranteed surrender cash values + long-term investments
  $\Rightarrow$ surrender activity increases with interest rates
- Life insurance surrender $\approx$ bank deposit withdrawals
  $\Rightarrow$ fragility & (fire sale) externalities
- Trade-off between:
  value from asset insulation $\leftrightarrow$ long-term investments (Chodorow-Reich et al. (2020))
  vs. fragility due to surrender option
- Fire sale externalities significant ($\approx 0.8 - 1\%$ price impact)
  $\Rightarrow$ surrender options may contribute to systemic risk

Thank you.

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