Intermediary Demand for Duration and Corporate Financing: Evidence from Longevity Shocks*

Zhanhui Chen† Vidhan K. Goyal‡ Pingyi Lou§ Wenjun Zhu¶

Abstract

We study whether changes in financial intermediaries' demand for duration affect corporate financing. Life insurers provide a setting because revisions in life expectancy alter the duration of their liabilities, generating plausibly exogenous shifts in demand for duration. Improvements in longevity increase insurers' purchases of long-maturity corporate bonds and their corporate bond portfolio duration. Positive longevity shocks are associated with lower corporate term spreads. Consistent with these market-level responses, firms with greater exposure to insurer demand issue longer-maturity debt. The results identify a financial-market transmission mechanism through which revisions in longevity affect corporate financing by changing intermediaries' demand for duration.

JEL classification: G22, G12, G32, J11

Keywords: life insurers; corporate bond markets; debt maturity; longevity shocks; real investment

*We thank Jennie Bai (Discussant), Turan Bali, Itzhak Ben-David, Tobias Berg, Jaewon Choi, Pierre Collin-Dufresne, Shaun Davies, Stephen Dimmock, Andrew Ellul, Thierry Foucault, Shan Ge, Bing Han, Davidson Heath (Discussant), Gerard Hoberg, Jingzhi Huang, Kristy Jansen (Discussant), Yan Ji, Gergana Jostova, Chotibhak Jotikasthira, Andy Kim, Kyuri Kim (Discussant), Arthur Krebbers, Jian Li, Shuo Liu, Yao Lu, Abhiroop Mukherjee, Yoshio Nozawa, Dimitris Papanikolaou, Heungju Park, Lukas Schmid, Sang Byung Seo (Discussant), Zhaogang Song, Ian Tonks (Discussant), Patricio Valenzuela (Discussant), Emil Verner, Takeshi Yamada, Motohiro Yogo, Jialin Yu, Yao Zeng, Chu Zhang, and participants at numerous conferences and seminars for very useful suggestions. Zhanhui Chen acknowledges financial support from the Hong Kong Research Grants Council (GRF 16504522, GRF 16503423) and the Research Database Matching Fund of the School of Business and Management. Wenjun Zhu acknowledges funding from the Singapore Ministry of Education Academic Research Fund Tier 3 (MOE-MOET32022-0006) and the Singapore Ministry of Education Academic Research Fund Tier 1 (RG137/25).

†Zhanhui Chen, HKUST; E-mail: chenzhanhui@ust.hk.

‡Vidhan K. Goyal, HKUST and ABFER; E-mail: goyal@ust.hk.

§Pingyi Lou, Fudan University; E-mail: plou@fudan.edu.cn.

¶Wenjun Zhu, Nanyang Technological University; E-mail: wjzhu@ntu.edu.sg.

1 Introduction

Corporate bond markets allocate financing across maturities, determining the relative cost of short- and long-term borrowing. Existing research largely explains firms' debt maturity choices using firm-specific financing considerations, including rollover risk, agency conflicts, and information asymmetry (Barclay and Smith, 1995; Guedes and Opler, 1996; Choi, Hackbarth, and Zechner, 2018). Debt maturity may also depend on the supply of duration in capital markets. If financial intermediaries increase their demand for duration, implemented through purchases of long-duration corporate bonds, the relative cost of long-term borrowing should fall; if that demand declines, long-term financing should become relatively more expensive, consistent with preferred-habitat theories of segmented bond markets (Greenwood, Hanson, and Stein, 2010; Vayanos and Vila, 2021). Yet establishing whether changes in the supply of duration affect corporate financing has proved difficult because financial intermediaries typically adjust their portfolios in response to the same changes in interest rates, credit conditions, and firms' investment opportunities that influence firms' financing decisions. As a result, it remains difficult to determine whether exogenous changes in intermediary demand for duration affect borrowing costs across maturities and, ultimately, firms' debt maturity choices.

Life insurers provide a natural setting in which to study this question because they are among the largest investors in long-duration corporate bonds while also managing liabilities whose duration depends on policyholders' longevity. They manage this exposure by matching the duration of their asset portfolios to the duration of their liabilities. Unlike many other financial intermediaries, their portfolio decisions are governed not only by expected investment returns but also by asset–liability management. Regulatory capital requirements, asset adequacy tests, and internal risk-management practices create strong incentives to maintain alignment between the duration of assets and liabilities. Therefore, changes in liability duration generate corresponding changes in insurers' demand for duration, which they satisfy primarily through purchases of long-duration corporate bonds (Domanski, Shin, and Sushko, 2017; Ozdagli and Wang, 2020).

Revisions in life expectancy provide a source of plausibly exogenous variation in this demand. Improvements in longevity extend the duration of insurers' liabilities, whereas deteriorations in longevity shorten it. Because these revisions originate outside corporate credit markets, they generate systematic changes in insurers' demand for duration that are plausibly unrelated to firms' financing decisions. As a result, they provide a source of exogenous variation that allows us to identify the effects of intermediary demand on corporate financing.

Whether these changes in intermediary demand affect corporate financing depends on the extent to which arbitrage transmits, rather than fully offsets, shifts in maturity-specific demand. Preferred-habitat theories predict that maturity-specific demand influences bond prices when arbitrage capacity is limited and intermediaries absorbing demand shocks face balance-sheet or risk-bearing constraints (Greenwood, Hanson, and Stein, 2010; Vayanos and Vila, 2021). In this setting, increases in insurers' demand for duration, implemented through purchases of long-maturity corporate bonds, should lower the relative cost of long-term borrowing, compress corporate term spreads, and encourage firms to issue longer-maturity debt.

We examine two implications of this mechanism. First, we test whether revisions in life expectancy increase life insurers' demand for duration, leading them to purchase longer-maturity corporate bonds and lengthen the duration of their corporate bond portfolios. Second, we examine whether these shifts in intermediary demand affect corporate bond prices and firms' debt maturity choices. We show that improvements in life expectancy increase insurers' demand for duration and lower corporate term spreads. Firms with greater exposure to insurer demand respond by issuing longer-maturity debt.

Our empirical analysis measures these revisions using annual changes in weighted-average period life expectancy, which we refer to as longevity shocks. The measure aggregates age-specific life expectancy using population exposure weights and captures changes in expected survival that alter the duration of insurers' liabilities. Between 1974 and 2018, annual changes averaged 0.15 years and had a standard deviation of 0.14 years, indicating substantial year-to-year variation relative to the average rate of improvement in longevity.[1]

The insurer-level evidence is consistent with a liability-driven increase in demand for duration. Longevity improvements lead life insurers to purchase longer-maturity investment-grade corporate bonds and reduce exposures to shorter-maturity bonds, thereby increasing the duration of their corporate bond portfolios. A one-year increase in life expectancy is associated with an approximately 0.77-year increase in portfolio duration. The duration response is strongest among insurers with greater exposure to longevity-sensitive liabilities, greater financial flexibility, and more intensive regulatory oversight, consistent with active duration management.

Several additional tests support the interpretation that these portfolio adjustments reflect changes in insurers' demand for duration rather than changes in issuer fundamentals or local economic conditions. Exploiting cross-state variation in local mortality conditions, we find that insurers increase portfolio duration through purchases of non-local bonds whose issuers are headquartered outside the insurer's domicile state. Moreover, insurers exposed to different longevity shocks trade the same non-local bond in opposite directions, providing within-bond evidence that is difficult to reconcile with issuer-specific fundamentals, local economic conditions, or common information shocks. Finally, similar duration responses emerge when identification is based on opioid-related mortality and prescription drug monitoring programs.

We next examine whether these shifts in intermediary demand are transmitted to corporate financing. Consistent with the predicted price effects, improvements in longevity are associated with lower corporate term spreads and greater issuance at long

[1]Internet Appendix Figure A.1 plots both the level of U.S. life expectancy and annual changes from 1950 to 2018. Year-to-year fluctuations in life expectancy reflect changes in mortality conditions associated with medical progress, behavioral factors, public health shocks, environmental conditions, and broader socioeconomic developments (Fuchs, 2004; Shaw, Horrace, and Vogel, 2005; Cutler, Deaton, and Lleras-Muney, 2006; OECD, 2010; Moreno-Serra and Smith, 2015; Chiu and Pain, 2018; Woolf and Schoomaker, 2019).

maturities in the aggregate. At the firm level, debt maturity increases following positive longevity shocks, with the strongest responses concentrated among investment-grade issuers and firms whose bonds are more heavily held by insurers. We additionally find that insurers' demand for duration is positively associated with long-term investment among firms that rely more heavily on insurer financing.

More broadly, our findings identify a financial-market transmission channel through which longevity shocks affect corporate financing. Existing research has largely emphasized the effects of demographic change on household savings, consumption, and portfolio allocation. Our evidence shows that revisions in longevity also affect firms' financing conditions by altering regulated financial intermediaries' demand for duration. More generally, the results suggest that intermediary balance sheets transmit demographic forces to capital markets by shifting the supply of duration, thereby affecting firms' financing decisions.

This paper contributes to several strands of research. First, we contribute to the literature on institutional investors, segmented bond markets, and preferred-habitat theories of asset pricing. Prior research shows that life insurers affect corporate bond markets through balance-sheet capacity, portfolio demand, regulation, liquidity provision, risk management, accounting incentives, and monetary policy transmission.[2] We identify revisions in longevity as a source of plausibly exogenous variation in insurers' demand for duration and show that these demand shifts affect both corporate bond markets and corporate financing choices. Improvements in life expectancy are associated with systematic adjustments in insurers' corporate bond portfolio duration, lower corporate term spreads, and greater issuance at long maturities. The results provide evidence that maturity-specific demand from large institutional investors affects both the pricing and financing consequences of corporate debt when arbitrage capacity across maturities is limited, consistent with preferred-habitat theories.

[2]See, among others, Ellul, Jotikasthira, and Lundblad (2011); Ge and Weisbach (2021); Kubitza (2026); Domanski, Shin, and Sushko (2017); Yu (2020); Jansen (2025); Becker and Ivashina (2015); Ozdagli and Wang (2020); Ellul et al. (2022); Bretscher et al. (2025); Murray and Nikolova (2022); Ellul et al. (2015); Becker, Opp, and Saidi (2022); Sen (2023); O'Hara, Rapp, and Zhou (2025); Kaufmann, Storz, and Leyva (2024); Fang and Xiao (2025); Kirti and Singh (2025); Coppola (2025); Siani (2025).

Second, we contribute to the literature on corporate debt maturity and investor-driven corporate finance. Existing research emphasizes rollover risk, information asymmetry, agency conflicts, and macro-financial conditions as determinants of maturity choice (Barclay and Smith, 1995; Guedes and Opler, 1996; Stohs and Mauer, 1996; Choi, Hackbarth, and Zechner, 2018; Chaderina, Weiss, and Zechner, 2022). A growing literature further shows that investor demand and capital-supply conditions influence corporate financing decisions (Becker and Ivashina, 2015; Zhu, 2021; Barbosa and Ozdagli, 2023; Kubitza, 2026; Coppola, 2025; Siani, 2025). A central challenge in both literatures is identifying plausibly exogenous variation in financing conditions. We address this challenge by identifying plausibly exogenous shifts in insurer demand for duration induced by revisions in life expectancy. Whereas prior work shows that investor composition and capital supply affect corporate financing outcomes, we identify shifts in insurer demand for duration as a source of variation in financing conditions that affects the relative cost of borrowing across maturities. Firms with greater exposure to insurer demand respond by extending debt maturity, particularly within investment-grade markets where insurer participation is concentrated.

Finally, we contribute to the literature on demographics and finance. Prior research links demographic change and life expectancy to consumption, savings, labor supply, productivity, and household portfolio allocation (Bloom and Canning, 2000; Murphy and Topel, 2006; Acemoglu and Johnson, 2007; Bakshi and Chen, 1994; Goyal, 2004; Chen and Yang, 2019), while related work studies demographic demand shifts and industry-level effects (DellaVigna and Pollet, 2007, 2013; Cunha and Pollet, 2020). We show that revisions in longevity also affect corporate financing by changing the demand for duration of regulated financial intermediaries that are important participants in corporate bond markets. The results identify intermediary balance sheets as a financial-market transmission mechanism through which demographic forces influence the supply of long-term corporate financing.

2 Institutional foundations of duration transmission

This section describes the institutional features that allow revisions in longevity to generate plausibly exogenous shifts in insurers' demand for duration. The mechanism rests on two institutional features of U.S. life insurers. First, life insurers manage long-duration liabilities and operate under regulatory and internal asset–liability management frameworks that discourage persistent duration mismatches. As a result, revisions in longevity alter the duration of insurers' liabilities and create incentives to rebalance the maturity structure of their asset portfolios. Second, life insurers are major investors in long-maturity investment-grade corporate bonds and hold a substantial fraction of their financial assets in this market segment. Thus, insurers implement these duration adjustments largely through changes in their corporate bond holdings. When insurers rebalance their portfolios in response to longevity shocks, these trades generate shifts in demand for duration that affect the relative pricing of long- and short-maturity corporate debt and, in turn, firms' financing choices.

2.1 Regulation and asset–liability duration matching

Life insurers manage their balance sheets under a regulatory framework that closely monitors asset–liability mismatches. Statutory reserve requirements, asset adequacy testing, and the NAIC's Own Risk and Solvency Assessment framework require insurers to regularly evaluate whether assets are sufficient to meet projected liabilities under a range of scenarios and discourage persistent duration mismatches.[3] Rating agencies such as S&P and Moody's likewise evaluate asset–liability management practices and duration risk when assessing financial strength. Together, regulatory oversight and rating-agency scrutiny give insurers strong incentives to adjust portfolio duration when

[3]Under the U.S. state-based solvency framework, insurers are required to maintain statutory reserves under the Standard Valuation Law (NAIC Model Law 820), as implemented through the NAIC Valuation Manual and the Actuarial Opinion and Memorandum Regulation (NAIC Model Law 822), which mandate asset adequacy analysis (National Association of Insurance Commissioners, 2010a,c, 2026). These evaluations are conducted by appointed actuaries under established professional standards; Actuarial Standards of Practice (ASOP) Nos. 7 and 22 govern the methodology used to assess reserve adequacy through cash-flow testing (Actuarial Standards Board, 2001, 2002). The NAIC's Risk Management and Own Risk and Solvency Assessment framework further requires insurers to report risk exposures, investment horizons, and asset–liability management policies (National Association of Insurance Commissioners, 2023).

liability duration changes and to avoid persistent asset–liability mismatches.

Because the timing of cash flows from life insurance and annuity liabilities depends on expected longevity, revisions in life expectancy alter both projected liability cash flows and the effective duration of insurers' liabilities (see our calibration of this liability-duration channel in Internet Appendix IE). In the institutional setting described above, these changes are expected to trigger corresponding adjustments in the duration of insurers' asset portfolios. That is, improvements in longevity increase insurers' target asset duration, whereas deteriorations in longevity reduce it.

2.2 Life insurers as dominant investors in corporate bond markets

Life insurers can transmit the effects of longevity shocks to corporate bond markets because corporate bonds are the primary instrument through which they manage portfolio duration. Figure 1 illustrates this role using data from the Federal Reserve's Financial Accounts of the United States (Z.1, Tables L.116, F.116, and L.213; March 2023 release), supplemented with NAIC Schedule D and TRACE data.[4]

— Figure 1 about here —

Panel A shows that corporate bonds are the largest asset class on life insurers' balance sheets, accounting for roughly 40% of total financial assets over the sample period. Panel B shows that corporate bonds also account for the majority of insurers' net financial asset acquisitions. Together, these patterns indicate that duration management is implemented primarily through corporate bond portfolios rather than through reallocations across asset classes.

Panel C highlights the scale of insurers' participation in corporate bond markets. Life insurers hold roughly one-quarter of all outstanding corporate and foreign bonds, making them the largest domestic sectoral holder over our sample period. Given this large market presence, changes in insurers' demand for duration have the potential to affect the relative pricing of long- and short-maturity corporate debt. Panel D provides

[4] Detailed sub-period averages and balance sheet breakdowns underlying Figure 1 are reported in Internet Appendix Table IB.

evidence on trading activity. Insurers account for a substantial share of trading volume in the investment-grade corporate bond segment but a much smaller share in the high-yield segment. This asymmetry suggests that the effects of insurer rebalancing should be concentrated in investment-grade markets, where insurer participation and demand for duration are greatest.

The central force in our setting is liability-driven demand for duration by regulated intermediaries. Changes in life expectancy can affect insurers' liability duration and, consequently, their demand for long-maturity corporate bonds. The effects of these portfolio adjustments depend on imperfect substitutability across maturities and limited arbitrage capacity in corporate bond markets (Greenwood, Hanson, and Stein, 2010). The long end of the corporate bond market is particularly exposed because long-maturity bonds carry greater duration risk, are less liquid than short-maturity bonds, and are held disproportionately by life insurers with concentrated exposure to investment-grade credit. Arbitrage capacity may also be constrained by dealer balance sheets, limiting intermediaries' ability to absorb large shifts in demand (Duffie, 2017; He, Kelly, and Manela, 2017). As a result, increases in insurer demand for long-maturity bonds can lower long-term yields relative to short-term yields and affect the relative cost of borrowing across maturities. We test two implications of this mechanism. First, longevity shocks should induce duration rebalancing within insurers' corporate bond portfolios. Second, these portfolio adjustments should affect the relative pricing of long- and short-maturity corporate debt and, in turn, firms' debt maturity choices.

3 Data and variables

3.1 Longevity shocks

We construct annual U.S. population-level longevity shocks from 1974 to 2018 using mortality and population data from the Human Mortality Database.[5] For each year t,

[5] Available at mortality.org. Our sample ends in 2019 to exclude the COVID period, during which large mortality shocks coincide with substantial monetary and fiscal interventions and potential changes in regulatory conditions affecting life insurers.

we compute weighted-average period life expectancy, denoted E_t, as

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

where $e_{x,t}$ denotes remaining period life expectancy at age x and $N_{x,t}$ denotes population exposure at that age.[6] We use period rather than cohort life expectancy because insurers' liability projections and asset–liability management decisions are based primarily on contemporaneous mortality assumptions.[7] Weighting by population exposure gives greater influence to longevity changes affecting larger cohorts and allows the measure to capture broad shifts in aggregate mortality conditions relevant for insurer liabilities.

We define *LongevityShocks* as the annual change in weighted-average life expectancy, $\Delta E_t = E_t - E_{t-1}$. These annual changes capture revisions in aggregate mortality conditions that, in the institutional setting described above, may affect insurers' demand for duration.[8]

Internet Appendix Figure A.1 plots the level of life expectancy and its annual changes. Although life expectancy evolves gradually over long horizons, annual revisions exhibit substantial variation around the underlying trend. Panel A of Table 1 shows that longevity shocks average 0.15 years over 1974–2018 and have a standard deviation of 0.14 years. Thus, year-to-year fluctuations in life expectancy are nearly as large as the average annual improvement in longevity, indicating economically meaningful variation around the long-run trend.

— Table 1 about here —

In addition, we construct state-level longevity shocks (*LocalLongevityShocks*) using mortality data from the U.S. Mortality Database over 1989–2018.[9] For each state–year,

[6] Ages above 99 are excluded due to data limitations. Younger cohorts are included because certain life insurance products cover these age groups. Results are robust to restricting the sample to ages 20–65.

[7] The NAIC valuation framework bases statutory reserves on current mortality assumptions and tables (National Association of Insurance Commissioners, 2010b). These may incorporate projected mortality improvement in a generational framework where required, but are anchored in period-based measures.

[8] Regulatory reviews, asset adequacy assessments, and portfolio management decisions are conducted on an ongoing basis, making year-over-year revisions in life expectancy a natural horizon over which insurers may adjust portfolio duration.

[9] Available at usa.mortality.org. See Mila (2019).

we compute the annual change in weighted-average period life expectancy using the same methodology as for the national measure. These state-level measures allow us to exploit cross-sectional variation in mortality conditions while controlling for aggregate mortality trends common across insurers. As discussed later, this variation helps distinguish liability-driven portfolio adjustments from common macroeconomic and financial conditions. State-level shocks average 0.10 years and have a standard deviation of 0.21 years (Panel A), indicating substantial variation across states and over time.

— Figure 2 about here —

Figure 2 illustrates the geographic dispersion in state-level longevity shocks by mapping annual changes in life expectancy at four decade endpoints (1990, 2000, 2010, and 2018). The figure reveals substantial within-year heterogeneity in both the magnitude and sign of longevity shocks across states. Positive and negative shocks frequently coexist within the same year, generating substantial within-year variation in mortality conditions across states.

3.2 Bond market variables and issuance outcomes

We construct standard macro-financial controls to account for movements in interest rates, credit conditions, and investor sentiment that may co-move with longevity shocks. Panel B of Table 1 reports summary statistics. Interest-rate conditions are measured using the annual change in the one-year Treasury yield (Δ*Treasury1Y*), while credit conditions are captured by the credit spread (*CreditSpread*), defined as the yield difference between Moody's Baa Corporate Bond Index and the 20-year Treasury yield. We also include the excess bond premium (*EBP*), which captures variation in investor risk sentiment in corporate bond markets (Gilchrist and Zakrajšek, 2012; López-Salido, Stein, and Zakrajšek, 2017).

To examine maturity-specific pricing effects, we define the Treasury term spread (*TermSpread*) as the yield difference between 10- and 1-year Treasury securities. We also construct the change in the corporate term spread (Δ*CorpTermSpread*), measured as the annual change in the yield difference between long-term (maturity >10 years) and short-term (maturity ≤ 3 years) corporate bonds.

Data on corporate bond issuance by U.S. nonfinancial firms are obtained from the Mergent Fixed Income Securities Database (FISD). We use these data to construct issuance-based measures of firms' debt maturity decisions. The ratio of long-term to short-term issuance captures shifts in issuance composition, while the issuance-weighted average duration of newly issued bonds (*NewBondDuration*) summarizes the maturity profile of new financing.[10]

3.3 Life insurers and corporate issuers

Panel C of Table 1 reports summary statistics for life insurers from 1995 to 2019 based on NAIC statutory filings. Insurers in our sample are large and highly leveraged, with substantial exposure to fixed-income markets. The average risk-based capital ratio (RBC), defined as total adjusted capital divided by authorized control level capital, is 17.57, indicating capital levels well above regulatory minimums. The data also exhibit substantial cross-sectional variation in capitalization, portfolio composition, and liability structure, which we later use to examine heterogeneity in insurers' duration responses.

Insurers' bond portfolios are heavily concentrated in investment-grade securities. On average, 55% of holdings are NAIC 1 and 27% are NAIC 2, indicating a strong preference for high-quality corporate bonds. This concentration is consistent with regulatory capital incentives, because risk-based capital charges increase sharply with credit risk, making lower-rated bonds disproportionately costly to hold (see Internet Appendix IC). This composition also aligns with asset–liability management practices that favor high-quality fixed-income assets for long-duration liability matching.

Using transaction-level data from NAIC Schedule D filings, we construct measures of bond holdings, trading activity, and changes in portfolio duration. The average

[10]Macaulay duration estimates do not adjust for callable or convertible features, introducing measurement noise into the duration measures.

annual change in insurers' corporate bond duration (Δ*InsDuration*) is 0.04 years, with substantial variation across insurers and over time.

Panel D of Table 1 reports summary statistics for corporate bond issuers from 1975 to 2019 using Compustat data. The sample exhibits substantial variation in firm characteristics, including profitability, leverage, cash holdings, and asset tangibility. These variables are used as controls in the firm-level analyses to account for differences in firms' financing conditions and investment opportunities.

4 Life insurers' corporate bond duration adjustments

We begin by examining whether improvements in longevity are associated with changes in life insurers' demand for duration. Specifically, we study whether revisions in life expectancy are followed by systematic changes in the duration of insurers' corporate bond portfolios. Because national longevity shocks vary only over time, the evidence in this section should be viewed as establishing the basic relation between longevity and portfolio duration. Section 5 subsequently exploits cross-state variation in local mortality conditions, together with bond-level trading tests, to more sharply distinguish liability-driven duration adjustment from common macroeconomic and financial influences.

4.1 Duration adjustments

Figure 3 plots average annual changes in insurers' corporate bond portfolio duration against lagged longevity shocks. The two series exhibit positive co-movement over time ($\rho = 0.32$), with increases in portfolio duration generally coinciding with positive longevity shocks. To examine this relation formally, we estimate:

$$\Delta InsDuration_{i,t} = \beta \cdot LongevityShocks_{t-1} + \mathbf{X}'_{i,t}\gamma + \zeta_i + \epsilon_{i,t}. \tag{2}$$

The dependent variable is the annual change in insurer i's corporate bond portfolio duration ($\Delta InsDuration_{i,t}$), and the key explanatory variable is the lagged annual change in national life expectancy ($LongevityShocks_{t-1}$). The control vector includes measures of interest-rate conditions, credit-market conditions, macroeconomic activity, and time-varying insurer characteristics that may independently affect portfolio duration (Kaufmann, Storz, and Leyva, 2024; Fang and Xiao, 2025; Kirti and Singh, 2025; Kubitza, 2026). Insurer fixed effects, ζ_i, absorb time-invariant differences in business models, liability composition, and investment policies across insurers. Standard errors are clustered by insurer domicile state, reflecting the state-based structure of insurance regulation. In Internet Appendix Table ID, we show that the baseline duration response remains statistically significant when standard errors are instead clustered by year or two-way clustered by insurer domicile state and year.

— Figure 3 about here —

Improvements in longevity are associated with economically meaningful increases in insurers' corporate bond portfolio duration. As reported in Table 2, Column (1) shows that the coefficient on lagged longevity shocks is 0.77 ($p < 0.01$). It remains nearly unchanged in Column (2), which introduces interest-rate controls, credit-market controls, and insurer fixed effects, and declines only modestly to 0.69 ($p < 0.01$) in Column (3) after further controlling for macroeconomic conditions and time-varying insurer characteristics. The stability of the coefficient across increasingly demanding specifications indicates that the relation between longevity shocks and portfolio-duration adjustment is not driven by the observable interest-rate, credit-market, and macroeconomic conditions captured by our controls.

How large is this response? To assess its economic magnitude, we evaluate the estimates at the sample standard deviation of longevity shocks. A one-standard-deviation shock increases portfolio duration by approximately 0.10 to 0.11 years, based on the Column (1) and Column (3) coefficients of 0.77 and 0.69. This effect is roughly twice as large as that of a one-standard-deviation change in the one-year Treasury yield. To assess whether this magnitude is economically plausible, Internet Appendix IE calibrates the corresponding change in insurers' liability duration. Using the U.S. period life table from the Social Security Administration, a one-standard-deviation increase in life expectancy raises the Macaulay duration of a representative portfolio of annuity and life insurance liabilities by approximately 0.09 years at the industry-average liability mix (Appendix Table IE). The estimated increase in asset duration therefore closely matches the calibrated increase in liability duration, indicating that insurers adjust asset duration nearly one for one with longevity-driven changes in liability duration. This near-unit pass-through is consistent with asset–liability duration matching.

— Table 2 about here —

Placebo test using P&C insurers. An alternative interpretation of the baseline results is that longevity shocks proxy for broader macroeconomic or financial conditions that affect institutional investors generally. To assess this possibility, we examine property and casualty (P&C) insurers. P&C insurers participate in the same corporate bond markets as life insurers and are exposed to many of the same aggregate financial conditions, but their liabilities are substantially shorter in duration and are not closely linked to changes in life expectancy. If the estimated duration response reflects common macroeconomic or financial forces rather than liability-driven demand for duration, similar portfolio adjustments should also be observed among P&C insurers.

Column (4) of Table 2 provides little evidence of a duration response among P&C insurers. Whereas a one-year increase in life expectancy is associated with an increase in portfolio duration of approximately 0.7 years for life insurers, the corresponding estimate for P&C insurers is close to zero and statistically indistinguishable from zero. Because the two sectors operate in the same corporate bond markets and face many of the same aggregate financial conditions, the absence of a comparable response among P&C insurers is difficult to reconcile with an explanation based solely on broad macroeconomic or capital-market forces. Instead, the evidence is consistent with the view that longevity shocks affect portfolio-duration decisions through insurers' exposure to longevity-sensitive liabilities.

Robustness. We conduct several additional tests to assess whether the baseline duration response reflects factors other than changes in longevity-related liability exposure.

A first concern is that the results reflect the long-run upward trend in life expectancy rather than revisions in mortality conditions. To address this possibility, we re-center annual longevity shocks by subtracting their expanding historical mean, thereby removing persistent drift in life-expectancy improvements while preserving short-run mortality variation. As reported in Internet Appendix Table IF, the estimated duration response remains virtually unchanged. This finding suggests that the baseline results are driven by revisions in mortality conditions rather than by the secular increase in life expectancy.

A second concern is that the estimated duration response reflects broader developments in corporate bond markets rather than changes in insurers' liability exposure. Column (1) of Internet Appendix Table IG controls for market-wide corporate bond illiquidity using an Amihud measure constructed from TRACE transaction data. If changes in trading conditions affect insurers' ability to rebalance portfolios or portfolio tilting, they could generate variation in portfolio duration unrelated to mortality conditions. Column (2) controls for changes in corporate bond holdings by mutual funds and pension funds. If the estimated effect reflects broad institutional demand shifts rather than insurer-specific liability management, controlling for these holdings should attenuate the relation between longevity shocks and duration adjustment. Column (3) controls for policyholder surrender and lapse behavior, which alter the timing of liability cash flows and may therefore affect desired duration exposure independently of mortality conditions. Across all three specifications, the estimated coefficient on *LongevityShocks* remains positive and statistically significant.

A final concern is that the duration response reflects alternative portfolio-management practices rather than liability-driven duration adjustment. Because long-maturity bonds generally offer higher yields, reallocations toward higher-yield securities may mechanically increase portfolio duration. Similarly, insurers may use interest-rate derivatives to manage duration exposure rather than adjust corporate bond holdings. To address these possibilities, Column (4) of Internet Appendix Table IG controls for reaching-for-yield behavior following Choi and Kronlund (2018), while Column (5) controls for derivative use identified from NAIC Schedule DB filings following Sen (2023). The estimated coefficient on *LongevityShocks* remains economically meaningful and statistically significant in both specifications.

Overall, the estimated duration response is robust to adjustments for secular longevity trends, bond-market conditions, common institutional demand, policyholder behavior, and alternative portfolio-management practices.

4.2 Cross-sectional heterogeneity in duration adjustment

A liability-driven duration-management channel yields several cross-sectional predictions. Duration responses should be stronger among insurers with greater capacity to rebalance portfolios, greater exposure to longevity-sensitive liabilities, and stronger incentives to maintain asset-liability alignment. We examine each prediction in turn.

4.2.1 Exposure to longevity risk

A key implication of the liability-driven duration-management channel is that duration responses should be strongest among insurers whose liabilities are most exposed to longevity risk. Because improvements in life expectancy affect annuity and life insurance liabilities in opposite ways, insurers' exposure to longevity risk depends on product mix and the extent to which annuity and life insurance business naturally hedge one another (Cox and Lin, 2007). When policyholders live longer than previously expected, annuity providers expect to make benefit payments for a longer period, increasing the longevity exposure of their liabilities. In contrast, life insurers expect death-benefit payments to occur later than previously anticipated, partially offsetting the effects of longevity improvements on overall liability exposure. Therefore, insurers with relatively large annuity books are more exposed to longevity shocks, whereas life insurance business provides a natural hedge. The duration response to longevity shocks should therefore be strongest among insurers whose product mix is tilted toward annuities.

To measure exposure to longevity risk, we exploit cross-sectional variation in insurers' liability composition. Simulations reported in Internet Appendix IH imply that the variance-minimizing product mix requires life insurance premiums to constitute 81.9% of total premiums. Although the average life-insurance premium share in our sample is 74.4%, exposure to longevity risk varies substantially across insurers. Life insurance premium shares span nearly the entire unit interval, ranging from firms that write almost exclusively annuities to firms that write almost exclusively life insurance, and the cross-sectional standard deviation is large. We therefore compute the deviation of an insurer's life insurance premium share from the simulation-implied benchmark and interact this measure with longevity shocks. The specification exploits variation in insurers' liability composition while controlling for time-invariant insurer characteristics through insurer fixed effects. Because annuity and life insurance liabilities carry opposite longevity exposure, insurers whose life insurance share falls below this benchmark hold more annuity-tilted books with greater net longevity exposure, and the signed interaction captures this directional prediction.

Column (1) of Table 3 provides direct evidence on the liability-exposure mechanism. The interaction between longevity shocks and the liability-composition measure is negative and statistically significant, indicating that duration responses decline as insurers become less exposed to longevity risk. Evaluated 20 percentage points below and above the sample mean of the composition measure, the estimated duration response ranges from approximately 0.72 years for relatively annuity-heavy insurers to 0.48 years for relatively life-insurance-heavy insurers, a difference of roughly 50%. The result indicates that exposure to longevity-sensitive liabilities is an important determinant of insurers' duration adjustment following longevity shocks and provides direct support for the liability-driven duration-management channel.

— Table 3 about here —

4.2.2 Financial flexibility

Adjusting duration through corporate bond portfolios requires trading relatively illiquid long-maturity securities. Insurers facing funding or liquidity constraints may be more likely to manage duration using more liquid balance-sheet instruments, such as Treasury securities, rather than through transactions in long-maturity corporate bonds. In contrast, insurers with greater financial flexibility are likely to face lower funding constraints, broader market access, and lower trading costs, making it easier to implement duration adjustments through corporate bond markets. If longevity shocks increase insurers' demand for duration, the response of corporate bond portfolio duration should therefore be stronger among financially flexible insurers.

Following Ge and Weisbach (2021), we proxy for financial flexibility using insurer size and interact longevity shocks with an indicator for large insurers, defined each year as insurers above the median level of total assets. Larger insurers typically have greater balance-sheet capacity and lower transaction costs, which may facilitate duration rebalancing through corporate bond holdings. The evidence is consistent with this prediction. Column (2) of Table 3 shows that the duration response to longevity shocks is significantly stronger for large insurers. A one-year increase in life expectancy is associated with an approximately 0.88-year increase in corporate bond duration for large insurers, compared with about 0.47 years for small insurers, and the difference is statistically significant at the 5% level ($p = 0.041$). The estimates suggest that financially flexible insurers are more likely to implement duration adjustments through corporate bond portfolios, consistent with constrained insurers relying more heavily on alternative duration-management instruments.

4.2.3 Regulatory enforcement intensity

We next examine whether the duration response varies with the intensity of regulatory oversight. Life insurers are subject to asset adequacy reviews, supervisory examinations, and other forms of regulatory monitoring that place considerable emphasis on asset–

liability management. If longevity shocks alter insurers' desired duration exposure, insurers operating under more intensive supervisory scrutiny should have stronger incentives to adjust portfolio duration in order to maintain asset–liability alignment.

Although insurance regulation is coordinated by the NAIC, supervisory oversight is implemented by state insurance departments, generating cross-state variation in examination intensity and supervisory capacity (Grace, 2015; Alexander, Grace, and Luo, 2024). We exploit this variation by constructing an enforcement-intensity measure based on the number of financial and market-conduct examinations conducted per domiciled life insurer in each state-year using data from the NAIC's Insurance Department Resources Report. Insurers are then classified each year into high- and low-enforcement groups based on the cross-sectional median of this measure.

The evidence is consistent with this prediction. Column (3) of Table 3 shows that the interaction between longevity shocks and high enforcement is positive and statistically significant. The implied duration response is approximately 1.03 years in high-enforcement states, compared with 0.37 years in low-enforcement states, indicating that the response is nearly three times larger under more intensive supervision. The difference across groups is statistically significant ($p < 0.01$). These results suggest that regulatory oversight reinforces insurers' incentives to adjust portfolio duration in response to longevity-induced changes in liability exposure.

Overall, duration adjustment is strongest among insurers with greater exposure to longevity-sensitive liabilities, greater financial flexibility, and more intensive supervisory oversight. Taken together, these results suggest that both exposure to longevity risk and insurers' ability and incentives to rebalance portfolios are important determinants of duration adjustment following longevity shocks.

5 Evidence on the liability-driven duration channel

We now turn to tests that more directly isolate the liability-driven duration channel from common aggregate conditions. By exploiting cross-state variation in local mortality conditions among geographically concentrated insurers, we can distinguish liability-driven portfolio adjustments from macroeconomic and financial forces that affect all insurers simultaneously.

We organize the evidence in three layers. First, we examine whether local longevity shocks predict duration adjustments among local life insurers, including adjustments in non-local bonds whose issuers are headquartered outside the insurer's domicile state. This test uses within-year variation in mortality conditions and reduces the concern that the results are driven by national macroeconomic or financial shocks. Second, we use opioid-related mortality and must-access Prescription Drug Monitoring Program adoption to isolate mortality variation arising from sources distinct from ordinary state-level economic conditions. Third, we compare trades in the same bond across insurers exposed to different local longevity shocks. By fixing issuer fundamentals, bond characteristics, and common information shocks, this within-bond test compares how different insurers trade the same bond. It therefore provides particularly sharp evidence that differences in liability exposure generate differences in demand for duration.

5.1 Local longevity shocks and non-local bond trades

We begin with the primary local-shock specification. Local life insurers are disproportionately exposed to mortality conditions in their home states, so positive local longevity shocks should increase their demand for duration if liability-driven duration management is operative. Panel A of Table 4 estimates this relation using all corporate bonds in local insurers' portfolios. In addition to portfolio duration, we examine maturity-specific net purchases by credit rating to determine whether duration adjustment reflects a reallocation toward long-maturity corporate bonds.

The results indicate that positive local longevity shocks affect both portfolio duration and the composition of insurers' bond purchases. A one-year increase in local life expectancy is associated with an approximately 0.43-year increase in portfolio duration ($p < 0.01$). Consistent with active duration rebalancing, insurers increase net purchases of long-term bonds (maturity ≥ 10 years) and reduce net purchases of short-term bonds (maturity ≤ 3 years). This maturity reallocation is concentrated in investment-grade securities, where insurer participation is greatest, and is largely absent in speculative-grade bonds. The pattern suggests that insurers respond to local longevity shocks by increasing duration exposure through the segment of the corporate bond market in which they are most active.

Panel B provides a sharper test by restricting attention to non-local bonds, defined as bonds issued by firms headquartered outside the insurer's domicile state. If local longevity shocks affect portfolio duration through liability exposure rather than through local economic or credit-market conditions, the response should persist in securities whose issuers are less directly exposed to the insurer's local economy. The results support this prediction. Portfolio duration continues to increase following positive local longevity shocks, with an estimated effect of approximately 0.29 years ($p < 0.01$). Insurers also continue to tilt purchases toward longer-maturity non-local securities. The persistence of both the duration response and the maturity reallocation in non-local bonds is difficult to reconcile with explanations based primarily on local issuer fundamentals or local credit conditions and instead points to changes in insurers' demand for duration.

— Table 4 about here —

5.2 Identification using opioid mortality and PDMP adoption

A remaining concern is that local longevity shocks may proxy for unobserved state-level economic or financial conditions rather than changes in expected liability exposure. To address this concern, we focus on mortality variation associated with the opioid crisis and related policy interventions, which generated substantial cross-state differences in life expectancy during our sample period. Prior research attributes much of this variation to supply-side and regulatory factors, including prescribing practices, pharmaceutical marketing, regulatory environments, and the diffusion of synthetic opioids, rather than solely to contemporaneous economic or credit-market conditions (Alpert et al., 2022; Paulozzi et al., 2011; Paulozzi, Mack, and Hockenberry, 2014; Finkelstein et al., 2022; Currie, Jin, and Schnell, 2019; Currie and Schwandt, 2021; Ruhm, 2018). We use this setting in two complementary ways: an instrumental-variables design based on opioid mortality and a policy-based design based on the adoption of must-access Prescription Drug Monitoring Programs (PDMPs).

Instrumental-variable evidence. We instrument state-level longevity shocks using opioid-related deaths per 100,000 population. Because opioid mortality contributed importantly to cross-state variation in life expectancy during our sample period, the instrument isolates the component of longevity variation associated with the opioid crisis. Column (1) of Table 5 reports a strong first stage: higher opioid mortality significantly reduces local life expectancy, and the Kleibergen–Paap F-statistic equals 23.4. Column (2) reports the second-stage estimates. Instrumented longevity shocks are positively associated with insurers' corporate bond portfolio duration ($\beta = 1.261$, $p < 0.10$), with an estimated magnitude similar to that obtained in the baseline local-shock specifications.

— Table 5 about here —

Policy-based evidence. We complement the IV analysis using staggered adoption of must-access Prescription Drug Monitoring Programs (PDMPs), which have been shown to reduce opioid misuse and overdose mortality (Buchmueller and Carey, 2018). If mortality conditions affect insurers' demand for duration, insurers headquartered in adopting states should adjust portfolio duration following PDMP adoption. Column (3) of Table 5 shows that insurers in adopting states increase portfolio duration relative to insurers in non-adopting states ($\beta = 0.184$, $p < 0.01$). The positive estimate indicates that improvements in mortality conditions associated with PDMP adoption are followed by increases in insurers' demand for duration.

The IV and policy-based evidence reinforce the interpretation of the local-shock results. Both approaches isolate mortality variation associated with the opioid crisis and related policy interventions, yet they yield the same qualitative conclusion: improvements in mortality conditions are associated with increases in insurers' portfolio duration. These findings reduce the concern that the local longevity-shock estimates primarily reflect unobserved state-level economic or financial conditions and strengthen the interpretation that changes in expected liability exposure affect insurers' demand for duration.

5.3 A direct bond-level test of liability-driven demand

The sharpest implication of the liability-driven duration channel is a within-bond prediction: insurers exposed to different local longevity shocks should trade the same bond differently. We test this prediction by comparing trades in the same bond across insurers facing different local mortality conditions. Because the comparison is made within a bond, issuer fundamentals, bond characteristics, and common information shocks are held fixed. To focus on economically meaningful rebalancing, we restrict attention to bonds in the top 30% of each insurer's portfolio-weight distribution, thereby reducing noise from small positions.

— Table 6 about here —

Table 6 reports instrumental-variable estimates that instrument the correlation in local longevity shocks between states i and j using the correlation in opioid mortality across those states. The instrument isolates differences in mortality conditions across insurers while absorbing common national mortality trends. Column (2) shows that insurers exposed to negatively correlated longevity shocks are significantly more likely to trade the same bond in opposite directions ($p < 0.01$), consistent with liability exposure generating opposing incentives to adjust duration.

Columns (3)–(4) sharpen the test by restricting the sample to non-local bonds (issued outside both insurers' home states). This restriction reduces the scope for local economic conditions in either insurer's home state to directly affect the traded bonds while preserving the within-bond comparison. The opposite-direction trading pattern remains economically and statistically significant: insurers exposed to opposing longevity shocks continue to trade the same non-local bond in opposite directions. This pattern is difficult to reconcile with issuer-specific fundamentals, local credit conditions, or common information shocks, and is consistent with differences in liability exposure generating differences in demand for the same security.

Overall, the results in this section strengthen the interpretation that longevity shocks affect insurers' corporate bond portfolios through liability exposure. The local-shock tests show that duration responses follow local longevity shocks, the opioid and PDMP tests isolate mortality variation from sources less directly tied to local financial conditions, and the within-bond comparisons show that insurers exposed to different longevity shocks trade the same bonds differently.

6 Aggregate corporate bond market outcomes

Having established that longevity shocks affect insurers' demand for duration, we next examine whether these demand shifts are reflected in corporate bond market outcomes. If insurer demand affects the relative pricing of long- and short-maturity corporate debt, improvements in life expectancy should lower long-term borrowing costs and induce firms to issue debt at longer maturities. We begin by examining aggregate pricing and issuance outcomes before turning to firm-level financing decisions.

6.1 Corporate bond pricing and maturity-specific demand

We first examine whether longevity shocks are associated with changes in the corporate term spread, defined as the yield difference between long-term (maturity $>$ 10 years) and short-term (maturity ≤ 3 years) corporate bonds. If insurer demand for duration affects bond prices, improvements in longevity should be associated with declines in this spread.

Figure 4 plots annual changes in the corporate term spread against lagged longevity shocks. The figure reveals a negative relation between the two series: positive longevity shocks tend to coincide with subsequent declines in the corporate term spread, consistent with the prediction that longevity improvements reduce the relative cost of long-term borrowing.

— Figure 4 about here —

The negative relation in Figure 4 is confirmed in regression analysis. Column (1) of Table 7 reports estimates from time-series regressions of annual changes in the corporate term spread on lagged longevity shocks, controlling for inflation, GDP growth, short-term Treasury yields, Treasury term spreads, credit spreads, and the excess bond premium. The estimated coefficient on *LongevityShocks* is negative and statistically significant ($\beta = -5.653$, $p < 0.01$).[11] Evaluated at the sample standard deviation of longevity shocks (0.14 years), the estimates imply an approximately 79-basis-point decline in the annual change in the corporate term spread. Because the analysis relies on aggregate annual time-series variation, the estimates should be interpreted as market-level evidence that complements the insurer-level findings rather than as standalone causal estimates.

— Table 7 about here —

6.2 Aggregate issuance maturity responses

If longevity-driven shifts in insurer demand lower the relative cost of long-term borrowing, firms should respond by issuing debt at longer maturities. We examine this prediction using aggregate measures of issuance duration and issuance composition constructed from FISD data.

Figure 5 plots annual changes in the issue-size-weighted average duration of newly issued corporate bonds against lagged longevity shocks. The two series exhibit positive co-movement ($\rho = 0.47$), consistent with firms issuing longer-maturity debt following positive longevity shocks.

[11] Treasury term spreads load positively, reflecting co-movement with the risk-free yield curve, while the excess bond premium loads negatively, capturing cyclical variation in credit conditions.

— Figure 5 about here —

The positive relation in Figure 5 is confirmed in regression analysis. Column (2) of Table 7 shows that lagged longevity shocks are positively associated with issuance duration ($\beta = 2.477$, $p < 0.05$). Evaluated at the sample standard deviation of longevity shocks (0.14 years), the estimates imply an increase of approximately 0.35 years in issuance duration, corresponding to roughly one-third of a typical annual fluctuation in the series. The estimates indicate that shifts in insurer demand are associated with economically meaningful changes in the maturity structure of new corporate bond issuance.

— Figure 6 about here —

Figure 6 provides complementary evidence using issuance composition rather than issuance duration. The figure plots annual changes in the log ratio of long-term to short-term corporate bond issuance against lagged longevity shocks. The two series exhibit positive co-movement ($\rho = 0.54$), indicating that improvements in longevity tend to coincide with increases in the relative share of long-maturity issuance.

Column (3) of Table 7 formalizes this relation. The coefficient on *LongevityShocks* is positive and statistically significant ($\beta = 1.714$, $p < 0.05$). Evaluated at the sample standard deviation of longevity shocks, the estimates imply an increase of approximately 0.24 in the log ratio of long- to short-term issuance, corresponding to roughly a 27% increase in the relative share of long-maturity issuance. The issuance-composition results reinforce the evidence from issuance duration by indicating that firms tilt borrowing toward longer maturities following positive longevity shocks. As with the pricing results, these aggregate issuance patterns should be interpreted as market-level evidence that complements the insurer-level findings.

7 Firm-level financing responses

The evidence thus far suggests that longevity shocks affect insurers' demand for duration and are associated with changes in corporate bond pricing and issuance patterns.

We next examine whether these aggregate patterns are reflected in firms' financing decisions. Specifically, we test whether firms extend debt maturity following positive longevity shocks and whether the response is stronger among firms with greater exposure to insurer demand.

To conduct the analysis, we combine bond-level issuance data from Mergent FISD with firm-level financial information from Compustat. Issuers are matched using Capital IQ CUSIPs supplemented by manual name matching. More than 80% of bond issues are successfully linked to firm-level financial data, allowing us to relate issuance maturity decisions to longevity shocks and cross-sectional differences in exposure to insurer demand.

We classify newly issued bonds into four maturity categories: short-term (0–3 years), medium-term (3–10 years), long-term (10–20 years), and extra-long-term (20+ years). If longevity-driven shifts in insurer demand lower the relative cost of long-term borrowing, firms should substitute toward longer-maturity debt. To examine this prediction, we model issuance as a discrete choice across maturity categories using the following multinomial logit specification:

$$\log\left(\frac{P(Issue_{i,t}=j)}{P(Issue_{i,t}=s)}\right) = \beta_j \cdot LongevityShocks_{t-1} + \mathbf{Z}'_{i,t-1}\lambda_j, \tag{3}$$

where $Issue_{i,t} = j$ indicates that a bond issued by firm i at time t falls into maturity category j, and s denotes the short-term baseline category. The coefficients β_j capture how longevity shocks affect the relative likelihood of issuing in category j versus short-term debt. The specification includes macroeconomic conditions, credit-market variables, and firm characteristics contained in $\mathbf{Z}_{i,t-1}$. Standard errors are clustered by issuer headquarters state. Because *LongevityShocks* varies only at the year level, we also verify that the results are robust to clustering standard errors by year; these estimates are reported in Internet Appendix Table II.

— Table 8 about here —

Column (1) of Table 8 reports the multinomial logit estimates. Positive longevity shocks are associated with an increased likelihood of issuing medium-, long-, and extra-long-maturity debt relative to short-term debt, with the strongest response concentrated in the extra-long maturity category. The pattern is consistent with firms shifting borrowing toward maturities that are most sensitive to declines in long-term financing costs. Together with the aggregate issuance evidence in Section 6, these results indicate that changes in insurer demand for duration are associated with meaningful shifts in firms' maturity choices.

Internet Appendix IJ reports average marginal effects from the baseline multinomial specification, which facilitate interpretation of the economic magnitudes. The economic magnitudes are substantial. A one-year increase in life expectancy is associated with a 15.5 percentage point increase in the probability of issuing debt with maturity greater than 20 years, accompanied by declines of 5.5 and 16.3 percentage points in the probabilities of issuing short-term and medium-term debt, respectively. The estimated marginal effect for issuance with maturity between 10 and 20 years is also positive, although less precisely estimated. These results indicate that firms respond to longevity shocks primarily by shifting issuance toward the longest-maturity segment of the corporate bond market.

Excluding demographic-sensitive industries. Demographic trends may directly affect firms in industries whose demand depends strongly on age structure, including healthcare, pharmaceuticals, and leisure (Acemoglu and Linn, 2004; DellaVigna and Pollet, 2007, 2013; Cunha and Pollet, 2020). If improvements in life expectancy increase expected product demand in these sectors, firms may extend debt maturity in anticipation of stronger long-run cash flows rather than changes in financing conditions.

To assess this possibility, we re-estimate the model after excluding the 20 industries identified by DellaVigna and Pollet (2007) as most sensitive to demographic-driven consumption changes. Column (2) shows that the estimated maturity response remains economically and statistically significant in the restricted sample. The estimated magnitudes in Column (2) remain comparable to those in the full-sample specification reported in Column (1), and firms outside demographic-sensitive industries continue to shift issuance toward longer maturities following positive longevity shocks. The persistence of the effect after excluding industries with the strongest direct demographic exposure suggests that the results are unlikely to be driven primarily by changes in expected product demand and instead are consistent with shifts in borrowing conditions associated with insurer demand.

The insurer demand channel. The insurer-demand mechanism yields a particularly sharp cross-sectional prediction. If longevity shocks affect firms' financing decisions through insurers' demand for duration, maturity adjustments should be concentrated among firms whose borrowing costs are most exposed to insurer participation in long-maturity corporate bond markets.

Life insurers disproportionately invest in firms that are already represented in their portfolios and often participate repeatedly in those firms' new bond issues (Zhu, 2021; Barbosa and Ozdagli, 2023; Kubitza, 2026). We classify firms as insurer-dependent if insurers hold more than the sample median share of their outstanding bonds and estimate the multinomial logit separately for high- and low-dependence firms. If insurer demand affects firms' maturity choices, the response to longevity shocks should be strongest among insurer-dependent firms.

The evidence strongly supports this prediction. As reported in Column (3), firms with greater insurer ownership shift issuance away from short-term financing and toward longer maturities following positive longevity shocks, with the strongest effects concentrated in the extra-long maturity category. In contrast, Column (4) shows no statistically significant maturity response among firms with low insurer ownership. Coefficients are small and statistically indistinguishable from zero across all maturity categories. The absence of a detectable response among low-exposure firms suggests that maturity adjustment is concentrated among firms whose borrowing conditions are most exposed to insurer demand.

We further sharpen the test by exploiting insurers' well-documented preference for investment-grade corporate bonds. Regulatory capital incentives and portfolio mandates strongly favor investment-grade securities, implying that any insurer-demand channel should operate primarily in this segment of the market. As reported in Column (5), investment-grade firms exhibit large and statistically significant increases in the relative odds of issuing medium-, long-, and extra-long-term debt versus short-term debt following positive longevity shocks, with the strongest effects concentrated at longer maturities. In contrast, Column (6) shows no statistically significant response among speculative-grade firms. The maturity response is therefore concentrated in the segment of the corporate bond market where insurer participation and demand for duration are greatest.

Overall, Columns (3)–(6) show that maturity adjustment is concentrated among firms most exposed to insurer demand and largely absent where insurers play a limited role. The stronger response among insurer-dependent firms and investment-grade issuers suggests that insurer demand for duration influences firms' financing decisions through corporate bond markets.

8 Real investment responses to longevity shocks

The preceding evidence indicates that longevity shocks affect insurers' demand for duration, corporate bond pricing, and firms' financing choices. We next examine whether these financing responses are also associated with firms' investment activity. Because the investment analysis is more indirect than the insurer-level, bond-level, and financing evidence developed earlier in the paper, we view it as suggestive rather than causal evidence on the real effects of changes in long-term financing conditions.

To examine whether insurer demand for duration is associated with firms' investment activity, we construct issuer-level measures of insurer net purchases of long-term corporate bonds. Specifically, $InsNP^{LT}$ denotes four-quarter cumulative net purchases of bonds with remaining maturity greater than ten years, scaled by bonds outstanding. Higher values therefore proxy for stronger insurer demand for long-duration debt. If stronger insurer demand lowers the cost of long-term financing, firms may respond by increasing long-term investment. Long-term investment is measured as capital expenditures scaled by lagged total assets. All specifications include firm and year fixed effects together with standard firm-level controls.

— Table 9 about here —

Panel A of Table 9 shows that capital expenditures are positively associated with insurer net purchases of long-term corporate bonds. The estimated relation remains statistically significant after including firm and year fixed effects and persists when demographic-sensitive industries are excluded. The association is strongest among investment-grade firms and firms whose bonds are predominantly held by insurers, consistent with the earlier evidence that the financing effects of insurer demand are concentrated where insurer participation is greatest.

Panel B reports analogous specifications using insurer net purchases of short-term corporate bonds. In contrast to the long-duration results, the estimated associations are smaller and generally statistically insignificant across specifications. The absence of comparable effects for short-duration purchases suggests that the investment relation is tied more strongly to insurer demand for long-duration debt.

Overall, the investment evidence is consistent with the financing patterns documented earlier in the paper. The strongest associations appear among insurer-dependent firms and investment-grade issuers, where insurer participation in long-duration corporate bond markets is greatest.

9 Conclusions

This paper studies whether changes in financial intermediaries' demand for duration affect corporate financing. Life insurers provide a natural setting because revisions in life expectancy alter the duration of their liabilities while remaining plausibly unrelated to firms' financing decisions. We show that improvements in longevity increase insurers' demand for duration, leading them to purchase longer-maturity corporate bonds and increase the duration of their corporate bond portfolios.

Several pieces of evidence support a liability-driven duration channel. Insurers increase portfolio duration following improvements in longevity, with the strongest responses among insurers whose liabilities are more exposed to longevity risk and whose balance sheets provide greater capacity and stronger incentives to rebalance duration. The evidence is reinforced by tests exploiting local mortality variation, opioid-related mortality, prescription drug monitoring programs, and within-bond comparisons that hold issuer fundamentals and common information shocks fixed.

We then examine whether these shifts in intermediary demand affect corporate financing. At the aggregate level, positive longevity shocks are associated with lower corporate term spreads and greater issuance at long maturities. At the firm level, debt maturity increases among investment-grade firms and firms whose bonds are more heavily held by life insurers. We also find that stronger insurer demand for duration is associated with greater long-term investment among firms that rely more heavily on insurer financing.

Overall, the findings identify a financial-market transmission mechanism through which revisions in longevity affect corporate financing. More broadly, they suggest that intermediary balance sheets transmit demographic forces to capital markets by shifting the supply of duration. The results therefore indicate that liability-driven portfolio adjustments by large institutional investors can influence the supply and pricing of long-term corporate financing when arbitrage across maturities is limited.

References

Acemoglu, D., and S. Johnson. 2007. Disease and development: The effect of life expectancy on economic growth. *Journal of Political Economy* 115:925–85.

Acemoglu, D., and J. Linn. 2004. Market size in innovation: Theory and evidence from the pharmaceutical industry. *Quarterly Journal of Economics* 119:1049–90.

Actuarial Standards Board. 2001. Actuarial standard of practice no. 22: Statements of opinion based on asset adequacy analysis by actuaries for life or health insurers. https://www.actuarialstandardsboard.org/wp-content/uploads/2014/02/asop022_167.pdf.

———. 2002. Actuarial standard of practice no. 7: Analysis of life, health, or property/casualty insurer cash flows. https://www.actuarialstandardsboard.org/wp-content/uploads/2014/01/asop007_128.pdf.

Alexander, C. S., M. F. Grace, and J. Luo. 2024. The market for model laws: The diffusion of NAIC model laws. *Journal of Risk and Insurance* 92:5–32.

Alpert, A., W. N. Evans, E. M. Lieber, and D. Powell. 2022. Origins of the opioid crisis and its enduring impacts. *Quarterly Journal of Economics* 137:1139–79.

Bakshi, G. S., and Z. Chen. 1994. Baby boom, population aging, and capital markets. *Journal of Business* 67:165–202.

Barbosa, M., and A. Ozdagli. 2023. Is public debt arm's length? Evidence from corporate bond purchases of life insurance companies. Working paper, University of Chicago.

Barclay, M. J., and C. W. Smith. 1995. The maturity structure of corporate debt. *Journal of Finance* 50:609–31.

Becker, B., and V. Ivashina. 2015. Reaching for yield in the bond market. *Journal of Finance* 70:1863–901.

Becker, B., M. M. Opp, and F. Saidi. 2022. Regulatory forbearance in the U.S. insurance industry: The effects of removing capital requirements for an asset class. *Review of Financial Studies* 35:5438–82.

Bloom, D. E., and D. Canning. 2000. The health and wealth of nations. *Science* 287:1207–9.

Bretscher, L., L. Schmid, I. Sen, and V. Sharma. 2025. Institutional corporate bond pricing. *Review of Financial Studies* forthcoming.

Buchmueller, T. C., and C. Carey. 2018. The effect of prescription drug monitoring programs on opioid utilization in Medicare. *American Economic Journal: Economic Policy* 10:77–112.

Chaderina, M., P. Weiss, and J. Zechner. 2022. The maturity premium. *Journal of Financial Economics* 144:670–94.

Chen, Z., and B. Yang. 2019. In search of preference shock risks: Evidence from longevity risk and momentum profits. *Journal of Financial Economics* 133:225–40.

Chiu, Y., and D. L. Pain. 2018. Mortality improvement: Understanding the past and framing the future. Report, Swiss Re Institute.

Choi, J., D. Hackbarth, and J. Zechner. 2018. Corporate debt maturity profiles. *Journal of Financial Economics* 130:484–502.

Choi, J., and M. Kronlund. 2018. Reaching for yield in corporate bond mutual funds. *Review of Financial Studies* 31:1930–65.

Coppola, A. 2025. In safe hands: The financial and real impact of investor composition over the credit cycle. *Review of Financial Studies* 38:2275–325.

Cox, S. H., and Y. Lin. 2007. Natural hedging of life and annuity mortality risks. *North American Actuarial Journal* 11:1–15.

Cunha, I., and J. Pollet. 2020. Why do firms hold cash? Evidence from demographic demand shifts. *Review of Financial Studies* 33:4102–38.

Currie, J., J. Jin, and M. Schnell. 2019. U.S. employment and opioids: Is there a connection? *Research in Labor Markets* 47:253–80.

Currie, J., and H. Schwandt. 2021. The opioid epidemic was not caused by economic distress but by factors that could be more rapidly addressed. *The Annals of the American Academy of Political and Social Science* 695:276–91.

Cutler, D., A. Deaton, and A. Lleras-Muney. 2006. The determinants of mortality. *Journal of Economic Perspectives* 20:97–120.

DellaVigna, S., and J. M. Pollet. 2007. Demographics and industry returns. *American Economic Review* 97:1667–702.

———. 2013. Capital budgeting versus market timing: An evaluation using demographics. *Journal of Finance* 68:237–70.

Domanski, D., H. S. Shin, and V. Sushko. 2017. The hunt for duration: Not waving but drowning? *IMF Economic Review* 65:113–53.

Duffie, D. 2017. Dealer capacity and market liquidity. *Journal of Finance* 72:2219–64.

Ellul, A., C. Jotikasthira, A. Kartasheva, C. T. Lundblad, and W. Wagner. 2022. Insurers as asset managers and systematic risk. *Review of Financial Studies* 35:5483–534.

Ellul, A., C. Jotikasthira, and C. T. Lundblad. 2011. Regulatory pressure and fire sales in the corporate bond market. *Journal of Financial Economics* 101:596–620.

Ellul, A., C. Jotikasthira, C. T. Lundblad, and W. Yihui. 2015. Is historical cost accounting a panacea? Market stress, incentive distortions, and gains trading. *Journal of Finance* 70:2489–538.

Fang, C., and K. Xiao. 2025. What do $40 trillion of portfolio holdings say about monetary policy transmission? Available at SSRN 5025417.

Finkelstein, A., M. Gentzkow, D. Li, and H. L. Williams. 2022. What drives risky prescription opioid use? Evidence from migration. NBER Working Paper No. 30471.

Fuchs, V. R. 2004. Reflections on the socioeconomic correlates of health. *Journal of Health Economics* 23:653–61.

Ge, S., and M. S. Weisbach. 2021. The role of financial conditions in portfolio choices: The case of insurers. *Journal of Financial Economics* 142:803–30.

Gilchrist, S., and E. Zakrajšek. 2012. Credit spreads and business cycle fluctuations. *American Economic Review* 102:1692–720.

Goyal, A. 2004. Demographics, stock market flows, and stock returns. *Journal of Financial and Quantitative Analysis* 39:115–42.

Grace, M. F. 2015. Economics of state versus federal regulation. In *Research Handbook on the Economics of Insurance Law*, 321–74. Edward Elgar Publishing Ltd; CHELTENHAM.

Greenwood, R., S. Hanson, and J. C. Stein. 2010. A gap-filling theory of corporate debt maturity choice. *Journal of Finance* 65:993–1028.

Guedes, J., and T. Opler. 1996. The determinants of the maturity of corporate debt issues. *Journal of Finance* 51:1809–33.

He, Z., B. Kelly, and A. Manela. 2017. Intermediary asset pricing: New evidence from many asset classes. *Journal of Financial Economics* 126:1–35.

Jansen, K. A. E. 2025. Long-term investors, demand shifts, and yields. *Review of Financial Studies* 38:114–57.

Kaufmann, C., M. Storz, and J. Leyva. 2024. Insurance corporations' balance sheets, financial stability and monetary policy. ECB Working Paper Series No 2892.

Kirti, D., and A. V. Singh. 2025. The insurer channel of monetary policy. IMF Working Paper No. 25/54.

Kubitza, C. 2026. Investor-driven corporate finance: Evidence from insurance markets. *Review of Financial Studies* forthcoming.

Lee, R. D., and L. R. Carter. 1992. Modeling and forecasting U.S. mortality. *Journal of the American Statistical Association* 87:659–71.

López-Salido, D., J. C. Stein, and E. Zakrajšek. 2017. Credit-market sentiment and the business cycle. *Quarterly Journal of Economics* 132:1373–426.

Mila, A. 2019. About mortality data for United States. https://www.mortality.org/hmd/USA/InputDB/USAcom.pdf.

Moreno-Serra, R., and P. C. Smith. 2015. Broader health coverage is good for the nation's health: Evidence from country level panel data. *Journal of the Royal Statistical Society. Series A, (Statistics in Society)* 178:101–24.

Murphy, K. M., and R. H. Topel. 2006. The value of health and longevity. *Journal of Political Economy* 114:871–904.

Murray, S., and S. Nikolova. 2022. The bond pricing implications of rating-based capital requirements. *Journal of Financial and Quantitative Analysis* 57:2177–207.

National Association of Insurance Commissioners. 2010a. Actuarial opinion and memorandum regulation (model law 822).

———. 2010b. The naic model rule (regulation) for recognizing a new annuity mortality table for use in determining reserve liabilities for annuities (model 821).

———. 2010c. Standard valuation law (model law 820).

———. 2023. Risk management and own risk and solvency assessment model act (model law 505).

———. 2026. Valuation manual. January 1, 2026 edition.

OECD. 2010. Health care systems: Efficiency and policy settings. Working Paper, OECD.

Ozdagli, A., and Z. Wang. 2020. Interest rates and insurance company investment behavior. Working paper, Federal Reserve Bank of Dallas.

O'Hara, M., A. C. Rapp, and X. A. Zhou. 2025. Bond market resiliency: The role of insurers. *Review of Financial Studies* forthcoming.

Paulozzi, L. J., C. M. Jones, K. A. Mack, and R. A. Rudd. 2011. Vital signs: Overdoses of prescription opioid pain relievers–United States, 1999–2008. *MMWR: Morbidity and Mortality Weekly Report* 60:1487–92.

Paulozzi, L. J., K. A. Mack, and J. M. Hockenberry. 2014. Vital signs: Variation among states in prescribing of opioid pain relievers and benzodiazepines–United States, 2012. *MMWR: Morbidity and Mortality Weekly Report* 63:563–8.

Ruhm, C. J. 2018. Corrected US opioid-involved drug poisoning deaths and mortality rates, 1999-2015. *Addiction* 113:1139–344.

Sen, I. 2023. Regulatory limits to risk management. *Review of Financial Studies* 36:2175–223.

Shaw, J. W., W. C. Horrace, and R. J. Vogel. 2005. The determinants of life expectancy: An analysis of the OECD health data. *Southern Economic Journal* 71:768–83.

Siani, K. 2025. Raising bond capital in segmented markets. *Review of Financial Studies* forthcoming.

Stohs, M. H., and D. C. Mauer. 1996. The determinants of corporate debt maturity structure. *Journal of Business* 69:279–312.

Vayanos, D., and J.-L. Vila. 2021. A preferred-habitat model of the term structure of interest rates. *Econometrica* 89:77–112.

Woolf, S. H., and H. Schoomaker. 2019. Life expectancy and mortality rates in the United States, 1959-2017. *JAMA* 322:1996–2016.

Yu, Y. 2020. Hunt-for-duration in the corporate bond market. Working paper, Princeton University.

Zhu, Q. 2021. Capital supply and corporate bond issuances: Evidence from mutual fund flows. *Journal of Financial Economics* 141:551–72.

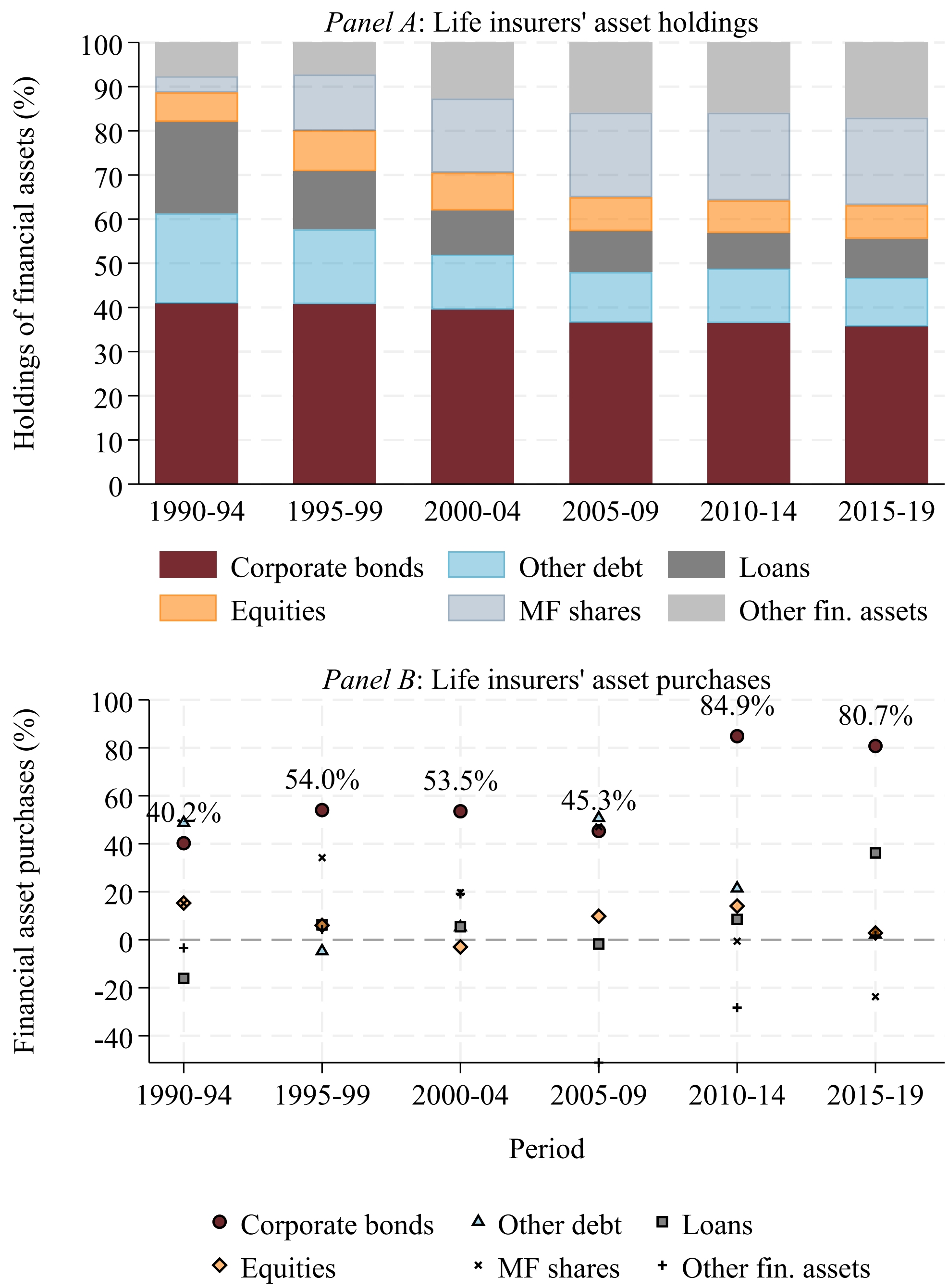
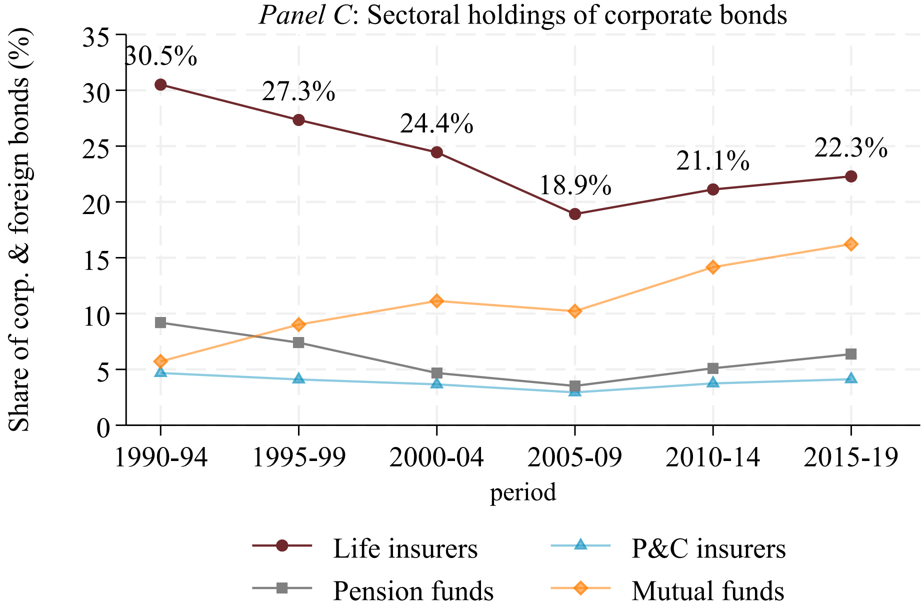


Figure 1. Life insurers in corporate bond markets



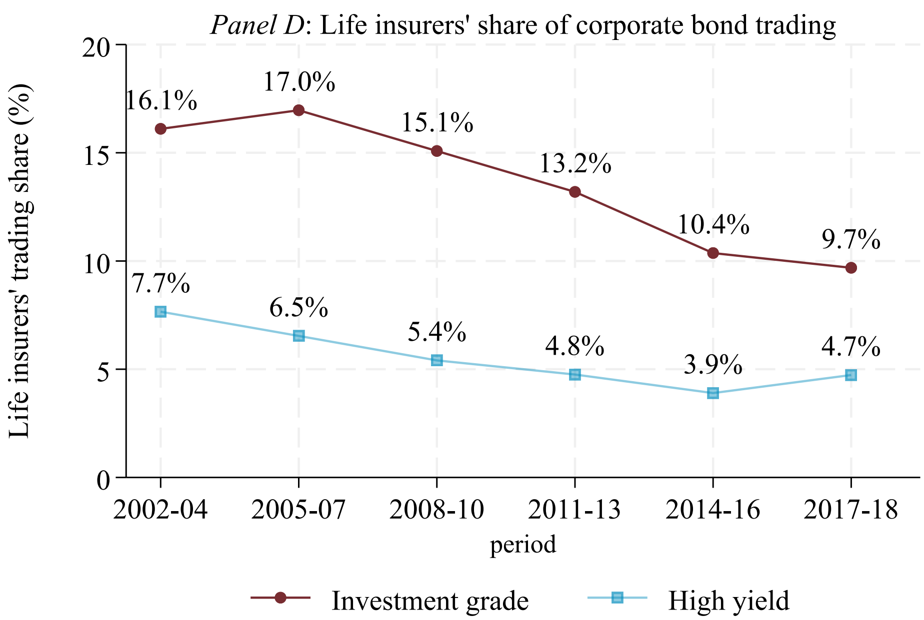
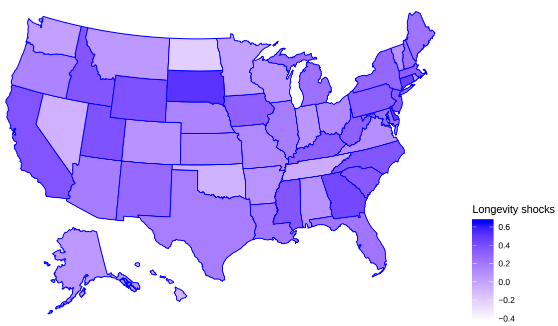
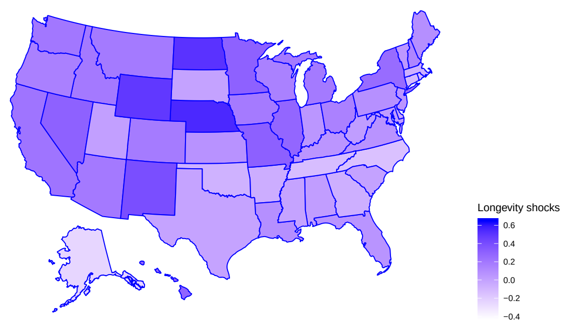


Figure 1 (continued)

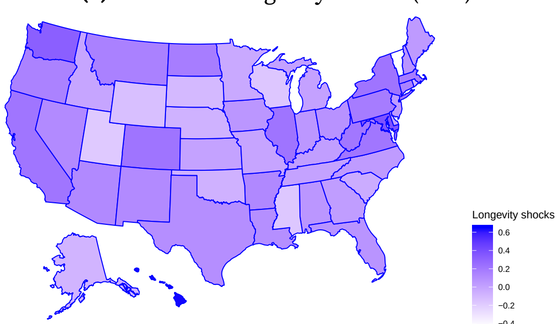
Panels A–C use data from the Federal Reserve's *Financial Accounts of the United States* (Z.1), March 2023 release. Panel A reports life insurers' asset holdings by category as a share of total financial assets (Table L.116). Panel B reports net acquisitions by asset category as a share of total net financial asset acquisitions by life insurers (Table F.116). Panel C reports sectoral holdings of corporate and foreign bonds by major institutional investors, including life insurers, as a share of total outstanding bonds (Table L.213). Panel D reports life insurers' share of corporate bond trading volume by credit quality using NAIC Schedule D and TRACE data. All values are annual and averaged within each sub-period.



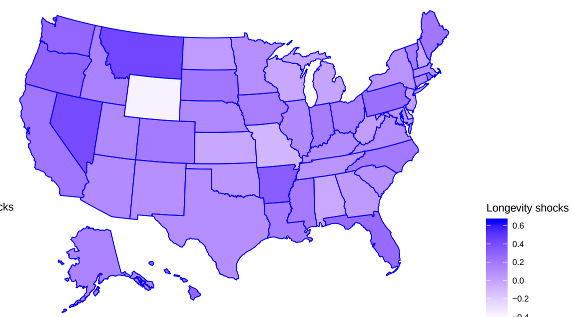
(a) State-level longevity shocks (1990)



(b) State-level longevity shocks (2000)



(c) State-level longevity shocks (2010)



(d) State-level longevity shocks (2018)

Figure 2. State-level longevity shocks across years

This figure maps state-level longevity shocks in 1990, 2000, 2010, and 2018. Longevity shocks are defined as annual changes in weighted-average period life expectancy at the state level. Darker shades indicate increases in life expectancy, while lighter shades indicate smaller or negative shocks. The maps illustrate substantial cross-sectional dispersion in both the magnitude and sign of longevity shocks across states within the same year.

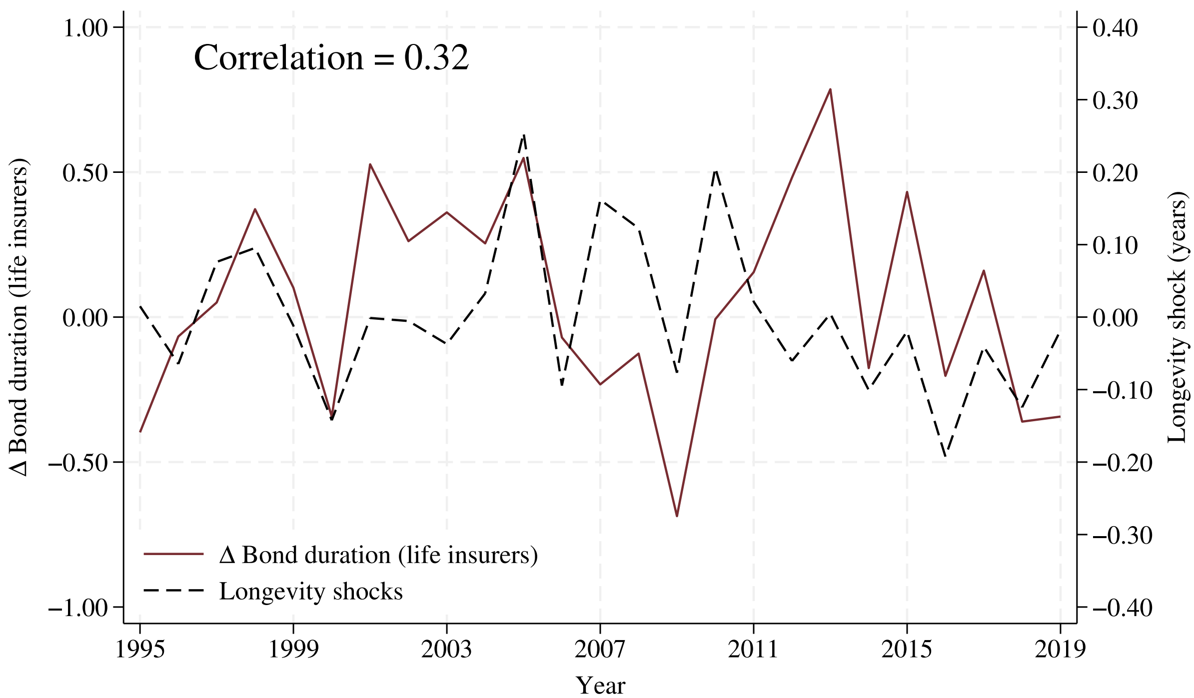


Figure 3. Changes in bond portfolio duration of life insurers and longevity shocks

This figure plots the average annual change in the duration of corporate bond portfolios held by U.S. life insurers (red solid line) together with lagged longevity shocks (blue dashed line), measured as annual changes in weighted-average life expectancy. Bond portfolio data are constructed from NAIC Schedule D filings. Life expectancy data are obtained from the Human Mortality Database. Duration changes are averaged across insurers within each year. The sample period is 1995–2019.

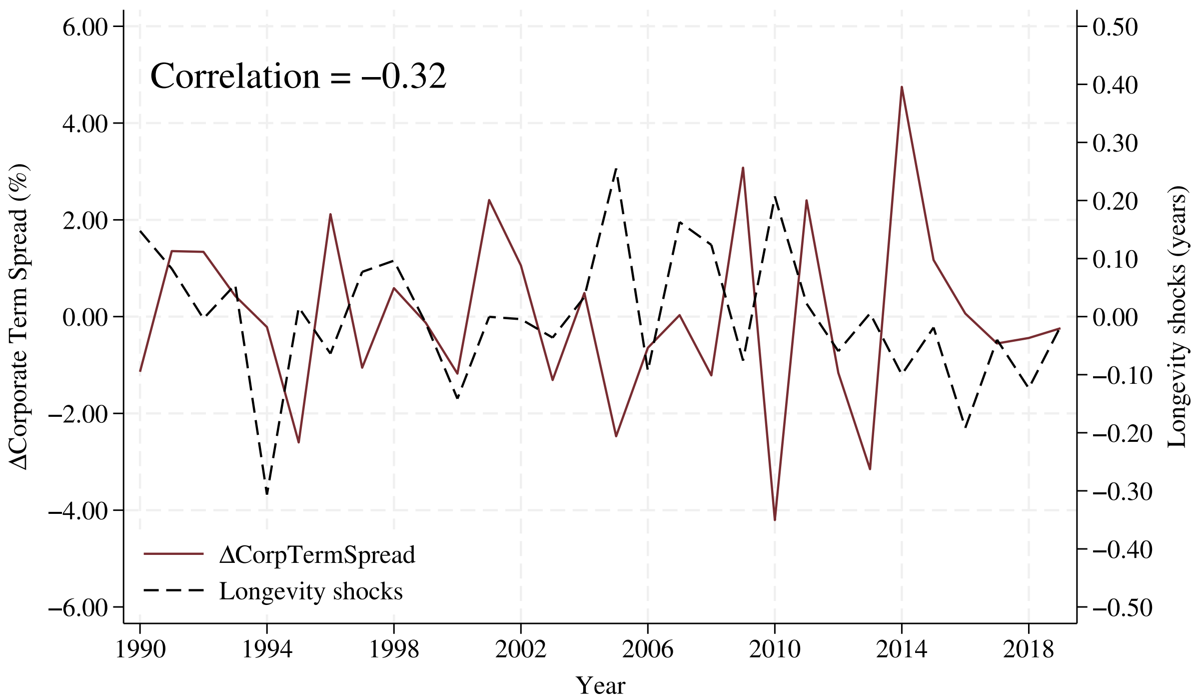


Figure 4. Changes in corporate bond term spreads and longevity shocks

This figure plots annual changes in the corporate term spread (red solid line), defined as the yield difference between long-term (maturity > 10 years) and short-term (maturity ≤ 3 years) corporate bonds, from 1990 to 2019, together with lagged longevity shocks (blue dashed line), measured as annual changes in weighted-average life expectancy.

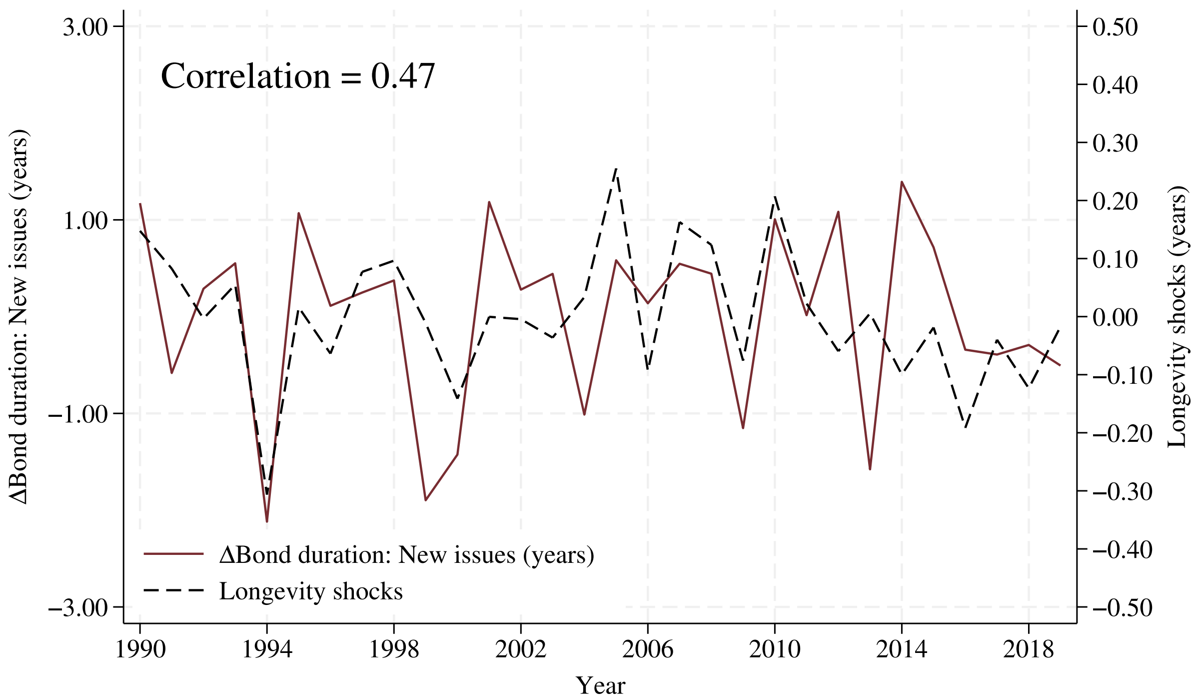


Figure 5. Changes in the average duration of new bond issues and longevity shocks

This figure plots annual changes in the issue-size–weighted average duration of newly issued corporate bonds (red solid line) from 1990 to 2019, together with lagged longevity shocks (blue dashed line). Bond duration is computed using issuance data from Mergent FISD. Longevity shocks are measured as annual changes in weighted-average period life expectancy.

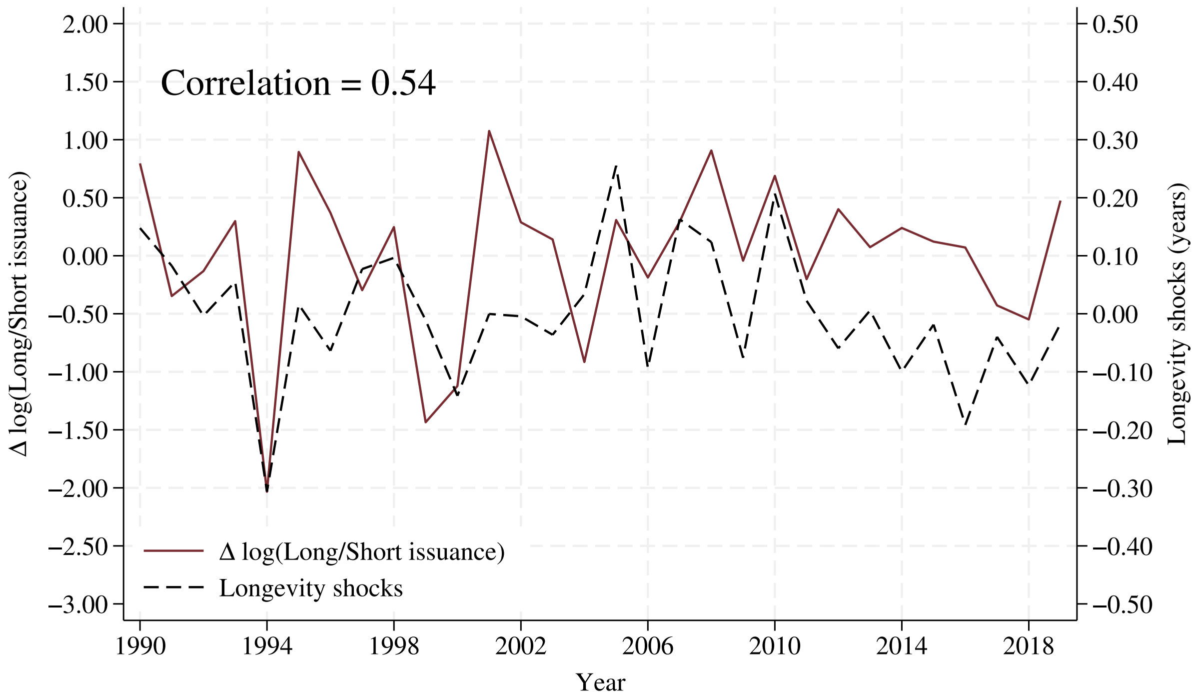


Figure 6. Corporate bond issuance maturity and longevity shocks

This figure plots the annual change in the log ratio of long-term to short-term corporate bond issuance (solid line) from 1990 to 2019, together with lagged longevity shocks (dashed line). Long-term bonds are defined as those with maturity $\geq$ 10 years and short-term bonds as those with maturity $\leq$ 3 years. Issuance is aggregated across firms within each year using data from Mergent FISD. Longevity shocks are measured as annual changes in weighted-average period life expectancy using data from the Human Mortality Database.

Table 1. Summary statistics: Longevity shocks, insurers, and corporate bond markets

This table presents summary statistics for the main variables used in the analysis. Panel A reports the national- and state-level longevity shocks. Panel B summarizes aggregate bond market and macro-financial variables. Panel C reports characteristics of life insurers in the NAIC Schedule D sample. Panel D reports firm characteristics from Compustat. Panel A covers 1974–2018 for national longevity shocks and 1989–2018 for state-level longevity shocks. Panel B covers 1990–2019. Panel C covers 1995–2019. Panel D covers 1990–2019. Variable definitions are provided in Appendix A.

				Distribution		
	N	Mean	SD	$P10$	Median	$P90$
Panel A: Longevity shocks						
LongevityShocks (years)	45	0.15	0.14	-0.01	0.12	0.33
LocalLongevityShocks (years)	1,530	0.10	0.21	-0.16	0.10	0.36
Panel B: Bond market characteristics						
ΔTreasury1Y (%)	30	-0.21	1.39	-2.25	-0.09	1.34
TermSpread (%)	30	1.42	1.13	0.12	1.56	2.98
CreditSpread (%)	30	2.01	0.64	1.24	1.90	2.87
EBP (%)	30	0.11	0.74	-0.54	-0.10	0.74
ΔCorpTermSpread (%)	30	0.03	1.91	-2.56	-0.24	2.38
LTtoSTDebt	30	5.07	3.86	0.93	4.25	10.48
ΔNewBondDuration (years)	30	0.01	0.95	-1.50	0.26	1.13
Panel C: Life insurer characteristics						
InsAssets (MM$)	15,523	6,663	23,996	13	338	12,363
InsLeverage	15,523	0.73	0.25	0.34	0.83	0.95
RBC	15,523	17.57	30.62	4.42	8.89	32.61
InsROA	15,523	0.02	0.05	-0.02	0.01	0.06
NPWGrowth	15,523	0.11	1.24	-0.44	-0.01	0.44
NAIC1	10,250	0.55	0.11	0.42	0.54	0.68
NAIC2	10,250	0.27	0.10	0.16	0.26	0.41
NAIC3	10,250	0.07	0.04	0.02	0.06	0.10
NAIC4	10,250	0.07	0.04	0.02	0.07	0.12
NAIC5	10,250	0.02	0.02	0.00	0.02	0.05
NAIC6	10,250	0.02	0.02	0.00	0.01	0.04
DerivativeHedging	8,391	-0.02	0.10	0.00	0.00	0.00
BondDurationIns (years)	15,523	6.96	2.51	3.78	6.90	10.21
ΔBondDurationIns (years)	15,523	0.04	1.12	-0.93	-0.04	1.14

Table 1: Continued

	N	Mean	SD	Distribution		
				$P10$	Median	$P90$
Panel D: Firm characteristics						
Assets (MM$)	48,131	6,669	24,314	70	906	14,136
ROA	48,131	0.16	0.07	0.08	0.15	0.25
TobinsQ	48,131	1.63	1.07	0.83	1.29	2.77
Leverage	48,131	0.28	0.15	0.08	0.28	0.48
Age	48,131	17.14	12.54	3.00	15.00	36.00
Cash	48,131	0.08	0.10	0.01	0.05	0.21
EquityIssue	48,131	0.01	0.07	-0.03	0.00	0.03
NIGrowth	48,131	0.06	0.72	-0.65	0.08	0.72
Tangibility	48,131	0.46	0.28	0.13	0.40	0.86
Capex	48,131	0.09	0.08	0.02	0.06	0.17

Table 2. Effect of longevity shocks on insurers' bond portfolio duration

This table reports regressions of changes in insurers' corporate bond portfolio duration ($\Delta InsDuration_{i,t}$) on lagged longevity shocks ($LongevityShocks_{t-1}$). Columns (1)–(3) present results for life insurers with progressively richer specifications: column (2) adds interest rates and credit controls, along with insurer fixed effects, and column (3) further incorporates macroeconomic variables—including inflation growth, GDP growth, and state-level GDP and population growth—as well as time-varying insurer characteristics. Column (4) reports results for property and casualty (P&C) insurers as a placebo test. Interest-rate and credit controls include the change in the one-year Treasury yield, the term spread (10-year minus one-year Treasury yield), and the BAA corporate bond spread. Variable definitions are provided in Appendix A. Standard errors, reported in parentheses, are clustered by insurer domicile state, reflecting the state-based structure of insurance regulation and allowing for arbitrary correlation in residuals across insurers and over time within a state. The sample period is 1995–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: $\Delta InsDuration_{i,t}$			
	Life insurers: Baseline			P&C insurers: Placebo
	(1)	(2)	(3)	(4)
LongevityShocks	0.766***	0.783***	0.687***	0.042
	(0.105)	(0.112)	(0.128)	(0.096)
Interest rate and credit controls	No	Yes	Yes	Yes
Insurer controls	No	No	Yes	Yes
Macro controls	No	No	Yes	Yes
Insurer FE	No	Yes	Yes	Yes
R^2	0.005	0.059	0.071	0.060
Observations	15,856	15,786	15,523	26,094

Table 3. Heterogeneity in life insurers' response to longevity shocks

This table reports regressions of changes in insurers' corporate bond portfolio duration (Δ InsDuration$_{i,t}$) on lagged longevity shocks (LongevityShocks$_{t-1}$). Column (1) examines heterogeneity by liability composition, interacting longevity shocks with the deviation of an insurer's life-insurance premium share from the variance-minimizing benchmark of 0.819 implied by the natural-hedging simulation described in Internet Appendix IH. Column (2) examines heterogeneity by insurer size, interacting longevity shocks with an indicator for large insurers. Column (3) examines heterogeneity by regulatory enforcement intensity, interacting longevity shocks with an indicator for insurers domiciled in states with above-median enforcement intensity. All specifications include insurer fixed effects and the full set of interest-rate and credit controls, macroeconomic controls, and insurer characteristics used in Table 2, Column (3). Standard errors, reported in parentheses, are clustered by insurer domicile state. The sample period is 1995–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Liability composition	Insurer size	Enforcement intensity
	(1)	(2)	(3)
LongevityShocks	0.603***	0.475***	0.375***
	(0.121)	(0.160)	(0.131)
LongevityShocks × Deviation	-0.609**		
	(0.258)		
Deviation	-0.075		
	(0.086)		
LongevityShocks × Large		0.407**	
		(0.176)	
Large		-0.120**	
		(0.047)	
LongevityShocks × HighEnforcement			0.651***
			(0.188)
HighEnforcement			-0.071
			(0.049)
Interest-rate and credit controls	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes
Insurer FE	Yes	Yes	Yes
R^2	0.068	0.072	0.073
Observations	13,629	15,523	15,485

Table 4. Corporate bond adjustments by local life insurers

This table examines corporate bond portfolio adjustments by local life insurers in response to local longevity shocks. Local life insurers are defined as insurers deriving at least 80% of their revenues from their home state. Column (1) reports the effect of local longevity shocks on changes in corporate bond portfolio duration. Columns (2)–(4) examine net purchases of long-term bonds (maturity $\geq$ 10 years), and Columns (5)–(7) examine net purchases of short-term bonds (maturity $\leq$ 3 years). Net purchases are scaled by the market value of the insurer's corporate bond portfolio and are reported separately for all bonds, investment-grade bonds, and speculative-grade bonds. Panel A reports results using all bonds held by insurers. Panel B restricts the analysis to non-local bonds, defined as bonds issued by firms headquartered outside the insurer's domicile state. All specifications include the same interest-rate and credit controls, macroeconomic controls, insurer characteristics, and insurer fixed effects as Table 2, Column (3). Standard errors, reported in parentheses, are clustered by insurer domicile state. Variable definitions are provided in Appendix A. The sample period is 1995–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable	ΔInsDuration	Life insurers' net corporate bond purchases					
		Long-term (≥10y)			Short-term (≤3y)		
		All Bonds	Invest. grade	Spec. grade	All Bonds	Invest. grade	Spec. grade
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A: Duration adjustments through both local and non-local bonds							
LocalLongevityShocks	0.425***	0.098**	0.053*	0.001	-0.037**	-0.032**	0.001
	(0.090)	(0.049)	(0.028)	(0.006)	(0.016)	(0.012)	(0.004)
R^2	0.07	0.05	0.04	0.05	0.03	0.03	0.03
Observations	5,437	5,183	5,183	5,183	5,183	5,183	5,183
Panel B: Duration adjustment through non-local corporate bonds							
LocalLongevityShocks	0.290***	0.057*	0.052*	0.006**	-0.019	-0.023	0.001
	(0.060)	(0.032)	(0.027)	(0.003)	(0.014)	(0.015)	(0.002)
R^2	0.08	0.03	0.03	0.04	0.03	0.03	0.02
Observations	5,437	5,183	5,183	5,183	5,183	5,183	5,183
Specification controls (apply to both panels):							
Interest rate and credit controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Table 5. Exogenous variation in longevity and insurers' duration adjustment

This table examines whether the relation between longevity shocks and insurers' duration adjustments is robust to alternative sources of mortality variation. Columns (1) and (2) report instrumental-variable estimates for local life insurers, defined as insurers deriving at least 80% of their revenues from their home state. State-level opioid mortality (deaths per 100,000 population) is used as an instrument for local longevity shocks. Column (1) reports the first-stage regression of local longevity shocks on opioid mortality, and Column (2) reports the corresponding second-stage estimates. Column (3) reports difference-in-differences estimates based on the staggered adoption of state-level Prescription Drug Monitoring Programs (PDMPs) with must-access provisions. The reported coefficient is the interaction between an indicator for states that adopted a must-access PDMP (*PDMPState*) and an indicator for the post-adoption period (*Post*). Columns (1) and (2) include interest-rate and credit controls, macroeconomic controls, insurer characteristics, and insurer fixed effects. Column (3) includes insurer characteristics, insurer fixed effects, and year fixed effects. The Kleibergen–Paap first-stage F-statistic is reported. Standard errors, reported in parentheses, are clustered by insurer domicile state. Variable definitions are provided in Appendix A. The sample period is 1999–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Instrumental variable		Difference-in-differences
	First stage	Second stage	DiD
Dependent variable	LocalLongevityShocks	ΔDuration	ΔDuration
	(1)	(2)	(3)
Instrument			
OpioidMortality	-0.009***		
	(0.002)		
Endogenous variable			
LocalLongevityShocks		1.261**	
		(0.615)	
Difference-in-differences			
PDMPState $\times$ Post			0.184**
			(0.074)
Interest-rate and credit controls	Yes	Yes	No
Macro controls	Yes	Yes	No
Insurer controls	Yes	Yes	Yes
Insurer fixed effects	Yes	Yes	Yes
Year fixed effects	No	No	Yes
First-stage F-statistic	23.4		
R^2	0.18	0.01	0.10
Observations	5,419	5,419	5,419

Table 6. Opposite-direction bond trades and cross-state longevity shocks

This table examines whether insurers exposed to opposing local longevity shocks trade the same corporate bond in opposite directions. The analysis is conducted at the state-pair level. Columns (1) and (3) report first-stage regressions in which the correlation in local longevity shocks between states i and j (LongevityCorr$_{i,j}$) is instrumented using the correlation in opioid mortality between the same states. Columns (2) and (4) report the corresponding second-stage estimates. The dependent variable equals one if insurers headquartered in states i and j trade the same bond in opposite directions during the same period, and zero otherwise. Columns (3) and (4) restrict the sample to bonds issued by firms headquartered outside both insurers' home states, thereby reducing the influence of local economic conditions in either state. Local life insurers are defined as insurers deriving at least 80% of their revenues from their home state. All specifications include the same interest-rate and credit controls, macroeconomic controls, insurer characteristics, and insurer fixed effects as Table 2, Column (3), together with state-level macroeconomic controls (GDP growth and population growth). Standard errors, reported in parentheses, are clustered at the state-pair level. Variable definitions are provided in Appendix A. The sample period is 1995–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	All bonds		Non-local bonds (Excl. bonds in i and j)	
	First stage	Second stage	First stage	Second stage
Dependent variable	LongevityCorr$_{i,j}$	Opposite Trades	LongevityCorr$_{i,j}$	Opposite Trades
	(1)	(2)	(3)	(4)
OpioidMortalityCorr$_{i,j}$	0.250***		0.243***	
	(0.077)		(0.070)	
LongevityCorr$_{i,j}$		-0.064***		-0.069**
		(0.023)		(0.028)
Credit controls	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes
State macro controls	Yes	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes	Yes
R^2	0.174	0.001	0.171	0.001
Observations	173,376	173,376	123,516	123516

Table 7. Longevity shocks, corporate bond pricing, and issuance maturity

This table examines whether longevity shocks affect corporate bond pricing and aggregate issuance outcomes. Column (1) analyzes the annual change in the corporate term spread, defined as the yield difference between long-term (maturity $>$ 10 years) and short-term (maturity $\leq$ 3 years) corporate bonds. Columns (2) and (3) examine issuance outcomes. Column (2) analyzes the annual change in the issue-size-weighted average duration of newly issued corporate bonds. Column (3) analyzes the annual change in the log ratio of long-term to short-term corporate bond issuance, aggregated across firms. All specifications include controls for interest rates, credit-market conditions, and macroeconomic conditions. Standard errors, reported in parentheses, are Newey–West standard errors with two lags. Variable definitions are provided in Appendix A. The sample period is 1990–2019. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable		
	ΔCorpTermSpread	ΔNewBondDuration	$\Delta\ln$(Long-term/Short-term)
	(1)	(2)	(3)
LongevityShocks	-5.653***	2.477**	1.714**
	(1.959)	(0.909)	(0.685)
ΔTermSpread	1.198***	-0.416**	-0.236**
	(0.299)	(0.155)	(0.085)
ΔEBP	-0.685***	-0.037	0.051
	(0.233)	(0.092)	(0.048)
ΔTreasury1Y	-0.100	-0.331***	-0.294***
	(0.209)	(0.107)	(0.079)
ΔCreditSpread	0.334	-0.266	-0.122
	(0.544)	(0.376)	(0.225)
CPIGrowth	0.041	-0.094	-0.060
	(0.311)	(0.170)	(0.086)
GDPGrowth	0.187	-0.083	-0.109
	(0.174)	(0.117)	(0.081)
Constant	0.123	0.054	0.134
	(1.035)	(0.483)	(0.271)
R^2	0.484	0.455	0.654
Observations	30	30	30

Table 8. Longevity shocks and corporate bond maturity choices

This table reports multinomial logit regressions examining how longevity shocks affect firms' bond maturity choices at issuance. Bond maturities are classified as short-term (< 3 years), medium-term (3–10 years), long-term (10–20 years), and extra-long-term (> 20 years), with short-term bonds as the base category. Reported coefficients represent log-odds ratios relative to short-term debt. Column (1) reports results for the full sample of firms. Column (2) excludes firms operating in demographic-sensitive industries identified by DellaVigna and Pollet (2007). Columns (3)–(4) split the sample by exposure to life insurer demand, defining insurer-dependent firms as those with above-median insurer bond holdings. Columns (5)–(6) split firms by credit rating (investment-grade versus speculative-grade). All specifications include macroeconomic controls, credit-market controls, and firm-level controls for firm size (ln(Assets)), profitability (ROA), Tobin's Q, leverage, firm age, cash holdings, equity issuance, net income growth, and asset tangibility. Variable definitions are provided in Appendix A. Standard errors, reported in parentheses, are clustered by issuer state. The sample period is 1990–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	All firms	Non-demographic industries	Insurer-dependent firms		Investment-grade firms	
			Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Base category: short-term maturity (<3 years)						
Panel A: Medium-term maturity (3–10 years)						
LongevityShocks	3.978***	4.710***	4.097***	-9.156	6.489*	1.365
	(1.271)	(1.376)	(1.254)	(8.206)	(3.499)	(2.328)
Panel B: Long-term maturity (10–20 years)						
LongevityShocks	4.784***	5.561***	5.169***	-8.310	7.155**	2.859
	(1.108)	(1.205)	(1.018)	(8.018)	(3.119)	(2.298)
Panel C: Extra-long maturity (≥ 20 years)						
LongevityShocks	5.267***	6.096***	5.838***	-7.757	7.625**	2.490
	(1.092)	(1.199)	(1.056)	(7.536)	(3.181)	(2.061)
Interest rate and credit controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
McFadden's R^2	0.11	0.11	0.06	0.08	0.10	0.12
Observations	6,225	5,685	4,002	2,223	2,720	2,723

Table 9. Insurer bond demand and corporate investment

This table reports regressions examining the relation between insurer demand for corporate bonds and firms' investment. The sample consists of firms with observable corporate bond issuance and insurer trading activity. The dependent variable is capital expenditures scaled by lagged total assets. $InsNP^{LT}$ denotes four-quarter cumulative insurer net purchases of long-term corporate bonds, scaled by bonds outstanding, where long-term bonds are defined as bonds with remaining maturity greater than ten years. $InsNP^{ST}$ is defined analogously for short-term bonds with remaining maturity less than three years. Panel A reports results for long-term insurer demand, while Panel B reports results for short-term insurer demand. Column (1) reports the full sample. Column (2) excludes demographic-sensitive industries. Columns (3)–(4) split firms by insurer dependence, and Columns (5)–(6) split firms by credit rating (investment-grade versus non-investment-grade). All specifications include firm and year fixed effects together with firm-level controls for firm size (ln(Assets)), profitability (ROA), Tobin's Q, leverage, firm age, cash holdings, equity issuance, net income growth, and asset tangibility. Variable definitions are provided in Appendix A. Standard errors, reported in parentheses, are clustered by firm and year. The sample period is 1995–2019. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels.

	All firms	Non-demographic industries	Insurer dependence		Credit rating	
			High	Low	IG	Non-IG
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Long-term insurer demand						
InsNP^{LT}	0.039***	0.040***	0.033*	0.020	0.028**	0.018
	(0.013)	(0.013)	(0.017)	(0.027)	(0.012)	(0.049)
R-squared	0.843	0.846	0.871	0.861	0.836	0.880
Observations	3,393	3,115	2,155	1,054	2762	527
Panel B: Short-term insurer demand						
InsNPST	0.021	0.021	0.023	-0.032	0.042	0.023
	(0.016)	(0.016)	(0.019)	(0.039)	(0.025)	(0.061)
R-squared	0.843	0.847	0.835	0.895	0.870	0.868
Observations	3340	3065	2783	442	2168	969
Specification controls (apply to all panels):						
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes

Appendix

A Variable Definitions, Data Sources, and Sample Period

This appendix defines all variables used in the analysis and reports their data sources and sample periods.

Panel A: Longevity and Mortality Data

LongevityShocks Annual change in U.S. life expectancy constructed from period life tables and exposure data from the Human Mortality Database (HMD; https://mortality.org; Mila, 2019), 1974–2018.

AdjustedLongevityShocks Annual longevity shocks adjusted by subtracting the expanding historical average of annual longevity shocks over the period 1960 through year t from the contemporaneous annual longevity shock.

LocalLongevityShocks State-level longevity shocks, defined analogously using data from the U.S. Mortality Database (https://usa.mortality.org), 1989–2018.

LongevityCorr$_{i,j}$ Time-series correlation of longevity shocks between states i and j.

OpioidMortality State-level opioid-related mortality per 100,000 population, based on CDC WONDER data using ICD-10 codes X40–X44 (unintentional poisoning) and Y10–Y14 (undetermined intent), 1999–2019.

PDMPState Indicator equal to one if a state ever implemented a prescription drug monitoring program (PDMP) with a must-access provision, and zero otherwise (Buchmueller and Carey, 2018). Source: Prescription Drug Abuse Policy System, 1999–2019.

Panel B: Macroeconomic and Credit Market Data

CPIGrowth Growth rate of Consumer Price Index. Source: FRED (CPIAUCSL), 1990–2019.

GDPGrowth Real GDP growth rate. Source: FRED (GDPC1), 1990–2019.

StateGDPGrowth State-level real GDP growth rate. Source: U.S. Bureau of Economic Analysis (SAGDP1), 1990–2019.

StatePopGrowth State-level population growth rate. Source: U.S. Bureau of Economic Analysis (SAINC51), 1990–2019.

IndProdGrowth U.S. industrial production growth rate. Source: FRED (INDPRO), 1990–2019.

CreditSpread Yield difference between Moody's Baa-rated corporate bonds and 20-year Treasury bonds. Source: FRED (GS20), 1990–2019.

$\triangle$**Treasury1Y** Annual change in the 1-year Treasury yield. Source: FRED (GS1), 1990–2019.

TermSpread Yield difference between 10-year and 1-year Treasury yields. Source: FRED (GS10 and GS1), 1990–2019.

TermSpread$^{\perp}$ Orthogonalized Treasury term spread, defined as the residual from regressing the term spread on longevity shocks. Source: FRED (GS10 and GS1), 1990–2019.

Amihud Market-wide corporate bond illiquidity computed from TRACE data. Daily bond-level Amihud measures are aggregated to annual averages and then averaged across bonds. Source: TRACE, 2002–2019.

ΔPensionShare Change in the share of corporate bonds held by pension funds. Source: FRED (BOGZ1FL593063045Q), 1995–2019.

ΔMutualFundShare Change in the share of corporate bonds held by mutual funds. Source: FRED (BOGZ1FL653063043Q), 1995–2019.

Panel C: Bond Market Variables

ΔCorpTermSpread Annual change in the yield spread between long-term (>10 years) and short-term (<3 years) corporate bonds. Bond yields are weighted by their issue size. Source: Mergent FISD, 1990–2019.

Δ ln(**Long-term**/**Short-term**) Annual change in the log ratio of long-term to short-term corporate bond issuance. Source: Mergent FISD, 1990–2019.

ΔNewBondDuration Annual change in the Macaulay duration of newly issued corporate bonds. Source: Mergent FISD, 1990–2019.

ΔIssueSize Annual change in the log ratio of long-term to short-term bond issue size. Source: Mergent FISD, 1990–2019.

Panel D: Life Insurer Characteristics

ΔInsDuration Annual change in the Macaulay duration of life insurers' corporate bond portfolios. Source: NAIC Schedule D filings, 1995–2019.

NetBuyLTBond Net purchases of long-term corporate bonds (maturity ≥10 years), scaled by the market value of the insurer's bond portfolio. Source: NAIC, 1995–2019.

NetBuySTBond Net purchases of short-term corporate bonds (maturity ≤3 years), scaled by the market value of the insurer's bond portfolio. Source: NAIC, 1995–2019.

RBC Risk-based capital ratio, defined as adjusted total capital divided by required risk-based capital; lower values indicate lower capital adequacy. Source: NAIC, 1995–2019.

NPWGrowth Growth rate of net premiums written. Source: NAIC, 1995–2019.

InsROA Insurer return on assets, measured as net income divided by average total assets. Source: NAIC, 1995–2019.

ln(InsAssets) Natural logarithm of total assets. Source: NAIC, 1995–2019.

InsLeverage Ratio of total liabilities to total assets. Source: NAIC, 1995–2019.

Deviation Deviation between an insurer's life insurance premium share and the industry-level optimal natural hedging share (see Appendix IH). The life insurance share equals direct premiums written for life insurance divided by the sum of life insurance and annuity premiums.

HighRFY Indicator equal to one if an insurer's reach-for-yield (RFY) measure exceeds the sample median. RFY is defined as the value-weighted average deviation of bond yields from rating- and maturity-matched benchmarks.

DerivativeUser Indicator equal to one if the insurer uses interest rate derivatives. Source: NAIC Schedule DB.

HighEnforcement We compute enforcement intensity as the number of financial and market conduct examinations conducted by a state insurance department, scaled by the number of domiciled life insurers. HighEnforcement is a dummy which equals 1 if a state's enforcement intensity is above the sample median. Source: NAIC Insurance Department Resources Report.

SurrenderRate Fraction of policies surrendered during the year.

LapseRate Fraction of policies allowed to lapse during the year.

Panel E: Firm Characteristics

InsurerDepFirm Indicator equal to one if the average share of a firm's bonds held by life insurers exceeds the cross-sectional median; zero otherwise. Source: Mergent FISD, 1990–2019.

ln(Assets) Natural logarithm of total assets. Source: Compustat, 1975–2019.

ROA Firm profitability, measured as operating income before depreciation divided by average total assets. Source: Compustat, 1975–2019.

TobinsQ Market-to-book ratio defined as book assets plus market value of equity minus book equity and deferred taxes, divided by book assets. Source: Compustat, 1975–2019.

Leverage Ratio of total debt to total assets. Source: Compustat, 1975–2019.

Age Firm age, measured as years since IPO or first CRSP appearance if IPO date is unavailable. Source: Compustat and CRSP, 1975–2019.

Cash Cash and cash equivalents divided by total assets. Source: Compustat, 1975–2019.

EquityIssues Net equity issuance, defined as equity sales minus equity repurchases, scaled by lagged assets. Source: Compustat, 1975–2019.

NetIncomeGrowth Log growth rate of net income. Source: Compustat, 1975–2019.

Tangibility Net property, plant, and equipment (PPENT), scaled by lagged total assets. Source: Compustat, 1975–2019.

CAPEX Capital expenditure (capex) scaled by lagged total assets. Source: Compustat, 1975–2019.

Internet Appendix for

"Intermediary Demand for Duration and Corporate Financing: Evidence from Longevity Shocks"

Intended for online publication only

IA U.S. Life Expectancy and Longevity Shocks, 1950–2018

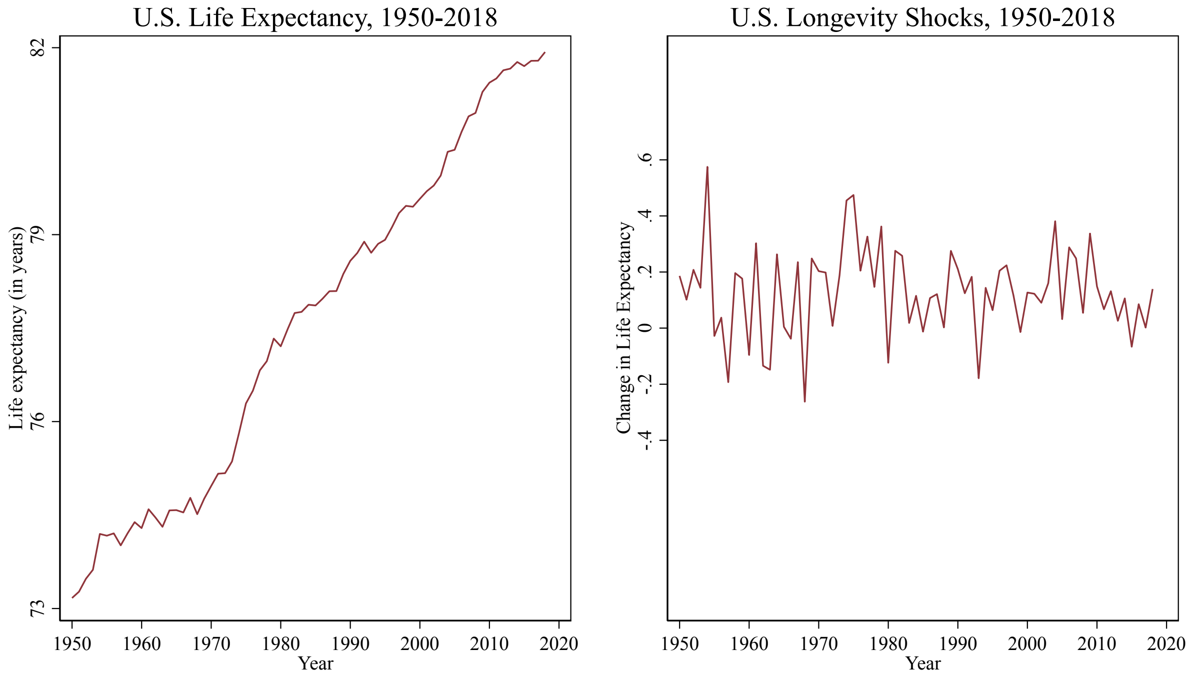


Figure A.1. U.S. Life Expectancy and Longevity Shocks, 1950-2018

The figure plots U.S. weighted-average period life expectancy and its annual changes (longevity shocks) from 1950 to 2018. Life expectancy is constructed as the population-weighted average of period life expectancy across age cohorts using data from the Human Mortality Database. Longevity shocks are defined as annual changes in weighted-average period life expectancy. The figure illustrates the long-run increase in life expectancy together with substantial year-to-year variation around the underlying trend.

IB Life Insurers' Financial Assets and Corporate Bond Holdings

This table summarizes life insurers' asset holdings and net acquisitions, as well as sectoral holdings of corporate and foreign bonds, using data from the Federal Reserve's *Financial Accounts of the United States* (Z.1), March 2023 release, for the period 1990–2019. Panel A reports the average composition of life insurers' financial assets as a share of total financial assets (Table L.116). Panel B reports average net acquisitions by asset class as a share of total net financial asset acquisitions (Table F.116). Panel C reports average holdings of corporate and foreign bonds by major U.S. sectors as a share of total outstanding bonds (Table L.213). The corresponding row numbers from the Financial Accounts used in each construction are reported in parentheses.

	All years	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
Panel A: Composition of financial assets (%)							
Deposits and liquid assets (2 to 4)	1.9	1.3	1.2	2.3	2.7	2.1	1.8
Corporate bonds (10)	**38.3**	**40.9**	**40.8**	**39.5**	**36.5**	**36.5**	**35.7**
Other debt (6 to 9)	14.1	20.4	17.0	12.5	11.5	12.4	11.0
Loans (11)	11.7	20.7	13.1	10.0	9.3	8.1	8.8
Corporate equities (14)	7.9	6.7	9.2	8.6	7.7	7.4	7.7
Mutual fund shares (15)	15.3	3.7	12.7	16.8	19.2	19.8	19.8
Other financial assets (16 to 20)	10.9	6.4	6.1	10.4	13.2	13.9	15.2
Panel B: Acquisitions of financial assets (%)							
Additions to liquid assets (4 to 6)	-8.7	0.8	4.1	1.4	-37.8	-20.7	0.1
Purchase of corporate bonds (12)	**59.8**	**40.2**	**54.0**	**53.5**	**45.3**	**84.9**	**80.7**
Purchase of loans (13)	6.4	-16.1	6.2	5.4	-1.8	8.5	36.2
Purchase of other debt (8 to 11)	20.6	48.7	-4.7	5.2	50.7	21.4	2.2
Purchase of equity (16)	7.5	15.3	6.0	-3.0	9.8	14.1	2.8
Purchase of mutual fund shares (17)	15.3	15.2	34.2	19.7	47.1	-0.6	-23.7
Purchase of other fin. assets (18 to 22)	-0.9	-4.2	0.1	17.7	-13.4	-7.6	1.7

Table IB: Continued

	All years	1990-1994	1995-1999	2000-2004	2005-2009	2010-2014	2015-2019
Panel C: Holdings of Corporate and Foreign Bonds: Major Sectors (%)							
All sectors	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*	*100.0*
Household sector (13)	10.6	14.3	16.5	10.3	8.5	10.9	3.1
Federal/state government (14 and 15)	1.5	1.0	1.4	1.8	1.6	1.7	1.7
Banks (16, 19 to 21)	7.8	9.0	6.2	8.3	10.3	7.5	5.7
Property-casualty insurance (24)	3.9	4.7	4.1	3.7	2.9	3.7	4.1
Life insurance companies (27)	**24.1**	**30.5**	**27.3**	**24.4**	**18.9**	**21.1**	**22.3**
Private pension funds (30)	6.0	9.2	7.4	4.7	3.5	5.1	6.4
Government retirement funds (31 and 32)	5.2	7.6	6.5	4.7	3.8	4.5	4.4
Mutual funds (33 and 34)	11.1	5.7	9.0	11.1	10.2	14.2	16.2
Closed-end funds and ETF (35 and 36)	1.4	0.9	0.8	0.7	0.9	1.9	3.5
Other institutions (37, 40 to 44)	7.3	5.7	8.0	10.7	11.2	5.3	2.7
Rest of the world (45)	20.2	11.6	12.9	18.8	23.9	24.7	29.4
Discrepancy (48)	0.8	-0.2	-0.2	0.8	4.3	-0.7	0.5

IC NAIC Designation and Risk-based Capital Requirements for Bonds

This table reports the NAIC bond designation categories, their corresponding risk-based capital (RBC) requirements for U.S. life insurers, and the associated S&P credit-rating equivalents as of 2018. Additional details on the NAIC designation framework and RBC factors are available from the National Association of Insurance Commissioners (NAIC).

	S&P ratings	Risk-based Capital
NAIC Designation 1	AAA/AA+/AA/AA-/A+/A/A-	0.39%
NAIC Designation 2	BBB+/BBB/BBB-	1.26%
NAIC Designation 3	BB+/BB/BB-	4.46%
NAIC Designation 4	B+/B/B-	9.70%
NAIC Designation 5	CCC+/CCC/CCC-	22.31%
NAIC Designation 6	CC/C/D	30.00%

ID Robustness of Inference to Alternative Clustering Schemes

This table examines the sensitivity of the estimates reported in Table 2 to alternative clustering schemes. Panel A reports the same specifications as Table 2 with standard errors clustered by year. Panel B reports the same specifications with two-way clustering by insurer domicile state and year. Two-way clustering allows residuals to be arbitrarily correlated across insurers within a state and across observations within a year. Variable definitions are provided in Appendix A. All specifications correspond to the matching columns in Table 2 and differ only in the clustering of standard errors; coefficient estimates, controls, fixed effects, observations, and R^2 are therefore identical to those reported in Table 2. Variable definitions are provided in Appendix A. Standard errors are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: $\Delta InsDuration_{i,t}$			
	Life insurers Baseline			P&C insurers Placebo
	(1)	(2)	(3)	(4)
Panel A: Year clustering				
$LongevityShocks$	0.766*	0.783*	0.687*	0.042
	(0.391)	(0.388)	(0.335)	(0.618)
Interest rate and credit controls	No	Yes	Yes	Yes
Insurer controls	No	No	Yes	Yes
Macro controls	No	No	Yes	Yes
Insurer FE	No	Yes	Yes	Yes
R^2	0.005	0.059	0.071	0.060
Observations	15,856	15,786	15,523	26,094
Panel B: Two-way clustering by state and year				
$LongevityShocks$	0.766*	0.783**	0.687**	0.042
	(0.375)	(0.359)	(0.317)	(0.601)
Interest rate and credit controls	No	Yes	Yes	Yes
Insurer controls	No	No	Yes	Yes
Macro controls	No	No	Yes	Yes
Insurer FE	No	Yes	Yes	Yes
R^2	0.005	0.059	0.071	0.060
Observations	15,856	15,786	15,523	26,094

IE Validating the duration response with asset-liability management

A natural question is whether insurers' duration response to longevity shocks is consistent with their asset–liability management practice. This appendix calibrates the change in the Macaulay duration of standard annuity and life insurance liabilities induced by the same longevity shock used in our tests, and compares this change with the estimated asset-duration response of 0.77 years per one-year revision in life expectancy (Table 2). The exercise asks whether the baseline response is the magnitude that asset–liability duration matching would predict. Here we study the *duration* of liabilities, which governs the asset-duration adjustment required to maintain asset–liability alignment.

Mortality and the longevity shock. We use the U.S. period life table, taking one-year death probabilities q_x from the Social Security Administration period table for 2023.[12] The t-year survival probability from age x is ${}_tp_x = \prod_{j=0}^{t-1}(1 - q_{x+j})$, and period life expectancy at age x is $e_x = \frac{1}{2} + \sum_{t \geq 1} {}_tp_x$. We form the population-weighted period life expectancy $E = \sum_x (x + e_x)\,\omega_x$ exactly as in our construction of E_t in Section 3, with stationary life-table weights ω_x.

A longevity shock is a uniform proportional improvement in the force of mortality, $\mu(x) \mapsto k\,\mu(x)$, implemented as $q_x \mapsto 1 - (1 - q_x)^k$. We solve for the k that raises E by exactly one year, matching the definition of *LongevityShocks*. The calibrated improvement is $k = 0.909$, which raises E by 1.00 year and raises remaining life expectancy at age 65 by 0.73 years.

Liability duration. Let $v = (1 + r)^{-1}$. For an annuity paying \$1 per year while the annuitant is alive, and for a life insurance policy paying \$1 at the end of the year of death, the present values and Macaulay durations are

$$PV_x^A = \sum_{t \geq 1} v^t\, {}_tp_x, \qquad D_x^A = \frac{\sum_{t \geq 1} t\, v^t\, {}_tp_x}{PV_x^A}, \tag{E.1}$$

$$PV_x^L = \sum_{t \geq 1} v^t\, {}_{t-1}p_x\, q_{x+t-1}, \qquad D_x^L = \frac{\sum_{t \geq 1} t\, v^t\, {}_{t-1}p_x\, q_{x+t-1}}{PV_x^L}. \tag{E.2}$$

We report a deferred annuity issued at age 45 with payments from age 65, representative of the long-dated annuity liabilities that dominate insurers' longevity-exposed reserves, and whole-life insurance issued at age 45.[13] The duration sensitivity to the shock is $\Delta D = D(\text{post-shock}) - D(\text{baseline})$.

Net liability. An insurer's book combines annuity and life insurance liabilities, whose values move in opposite directions when longevity improves. For a book holding quantities q_A and q_L

[12] Available at https://www.ssa.gov/oact/STATS/table4c6.html. Using the Human Mortality Database period rates or the Lee–Carter framework of Appendix IH yields similar results.

[13] Using a short immediate payout annuity issued at age 65 leaves the standalone annuity sensitivity essentially unchanged (0.24 versus 0.24 years), confirming that the sensitivity reflects the payout phase rather than the duration level. It does, however, lower the net-liability sensitivity at realistic mixes (to about 0.44 to 0.53 years per one-year shock), because the wider duration gap between a short annuity and long-dated life liabilities amplifies the natural-hedge reweighting described below.

of the two contracts, the net-liability duration is the value-weighted average

$$D^{\text{net}} = \frac{q_A\, PV^A\, D^A + q_L\, PV^L\, D^L}{q_A\, PV^A + q_L\, PV^L}. \tag{E.3}$$

We set quantities so that the life insurance share of liability value equals a target w at baseline, then hold quantities fixed under the shock so that the value weights reweight endogenously, capturing the natural-hedge offset.

Results. Panel A of Table IE reports standalone sensitivities. A one-year longevity shock raises annuity duration by about 0.22 to 0.27 years and whole-life duration by about 0.78 to 0.87 years across discount rates. The death-benefit liability is the most duration-sensitive because improving mortality shifts a single far-dated payment later, whereas an annuity's near-dated payments anchor its duration. Panel B reports the net-liability sensitivity across the book mix. At the industry-average life shares of 74.4%, the net-liability duration rises by 0.66 years per one-year shock, or 0.09 years per one-standard-deviation shock. These values bracket the estimated asset-duration response of 0.69 years per one-year shock (0.10 years per one-standard-deviation shock), indicating that the baseline response is close to what asset–liability duration matching of a representative liability book requires.

Table IE. Liability-duration sensitivity to a one-year longevity shock

This table reports the change in the Macaulay duration of insurers' liabilities induced by a longevity shock that raises population-weighted period life expectancy by one year. Mortality uses the Social Security Administration 2023 period life table. The shock is a uniform proportional improvement in the force of mortality, calibrated to $k = 0.909$. Panel A reports standalone durations for a deferred annuity (issued at 45, paying from 65) and whole-life insurance (issued at 45), at annual discount rates of 3%, 4%, and 5%; D_{base} is the baseline duration without longevity shocks, ΔD the change per one-year shock, ΔD is the duration change per one-year shock. Panel B reports the net-liability duration at a 4% discount rate across the life insurance value share w, combining the deferred annuity and whole-life contracts. For comparison, the estimated asset-duration response in Table 2 is 0.69 years per one-year shock.

Panel A: Standalone liability duration (years)

	$r = 3\%$		$r = 4\%$		$r = 5\%$	
	D_{base}	ΔD	D_{base}	ΔD	D_{base}	ΔD
Deferred annuity (45 to 65)	29.57	0.27	29.04	0.24	28.55	0.22
Whole life (45)	31.50	0.87	29.66	0.83	27.78	0.78

Panel B: Net-liability duration by life insurance value share ($r = 4\%$)

Life value share w	0.00	0.25	0.50	0.744	1.00
D_{base} (years)	29.04	29.20	29.35	29.50	29.66
ΔD (years)	0.24	0.37	0.51	0.66	0.83

IF Insurers' bond portfolio duration: Robustness using mean-adjusted longevity shocks

This table reports regressions of changes in insurers' corporate bond portfolio duration ($\Delta InsDuration_{i,t}$) on lagged mean-adjusted longevity shocks ($AdjustedLongevityShocks_{t-1}$). Mean-adjusted longevity shocks are constructed by subtracting the expanding historical average of annual longevity shocks from the contemporaneous annual longevity shock, thereby reducing the influence of the long-run trend in life-expectancy improvements while preserving short-run longevity variation. The specification and column structure follow Table 2. Columns (1)–(3) report results for life insurers with progressively richer control specifications. Column (4) reports results for property and casualty (P&C) insurers as a placebo test. Variable definitions are provided in Appendix A. Standard errors, reported in parentheses, are clustered by insurer domicile state. The sample period is 1995–2019. $*$, $**$, and $***$ denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent variable: $\Delta InsDuration_{i,t}$			
	Life insurers Baseline			P&C insurers Placebo
	(1)	(2)	(3)	(4)
AdjustedLongevityShocks	0.757***	0.777***	0.678***	0.015
	(0.104)	(0.111)	(0.127)	(0.096)
Interest rate and credit controls	No	Yes	Yes	Yes
Macroeconomic controls	No	No	Yes	Yes
Insurer controls	No	No	Yes	Yes
Insurer fixed effects	No	Yes	Yes	Yes
R^2	0.01	0.06	0.07	0.06
Observations	15,856	15,786	15,523	26,094

IG Robustness: Effect of longevity shocks on insurers' bond portfolio duration

This table reports robustness tests for the relation between changes in insurers' corporate bond portfolio duration ($\Delta InsDuration_{i,t}$) and lagged longevity shocks ($LongevityShocks_{t-1}$). Column (1) adds a market-wide corporate bond illiquidity measure ($Amihud$) constructed from TRACE transaction data. Column (2) controls for changes in corporate bond holdings by other institutional investors, including mutual funds ($\Delta MutualFundShare$) and pension funds ($\Delta PensionShare$), to account for common-demand effects in corporate bond markets. Column (3) controls for policyholder surrender and lapse rates, which may affect the effective duration of insurers' liabilities. Column (4) controls for reaching-for-yield incentives using an indicator for insurers with above-median reaching-for-yield behavior ($HighRFY$). Column (5) controls for interest-rate derivative use using an indicator for insurers with net interest-rate derivative exposure ($DerivativeUser$). The sample period is 1995–2019 except in Column (1), which begins in 2002 because of TRACE data availability, and Column (5), which is estimated over 2006–2019 because Schedule DB derivative data are available beginning in 2006. All specifications include insurer fixed effects, interest-rate and credit controls, macroeconomic controls, and insurer characteristics. Variable definitions are provided in Appendix A. Standard errors, reported in parentheses, are clustered by insurer domicile state. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
LongevityShocks	0.628***	0.681***	0.725***	0.683***	0.678***
	(0.144)	(0.133)	(0.125)	(0.128)	(0.199)
Illiquidity	-0.734***				
	(0.125)				
Δ MFShare		-10.494***			
		(1.237)			
Δ PensionShare		5.004***			
		(1.346)			
Δ SurrenderRate			0.002		
			(0.002)		
ΔLapseRate			0.001		
			(0.002)		
$HighRFY$				0.121***	
				(0.028)	
$DerivativeUser$					-0.304***
					(0.044)
Insurer FE	Yes	Yes	Yes	Yes	Yes
Interest-rate and credit controls	Yes	Yes	Yes	Yes	Yes
Insurer controls	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes
R^2	0.087	0.076	0.072	0.073	0.096
Observations	11,447	15,523	13,917	15,523	8,391

IH Natural Hedge Ratio of Life Insurance Companies

We derive the natural hedge ratio for life insurance companies using the Lee–Carter mortality model (Lee and Carter, 1992). The model specifies the logarithm of the mortality rate for individuals of age x in year t, denoted by $m_{x,t}$, as

$$\log(m_{x,t}) = \alpha_x + \beta_x \kappa_t, \tag{D.1}$$

where α_x captures age-specific mortality patterns, κ_t is a time-varying mortality index representing aggregate mortality conditions, and β_x governs how changes in κ_t affect mortality across ages. Standard identification constraints impose $\sum_t \kappa_t = 0$ and $\sum_x \beta_x = 1$.

The one-year death probability for an individual aged x in year t is approximated by

$$q_{x,t} \approx 1 - \exp(-m_{x,t}),$$

which assumes a constant mortality rate within the year. The *ex post* probability that an individual aged x at time t survives for an additional T years is

$$S_{x,t}(T) = \prod_{s=1}^{T} \Big(1 - q_{x+s-1,t+s}\Big).$$

Because future mortality rates are unknown at time t, the corresponding expected survival probability conditional on the mortality index is

$$p_{x,t}(T, \kappa_t) = \mathbb{E}\big(S_{x,t}(T) \mid \kappa_t\big).$$

Annuity liabilities Consider an annuity portfolio consisting of k in-force annuitants with ages $x_1, \ldots, x_k$ at the valuation date. Each annuitant receives an annual payment of \$1 until death. The expected future liability per in-force annuitant at valuation date t is

$$FL_t^A = \frac{1}{k} \sum_{i=1}^{k} \sum_{s=1}^{\infty} (1+r)^{-s} p_{x_i,t}(s, \kappa_t), \tag{D.2}$$

where r is the annual interest rate and superscript A denotes annuity liabilities.

Life insurance liabilities The *ex post* probability that an individual aged x at time t survives until $t + T - 1$ and dies in year $t + T$ is

$$D_{x,t}(T) = \prod_{s=1}^{T-1} \Big(1 - q_{x+s-1,t+s}\Big) \cdot q_{x+T-1,t+T}.$$

The corresponding expected death probability is

$$q_{x,t}(T, \kappa_t) = \mathbb{E}\big(D_{x,t}(T) \mid \kappa_t\big).$$

For a life insurance portfolio consisting of k in-force policies with insured ages $x_1, \ldots, x_k$ at the valuation date and paying $1 upon death, the expected future liability per policy at valuation date t is

$$FL_t^L = \frac{1}{k}\sum_{i=1}^{k}\sum_{s=1}^{\infty}(1+r)^{-s} q_{x_i,t}(s, \kappa_t), \tag{D.3}$$

where superscript L denotes life insurance liabilities.

Natural hedge simulation We simulate the natural hedge under the following assumptions: (1) Annuity and life insurance policies cover insured individuals aged 35–80, reflecting the age distribution most relevant for major life insurance and annuity products. (2) Annuities pay $1 annually until death or for a maximum of 20 years. (3) Life insurance contracts are 20-year term policies paying $1 upon death. (4) The discount rate is constant at $r = 1\%$. (5) The U.S. mortality index is estimated from Human Mortality Database data (1933-2018, ages 0-99). (6) Time 0 corresponds to the end of 2018. (7) Mortality dynamics are simulated using 10,000 draws from the estimated Lee-Carter model.

Optimal hedge ratio Because annuity and life insurance liabilities respond differently to mortality improvements, combining the two products may partially hedge insurers' exposure to longevity-induced variation in effective liability duration. Using the simulated mortality paths from the Lee–Carter model, we compute scenario-specific present values of annuity and life insurance liabilities, denoted by $\widetilde{FL}_0^A$ and $\widetilde{FL}_0^L$. Consider a portfolio holding X annuity contracts and θX life insurance contracts. Total liabilities under a given mortality scenario are

$$\widetilde{FL}_0 = (\widetilde{FL}_0^A + \theta \widetilde{FL}_0^L)X.$$

The natural hedge ratio θ is chosen to minimize the variance of total liabilities across simulated mortality paths:

$$\min_{\theta} \operatorname{Var}(\widetilde{FL}_0).$$

Let P^A and P^L denote total premiums collected from annuities and life insurance, respectively. The implied share of life insurance premiums is

$$\frac{P^L}{P^A + P^L} = \frac{\theta \mathbb{E}(\widetilde{FL}_0^L)}{\mathbb{E}(\widetilde{FL}_0^A) + \theta \mathbb{E}(\widetilde{FL}_0^L)}. \tag{D.4}$$

Results The simulation yields an optimal life insurance premium share ($\frac{P^L}{P^A+P^L}$) of 81.9%, which is stable across alternative cohort definitions and contract horizons. This benchmark exceeds the industry average life insurance premium share of 74.4% observed in NAIC data from 1995 to 2019. Cross-sectional dispersion is substantial, however, with a standard deviation of 35 percentage points, indicating that many insurers remain materially exposed to longevity-induced variation in projected liability horizons despite partial natural hedging. This heterogeneity provides a natural source of cross-sectional variation in insurers' incentives to adjust asset duration in response to longevity shocks. This variance-minimizing exposure governs the cross-sectional heterogeneity in duration responses; the average magnitude of the response is calibrated separately in Internet Appendix IE, which studies the duration of liabilities rather than the variance of their value.

II Longevity Shocks and Corporate Bond Maturity Choices: Robustness to Year Clustering

This table reports robustness of the multinomial logit estimates in Table 8 to clustering standard errors by year. The specifications correspond to those in Table 8 and differ only in the clustering of standard errors. Bond maturities are classified as short-term (< 3) years), medium-term (3–10 years), long-term (10–20 years), and extra-long-term (> 20 years), with short-term bonds as the omitted category. Reported coefficients represent log-odds ratios relative to short-term debt. All specifications include the same macroeconomic controls, credit-market controls, firm-level controls, and samples as the corresponding columns in Table 8. Standard errors, reported in parentheses, are clustered by year. The sample period is 1990–2019. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	All firms	Non-demographic industries	Insurer-dependent firms		Investment-grade firms	
			Yes	No	Yes	No
	(1)	(2)	(3)	(4)	(5)	(6)
Base category: short-term maturity (<3 years)						
Panel A: Medium-term maturity (3–10 years)						
LongevityShocks	4.053***	4.726***	4.179***	-6.869	6.481***	1.348
	(0.950)	(0.931)	(0.940)	(7.473)	(2.461)	(2.189)
Panel B: Long-term maturity (10–20 years)						
LongevityShocks	4.997***	5.725***	5.278***	-5.760	7.035***	3.261
	(0.910)	(0.957)	(1.051)	(7.564)	(2.650)	(2.154)
Panel C: Extra-long maturity ($\geq$ 20 years)						
LongevityShocks	5.407***	6.189***	5.896***	-5.411	7.334**	3.135
	(1.227)	(1.284)	(1.260)	(7.786)	(2.961)	(2.325)
Interest rate and credit controls	Yes	Yes	Yes	Yes	Yes	Yes
Macro controls	Yes	Yes	Yes	Yes	Yes	Yes
Firm controls	Yes	Yes	Yes	Yes	Yes	Yes
McFadden's R^2	0.11	0.10	0.05	0.09	0.10	0.12
Observations	6,806	6,221	4,415	2,391	2,932	3,067

IJ Average marginal effects from multinomial logit estimates

This table reports average marginal effects from the baseline multinomial logit specification in Column (1) of Table 8. Entries represent changes in the predicted probability of issuing bonds in each maturity category associated with a one-year increase in *LongevityShocks*. Standard errors, reported in parentheses, are clustered by the insurer domicile state. The sample period is 1990–2019. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	Short-term (< 3 years)	Medium-term (3–10 years)	Long-term (10–20 years)	Extra-long-term (> 20 years)
LongevityShocks	-0.0546***	-0.1625**	0.0618	0.1553**
	(0.0144)	(0.0653)	(0.0620)	(0.0639)
Observations	6,225	6,225	6,225	6,225