Life Expectancy and Corporate Debt Markets

Zhanhui Chen
HKUST

Vidhan K. Goyal
HKUST

Pingyi Lou
Fudan

Wenjun Zhu
NTU

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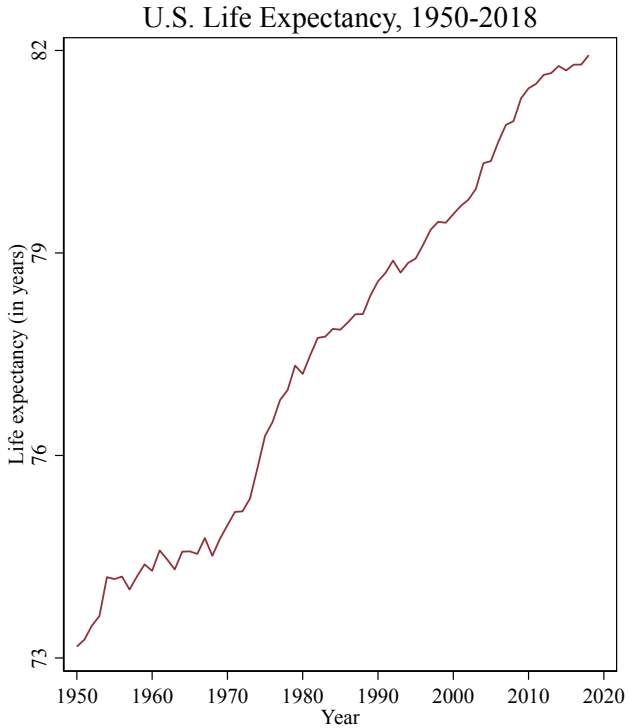
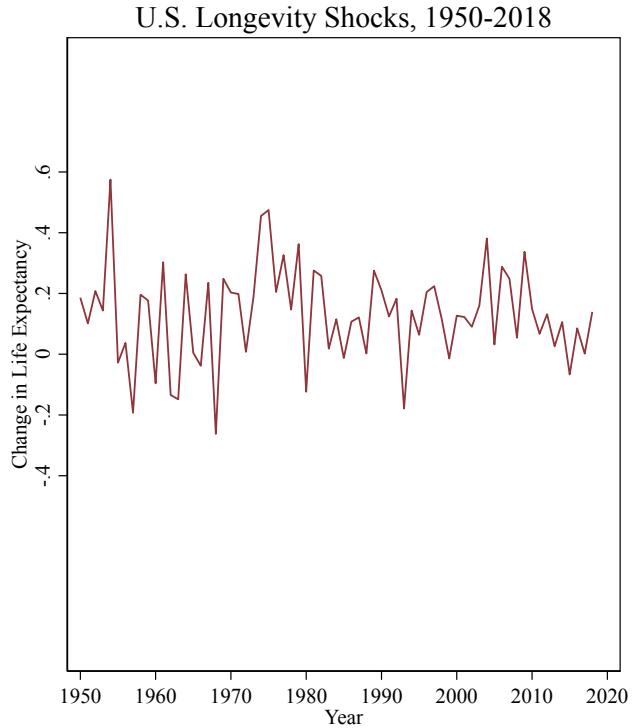
Life Expectancy Shocks

- Human life expectancy has increased over the last century, with substantial year-to-year variation.
  - Attributable to healthcare, environmental, lifestyle, biological, institutional, and socioeconomic factors.

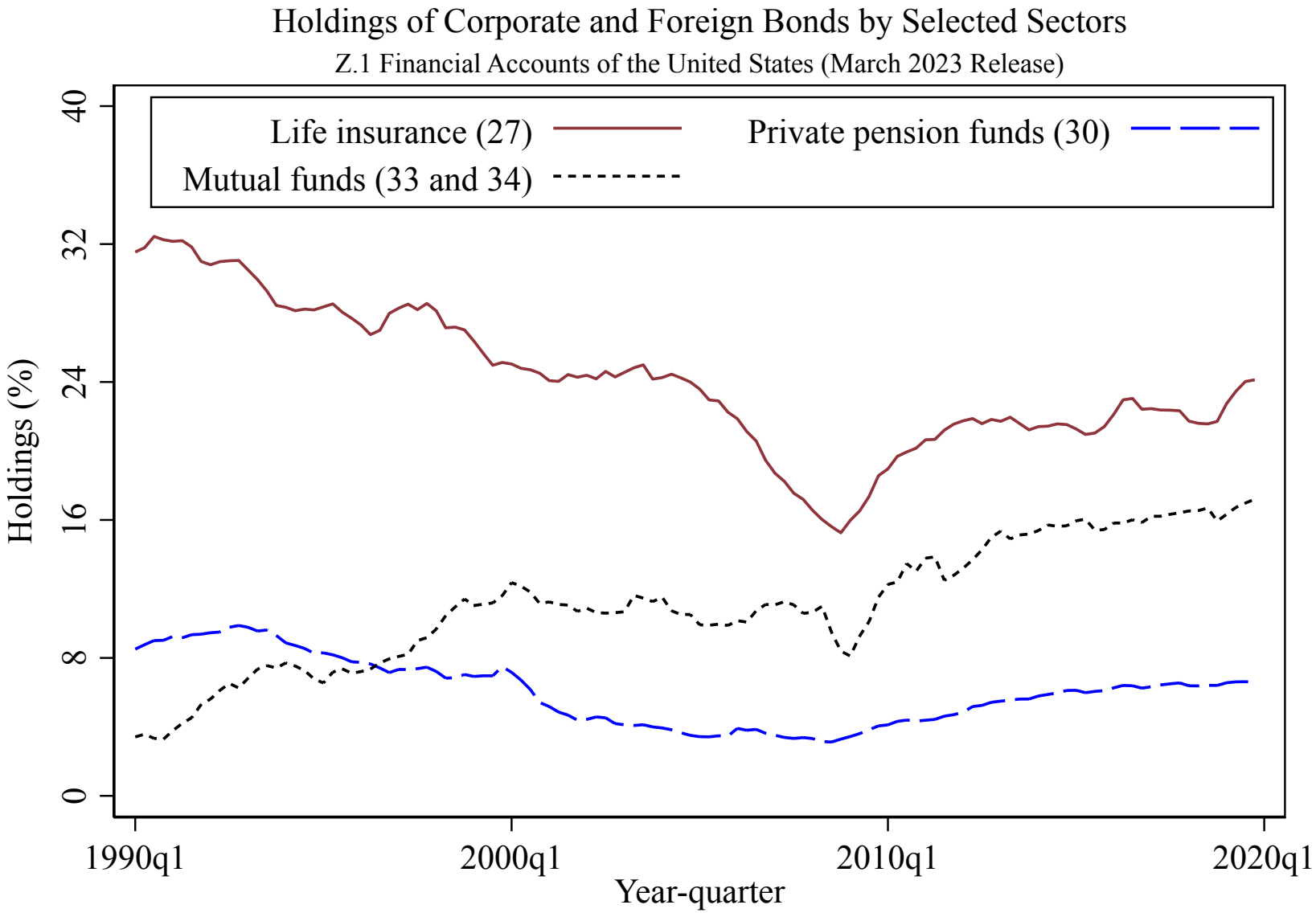




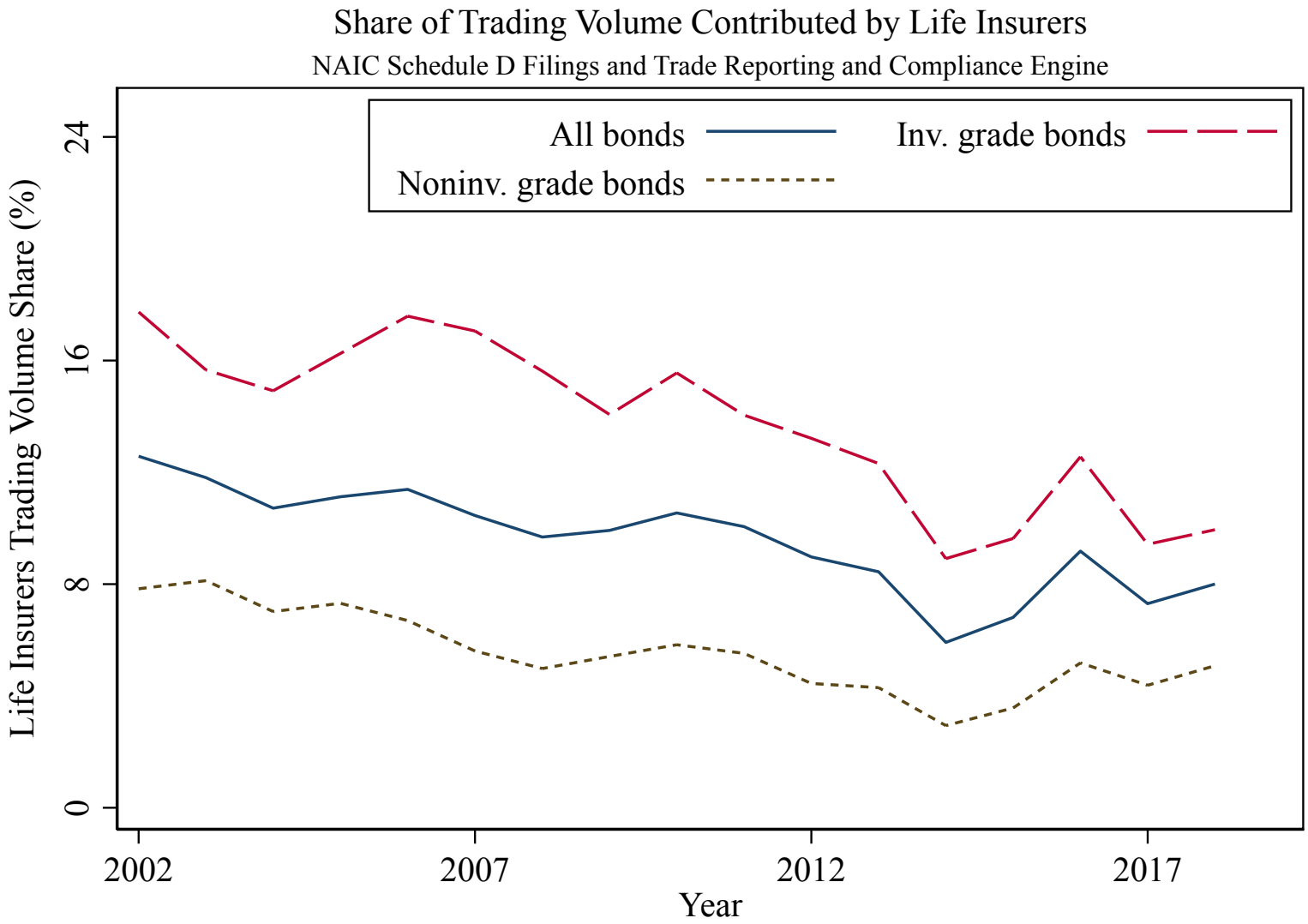
Longevity Shocks and Corporate Debt Markets

- Longevity shocks impact the duration of life insurers' liabilities (annuities & whole life insurance).
- Regulations require minimizing asset-liability duration gaps.
  - Compliance involves active duration matching, cash flow testing, and solvency reporting.
  - Mismatches increase risk classification and capital requirements.
- Life insurers hedge duration mismatches by adjusting asset duration, mainly via corporate bonds:
  - Longer lifespans prompt insurers to acquire longer-term assets; shorter lifespans increase demand for shorter-term assets.

Life Insurers are the Biggest Holders of Corporate Bonds



Life Insurer Trades Matter



Research Questions

Examine the effect of changes in life expectancy on corporate term spreads, long-term financing, and debt maturity choices.

Measuring Longevity Risk

- Human Mortality Database (HMD): annual U.S. population, life expectancy, and exposure data, including nationwide (1974-2018) and state level (1990-2019)
- The weighted average of period life expectancy of a population, E_t is measured as:

$$E_t = \frac{\sum_{x=0}^{99}(x + e_{x,t})E_{x,t}}{\sum_{x=0}^{99} E_{x,t}}, \tag{1}$$

where $e_{x,t}$ is the period remaining life expectancy for a person aged x in year t, and $E_{x,t}$ is the corresponding exposure of cohort x.

- Longevity risk is the first-order difference of E_t.

$$\Delta E_t = E_t - E_{t-1}. \tag{2}$$

  - Mean = 0.15 years per year. Annual σ = 0.14 years.

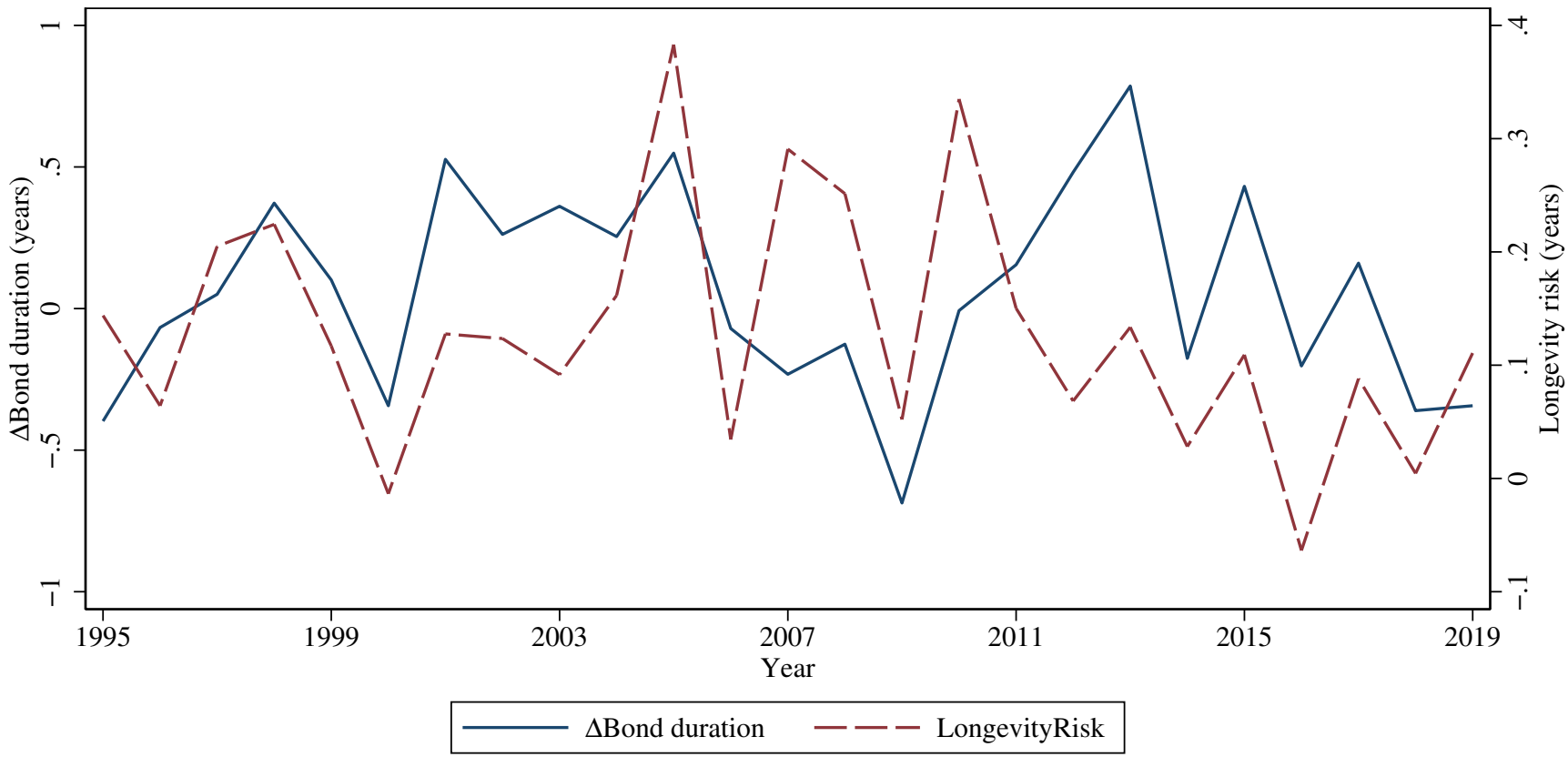
Other Data

- Life insurers' characteristics (NAIC filings)
- Insurer bond holdings (NAIC "Schedule D", 1995-2019)
  - Investment grade bonds comprise 82% of their corporate bond holdings.
- Corporate data: Compustat, 1975-2019
- TRACE: 2002-2019
- Other macro and bond market data: FRED, Mergent FISD, 1990-2019

Insurers' Bond Duration Changes in Response to Changes in Life Expectancy

Life Insurers' Bond Duration Responses to Longevity Risk

Changes in Bond Duration of Life Insurers and Longevity Risk (ρ=0.32)



Life Insurer Response to Longevity Risk

$$\Delta InsDuration_{i,t} = \beta \cdot LongevityShocks_{t-1} + \mathbf{X}'_{i,t} \cdot \lambda + \mathbf{Z}'_{t} \cdot \gamma + \zeta_i + \epsilon_{i,t},$$

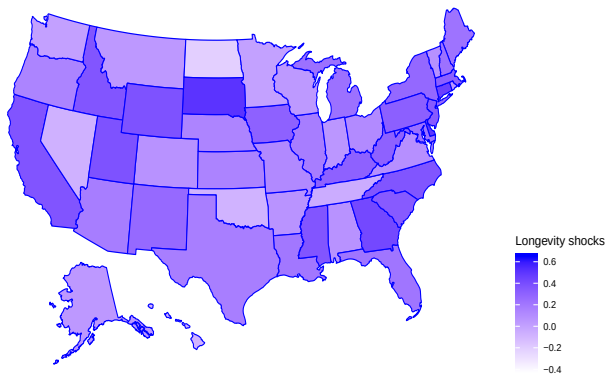
	(1)	(2)	(3)	(4)
LongevityRisk	0.687***	0.713***	0.686***	0.628***
	(0.089)	(0.088)	(0.181)	(0.117)
ReachingForYield		0.146***		
		(0.015)		
DerivativeHedging			0.525***	
			(0.139)	
Amihud				-0.734***
				(0.136)
Life insurer characteristics	Yes	Yes	Yes	Yes
Macroeconomic factors	Yes	Yes	Yes	Yes
Credit market conditions	Yes	Yes	Yes	Yes
Insurer FE	Yes	Yes	Yes	Yes

Examining Causality

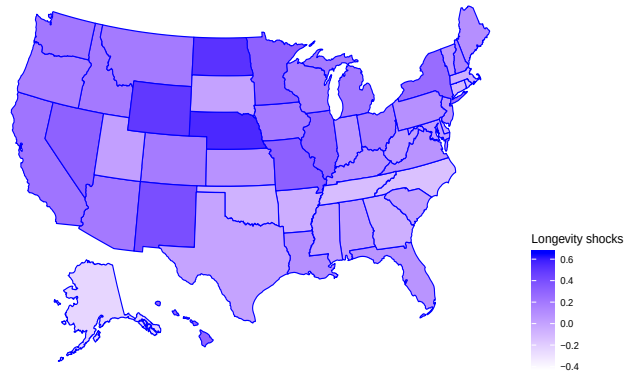
Duration Adjustments of Local Life Insurers

- Geographically concentrated life insurers (with $\geq 80\%$ of revenue from one state). *Local life insurers are affected by local longevity risk.*
- Do local life insurers adjust their corporate bond portfolio duration in response to state-specific longevity shocks?
- Local versus non-local bonds?

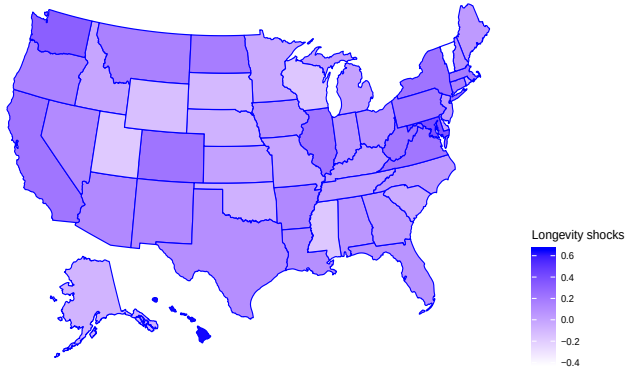
Geographic Disparities in State-level Longevity Risk



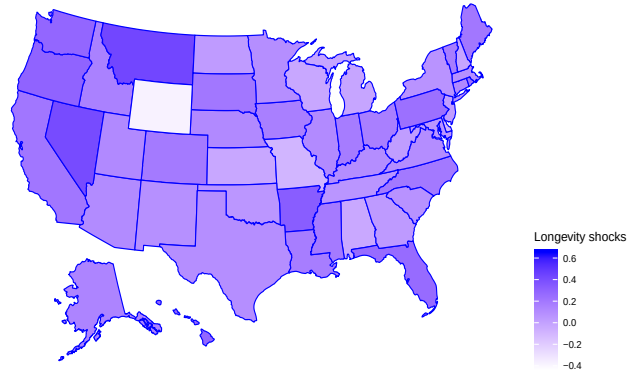
(a) State-level longevity risk (1990)



(b) State-level longevity risk (2000)



(c) State-level longevity risk (2010)



(d) State-level longevity risk (2018)

Local Life Insurers' Response to Local Longevity Shocks

	Duration adjustment through:					
	Both local and non-local corporate bonds			**Non-local corporate bonds**		
	Both +/- shocks	Only + shocks	Only - shocks	Both +/- shocks	Only + shocks	Only - shocks
	(1)	(2)	(3)	(4)	(5)	(6)
LocalLongevityShocks	0.425***	0.263*	1.254***	0.290***	0.229*	1.186***
	(0.090)	(0.139)	(0.440)	(0.060)	(0.136)	(0.384)
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Bond market controls	Yes	Yes	Yes	Yes	Yes	Yes
Insurer characteristics	Yes	Yes	Yes	Yes	Yes	Yes
Insurer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.07	0.09	0.20	0.08	0.10	0.24
Observations	5437	4144	1184	5437	4144	1184

First Experiment: Opioid Crisis and Local Longevity Risks

- Opioid overdose is a leading cause of injury death, accounting for 24.5 deaths per 100,000 population in 2012.
- The epidemic's roots lie in local physician prescribing practices and pharmaceutical marketing. No effect of economic conditions.
- Instrument state-level longevity shocks using state-level opioid-related death counts
- Opioid abuse (disproportionately affects the working-age population) reduces local life expectancy and affects the duration of insurers' liabilities.

Second Experiment: Prescription Drug Monitoring Program

- Staggered implementation of "must-access" Prescription Drug Monitoring Programs (PDMPs) across states
- PDMPs reduce opioid availability and abuse. Improve local life expectancy. States requiring mandatory PDMP experience a 9% reduction in fatal prescription overdoses, directly affecting demographic trends.
- State is considered "treated" ($PDMPState$=1) upon implementing a PDMP with a "must access" provision. $Year1$=1 for the first year following the adoption date. $Year2$=1 for the second or further years.

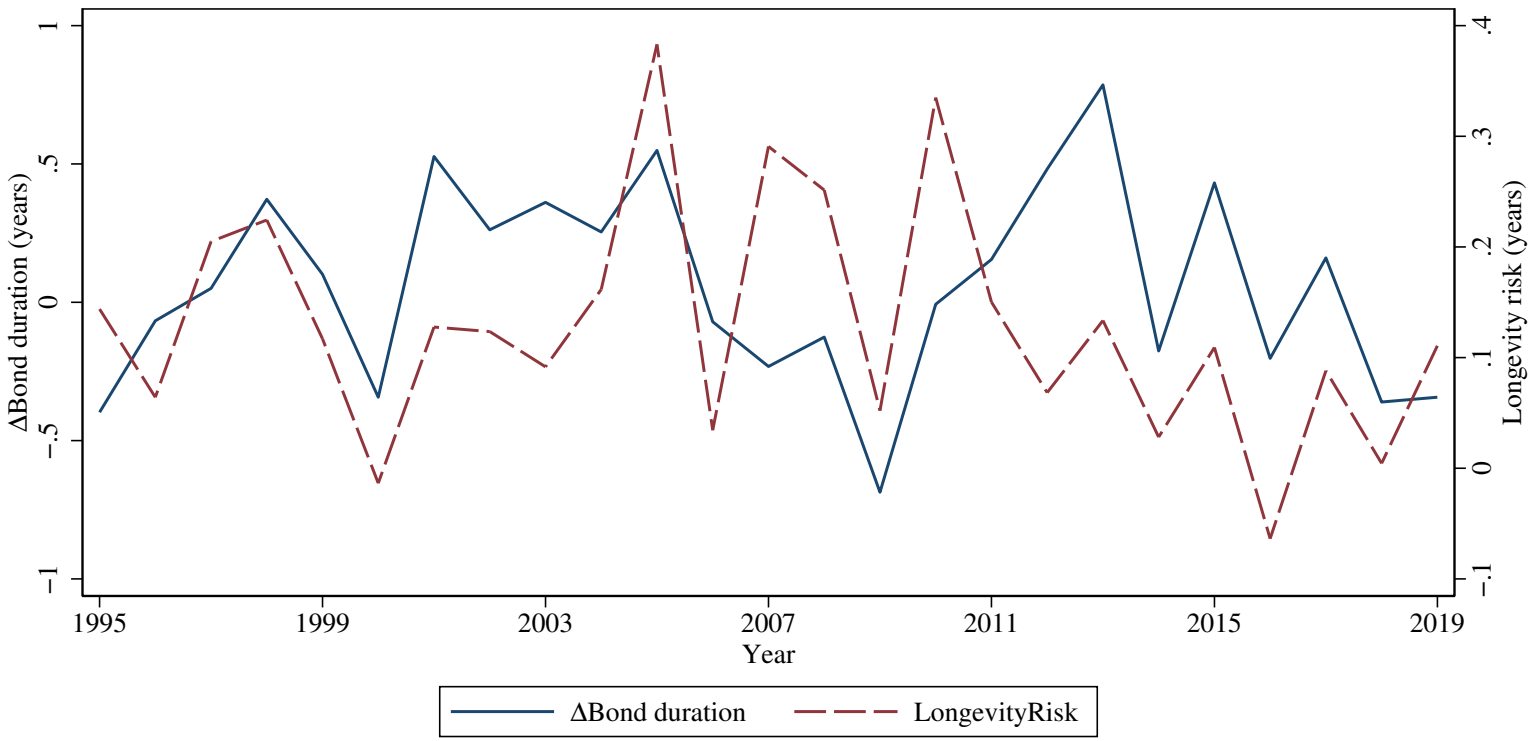
Local Longevity Shocks and Duration Adjustments: IV Regressions

	Instrumental Variable		
	First stage	Second stage	DID
Dependent Variable	LocLongShock	ΔInsDuration	ΔInsDuration
IV=OpioidMortality	-8.494***		
	(2.012)		
LocalLongevityShocks		1.255**	
		(0.639)	
PDMPState × Year1			0.348***
			(0.108)
PDMPState × Year2			-0.115
			(0.099)
Macro controls	Yes	Yes	Yes
Bond market controls	Yes	Yes	Yes
Insurer characteristics	Yes	Yes	Yes
Insurer fixed effects	Yes	Yes	Yes
R^2	0.179	0.009	0.070
Observations	5429	5429	5429

How Do Corporate Debt Markets Respond to Longevity Shocks? Aggregate Evidence

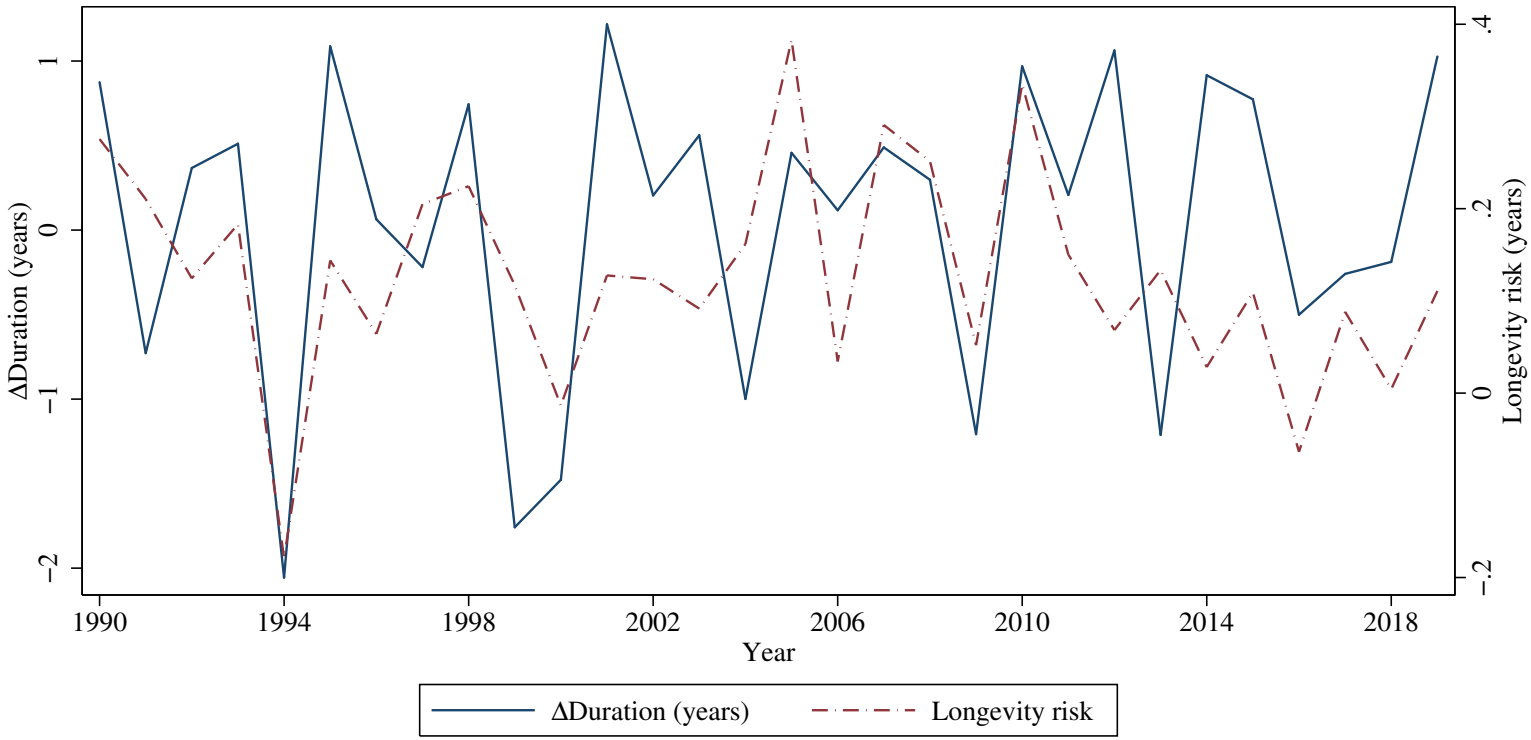
Do Longevity Shocks affect Corporate Term Spreads?

- With partially segmented markets, a shift in demand for bonds of specific maturities introduces predictability in bond returns.
  - Corporate term spreads decline when life expectancy increases (ρ= -0.23).



Supply Response: The Aggregate Evidence

- When the demand for long-term debt from the life insurance sector increases (and long-term yields decline), firms increase the supply of long-term debt (i.e. "fill the gap")



Firm-level Response

Maturity Responses to Longevity Shocks

- Long-term bond issues should be relatively more sensitive to changes in life expectancy.
  - **Sort bonds issues by firms into four categories:** Short-term ([0,3)), Medium-term ([3,10)), Long-term ([10,20)), and Very long-term debt ([20,...)).

$$Issue^{j}_{i,t} = \beta \cdot LongevityRisk_{t-1} + \mathbf{X}^{'}_{i,t-1} \cdot \lambda + \gamma_{Issuer} + \nu_{Period} + \epsilon_{i,t}.$$

Evidence

	All	Non-demogr.	Insurer-dependent?		Investment-grade?	
			Yes	No	Yes	No
Panel A: Maturity < 3 *years*						
LongevityRisk	-3.516***	-3.403*	-3.339***	5.514	-4.734*	-4.330
	(-2.8)	(-1.9)	(-2.6)	(0.6)	(-1.7)	(-1.4)
Panel B: Maturity $[10, 20)$ *years*						
LongevityRisk	0.692*	1.478***	1.451***	-0.189	1.559**	0.709
	(2.0)	(2.8)	(2.9)	(-0.4)	(2.1)	(1.2)
Panel C: Maturity ≥ 20 *years*						
LongevityRisk	2.658***	2.999***	3.377***	1.758	2.779***	0.791
	(6.3)	(5.2)	(6.7)	(1.5)	(3.6)	(1.0)
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Credit conditions	Yes	Yes	Yes	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
Period indicators	Yes	Yes	Yes	Yes	Yes	Yes
R^2	0.122	0.103	0.068	0.106	0.110	0.133
Observations	6806	3296	4415	2391	2932	3067

Bonds with a maturity of [3,10) years as the base category.

Conclusions

- We show that when longevity increases unexpectedly:
  - Life insurance companies buy more long-term bonds
  - Yield spread between long-term and short-term bonds decreases.
  - This reduces the cost of long-term debt and induces corporations to issue long-term debt
- We illustrate a plausible channel through which longevity shocks are transmitted to the real economy, i.e., the debt financing cost channel via the insurance sector and bond markets.