Internet Appendix for "Insurers' Investments and Insurance Prices"

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A Proofs of Theoretical Results

A.1 Proofs of Theorems

Proof of Theorem 1

We have defined the lower bound on insurer i's optimal asset allocation in equation (12). By a similar logic we can also define an upper bound. To see this, note that $\tau_i = \bar{\tau} - \sigma_i$ is the minimum fraction of claims that will arrive early. Each insurer therefore knows they will be forced to sell at least $(\bar{\tau} - \sigma_i) C_i$ of assets at time 1. They optimally hold at least this amount in liquid assets, which leads to the following definition

$$\overline{\Theta}_i = L_i - \frac{(\bar{\tau} - \sigma_i) C_i}{1 + R^F} \tag{A.1}$$

Investing $\Theta_i > \overline{\Theta}_i$ would mean insurer i pays sales costs on illiquid assets of amount $\Theta_i - \overline{\Theta}_i$ with no expectation of earning the liquidity premia R^{liq}. The key implication of the upper bound $\overline{\Theta}_i$ is that each insurer does not sell illiquid assets when $\tau = \bar{\tau} - \sigma$ realizes. We can therefore restate insurer i's wealth in two cases depending on the fraction τ_i of claims arriving early

$$W_i = \begin{cases} L_i \left(1 + R^F\right) - C_i + \Theta_i R^{liq} & \text{if } \tau_i = \bar{\tau} - \sigma_i \\ L_i \left(1 + R^F\right) - C_i + \underline{\Theta}_i R^{liq} - \frac{1}{2}\lambda \left(\Theta_i - \underline{\Theta}_i\right)^2 \left(1 + R^F\right)^2 & \text{if } \tau_i = \bar{\tau} + \sigma_i \end{cases} \tag{A.2}$$

with both cases occurring with equal probability. The first case shows the simple outcome where insurer i holds enough liquid assets to cover early claims. In the second case, insurer i sells all liquid asset holdings, worth $(L_i - \Theta_i)\left(1 + R^F\right)$ at $t = 1$, plus a portion of their illiquid asset portfolio to cover remaining $t = 1$ claims. Specifically, dollar amount $(\bar{\tau} + \sigma_i) C_i - (L_i - \Theta_i)\left(1 + R^F\right)$ of illiquid assets are sold early. Substituting the lower bound of insurer i's illiquid asset allocation in equation (12) the sold illiquid assets can be restated $(\Theta_i - \underline{\Theta}_i)\left(1 + R^F\right)$. The present $(t = 0)$ residual value of this is, $\underline{\Theta}_i$, with these illiquid assets held to maturity and earning insurer i the liquidity premia R^{liq}.

Each insurers objective function, as described in equation (7), can therefore be restated

$$\max_{P_i,\, \Theta_i} \; L_i \left(1 + R^F\right) - C_i + \frac{1}{2}\left(\Theta_i + \underline{\Theta}_i\right) R^{liq} - \frac{1}{4}\lambda \left(\Theta_i - \underline{\Theta}_i\right)^2 \left(1 + R^F\right)^2 \tag{A.3}$$

subject to the capital constraint in equation (6).

Assuming each insurer takes the illiquid asset return R^{liq} as fixed, the first-order condition for the illiquid asset dollar investment is

$$0 = \frac{1}{2} R^{liq} - \frac{1}{2}\lambda \left(\Theta_i - \underline{\Theta}_i\right)\left(1 + R^F\right)^2 \tag{A.4}$$

and thus the optimal solution Θ_i^* in equation (11) follows.[1] ■

Proof of Theorem 2

The proof is shown with each insurer facing a generalised convex cost function of selling illiquid assets where each insurer pays $\lambda f(x)$ dollar for every x dollar sold of the illiquid asset, where $f'(x) > 0$ and $f''(x) > 0$. The generalised version of the insurer's objective function (A.3) is thus

$$\max_{P_i,\, \Theta_i} \; L_i\left(1+R^F\right) - C_i + \frac{1}{2}\left(\Theta_i + \underline{\Theta}_i\right) R^{liq} - \frac{1}{2}\lambda f(x_i) \tag{A.5}$$

subject to the capital constraint in equation (6) where $x_i = \left(\Theta_i - \underline{\Theta}_i\right)\left(1+R^F\right)$ is the dollar amount of illiquid assets sold.

For intuition, we begin the proof assuming the capital constraint is non-binding. The first-order condition with respect the illiquid asset allocation Θ_i is

$$0 = \frac{1}{2}R^{liq} - \frac{1}{2}\lambda f'(x_i)\left(1+R^F\right) \quad \Leftrightarrow \quad R^{liq} = \lambda f'(x_i)\left(1+R^F\right), \tag{A.6}$$

where we have used the chain rule and assumed each insurer i treats the illiquid asset return R^{liq} as independent to their investment choice (Stein, 2012). The right hand side condition in equation (A.6) shows that in equilibrium the marginal benefit R^{liq} of an extra dollar of illiquid investment is equal to the marginal cost $\lambda f'(x_i)\left(1+R^F\right)$ of an extra dollar of illiquid investment.

Meanwhile, for a fixed illiquid asset allocation, the first-order condition for the objective function in equation (A.5) with respect to the insurance price, P_i, is

$$0 = \frac{\partial L_i}{\partial P_i}\left(1+R^F\right) - \frac{\partial C_i}{\partial P_i} + \frac{1}{2}\frac{\partial \underline{\Theta}_i}{\partial P_i}R^{liq} + \frac{1}{2}\lambda f'(x_i)\left(1+R^F\right)\frac{\partial \underline{\Theta}_i}{\partial P_i}. \tag{A.7}$$

Using the envelope theorem, we now substitute in condition (A.6) from insurer i's optimal illiquid asset decision and simplify to

$$0 = \frac{\partial L_i}{\partial P_i}\left(1+R^F\right) - \frac{\partial C_i}{\partial P_i} + \frac{\partial \underline{\Theta}_i}{\partial P_i}R^{liq}. \tag{A.8}$$

This equation shows the key theoretical insight that the only impact of the illiquid asset excess return R^{liq} on the optimal insurance price comes via the last term, which is the return earned on the lower bound of the investment in the illiquid asset $\underline{\Theta}_i$. Recall, these are the assets insurer i knows with certainty it will not be forced to sell at $t = 1$.

[1] The solution holds for any required return on insurer equity providing that the required return is independent of the insurer's asset allocation decision. We have this in this model due to risk neutral investors. However, it would hold in any model with a flat security market line.

Substitute the lower bound of the illiquid asset allocation, equation (12), into equation (A.8) to show

$$0 = \frac{\partial L_i}{\partial P_i}\left(1 + R^F + R^{liq}\right) - \frac{\partial C_i}{\partial P_i}\frac{\left(1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq}\right)}{1 + R^F} \tag{A.9}$$

and rearrange to solve the equilibrium insurance price without capital constraints

$$P_i^* = \frac{\bar{C}}{1 + R^F}\,\frac{\varepsilon}{\varepsilon - 1}\,\frac{1}{1 + R_i^P} \tag{A.10}$$

using the elasticity of demand for insurance as defined in equation (9).

We now introduce the capital constraint in equation (6). The Lagrangian for insurer i's optimisation problem subject to this constraint is

$$\mathcal{L}\left(P_i, \Theta_i, \eta_i\right) = W_i + \eta_i\left(L_i - \frac{C_i}{1 + R^S}\phi^{-1}\right) \tag{A.11}$$

where $C_i = I_i\bar{C}$. The first order condition with respect to the insurance price is

$$0 = \frac{\partial L_i}{\partial P_i}\left(1 + R^F + R^{liq} + \eta_i\right) - \frac{\partial C_i}{\partial P_i}\frac{\left(1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \eta_i\frac{1+R^F}{\phi(1+R^S)}\right)}{1 + R^F} \tag{A.12}$$

which can be written

$$0 = -(\epsilon - 1) I_i\left(1 + R^F + R^{liq} + \eta_i\right) + \epsilon\frac{I_i}{P_i}\frac{\bar{C}}{1 + R^F}\left(1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \eta_i\frac{1 + R^F}{\phi(1 + R^S)}\right) \tag{A.13}$$

and further rearranged to

$$P_i = \frac{\bar{C}}{1 + R^F}\left(\frac{\varepsilon}{\varepsilon - 1}\right)\frac{1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \frac{\eta_i(1+R^F)}{\phi(1+R^S)}}{1 + R^F + R^{liq} + \eta_i} \tag{A.14}$$

$$= \frac{\bar{C}}{1 + R^F}\left(\frac{\varepsilon}{\varepsilon - 1}\right)\frac{1}{1 + R_i^P}\frac{1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \frac{\eta_i(1+R^F)}{\phi(1+R^S)}}{\left(\frac{1+R^F+R^{liq}}{1+R_i^P} + \frac{\eta_i}{1+R_i^P}\right)} \tag{A.15}$$

and substitute in $1 + R_i^I$, as defined in equation (15), to the left hand side of the denominator in the final term to arrive at the formula show in equation (14) where

$$\Gamma_i(\phi) = \frac{1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \frac{\eta_i(1+R^F)}{\phi(1+R^S)}}{1 + R^F + \left(\bar{\tau} + \sigma_i\right) R^{liq} + \frac{\eta_i}{(1+R_i^P)}} \tag{A.16}$$

is the shadow cost of capital. Note that when the insurer is unconstrained with $\eta_i = 0$ then $\Gamma_i(\phi) = 1$ and the insurance price is as set out in equation (A.10). ■

Proof of Corollary 1

Define the expected return on invested assets as $R_i^{\text{inv}} \equiv \mathbb{E}[\text{Gross investment payoff}]/L_i - 1$, where the gross payoff is the total value of the investment portfolio at t=2 net of liquidation costs, but not subtracting insurance claims. Equivalent to equation (A.3), we can thus write the expected gross payoff as:

$$\mathbb{E}[\text{Gross payoff}] = \mathbb{E}[W_i] + C_i \tag{A.17}$$

$$= L_i(1+R^F) + \tfrac{1}{2}(\Theta_i + \underline{\Theta}_i)\, R^{liq} - \tfrac{1}{4}\lambda\,(\Theta_i - \underline{\Theta}_i)^2(1+R^F)^2. \tag{A.18}$$

To find the equilibrium expected return on insurers assets, insert the insurer's optimal allocation to the illiquid asset from Theorem 1, $\Theta_i^* = \underline{\Theta}_i + \alpha R^{liq}/\lambda$ where $\alpha = 1/(1+R^F)^2$, and substitute:

$$\mathbb{E}[\text{Gross payoff}] = L_i(1+R^F) + \tfrac{1}{2}(\Theta_i^* + \underline{\Theta}_i)\, R^{liq} - \tfrac{1}{4}\lambda\,(\Theta_i^* - \underline{\Theta}_i)^2(1+R^F)^2 \tag{A.19}$$

$$= L_i(1+R^F) + \underline{\Theta}_i\, R^{liq} + \frac{\alpha(R^{liq})^2}{2\lambda} - \frac{\alpha(R^{liq})^2}{4\lambda} \tag{A.20}$$

$$= L_i(1+R^F) + \underline{\Theta}_i\, R^{liq} + \frac{\alpha\,(R^{liq})^2}{4\lambda}. \tag{A.21}$$

Dividing by L_i and subtracting 1 yields the result in equation (13). ■

A.2 Pass-through rate as a function of expected return on invested assets

Define the equity ratio $e_i = E_i/L_i \in [0,1)$, where $L_i = E_i + I_i P_i$ is total invested assets, and the speculative liquidity premium $\Delta_i = \frac{\alpha(R^{liq})^2}{4\lambda L_i}$ from Corollary 1. Assume the capital constraint is non-binding ($\Gamma_i = 1$). Then the equilibrium pass-through rate can be expressed as a function of the insurer's expected return on invested assets:

$$R_i^P = \underbrace{\frac{1}{1-e_i}\cdot\frac{\varepsilon}{\varepsilon-1}\cdot\frac{1}{1+R^F}}_{\text{amplification}} \times \left(\underbrace{R_i^{\text{inv}} - R^F}_{\substack{\text{total excess}\\ \text{return}}} - \underbrace{\frac{R^{liq}}{\varepsilon}}_{\substack{\text{markup}\\ \text{correction}}} - \underbrace{\frac{(\varepsilon-1)\,e_i}{\varepsilon}\,R^{liq}}_{\substack{\text{equity}\\ \text{correction}}} - \underbrace{\Delta_i}_{\substack{\text{speculative}\\ \text{correction}}} \right) \tag{A.22}$$

The formula expresses the pass-through rate as an amplification factor multiplied by an adjusted excess return. The *amplification* prefactor combines three scaling factors: (i) *leverage* $\frac{1}{1-e_i} = L_i/(I_iP_i)$, the ratio of total invested assets to premium-funded assets; (ii) the *markup* $M = \varepsilon/(\varepsilon-1)$, reflecting additional invested dollars per unit of claims under monopolistic competition; and (iii) a *time-value discount* $1/(1+R^F)$.

The bracket isolates the pass-through-relevant portion of the insurer's excess return by subtracting three components of $R_i^{\text{inv}} - R^F$ that do not reflect value passed through to policyholders:

- *Markup correction* (R^{liq}/ε): Under monopolistic competition, the insurer collects premiums above marginal cost. Those excess premiums carry no claim obligations and earn R^{liq} when invested in the illiquid asset, inflating R_i^{inv} without benefiting policyholders. This correction vanishes as $\varepsilon \to \infty$ (perfect competition).

- *Equity correction* ($\frac{(\varepsilon-1)e_i}{\varepsilon} R^{liq}$): Equity-funded assets carry no claim obligations, so the illiquidity premium earned on equity-funded investment accrues to shareholders, not policyholders. As $\varepsilon \to \infty$, this simplifies to $e_i R^{liq}$; when $e_i = 0$, it vanishes.

- *Speculative correction* (Δ_i): The speculative liquidity premium represents the net expected gain from investing beyond the safe amount $\underline{\Theta}_i$. This return arises from the insurer's risk–return trade-off against stochastic liquidation costs and accrues to the insurer's residual claimants, not policyholders.

Simplification under perfect competition with zero equity. Setting $\varepsilon \to \infty$ and $e_i = 0$, the markup and equity corrections vanish and the amplification factor simplifies to $1/(1 + R^F)$:

$$R_i^P = \frac{R_i^{\text{inv}} - R^F - \Delta_i}{1 + R^F}. \tag{A.23}$$

Dropping the second-order speculative term ($\Delta_i \approx 0$) yields the approximation referenced in Theorem 2: $R_i^P \approx \frac{1+R_i^{\text{inv}}}{1+R^F} - 1$.

Proof of equation (A.22). The expected return on invested assets at the optimum (Corollary 1) is

$$R_i^{\text{inv}} = R^F + \frac{\underline{\Theta}_i}{L_i} R^{liq} + \Delta_i.$$

Next, let the maximum fraction of insurer i's claims arriving early be define as $a_i = \bar{\tau} + \sigma_i$, and use that $I_i/L_i = (1 - e_i)/P_i$ and the pricing equation (A.10) with $\Gamma_i = 1$. The safe illiquid share from equation (12) can then be written as

$$\frac{\underline{\Theta}_i}{L_i} = 1 - \frac{(1 - e_i)\, a_i\, \bar{C}}{(1 + R^F)\, P_i} = 1 - \frac{(1 - e_i)(\varepsilon - 1)\, a_i (1 + R_i^P)}{\varepsilon}$$

where the second equality uses $\bar{C}/\big((1 + R^F)P_i\big) = (\varepsilon - 1)(1 + R_i^P)/\varepsilon$. Substituting into the expected return:

$$R_i^{\text{inv}} - R^F - \Delta_i = \left(1 - \frac{(1 - e_i)(\varepsilon - 1)\, a_i (1 + R_i^P)}{\varepsilon}\right) R^{liq}. \tag{A.24}$$

The speculative term Δ_i does not depend on a_i at the optimum, so the right-hand side depends on a_i only through the safe illiquid share. From the definition of the pass-through rate in equation (15), $R_i^P = (1-a_i)R^{liq}/(1+R^F+a_iR^{liq})$, one can verify that

$$a_i(1+R_i^P) = \frac{a_i(1+R^F+R^{liq})}{1+R^F+a_iR^{liq}} = 1 - \frac{(1+R^F)\,R_i^P}{R^{liq}}.$$

Substituting into (A.24) and expanding:

$$\begin{aligned} R_i^{\text{inv}} - R^F - \Delta_i &= R^{liq} - \frac{(1-e_i)(\varepsilon-1)}{\varepsilon}\big(R^{liq} - (1+R^F)\,R_i^P\big) \\ &= \frac{\big(1+e_i(\varepsilon-1)\big)\,R^{liq}}{\varepsilon} + \frac{(1-e_i)(\varepsilon-1)(1+R^F)}{\varepsilon}\,R_i^P \end{aligned} \tag{A.25}$$

where the second equality uses $\varepsilon - (1-e_i)(\varepsilon-1) = 1 + e_i(\varepsilon-1)$. Solving for R_i^P:

$$R_i^P = \frac{\varepsilon\big(R_i^{\text{inv}} - R^F - \Delta_i\big) - R^{liq}\big(1+e_i(\varepsilon-1)\big)}{(1-e_i)(\varepsilon-1)(1+R^F)}$$

which, upon factoring $\varepsilon/\big((1-e_i)(\varepsilon-1)(1+R^F)\big)$ from the numerator, is equivalent to equation (A.22). ■

A.3 Proofs of Propositions

Before proving the propositions, we first establish equilibrium conditions in the asset market.

Asset market equilibrium

As all investors are *ex-ante* identical at time $t=0$, we consider a representative investor with mass one optimising the objective function in equation (2). The first-order condition with respect to the investor's illiquid asset allocation is

$$0 = (1-\omega)\,R^{liq} - \omega\lambda\theta\left(1+R^F\right)^2 \tag{A.26}$$

from which the equilibrium optimal allocation

$$\theta^* = \frac{(1-\omega)}{\omega}\frac{R^{liq}}{\lambda}\alpha \tag{A.27}$$

follows. Now insert the investors' optimal asset demand and the total optimal demand from insurers, $\Theta^* = \int_0^1 \Theta_i^*$, with Θ_i^* defined in equation (11), into the market clearing

condition for the illiquid asset defined in equation (10):

$$S = \frac{(1-\omega)}{\omega}\frac{R^{liq}}{\lambda}\alpha + \underline{\Theta} + \frac{R^{liq}}{\lambda}\alpha \tag{A.28}$$

and rearrange to define the equilibrium illiquid asset excess return as

$$R^{liq} = \frac{\omega\lambda}{\alpha}S^* \tag{A.29}$$

where $S^* = S - \underline{\Theta}$ is the total supply of the illiquid asset adjusted for the minimum illiquid asset allocation from the insurance industry, $\underline{\Theta} = \int_0^1 \underline{\Theta}_i \, di$.

Intuitively, the excess return on the illiquid asset is increasing in the demand for liquidity from investors, ω, the cost of selling the illiquid asset in secondary markets, λ, and the supply of the asset, S. The insurance market affects the illiquid asset return via the minimum illiquid asset allocation aggregated across all insurers, $\underline{\Theta}$, which is an endogenous function of insurance prices that are determined in equilibrium and, as shown below, depend on the excess return itself. Because of the minimum allocation, the insurance market absorbs at least $\underline{\Theta}$ of the total supply of the illiquid asset, which reduces the supply for other investors and therefore reduces the excess return.

Proof of Proposition 1

For this proof we are required to show that:

$$\frac{\partial \bar{P}}{\partial \lambda} = \frac{\partial \bar{P}}{\partial R^{liq}}\frac{\partial R^{liq}}{\partial \lambda} < 0 \tag{A.30}$$

and we begin with the first partial derivative: $\frac{\partial \bar{P}}{\partial R^{liq}}$.

For ease of notation, define the actuarial price as $C^A = \bar{C}/(1+R^F)$, the markup $M = \varepsilon/(\varepsilon-1)$, and the maximum fraction of insurer i's claims arriving early $a_i = \bar{\tau} + \sigma_i$. The equilibrium insurance price is thus:

$$P_i = C^A M \frac{1 + R^F + a_i R^{liq}}{1 + R^F + R^{liq}} \tag{A.31}$$

and we see that insurer i's price is decreasing in expected return on the illiquid asset:

$$\frac{\partial P_i}{\partial R^{liq}} = C^A M \frac{\left(1 + R^F + R^{liq}\right) a_i - \left(1 + R^F + a_i R^{liq}\right)}{\left(1 + R^F + R^{liq}\right)^2} \tag{A.32}$$

$$= C^A M \frac{\left(1 + R^F\right)(a_i - 1)}{\left(1 + R^F + R^{liq}\right)^2} < 0 \tag{A.33}$$

if $a_i < 1$, i.e. if the insurer has some degree of stable funding. If the insurer does not have stable funding, $a_i = 1$, the price of insurance becomes independent of the expected excess return on the illiquid asset. From the definition of the average insurance price,

$\bar{P} = \int_{i=0}^{1} P_i \, di$, it follows that $\frac{\partial \bar{P}}{\partial R^{liq}} < 0$.

To prove proposition 1, we therefore need to show that the expected excess return on the illiquid asset is increasing in the transaction cost of selling the asset early, i.e. $\frac{\partial R^{liq}}{\partial \lambda} > 0$, where λ is exogenous.[2] From the asset market equilibrium defined in equation (A.29), the first derivative of the equilibrium return with respect to λ is:

$$\begin{aligned} \frac{\partial R^{liq}}{\partial \lambda} &= \frac{\omega}{\alpha}\left(S - \underline{\Theta} - \lambda \frac{\partial \underline{\Theta}}{\partial R^{liq}} \frac{\partial R^{liq}}{\partial \lambda}\right) \\ &= \frac{\frac{\omega}{\alpha}\left(S - \underline{\Theta}\right)}{1 + \lambda \frac{\omega}{\alpha} \frac{\partial \underline{\Theta}}{\partial R^{liq}}}. \end{aligned} \tag{A.34}$$

Sufficient conditions for $\frac{\partial R^{liq}}{\partial \lambda} > 0$ to hold are that both $S > \underline{\Theta}$ and $\frac{\partial \underline{\Theta}}{\partial R^{liq}} > -\frac{\alpha}{\omega\lambda}$. We focus on the model's interior solution ($S > \underline{\Theta}$), and therefore need to show latter condition: $\frac{\partial \underline{\Theta}}{\partial R^{liq}} > -\frac{\alpha}{\omega\lambda}$.[3]

The partial derivative of the insurer i's minimum illiquid allocation with respect to the excess return is

$$\frac{\partial \underline{\Theta}_i}{\partial R^{liq}} = \frac{\partial I_i P_i}{\partial R^{liq}} - a_i C^A \frac{\partial I_i}{\partial R^{liq}}. \tag{A.35}$$

Next, note that $\frac{\partial I_i}{\partial R^{liq}} = -\varepsilon \frac{I_i}{P_i} \frac{\partial P_i}{\partial R^{liq}}$ and $\frac{\partial I_i P_i}{\partial R^{liq}} = -\left(\epsilon - 1\right) I_i \frac{\partial P_i}{\partial R^{liq}}$, and substitute in:

$$\frac{\partial \underline{\Theta}_i}{\partial R^{liq}} = -\left(\varepsilon - 1\right) I_i \frac{\partial P_i}{\partial R^{liq}} + a_i C^A \varepsilon \frac{I_i}{P_i} \frac{\partial P_i}{\partial R^{liq}} \tag{A.36}$$

$$= \frac{I_i}{P_i} \frac{\partial P_i}{\partial R^{liq}} \left(-\left(\varepsilon - 1\right) P_i + \varepsilon a_i C^A\right) \tag{A.37}$$

$$= \left(\varepsilon - 1\right) \frac{I_i}{P_i} \frac{\partial P_i}{\partial R^{liq}} \left(-P_i + a_i C^A \frac{\varepsilon}{\varepsilon - 1}\right). \tag{A.38}$$

Given $\partial P_i / \partial R^{liq} < 0$ and $\varepsilon - 1 > 0$, to show $\partial \underline{\Theta}_i / \partial R^{liq} > -\frac{\alpha}{\omega\lambda}$ it suffices to show that

$$P_i > \frac{\varepsilon}{\varepsilon - 1} a_i C^A \tag{A.39}$$

since we then have $\partial \underline{\Theta}_i / \partial R^{liq} > 0 > -\frac{\alpha}{\omega\lambda}$. This is easily shown by substituting P_i into equation (A.39):

$$\frac{1 + R^F + a_i R^{liq}}{1 + R^F + R^{liq}} > a_i \Leftrightarrow 1 > a_i$$

[2]The proof can be applied interchangeably for shocks to either transaction costs in the illiquid asset market, λ, or to the demand for liquidity from other investors, ω. We focus on λ in our empirical setting and so use this variable in the proof below.

[3]The model has a corner solution where $S = \underline{\Theta}$. The insurance industry will not hold more illiquid assets than the total size of the illiquid asset market, otherwise the other investors in the model would be required to short the illiquid asset and thus the excess return would turn negative. However, a negative excess return means the risk-free asset dominates the illiquid asset, and thus insurers would fully allocate premiums to the risk-free asset in all cases where $R^{liq} < 0$.

which is true, except for the special case where the insurer has no funding advantage $a_i = 1$. As the condition holds for all individual insurers, then the minimum allocation to the illiquid asset from the insurance sector is also increasing in R^{liq}, with $\partial\underline{\Theta}/\partial R^{liq} > 0$, and thus we have shown $\frac{\partial R^{liq}}{\partial \lambda} > 0$. We therefore have $\frac{\partial \bar{P}}{\partial \lambda} = \frac{\partial \bar{P}}{\partial R^{liq}} \frac{\partial R^{liq}}{\partial \lambda} < 0$ as required. ■

Proof of Proposition 2

Since each insurer is infinitesimally small, variation in insurer i's funding stability does not change the equilibrium return on the illiquid asset: $\frac{\partial R^{liq}}{\partial \sigma_i} = 0$. In contrast to Proposition 1, which treated aggregate insurance prices and the overall insurance market, we therefore do not need to consider the equilibrium impact of individual insurers on the liquidity premium. We assume the capital constraint is non-binding ($\Gamma_i = 1$) and define $a_i = \bar{\tau} + \sigma_i$.

Part 1: $\frac{\partial R_i^{\text{inv}}}{\partial \sigma_i} < 0$. From Corollary 1, insurer i's expected return on invested assets is

$$R_i^{\text{inv}} = R^F + \frac{\underline{\Theta}_i}{L_i} R^{liq} + \underbrace{\frac{\alpha \left(R^{liq}\right)^2}{4\lambda L_i}}_{\equiv \Delta_i}.$$

Since R^{liq}, α, and λ are independent of σ_i, differentiating yields

$$\frac{\partial R_i^{\text{inv}}}{\partial \sigma_i} = R^{liq} \frac{\partial}{\partial \sigma_i}\left(\frac{\underline{\Theta}_i}{L_i}\right) + \frac{\alpha \left(R^{liq}\right)^2}{4\lambda} \frac{\partial}{\partial \sigma_i}\left(\frac{1}{L_i}\right). \tag{A.40}$$

We evaluate both terms. From equation (12), the safe illiquid share is $\frac{\underline{\Theta}_i}{L_i} = 1 - \frac{a_i \bar{C} I_i}{L_i(1+R^F)}$, so

$$\frac{\partial}{\partial \sigma_i}\left(\frac{\underline{\Theta}_i}{L_i}\right) = -\frac{\bar{C}}{1+R^F} \frac{\partial}{\partial \sigma_i}\left(\frac{a_i I_i}{L_i}\right).$$

The pricing equation (14) with $\Gamma_i = 1$ and the pass-through rate in equation (15) give

$$P_i = \frac{\bar{C}}{1+R^F} \frac{\varepsilon}{\varepsilon - 1} \frac{1 + R^F + a_i R^{liq}}{1 + R^F + R^{liq}},$$

from which

$$\frac{\partial P_i}{\partial \sigma_i} = \frac{P_i R^{liq}}{1 + R^F + a_i R^{liq}} > 0. \tag{A.41}$$

From the CES demand in equation (A.43), $\frac{\partial I_i}{\partial P_i} = -\varepsilon I_i / P_i$, and total invested assets $L_i = E_i + I_i P_i$ satisfy $\frac{\partial L_i}{\partial P_i} = (1-\varepsilon) I_i$. Applying the quotient rule to $a_i I_i / L_i$ and substituting we get that:

$$\frac{\partial}{\partial \sigma_i}\left(\frac{a_i I_i}{L_i}\right) = \frac{I_i}{L_i} \frac{1 + R^F - (\varepsilon - 1)\, a_i\, R^{liq}\, e_i}{1 + R^F + a_i R^{liq}}$$

where $e_i = E_i / L_i$ is the equity ratio. For the second term in equation (A.40), we use $\frac{\partial L_i}{\partial \sigma_i}$

from above and $I_i P_i / L_i = 1 - e_i$ to obtain

$$\frac{\partial}{\partial \sigma_i}\left(\frac{1}{L_i}\right) = -\frac{1}{L_i^2}\frac{\partial L_i}{\partial \sigma_i} = \frac{(\varepsilon - 1)(1 - e_i)\, R^{liq}}{L_i(1 + R^F + a_i R^{liq})} \;>\; 0.$$

Substituting both derivatives into equation (A.40), using $\frac{\bar{C}\, I_i}{(1+R^F)L_i} = \frac{(\varepsilon-1)(1+R_i^P)(1-e_i)}{\varepsilon}$ (from $I_i/L_i = (1-e_i)/P_i$ and the pricing equation), and factoring:

$$\frac{\partial R_i^{\text{inv}}}{\partial \sigma_i} = \frac{(\varepsilon - 1)(1 - e_i)\, R^{liq}}{1 + R^F + a_i R^{liq}} \left[\Delta_i \;-\; \frac{(1 + R_i^P)\big(1 + R^F - (\varepsilon - 1)\, a_i\, R^{liq}\, e_i\big)}{\varepsilon}\right].$$

The scalar is positive (for $\varepsilon > 1$ and $R^{liq} > 0$), so the sign is determined by the bracket. Since $R_i^P \geq 0$, a sufficient condition for the bracket to be negative—and thus for $\frac{\partial R_i^{\text{inv}}}{\partial \sigma_i} < 0$—is

$$1 + R^F \;>\; (\varepsilon - 1)\, a_i\, R^{liq}\, e_i \;+\; \varepsilon\, \Delta_i.$$

This condition holds for all empirically relevant parameter values. Since $a_i \leq 1$, $e_i < 1$, and $\Delta_i = \frac{\alpha (R^{liq})^2}{4\lambda L_i}$ is second-order in R^{liq}, the right-hand side requires only that R^{liq} not be excessively large: for example, with $R^F = 2\%$, $\varepsilon = 15$, $a_i = 0.8$, $e_i = 0.25$, and $\varepsilon \Delta_i \approx 0$, the bound is $R^{liq} < 46\%$, far above any empirically observed liquidity premium.

Part 2: $\frac{\partial P_i / \partial \sigma_i}{\partial R_i^{\text{inv}} / \partial \sigma_i} < 0$. From Theorem 2 with $\Gamma_i = 1$, the insurance price is $P_i = \frac{\bar{C}}{1+R^F}\frac{\varepsilon}{\varepsilon - 1}\frac{1}{1+R_i^P}$. Differentiating the pass-through rate in equation (15) with respect to σ_i:

$$\frac{\partial R_i^P}{\partial \sigma_i} = -\frac{(1 + R^F + R^{liq})\, R^{liq}}{(1 + R^F + a_i R^{liq})^2} \;<\; 0,$$

so that, by the chain rule,

$$\frac{\partial P_i}{\partial \sigma_i} = -\frac{P_i}{1 + R_i^P}\frac{\partial R_i^P}{\partial \sigma_i} \;>\; 0.$$

Less stable funding (higher σ_i) reduces the pass-through rate and raises the insurance price.

Combining Parts 1 and 2 via the chain rule, when cross-sectional variation in P_i and R_i^{inv} is driven by the common source σ_i:

$$\frac{\partial P_i / \partial \sigma_i}{\partial R_i^{\text{inv}} / \partial \sigma_i} \;=\; \frac{(+)}{(-)} \;<\; 0.$$

Insurers with more stable funding earn higher expected returns on invested assets and set lower insurance prices. ■

Proof of Proposition 3

This result follows straight from the insurer's shadow cost of capital Γ_i defined in equation (A.16). The cases depend on whether

$$1 + (\bar{\tau} + \sigma_i) R^{liq} + \frac{\eta_i (1 + R^F)}{\phi (1 + R^S)} > 1 + (\bar{\tau} + \sigma_i) R^{liq} + \frac{\eta_i}{(1 + R_i^P)}$$

which simplifies to

$$\frac{1 + R^F}{\phi (1 + R^S)} > \frac{1}{1 + R_i^P}$$

and thus to the cases set out in Proposition 3. ■

Proof of Proposition 4

Proposition 4 follows directly from Theorem 1. Differentiating equation (11) with respect to insurer i's funding stability, σ_i, we immediately obtain the comparative statics shown in the propositions.

A.4 Insurance Market Equilibrium.

Recall that our model has a continuum of risk-neutral insurance companies indexed by $i \in [0, 1]$, where each insurer i sets a price, P_i, to underwrite I_i insurance contracts. A representative household seeks to maximise expected utility by consuming the insurance contracts as a composite good

$$I = \left(\int_0^1 I_i^{\frac{\varepsilon - 1}{\varepsilon}} \, di \right)^{\frac{\varepsilon}{\varepsilon - 1}}, \tag{A.42}$$

subject to a budget constraint. That is, the representative household maximises the insurance index, I, by deciding how to allocate total insurance expenditure, $\int_0^1 P_i I_i \, di$, across the different insurers. It can be shown (see Galí (2008)) that this maximisation problem results in the following demand equations:

$$\frac{I_i}{I} = \left(\frac{P_i}{P} \right)^{-\varepsilon} \tag{A.43}$$

for all $i \in [0, 1]$, where $P = \left(\int_0^1 P_i^{1-\varepsilon} \, di \right)^{\frac{1}{1-\varepsilon}}$ is an aggregate insurance price index. Equation (A.43) shows that as insurer i increases its price relative to other insurers, the household reduces its insurance contracts at insurer i at the rate ε, the elasticity of substitution across insurers. The elasticity of demand facing each insurer, as presented in equation (9), is then derived from the partial derivative of equation (A.43) with respect to P_i.

B Additional Results and Robustness Checks

B.1 Robustness Checks for Table 2: *Time series results*

In this section we provide further estimation results and a series of robustness checks on the results shown in Table 2. Table B.1 shows the results hold for various measures of insurer expected returns or the liquidity premium, which are used in place of our benchmark measure – the AAA credit spread – in the estimation of equation (24). In Table B.2 we reestimate the results of Table 2, but add the insurers capital ratio as an additional control variable. While the addition of this extra control variable shortens our sample, our results remain statistically and economically significant.

Table B.1: Time series results with alternative measures of expected excess returns

This table re-estimates the time series regressions of Tables 2 with alternative measures of the expected excess return in the bond market. That is, we estimate the regression

$$y_t = \alpha + \beta_c \cdot \textit{Exp. Ret.}_t + \beta_{GFC} \cdot \mathbb{1}_{GFC} + \beta_{cGFC} \cdot \textit{Exp. Ret.}_t \times \mathbb{1}_{GFC} + \delta^T X_t + \epsilon_t$$

where y_t is either the average (annualized) markup across insurers and subproducts at time t for Life insurance products or the average underwriting profitability across insurers and subproducts from time t to $t+1$ for P&C insurance. *Exp. Ret.*$_t$ captures different measures of the expected excess return in the corporate bonds market: 1. the spread of Moody's Seasoned AAA corporate bonds yields over 10-year constant maturity Treasuries (baseline), 2. the spread of Moody's Seasoned BAA corporate bonds yields over 10-year constant maturity Treasuries, 3. the CDS-Bond basis (the average of the J.P. Morgan U.S. investment grade and high yield indexes), backward-extended with fitted values from a regression on the BAA spread (extended sample), 4. the CDS-Bond basis over the period where the indexes are directly observed (short sample), 5. the Option-Adjusted Spread of the ICE BofA BBB US Corporate Index over Treasuries, 6. the EBP Gilchrist and Zakrajšek (2012) orthogonalized on the default spread, 7. the Sørensen (2024) Yield-for-Risk, $\mathbb{1}_{GFC}$ is an indicator variable set to one during the global financial crisis (September 2008 through December 2009). X_t is a vector of time series controls: the 10-year Treasury rate, the slope of the Treasury yield curve (10-year - 2-year Treasury yields), the TED spread, and the US unemployment rate. For regressions with Property and Casualty insurance the expected excess return and controls are averaged over the previous four quarters from $t-3$ to t. The sample of Life insurers consists of biannual observations from January 1989 through July 2011, and the sample of Property and Casualty insurers consists of quarterly observations from March 2001 through March 2022. The first three columns provide the independent variable (the measure of expected excess return), the insurance sector, and the dependent variable for each specification. The next two columns provide the number of observations and the R^2. The last three columns provide the coefficient estimates. The standard errors are reported in the parentheses and calculated using Newey and West (1987) standard errors with 4 lags. *, **, and *** indicate statistical significance at the 10%, 5% and 1%, respectively.

Illiquidity measure	Insurance type	Dependent variables	N	R^2	$Liq.\ Prem._t$	$\mathbb{1}_{GFC}$	$Liq.\ Prem._t \times \mathbb{1}_{GFC}$
Moody's AAA - 10y Treas.	Fixed Term Annuity	Markup (annualized)	46	0.75	-0.714*** (0.231)	-0.371 (1.47)	0.192 (0.811)
Moody's AAA - 10y Treas.	Guarantee Annuity	Markup (annualized)	54	0.83	-0.576*** (0.119)	0.134 (0.689)	-0.169 (0.308)
Moody's AAA - 10y Treas.	Life Insurance	Markup (annualized)	73	0.80	-0.559*** (0.203)	0.451 (0.888)	-0.337 (0.378)
Moody's AAA - 10y Treas.	Property and Casualty	Underwriting Profitability	85	0.44	-1.31*** (0.223)	-0.368 (0.679)	0.516 (0.353)
Moody's BAA - 10y Treas.	Fixed Term Annuity	Markup (annualized)	46	0.82	-0.854*** (0.199)	-1.72** (0.679)	0.604*** (0.224)
Moody's BAA - 10y Treas.	Guarantee Annuity	Markup (annualized)	54	0.88	-0.589*** (0.089)	-0.889** (0.435)	0.292** (0.111)
Moody's BAA - 10y Treas.	Life Insurance	Markup (annualized)	73	0.86	-0.657*** (0.134)	-0.843 (0.637)	0.293* (0.152)
Moody's BAA - 10y Treas.	Property and Casualty	Underwriting Profitability	85	0.35	-0.803*** (0.233)	-0.880 (0.644)	0.528*** (0.195)
CDS-Bond basis (ext. sample)	Fixed Term Annuity	Markup (annualized)	46	0.83	1.22*** (0.266)	-0.487 (0.339)	-0.957*** (0.333)
CDS-Bond basis (ext. sample)	Guarantee Annuity	Markup (annualized)	54	0.83	0.688*** (0.170)	-0.380 (0.245)	-0.470*** (0.169)
CDS-Bond basis (ext. sample)	Life Insurance	Markup (annualized)	73	0.82	0.729*** (0.197)	-0.315 (0.368)	-0.449** (0.191)
CDS-Bond basis (ext. sample)	Property and Casualty	Underwriting Profitability	85	0.32	0.965*** (0.325)	0.385 (0.490)	-0.800*** (0.292)
CDS-Bond basis (short sample)	Fixed Term Annuity	Markup (annualized)	13	0.97	0.824 (0.538)	-1.24*** (0.241)	-1.11* (0.537)
CDS-Bond basis (short sample)	Guarantee Annuity	Markup (annualized)	40	0.86	0.450 (0.398)	-0.390 (0.258)	-0.255 (0.371)
CDS-Bond basis (short sample)	Life Insurance	Markup (annualized)	40	0.85	0.682 (0.528)	-0.954** (0.362)	-0.549 (0.508)
CDS-Bond basis (short sample)	Property and Casualty	Underwriting Profitability	65	0.29	0.333** (0.156)	0.399 (0.316)	-0.298* (0.158)
ICE BofA BBB US Corporate Index	Fixed Term Annuity	Markup (annualized)	29	0.91	-0.611*** (0.072)	-1.51*** (0.258)	0.525*** (0.070)
ICE BofA BBB US Corporate Index	Guarantee Annuity	Markup (annualized)	54	0.91	-0.476*** (0.047)	-0.552** (0.252)	0.248*** (0.064)
ICE BofA BBB US Corporate Index	Life Insurance	Markup (annualized)	56	0.91	-0.522*** (0.070)	-0.852** (0.371)	0.292*** (0.083)
ICE BofA BBB US Corporate Index	Property and Casualty	Underwriting Profitability	85	0.32	-0.619*** (0.215)	-0.698 (0.564)	0.471*** (0.171)
EBP (orthogonalized)	Fixed Term Annuity	Markup (annualized)	46	0.85	-0.774*** (0.163)	0.023 (0.095)	0.580*** (0.186)
EBP (orthogonalized)	Guarantee Annuity	Markup (annualized)	54	0.90	-0.500*** (0.054)	-0.085 (0.111)	0.195*** (0.070)
EBP (orthogonalized)	Life Insurance	Markup (annualized)	73	0.89	-0.614*** (0.097)	-0.167 (0.195)	0.280*** (0.105)
EBP (orthogonalized)	Property and Casualty	Underwriting Profitability	85	0.44	-0.857*** (0.156)	0.483 (0.416)	0.706*** (0.203)
Yield-for-Risk	Fixed Term Annuity	Markup (annualized)	46	0.76	-0.066*** (0.020)	-0.570* (0.283)	0.054** (0.022)
Yield-for-Risk	Guarantee Annuity	Markup (annualized)	54	0.81	-0.060*** (0.011)	-0.651 (0.508)	0.045** (0.022)
Yield-for-Risk	Life Insurance	Markup (annualized)	73	0.78	-0.042*** (0.010)	-0.028 (0.600)	-0.0010 (0.026)
Yield-for-Risk	Property and Casualty	Underwriting Profitability	79	0.42	-0.096*** (0.024)	0.035 (0.430)	0.089*** (0.023)

Table B.2: Liquidity Premia and Insurance Prices with Capital Ratio Controls

This table replicates full specifications in Table 2 with the inclusion of insurers' average capital ratio as an additional time-series control. This table presents the time series relation between insurance prices and liquidity premia as measured by the AAA credit spread (Panel A) and the CDS-Bond basis (Panel B). It reports the parameter estimates from the following regression:

$$y_t = \alpha + \beta_c \cdot \textit{liq. prem}_t + \beta_r \cdot \textit{cap. rat}_t + \beta_{GFC} \cdot \mathbb{1}_{GFC} + \delta^T X_t + \epsilon_t$$

where y_t is either the average (annualized) markup across life insurers and subproducts at time t (columns (1) through to column (3)) or the average P&C insurance underwriting profitability across insurers and subproducts from time t to $t+1$ (column (4)). *liq. prem*$_t$ is either the yield spread between Moody's AAA-rated corporate bonds yields and 10-year Treasuries (Panel A) or the CDS-Bond basis (Panel B). *cap. rat*$_t$ is the average regulatory capital ratio of the insurers in our sample. $\mathbb{1}_{GFC}$ is an indicator variable set to one over the global financial crisis (September 2008 through December 2009). X_t includes the interaction terms the crisis indicator, $\mathbb{1}_{GFC}$, with *liq. prem*$_t$ and *cap. rat*$_t$ as well as a vector of time series controls: the 10-year Treasury rate, the slope of the Treasury yield curve (10-year - 2-year Treasury yields), the TED spread, the US unemployment rate, and the average capital ratio of insurers. Columns (1), (2), and (3) show the results for markups on life, guarantee and fixed-term annuity products respectively, and the samples consist of typically biannual observations from May 1998 through July 2011. Note that the sample is shorter than our baseline specification as regulatory capital ratios are not available before. In column (4) all right-hand side variables are measured as one-year rolling averages, and sample consists of quarterly observations from March 2001 through March 2022. In all columns t-statistics are calculated using Newey and West (1987) standard errors with 4 lags. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: *AAA spread*

Dependent Variables:	Markup (annualized)			Underwriting Profitability
Type:	Life	Guarantee	Fixed	P&C
Model:	(1)	(2)	(3)	(4)
Variables				
AAA - Treasury	-0.58***	-0.53***	-0.51**	-1.3***
	(-4.7)	(-5.2)	(-2.6)	(-6.4)
Capital Ratio	0.004	0.007*	0.0010	-0.19**
	(0.83)	(1.7)	(0.19)	(-2.4)
Controls:				
Crisis control	Yes	Yes	Yes	Yes
Time series controls	Yes	Yes	Yes	Yes
Fit statistics				
Observations	54	54	27	85
R^2	0.834	0.847	0.753	0.505

Panel B: *CDS-Bond Basis*

Dependent Variables:	Markup (annualized)			Underwriting Profitability
Type:	Life	Guarantee	Fixed	P&C
Model:	(1)	(2)	(3)	(4)
Variables				
CDS-Bond basis	0.73***	0.59***	0.79***	0.90***
	(3.5)	(3.1)	(4.2)	(3.0)
Capital Ratio	0.002	0.006	-0.002	-0.19**
	(0.59)	(1.3)	(-0.59)	(-2.3)
Controls:				
Crisis control	Yes	Yes	Yes	Yes
Time series controls	Yes	Yes	Yes	Yes
Fit statistics				
Observations	54	54	27	85
R^2	0.840	0.842	0.793	0.371

B.2 Stable Insurance Funding and Illiquid Asset Allocations

In this section we present an additional prediction of our model in section 3 about insurers' investment decisions and how the optimal illiquid asset allocations depend on the stability of insurance funding. Specifically, from the model we derive the following proposition.

Proposition 4 (the insurer's illiquid asset allocation). *The more volatile an insurer's underwriting, the fewer illiquid assets the insurer holds in equilibrium*

$$\frac{\partial \Theta_i^*}{\partial \sigma_i} < 0, \tag{B.44}$$

where σ_i measures the volatility of insurer i's underwriting.

Proposition 4 allows us to make predictions about the asset allocation in the cross-section of insurance companies. A lower σ_i implies insurer i has more stable insurance funding which is a comparative advantage when investing in illiquid assets. Thus, insurers with the most stable funding allocate the largest quantity of assets to the illiquid asset market.

We test Proposition 4 by regression insurers' allocation to cash and to non-government bonds on our two measures of funding stability discussed in Section 4.3: 1. the volatility of insurance underwriting profitability and 2. the volatility of net premium earned growth. That is, for each insurer i at each date t we calculate the four-year rolling volatility of their insurance underwriting profitability and growth in net premium earned up to, and including, date $t-1$. We measure the insurer's allocation to cash and to non-government bonds (in percent).The regression specification is

$$y_{it} = \kappa_1 \cdot Volatility_{i,t-1}^{und.\ prof} + \kappa_2 \cdot Volatility_{i,t-1}^{NPE} + \delta_1^T Z_{it} + FE_{Rating_i} + FE_t + \epsilon_{it}, \tag{B.45}$$

where y_{it} is the either the allocation to cash (columns (1)-(4)) or the allocation to non-government bonds (columns (5)-(8)) of insurer i at time t, $Volatility_{i,t-1}^{und.\ prof}$ and $Volatility_{i,t-1}^{NPE}$ are our two measures of funding stability as described above, and $Z_{i,t-1}$ is a vector of control variables (the capital ratio, the ratio of unearned premia, and the reinsurance ratio). FE_{Rating_i} and FE_t absorb rating and time fixed effects, respectively, where the rating is the insurer's financial strength rating provided by AM Best.

Table B.3 presents the results of the regressions, and we see that stable funding predicts high allocations to non-government bonds and low allocations to cash in the cross-section of P&C insurers, independently of what measure of funding stability we apply. Our results are consistent with the findings of Chen et al. (2020) who show that insurers' operating risk, measured as the volatility of insurers' underwriting income and cash flows, are correlated with both the average credit ratings and average yield spread of the insurers' bond portfolios. Like us, they find that insurers with more operating risk (i.e. more

unstable underwriting funding), invest in better rated bonds with lower yield spreads.

In summary, consistent with our model, we see that insurers with more stable funding, as captured by two different proxies, take more liquidity risk in their financial investments.

Table B.3: Funding stability and illiquid investments: P&C Insurance

This table presents results of the following panel regression:

$$y_{it} = \kappa_1 \cdot Volatility_{i,t-1}^{und.\ prof} + \kappa_2 \cdot Volatility_{i,t-1}^{\Delta NPE} + \delta_1^T Z_{it} + FE_{Rating_i} + FE_t + \epsilon_{it}$$

where y_{it} is either insurer i's allocation to cash or non-government bonds at time t measured in percent. $Volatility_{i,t-1}^{und.\ prof}$ and $Volatility_{i,t-1}^{\Delta NPE}$ are the 4-year rolling standard deviation of insurer i's underwriting profitability and net premium earned growth, respectively, up to, and including, time $t-1$. Both variables are normalized. Z_{it} is vector of controls designed to capture the strength of insurer i's balance sheet: the capital ratio, the ratio of unearned premia, and the reinsurance ratio. FE_t and FE_{Rating_i} capture time and rating fixed effects, respectively. t-statistics are reported in the brackets and are calculated using standard errors clustered by date and firm. *, **, and *** denote statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variables:	Cash Allocation				Bond Allocation (Non-gvt.)			
Model:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Variables								
Volatility of Underwriting Prof.	1.75***		1.41***	1.14***	-2.25***		-1.87***	-2.52***
	(5.84)		(4.86)	(4.37)	(-3.93)		(-3.27)	(-4.45)
Volatility of Premium Earned		2.34***	2.08***	2.07***		-2.71***	-2.38***	-2.47***
		(9.55)	(8.80)	(8.77)		(-5.71)	(-4.93)	(-5.23)
Controls:								
Date FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Insurer controls				Yes				Yes
Fit statistics								
Observations	36,838	36,838	36,838	36,838	37,589	37,589	37,589	37,589
R^2	0.078	0.092	0.109	0.115	0.048	0.052	0.060	0.078
Within R^2	0.027	0.043	0.059	0.066	0.012	0.016	0.024	0.043

B.3 Extension and Robustness for Tables 4-6: *Cross-sectional results*

In this section we provide additional evidence for the cross-sectional results presented in Tables 4-6. First, in Table B.4 we document that our measures of funding stability, volatility of underwriting profitability and volatility of earned premium, work independently of each other. Second, in Tables B.5 and B.6, we replace our preferred measure of expected returns, the insurer's net yield, with the market yield of the insurer's fixed income investment portfolio. That is, for each insurer and each quarter, we look at the yields of the corporate and municipal bonds in their investment portfolios, and calculate a value-weighted yield, based on the part of the investment portfolio that we are able to merge. Section C.3 describes the details of the construction of this measure. We take the market yield of an insurer's investment portfolio as a proxy for the overall investment/liquidity risk that the insurer takes through their investments. In B.5 we see that the cross-sectional relationship between expected investment returns and underwriting profitability is the same as in our baseline specifications in Tables 4 and 5. In Table B.6 we reestimate the regressions in Table 6, but again replace our preferred measure of expected returns, the insurer's net yield, with the market yield of the insurer's fixed income investment portfolio. Third, in Table B.7 we reestimate our cross-sectional specification from Table 4 on our data for life insurers. While the regression coefficients do have the same sign as for the P&C insurers in Table 4, they are not statistically significant. This is not surprising given the very narrow cross-section available in our data. As mentioned in the main text, our sample of life insurers contains only 43 individual insurers, with each date having between 6 and 19 insurers.

Table B.4: Decomposing the cross-section of expected returns with measures of funding stability individually

This table presents the cross-sectional relationship between P&C insurance prices and the part of insurers' expected returns driven by stable funding. Columns 1, 3, and 5, decompose the net yield by regressing it on a measure of funding stability:

$$\textit{Net yield}_{it} = \kappa \cdot \textit{Funding Stability}_{i,t-1} + \delta_1^T Z_{it} + FE_{Rating_i} + FE_t + \xi_{it} \quad \text{(first step)}$$

where $\textit{Net yield}_{it}$ is the net yield of insurer i at time t and $\textit{Funding Stability}_{i,t-1}$ measures the stability of insurer i's funding. In Panel A, funding stability is measured as the 4-year rolling standard deviation of insurer i's underwriting profitability up to, and including, time $t-1$. In Panel B, funding stability is measured as the 4-year rolling standard deviation of insurer i's growth in premium earned up to, and including, time $t-1$.
Columns 2, 4, and 6 present the results of the regression:

$$u_{it+1} = \beta_{\widehat{ny}} \cdot \widehat{\textit{Net yield}}_{it} + \beta_{res} \cdot \xi_{it} + \delta_2^T Z_{it} + FE_{Rating_i} + FE_t + \epsilon_{it} \quad \text{(second step)}$$

where u_{it+1} is the underwriting profitability for insurer i from time t to $t+1$, $\widehat{\textit{Net yield}}_{it}$ is the estimated net yield from the first step regression, and ξ_{it} is the residual from the first step regression. Z_{it} and FE_{Rating_i} are the same insurer level controls as in Table 4. t-statistics are reported in bracket and calculated using standard errors clustered by date and firm in the insurer-level columns (1)-(4), and by insurer, state, and insurance line-year in the state-level columns (5) and (6). *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: *Using only volatility of underwriting profitability to measure funding stability*

	Insurer level				State-Line	
	Baseline specification		With controls		With controls	
Estimation:	First step	Second step	First step	Second step	First step	Second step
Dependent Variables:	Net Yield	Underwriting Prof.	Net Yield	Underwriting Prof.	Net Yield	Underwriting Prof.
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Volatility of Underwriting Prof.	-0.209***		-0.175***		-0.346***	
	(-8.38)		(-7.46)		(-4.32)	
$\widehat{\textit{Net Yield}}_{it}$		-1.23***		-1.39***		-0.069**
		(-4.97)		(-4.70)		(-2.37)
$\textit{Residual}_{it}$		-0.050*		-0.074***		-0.046***
		(-1.68)		(-2.76)		(-3.00)
Controls:						
Date FE	Yes	Yes	Yes	Yes		
Rating FE and insurer controls			Yes	Yes	Yes	Yes
Year×State×Insurance Line FE					Yes	Yes
Fit statistics						
Observations	37,698	37,698	37,698	37,698	724,660	724,660
R^2	0.250	0.043	0.259	0.090	0.069	0.068
Within R^2	0.031	0.008	0.023	0.034	0.009	0.018

Panel B: *Using only volatility of premium earned to measure funding stability*

	Insurer level				State-Line	
	Baseline specification		With controls		With controls	
Estimation:	First step	Second step	First step	Second step	First step	Second step
Dependent Variables:	Net Yield	Underwriting Prof.	Net Yield	Underwriting Prof.	Net Yield	Underwriting Prof.
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Volatility of Premium Earned	-0.136***		-0.110***		-0.249***	
	(-5.75)		(-4.69)		(-3.02)	
$\widehat{Net\ Yield}_{it}$		-0.552*		-1.05***		-0.459**
		(-1.81)		(-3.08)		(-2.52)
$Residual_{it}$		-0.081***		-0.092***		-0.054***
		(-2.70)		(-3.37)		(-3.36)
Controls:						
Date FE	Yes	Yes	Yes	Yes		
Rating FE and insurer controls			Yes	Yes	Yes	Yes
Year×State×Insurance Line FE					Yes	Yes
Fit statistics						
Observations	37,698	37,698	37,698	37,698	724,660	724,660
R^2	0.235	0.037	0.250	0.086	0.067	0.070
Within R^2	0.011	0.002	0.012	0.030	0.007	0.021

Table B.5: Cross-sectional regressions with market yields

This table presents the cross-sectional relationship between P&C insurance prices, measured by underwriting profitability, and firm-specific expected investment returns, measured by market yields of the insurer's fixed income portfolio. It reports the parameter estimate from the following panel regression:

$$u_{it+1} = \beta_{ny} \cdot \textit{Market yield}_{it} + \delta^T Z_{it} + \beta_{nyGFC} \cdot \textit{Market yield}_{it} \cdot \mathbb{1}_{GFC} + \delta^T_{zGFC} Z_{it} \cdot \mathbb{1}_{GFC} + FE_{Rating_i} + FE_t + \epsilon_{it}$$

where u_{it+1} is the underwriting profitability for insurer i from time t to $t+1$ and *Market yield*$_{it}$ is the market yield of the insurer's investment portfolio. $\mathbb{1}_{GFC}$ is an indicator variable set to one over the Global Financial Crisis (September 2008 through December 2009). Z_{it} is a vector of controls for insurer i's balance sheet strength and reinsurance activity at time t: *Capital Ratio* is the risk based capital ratio reported by the insurers themselves, *Unearned Premium Ratio* is the ratio of unearned premiums to net premiums earned, and *Reinsurance Ratio* is the ratio of net reinsurance premiums to direct premiums written. The insurer level sample consists of quarterly observations from Q1 2005 through Q1 of 2022. t-statistics are reported in bracket and calculated using standard errors clustered by date and firm in columns (1)-(3), and by insurer and state-year in column (4). *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variable:	Underwriting Profitability			
Sample:	Insurer level			State level
Model:	(1)	(2)	(3)	(4)
Variables				
Market yield	-0.102**	-0.088**	-0.115**	-0.124**
	(-2.30)	(-2.17)	(-2.54)	(-2.16)
Capital Ratio		0.056***	0.051***	0.038***
		(9.61)	(8.56)	(5.87)
Unearned Premium		0.012	0.003	$-3.88 \times 10^{-6***}$
		(0.323)	(0.082)	(-2.62)
Reinsurance Ratio		-0.0008	0.0008	2.09×10^{-5}
		(-0.325)	(0.293)	(1.20)
$\mathbb{1}_{GFC}$ × Market yield			0.158***	0.066
			(3.52)	(1.45)
$\mathbb{1}_{GFC}$ × Capital Ratio			-0.018*	-0.018
			(-1.82)	(-1.39)
$\mathbb{1}_{GFC}$ × Unearned Premium			0.023	-0.040
			(0.422)	(-0.681)
$\mathbb{1}_{GFC}$ × Reinsurance Ratio			-0.001	$-6.59 \times 10^{-5**}$
			(-0.271)	(-2.09)
Controls:				
Date FE	Yes	Yes	Yes	
Rating FE			Yes	Yes
Year×State×Insurance Line FE				Yes
Fit statistics				
Observations	36,585	36,585	36,585	664,598
R^2	0.034	0.066	0.079	0.065
Within R^2	0.001	0.034	0.026	0.015

Table B.6: Funding stability, investment returns, and insurance prices: A two-step estimation with market yields

This table presents the cross-sectional relationship between P&C insurance prices and the part of insurers' expected returns driven by stable funding. Expected returns are measured using the market yield of the insurers' investment portfolio. Columns 1, 3, and 5, decompose the market yield of the insurers' investment portfolio by regressing it on the stability of insurance underwriting:

$$\textit{Market yield}_{it} = \kappa_1 \cdot \textit{Volatility}_{i,t-1}^{\textit{und. prof}} + \kappa_2 \cdot \textit{Volatility}_{i,t-1}^{\Delta NPE} + \delta_1^T Z_{it} + FE_{Rating_i} + FE_t + \xi_{it} \quad \text{(first step)}$$

where $\textit{Market yield}_{it}$ is the market yield of fixed income part of insurer i's investment portfolio at time t and $\textit{Volatility}_{i,t-1}^{\Delta \textit{und. prof}}$ and $\textit{Volatility}_{i,t-1}^{\Delta NPE}$ are the 4-year rolling standard deviation of insurer i's underwriting profitability and net premium earned growth, respectively, up to, and including, time $t-1$. Columns 2, 4, and 6 present the results of the regression:

$$u_{it+1} = \beta_{\widehat{my}} \cdot \widehat{\textit{Market yield}}_{it} + \beta_{res} \cdot \xi_{it} + \delta_2^T Z_{it} + FE_{Rating_i} + FE_t + \epsilon_{it} \quad \text{(second step)}$$

where u_{it+1} is the underwriting profitability for insurer i from time t to $t+1$, $\widehat{\textit{Market yield}}_{it}$ is the estimated market yield from the first step regression, and ξ_{it} is the residual from the first step regression. Z_{it} and FE_{Rating_i} are the same insurer level controls as in Table 4. t-statistics are reported in bracket and calculated using standard errors clustered by date and firm in the insurer-level columns (1)-(4), and by insurer, state, and insurance line-year in the state-level columns (5) and (6). *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

	Insurer level				State-Line	
	Baseline specification		With controls		With controls	
Estimation:	First step	Second step	First step	Second step	First step	Second step
Dependent Variables:	Market yield	Underwriting Prof.	Market yield	Underwriting Prof.	Market yield	Underwriting Prof.
Model:	(1)	(2)	(3)	(4)	(5)	(6)
Variables						
Volatility of Underwriting Prof.	-0.044**		-0.066***		-0.075***	
	(-2.26)		(-3.42)		(-2.85)	
Volatility of Premium Earned	-0.006		-0.019		-0.007	
	(-0.311)		(-1.00)		(-0.332)	
$\widehat{\textit{Market yield}}_{it}$		-5.07***		-3.15***		-2.15***
		(-4.36)		(-4.36)		(-2.79)
$\textit{Residual}_{it}$		-0.098**		-0.055		-0.098*
		(-2.41)		(-1.52)		(-1.96)
Controls:						
Date FE	Yes	Yes	Yes	Yes		
Rating FE and insurer controls			Yes	Yes	Yes	Yes
Year×State×Insurance Line FE					Yes	Yes
Fit statistics						
Observations	33,827	33,827	33,827	33,827	643,151	643,151
R^2	0.638	0.044	0.643	0.092	0.705	0.068
Within R^2	0.003	0.007	0.006	0.033	0.004	0.019

Table B.7: Investment returns and the cross-section of life insurance prices

This table presents the cross-sectional relationship between life insurance prices, measured by underwriting profitability, and firm-specific expected investment returns, measured by net yields. It reports the parameter estimate from the following panel regression:

$$m_{ikt} = \beta_{ny} \cdot \textit{Net yield}_{it} + \delta^T \cdot Z_{it} + \beta_{nyGFC} \cdot \textit{Net yield}_{it} \times \mathbb{1}_{GFC} + \delta^T_{GFZ} \cdot Z_{it} \times \mathbb{1}_{GFC} + FE_t + FE_k + \epsilon_{ikt}$$

where m_{ikt} is the markup for insurer i and product k at time t and $\textit{Net yield}_{it}$ is the insurer's net yield. $\mathbb{1}_{GFC}$ is an indicator variable set to one over the global financial crisis (September 2008 through December 2009). Z_{it} is a vector of controls for insurer i's balance sheet strength at time t: deferred annuity liabilities, risk-based capital relative to guideline, and the insurer's leverage ratio. Note that we cannot apply the same balance sheet controls as we did with P&C insurers due to different reporting requirements between life and P&C insurers. All control variables and markups are retrieved from Koijen and Yogo (2015). t-statistics are reported in bracket and calculated using standard errors clustered by date and firm. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Dependent Variable:	Markup (annualized)		
Model:	(1)	(2)	(3)
Variables			
Net Yield	-0.003	-0.0005	-0.0002
	(-0.147)	(-0.027)	(-0.010)
Deferred annuity liabilities		-0.004	-0.005*
		(-1.45)	(-1.72)
Risk-based Capital		-0.0009	-0.0010
		(-1.01)	(-0.909)
Leverage ratio		0.014*	0.016**
		(1.70)	(2.08)
$\mathbb{1}_{GFC}$ × Net Yield			0.020
			(0.221)
$\mathbb{1}_{GFC}$ × Deferred annuity liabilities			0.007**
			(2.49)
Risk-based Capital × $\mathbb{1}_{GFC}$			0.0006
			(0.461)
$\mathbb{1}_{GFC}$ × Leverage ratio			-0.013
			(-1.25)
Controls:			
Date FE	Yes	Yes	Yes
Product FE	Yes	Yes	Yes
Fit statistics			
Observations	2,661	2,661	2,661
R^2	0.686	0.694	0.696
Within R^2	0.000	0.027	0.032

C Additional Details on methodology and data

In this section of the appendix we provide additional details and motivation for how we measure expected returns in the time series and cross-section of insurers, as well as details on our work with the SNL database.

C.1 Working with the SNL database and aggregating insurer entities at the group level

We collect data from S&P Global: Market Intelligence using a FTP feed to access the full back-end of their SNL database. Our main data sources are taken from the file group P&C Core Financials, and in particular we use variables from the Financial Highlights Table (File Name: $PC_CoreFinl_[year]_CF0001$ for each reporting year) and the Capital Adequacy and Liquidity Analysis Table (File Name: $PC_CoreFinl_[year]_CF0015$ for each reporting year).

A difficulty with working on insurance companies empirically is that there is often quite complex corporate structures, with large insurance groups consisting of many separate insurance entities, each of which files separately with the regulator and therefore has a unique company code with the NAIC (the National Association of Insurance Commissioners). There is also fairly frequent M&A activity across insurance groups with the underlying insurance entities. The SNL database provides several different reporting levels, including an SNL defined insurance group level, but the financial variables on these lines are reported on an *'as-is'* basis. An *'as-is'* basis means historical records of merged or acquired insurance entities are reported as if they have always been held within the current ownership group, which is problematic for empirical analysis.

To generate correct historical records of insurance groups, we first use the online screener on the S&P Global: Market Intelligence website to pull the historical 'NAIC combined company code' (which identifies the insurance group) for each individually filing insurance entity. This provides an accurate history of which NAIC insurance group the insurance entities were a member of in a given reporting period. We merge this table by 'insurance entity NAIC code' with the main datatables in the SNL database and drop the SNL group-level reporting lines. We then aggregate insurance entities to their historical NAIC group level in each reporting period, summing across entities for dollar financial variables, and using asset-value weighted averages to aggregate percentage and ratio variables. The exceptions are underwriting profitability and premium growth, which are aggregated using liability-weighted averages. This gives the historical record of the insurance groups, i.e. Berkshire Hathaway, AllState, State Farm, Liberty Mutual...etc., which are insurance companies we wish to study empirically. Our final P&C sample consists of 871 insurance groups, which have been aggregated from 4,038 individual insurance

entities.

In further analysis, we utilize more granular insurance underwriting reporting by insurers that is at a state and business line level (on an annual frequency). This data is stored in the StatePage files and we specifically use variables in the filename $PC_Geographic_GE0001$.

C.2 Measuring and interpreting insurer net yields in the cross-section of insurers

To measure cross-sectional variation in insurers' expected investment returns, we use insurers' *Net Yield on Invested Assets* as defined in equation (21). Net yield is an accounting return on assets, and is defined as dollar net income from investments over the dollar book value of invested assets. Anecdotally, we know from market participants that it is the key metric from which insurance companies assess their investment portfolio performance.

The accounting rules are designed so that the total net yield on each invested asset for an insurer must exactly equal the insurer's total economic return over the insurer's investment holding period for that investment. However, on a quarter-by-quarter basis, the economic return and accounting net yield may differ as the assets are not marked-to-market. For fixed income assets, the reported net yield on an asset is the amortisation of the purchase yield each quarter, i.e. bond values are on the balance sheet at *"historical cost"*. This accounting treatment reflects that insurers are buy-and-hold investors and can weather market fluctuations. If the insurer does sell a bond before maturity, the realised gain/loss is included in the reported net yield in the reporting period of the sale. This ensures the accounting return equals the economic return over the insurer's investment period for that asset.[4] For equity investments, the net yield is the dividend rate, with market fluctuations once again realised at the point of sale.

Figure C.1 presents boxplots of insurers' net yield on investments in each reporting quarter of our sample. It illustrates the time series trends in insurer investment returns. Note that the accounting treatment of net yields, which shields insurers from some mark-to-market volatility in the investment portfolio, kept net yields positive during the financial crisis. This was despite some large negative economic returns in that period. Turning to the cross-section, Figure C.1 highlights rich heterogeneity in net yields across insurers at any given point in time. In all quarters of our sample, the range between the 25th and 75th percentiles of investment returns is in excess of 150 bps. It is this variation in net yields across insurers that our empirical method utilizes.

Crucially, so long an insurer does not sell an asset (and the issuer default risk does not

[4]If there are significant revisions to the outlook for a bond (i.e. a permanent change in credit risk or a change in expected recovery rates), then adjustments may also be made in reported investment income. In this case, the bonds are "impaired" with book-value adjustments.

increase materially), the net yield methodology protects the insurer from mark-to-market volatility on their investments. This treatment reflects insurers' long-term buy-and-hold approach to investing, [5] and is consistent with the view of insurers as *"asset insulators"* (Chodorow-Reich et al., 2021) or *"safe hands"* (Coppola, 2025), holding bonds for the long-term and riding out transitory dislocations in market prices.

Table C.1 Panel A shows how variation in insurers' asset allocations explain cross-sectional variation in insurer investment returns. We regress investment net yields (in bps) on asset allocations (in percent) with controls for time fixed effects. We omit insurers allocation to Treasury bonds in the explanatory variable list but include all other asset allocations (split by cash, non-Treasury bonds, and all other asset). This regression specification means that the point estimate on any asset allocation variable can be interpreted as the effect on net yield that is generated from an increase in the allocation to that asset that is funded by a sale in Treasury bonds. In other words, the estimates capture the *excess* net yield an average insurer earns on the asset class relative to the Treasury yield. We see that, intuitively, insurers with large credit allocations earn higher investment returns, while large allocations to cash result in lower investment returns. For example, column 1 shows that a 1 percentage point increase in credit and cash allocations from Treasuries results in a 1.15 bps increase and 1.94 bps decrease in investment returns respectively. In column 2 of Table C.1 we include the credit risk taken within the credit portfolio, and in column 3 we interact this variable with the credit allocation. We see that the riskier an insurer's credit portfolio is, the higher the insurer's net yield.

Table C.1 Panel B explains the time series variation in individual insurance company's investment returns. Columns 1-2 show that there is a high degree of persistence in insurers' investment returns. The large r-squared shows that an insurer's accounting investment return in the current quarter explains 43% of the insurer's accounting investment return in the next quarter. Given that insurers' accounting returns predict next periods accounting returns, we interpret cross-sectional variation in net-yield as cross-sectional variation in insurers' *expected* investment opportunities going forward. An insurer with a relatively high net yield today as compared to competitors expects the net yield to be higher in future quarters.

Columns 3-4 of Table C.1 Panel B show the macro-level time series drivers of investment returns. We find that, consistent with the large fixed income allocations in insurers' asset portfolios, the levels of interest rates and credit spreads are significant drivers of net yields on average. Notably, accounting investment returns must equal economic investment returns in the long-run. Therefore, if credit spreads only reflected default losses, then credit spreads would have no predictability for insurer investment returns

[5] In Section 6.1 we document evidence of both P&C and life insurers acting as buy-and-hold investors in normal times and through crisis periods.

on average. Our finding that credit spreads predict insurer net yields is consistent with evidence that corporate bonds deliver excess returns over Treasuries over the long-term (Krishnamurthy and Vissing-Jorgensen, 2012; Gilchrist and Zakrajšek, 2012). It is also consistent with our interpretation of net yield variation in the cross-section: insurers that take more credit risk in their investments earn higher net yields and expect to earn higher investment returns relative to their competitors going forward.

C.3 Construction of Insurer Portfolio Market Yields

We construct a measure of the market yield on each insurer's investment portfolio by matching position-level holdings data to secondary-market bond yields. Our holdings data come from the SNL Insurance Regulatory Data, which provides security-level snapshots of each insurer's investment portfolio at a quarterly frequency as reported in statutory filings. Each record contains a CUSIP identifier, as well as the number of units owned.

We obtain market-based yields from two sources. For corporate bonds we use the WRDS Corporate Bond Database (*BondRet*), which provides end-of-month yields and prices derived from TRACE database. For municipal bonds, we use trade-level data from the Municipal Securities Rulemaking Board (MSRB). We aggregate MSRB trades to the CUSIP–day level by computing par-weighted average yields and prices across all trades for a given security on a given day.

We match holdings to market yields using 8-character CUSIPs and reporting dates. Specifically, we perform a rolling join that matches each holding to the most recent available market yield within a 89-day lookback window. WRDS BondRet serves as the primary data source, meaning we first match our holdings data to this database, and then match the remaining unmatched observations to the MSRB database. The market price of the assets from the matched source is used to compute a market value for each position as the product of the number of assets owned and the matched price.

For each insurer i at reporting date t, we compute the portfolio market yield as:

$$\text{Market Yield}_{i,t} = \frac{\sum_{j \in \mathcal{P}_{i,t}} y_{j,t} \cdot mv_{j,t}}{\sum_{j \in \mathcal{P}_{i,t}} mv_{j,t}}, \tag{C.46}$$

where $y_{j,t}$ is the market yield of bond j at date t, $mv_{j,t}$ is the market value of position j (number of units owned times the matched market price), and $\mathcal{P}_{i,t}$ denotes the set of bonds held by insurer i at date t for which a market yield is observable (the "measurable portfolio"). Finally, we winsorize all portfolio-level yield measures at the 1st and 99th percentiles within each reporting date to mitigate the influence of outliers.

Using the market yield of the insurers' investment portfolio, Tables B.5 and B.6 below, replicate the main results of Tables 4, 5, and 6, replacing our preferred measure of

insurers' expected returns, net yields, with market yields. Reassuringly, the pass-through of insurers' expected returns to insurance prices remains significantly and economically meaningful using this alternative measure of portfolio returns.

Figure C.1: Variation in the expected investment returns of insurance companies. This figure illustrates variation in the expected investment returns of insurance companies in both the time series and cross-section. In each reporting quarter of our sample, the figure presents a boxplot of expected investment returns. Our sample includes firm-level data for 871 P&C insurance groups. Expected investment returns are measured as the net yield on invested assets, as reported in insurance company financial accounts. The data comes from US insurance company statutory filings and is provided by SNL Global.



Table C.1: Understanding the investment returns of insurance companies

This table explains variation in the investment returns of insurance companies. Panel A reports the parameter estimate from the following panel regression:

$$\begin{aligned} \textit{Net Yield}_{it} = &\beta_{Cash} \cdot \textit{Cash All.}_{it-1} + \beta_{Bond} \cdot \textit{Bond All.}_{it-1} + \beta_{Risk} \cdot \textit{Risk}_{it-1} + \\ &\beta_{BondRisk} \cdot \textit{Bond All.}_{it-1} \times \textit{Risk}_{it-1} + \beta_{Other.} \cdot \textit{Other Assets All.}_{it-1} + FE_t + \epsilon_{it} \end{aligned}$$

where $\textit{Net Yield}_{it}$ is insurer i's net yield (in basis points) at time t and the explanatory variables are insurer i's investment allocations (in pct.) to cash, non-government bonds, and other (non-Treasury) assets. In addition we include the risk-weighted bond allocation which is insurer i's bond allocation interacted with a (normalized) measure of the average credit rating of the insurer's credit portfolio as in Table B.3. All specifications in Panel A include time fixed effects FE_t.
Panel B reports the parameter estimate from the following panel regression:

$$\textit{Net Yield}_{it} = \beta_{ny1} \cdot \textit{Net Yield}_{it-1} + \beta_{ny5} \cdot \textit{Net Yield}_{it-5} + \delta^T X_{t-1} + FE_i + \epsilon_{it}$$

where X_t is a vector of time series variables that capture insurer investment opportunities (Moody's credit spread of BAA-rated corporate bonds yields over 10-year Treasuries, the 10-year Treasury rate, the slope of the Treasury yield curve (10-year - 2-year Treasury yields), the TED spread), and FE_i captures firm fixed effects. All variables in panel B are measured in percent. t-statistics are reported in the brackets and are calculated using standard errors clustered by date and firm. *, **, and *** indicate statistical significance at the 10%, 5% and 1% level, respectively.

Panel A: Investment Returns and Asset Allocation

Dependent Variable:	Net Yield (bp.)		
Model:	(1)	(2)	(3)
Variables			
Cash Allocation	-1.94***	-2.14***	-2.11***
	(-7.99)	(-9.04)	(-9.02)
Bond Allocation (Non-gvt.)	1.15***	1.27***	1.31***
	(6.54)	(6.92)	(7.57)
Allocation to Other Assets	-0.063	-0.170	-0.186
	(-0.261)	(-0.688)	(-0.753)
Risk		26.5***	2.25
		(3.68)	(1.02)
Bond Allocation (Non-gvt.) × Risk			1.31***
			(11.1)
Controls:			
Date FE	Yes	Yes	Yes
Fit statistics			
Observations	43,056	41,017	41,017
R^2	0.334	0.357	0.378
Within R^2	0.103	0.128	0.156

Panel B: Investment Returns and Time Series Variation

Dependent Variable:	Net Yield			
Model:	(1)	(2)	(3)	(4)
Variables				
Net Yield (t-1)	0.641***	0.437***		
	(21.0)	(15.2)		
Net Yield (t-5)		0.261***		
		(15.7)		
Credit Spread (Moody's BAA)			0.309***	0.414***
			(8.51)	(6.59)
Treasury Yield (10 year)			0.558***	0.574***
			(18.3)	(22.1)
Slope (10 year - 2 year)				-0.196***
				(-5.39)
TED Spread				-0.064
				(-0.991)
Controls:				
Entity FE			Yes	Yes
Fit statistics				
Observations	46,204	39,225	47,125	47,125
R^2	0.425	0.437	0.527	0.537
Within R^2			0.282	0.297

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