Regulation-induced Interest Rate Risk Exposure

Maximilian Huber

NYU Student Macro Lunch

November 1, 2021

Research Question

- How exposed are life insurers to interest rate risk?

Research Question

- How exposed are life insurers to interest rate risk?
- Naturally exposed through their business:
  - Liabilities: long-term mortality insurance policies and retirement savings vehicles $\Rightarrow$ 7% of household financial assets

Research Question

- How exposed are life insurers to interest rate risk?
- Naturally exposed through their business:
  - Liabilities: long-term mortality insurance policies and retirement savings vehicles $\Rightarrow$ 7% of household financial assets
  - Assets: bonds and mortgages $\Rightarrow$ more than 25% of corporate bonds

Research Question

- How exposed are life insurers to interest rate risk?
- Naturally exposed through their business:
  - Liabilities: long-term mortality insurance policies and retirement savings vehicles ⇒ 7% of household financial assets
  - Assets: bonds and mortgages ⇒ more than 25% of corporate bonds
- Maturity matching?

Research Question

- How exposed are life insurers to interest rate risk?
- Naturally exposed through their business:
  - Liabilities: long-term mortality insurance policies and retirement savings vehicles $\Rightarrow$ 7% of household financial assets
  - Assets: bonds and mortgages $\Rightarrow$ more than 25% of corporate bonds
- Maturity matching? Potential for risk-shifting

Research Question

- How exposed are life insurers to interest rate risk?
- Naturally exposed through their business:
  - Liabilities: long-term mortality insurance policies and retirement savings vehicles ⇒ 7% of household financial assets
  - Assets: bonds and mortgages ⇒ more than 25% of corporate bonds
- Maturity matching? Potential for risk-shifting ⇒ statutory regulation

Findings

- Quantification:

Findings

- Quantification: when interest rates fall by one-percentage-point...
  1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

     Regulatory micro data $\Rightarrow$ how long-term are the liabilities compared to assets?

Findings

- Quantification: when interest rates fall by one-percentage-point...
  1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

     Regulatory micro data ⇒ how long-term are the liabilities compared to assets?
  2. life insurers earn a half percentage point lower spread on newly issued policies.

     Incomplete pass-through from bond market interest rates to annuity interest rates

Findings

- Quantification: when interest rates fall by one-percentage-point...
    1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

       Regulatory micro data $\Rightarrow$ how long-term are the liabilities compared to assets?
    2. life insurers earn a half percentage point lower spread on newly issued policies.

       Incomplete pass-through from bond market interest rates to annuity interest rates
- Two exposures do not offset each other!

Findings

- Quantification: when interest rates fall by one-percentage-point...
    1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

       Regulatory micro data $\Rightarrow$ how long-term are the liabilities compared to assets?
    2. life insurers earn a half percentage point lower spread on newly issued policies.

       Incomplete pass-through from bond market interest rates to annuity interest rates
- Two exposures do not offset each other! Explanation:

Findings

- Quantification: when interest rates fall by one-percentage-point...
  1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

     Regulatory micro data ⇒ how long-term are the liabilities compared to assets?
  2. life insurers earn a half percentage point lower spread on newly issued policies.

     Incomplete pass-through from bond market interest rates to annuity interest rates
- Two exposures do not offset each other! Explanation:
  3. Model of a life insurer featuring statutory regulation

Findings

- Quantification: when interest rates fall by one-percentage-point...
    1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.
       Regulatory micro data $\Rightarrow$ how long-term are the liabilities compared to assets?
    2. life insurers earn a half percentage point lower spread on newly issued policies.
       Incomplete pass-through from bond market interest rates to annuity interest rates
- Two exposures do not offset each other! Explanation:
    3. Model of a life insurer featuring statutory regulation $\Rightarrow$ statutory hedging motives overpower economic hedging motives!

Findings

- Quantification: when interest rates fall by one-percentage-point...
    1. life insurers realize a capital loss of \$121 billion or 26% of capital in 2019.

       Regulatory micro data ⇒ how long-term are the liabilities compared to assets?
    2. life insurers earn a half percentage point lower spread on newly issued policies.

       Incomplete pass-through from bond market interest rates to annuity interest rates
- Two exposures do not offset each other! Explanation:
    3. Model of a life insurer featuring statutory regulation ⇒ statutory hedging motives overpower economic hedging motives!

       Empirical evidence, policy recommendations, learnings

0. Preliminaries

Interest Rate Sensitivity

- Value V of a risk-free bond:

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r}$$

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond?

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.
- Value E of a life insurer:

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.
- Value E of a life insurer: $E =$

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.
- Value E of a life insurer: $$E = \underbrace{A - L}_{\text{net assets}} +$$

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.

- Value E of a life insurer: $$E = \underbrace{A - L}_{\text{net assets}} + \underbrace{F}_{\text{franchise}}$$

Interest Rate Sensitivity

- Value V of a risk-free bond: $$V = \sum_{h=1}^{\infty} e^{-h \cdot r_h} \cdot b_h$$

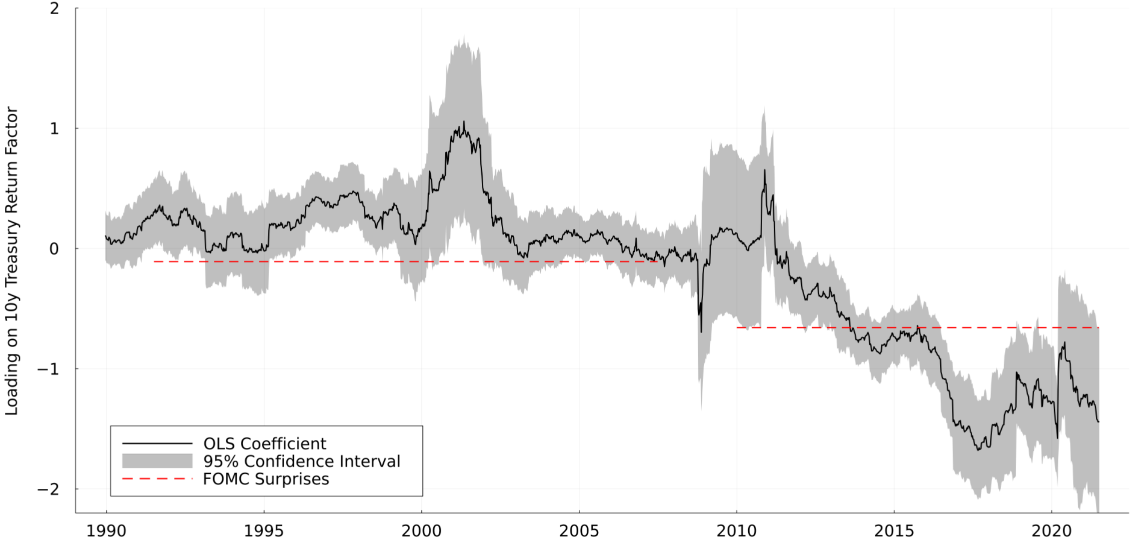
  where b_h is the cash flows in h years and r_h is the corresponding Treasury yield.

- Contemplate a level shift $\Rightarrow$ Duration:

$$D_V = -\frac{1}{V}\frac{\partial V}{\partial r} = \frac{1}{V}\sum_{h=1}^{\infty} h \cdot e^{-h \cdot r_h} \cdot b_h$$

- Duration of a 10-year zero-coupon bond? 10 years.
- Value E of a life insurer: $$E = \underbrace{A - L}_{\text{net assets}} + \underbrace{F}_{\text{franchise}}$$
- Duration:

$$D_E = \frac{A-L}{E} D_{A-L} + \frac{F}{E} D_F$$



Duration of Market Equity $D_E = 10 \cdot \beta^T$ in $rx_t^{\mathrm{L}} = \alpha + \beta^{\mathrm{M}} \cdot rx_t^{\mathrm{M}} + \beta^T \cdot rx_t^{\mathrm{T}} + \epsilon_t$

D_{A-L} | FOMC Table | FOMC w/o outliers | FOMC timing | FOMC Swanson | Banks

1. Net Assets $A - L$

Duration of Net Assets

- Duration of net assets D_{A-L} and duration gap G:

$$D_{A-L} = -\frac{1}{A-L}\frac{\partial(A-L)}{\partial r} = \frac{A}{A-L}\underbrace{\left(D_A - \frac{L}{A}D_L\right)}_{=G} \gtrless 0$$

Duration of Net Assets

- Duration of net assets D_{A-L} and duration gap G:

$$D_{A-L} = -\frac{1}{A-L}\frac{\partial(A-L)}{\partial r} = \frac{A}{A-L}\underbrace{\left(D_A - \frac{L}{A}D_L\right)}_{=G} \gtrless 0$$

- Estimate D_A from the transparent data on the assets.

Duration of Net Assets

- Duration of net assets D_{A-L} and duration gap G:

$$D_{A-L} = -\frac{1}{A-L}\frac{\partial(A-L)}{\partial r} = \frac{A}{A-L}\underbrace{\left(D_A - \frac{L}{A}D_L\right)}_{=G} \gtrless 0$$

- Estimate D_A from the transparent data on the assets.
- Estimate D_L from the statutory accounting data on the liabilities.

Actuarial and Reserve Value of a Liability

- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

Actuarial and Reserve Value of a Liability

- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

$$V_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \mathbb{E}_t \left[b_{t+h} \right]$$

Actuarial and Reserve Value of a Liability

- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

$$V_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \mathbb{E}_t \left[b_{t+h} \right] \qquad \hat{V}_t = \sum_{h=1}^{\infty} \left(1 + \hat{r}_S\right)^{-h} \cdot \hat{b}_{t+h}$$

where $\hat{r}_s$ is the reserve discount rate and $\hat{b}$ are reserve cash flows specific to a valuation standard S prescribed by regulation.

Actuarial and Reserve Value of a Liability

- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

$$V_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \mathbb{E}_t \left[b_{t+h} \right] \qquad \hat{V}_t = \sum_{h=1}^{\infty} \left(1 + \hat{r}_S\right)^{-h} \cdot \hat{b}_{t+h}$$

where $\hat{r}_s$ is the reserve discount rate and $\hat{b}$ are reserve cash flows specific to a valuation standard S prescribed by regulation.

Actuarial and Reserve Value of a Liability

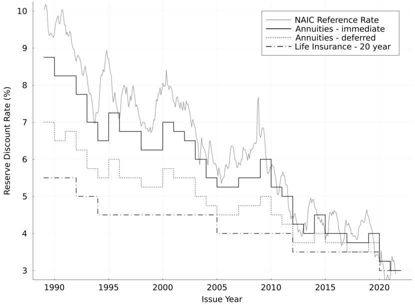
- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

$$V_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \mathbb{E}_t \left[b_{t+h} \right] \qquad \hat{V}_t = \sum_{h=1}^{\infty} \left(1 + \hat{r}_S\right)^{-h} \cdot \hat{b}_{t+h}$$

where $\hat{r}_s$ is the reserve discount rate and $\hat{b}$ are reserve cash flows specific to a valuation standard S prescribed by regulation.

- Pseudo-actuarial value:

$$\tilde{V}_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \hat{b}_{t+h}$$

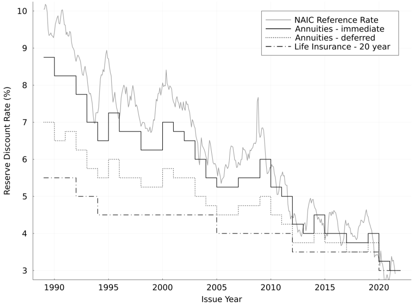


Actuarial and Reserve Value of a Liability

- Actuarial (fair) V and reserve value $\hat{V}$ of a liability:

$$V_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \mathbb{E}_t \left[b_{t+h} \right] \qquad \hat{V}_t = \sum_{h=1}^{\infty} \left(1 + \hat{r}_S\right)^{-h} \cdot \hat{b}_{t+h}$$

  where $\hat{r}_s$ is the reserve discount rate and $\hat{b}$ are reserve cash flows specific to a valuation standard S prescribed by regulation.



- Pseudo-actuarial value:

$$\tilde{V}_t = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot \hat{b}_{t+h}$$

- Popular policies: $\tilde{V}_t \approx V_t$ and $\tilde{D}_t \approx D_t$! ▸ Examples

Data

- Need $\hat{b}$ for the pseudo-actuarial value and duration!

Data

- Need $\hat{b}$ for the pseudo-actuarial value and duration!
- Back out from reserve values $\hat{V}$:

$$\hat{V}_{i,t,S} = \left(1+\hat{r}_S\right)^{-1}\hat{b}_{i,t+1,S} + \left(1+\hat{r}_S\right)^{-1}\hat{V}_{i,t+1,S}$$

Data

- Need $\hat{b}$ for the pseudo-actuarial value and duration!
- Back out from reserve values $\hat{V}$:

$$\hat{V}_{i,t,s} = \left(1+\hat{r}_s\right)^{-1}\hat{b}_{i,t+1,s} + \left(1+\hat{r}_s\right)^{-1}\hat{V}_{i,t+1,s}$$

- "Exhibit 5 - Aggregate Reserves for Life Contracts":
  - at the end of year t from 2001 to 2020
  - for each life insurer i out of 900

1 Valuation Standard	2 Total
Life Insurance:	
0100001. 58 CSO - NL 2.50% 1961-1969	243,737
⋮	⋮
0100025. 80 CSO - CRVM 4.50% 1998-2004	306,242,662
⋮	⋮
0100037. 01CSO CRVM - ANB 4.00% 2009	869,698
0199997. Totals (Gross)	466,142,285
0199998. Reinsurance ceded	339,424,855
0199999. Totals (Net)	126,717,430
Annuities (excluding supplementary contracts with life contingencies):	
0200001. 71 IAM 6.00% 1975-1982 (Imm)	359,802
⋮	⋮
0200028. 83 IAM 7.25% 1986 (Def)	188,675,689
⋮	⋮
0200043. Annuity 2000 4.75% 2004 (Def)	206,817,839
⋮	⋮
0200047. Annuity 2000 4.50% 2010 (Def)	1,731,459,797
0299997. Totals (Gross)	9,676,901,276
0299998. Reinsurance ceded	7,415,759
0299999. Totals (Net)	9,669,485,517
⋮	⋮
9999999. Totals (Net) - Page 3, Line 1	9,804,893,998

Exhibit 5 of the Great American Life Insurance Company in 2010

Data

- Need $\hat{b}$ for the pseudo-actuarial value and duration!
- Back out from reserve values $\hat{V}$:

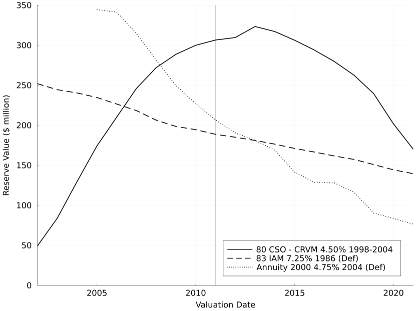
$$\hat{V}_{i,t,S} = \left(1 + \hat{r}_S\right)^{-1} \hat{b}_{i,t+1,S} + \left(1 + \hat{r}_S\right)^{-1} \hat{V}_{i,t+1,S}$$

- "Exhibit 5 - Aggregate Reserves for Life Contracts":
  - at the end of year t from 2001 to 2020
  - for each life insurer i out of 900
  - aggregated to valuation standard S (mortality table, reserve discount rate $\hat{r}$, issue years)

1 Valuation Standard	2 Total
Life Insurance:	
0100001. 58 CSO - NL 2.50% 1961-1969	243,737
⋮	⋮
0100025. 80 CSO - CRVM 4.50% 1998-2004	306,242,662
⋮	⋮
0100037. 01CSO CRVM - ANB 4.00% 2009	869,698
0199997. Totals (Gross)	466,142,285
0199998. Reinsurance ceded	339,424,855
0199999. Totals (Net)	126,717,430
Annuities (excluding supplementary contracts with life contingencies):	
0200001. 71 IAM 6.00% 1975-1982 (Imm)	359,802
⋮	⋮
0200028. 83 IAM 7.25% 1986 (Def)	188,675,689
⋮	⋮
0200043. Annuity 2000 4.75% 2004 (Def)	206,817,839
⋮	⋮
0200047. Annuity 2000 4.50% 2010 (Def)	1,731,459,797
0299997. Totals (Gross)	9,676,901,276
0299998. Reinsurance ceded	7,415,759
0299999. Totals (Net)	9,669,485,517
⋮	⋮
9999999. Totals (Net) - Page 3, Line 1	9,804,893,998

Exhibit 5 of the Great American Life Insurance Company in 2010

Empirics of Reserve Decay



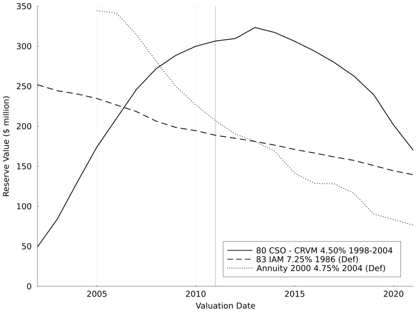
Evolution of selected reserve positions

Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.



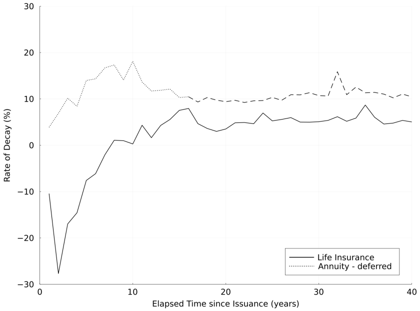
Evolution of selected reserve positions

Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.



Estimated reserve decay

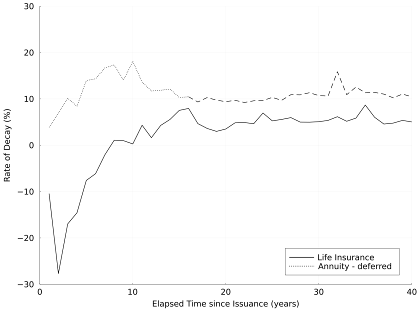
Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.

- Estimated model yields predictions for $\hat{b}$. Richer Models



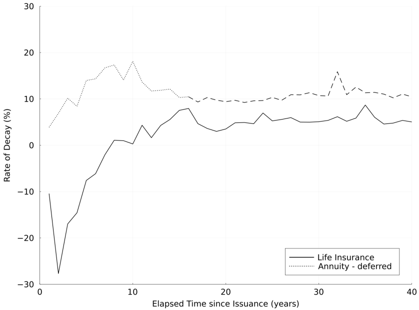
Estimated reserve decay

Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

  estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.
- Estimated model yields predictions for $\hat{b}$. ▸ Richer Models
- Calculate pseudo-actuarial duration D_L.



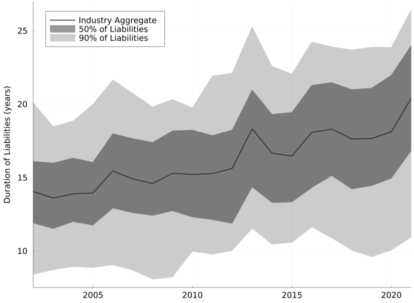
Estimated reserve decay

Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

  estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.
- Estimated model yields predictions for $\hat{b}$. ▸ Richer Models
- Calculate pseudo-actuarial duration D_L.



Duration of liabilities

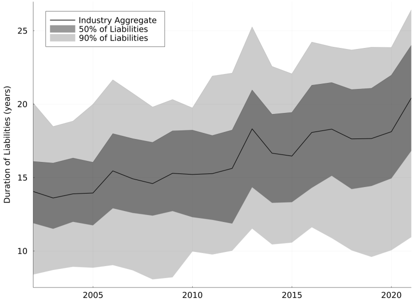
Empirics of Reserve Decay

- Reserve decay has life-cycle pattern:

$$\frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}} = \Psi_{t-\tau,S} + \epsilon_{i,t,S}$$

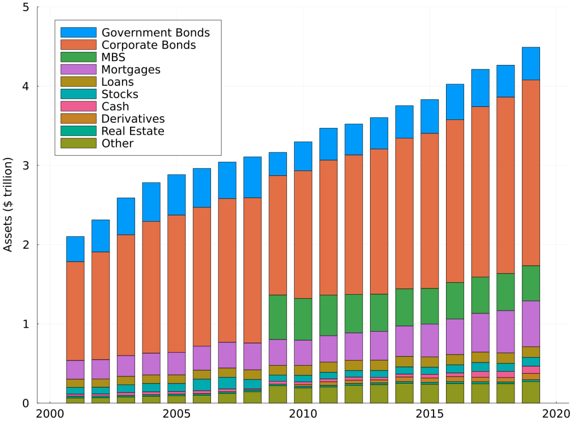
  estimated by least squares weighted by $\hat{V}_{i,t-1,S}$.
- Estimated model yields predictions for $\hat{b}$. Richer Models
- Calculate pseudo-actuarial duration D_L.
- Duration gap:

$$G = D_A - \frac{L}{A} D_L$$

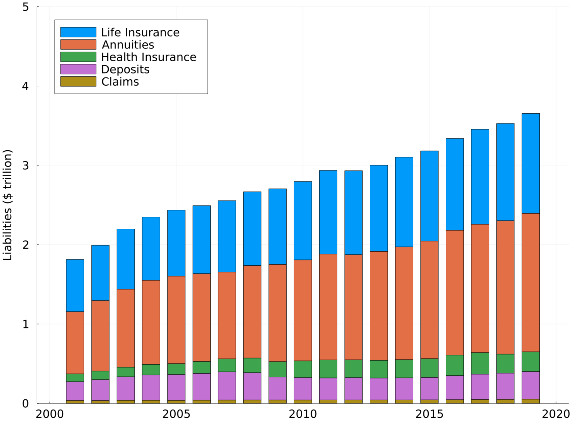


Duration of liabilities

Net assets

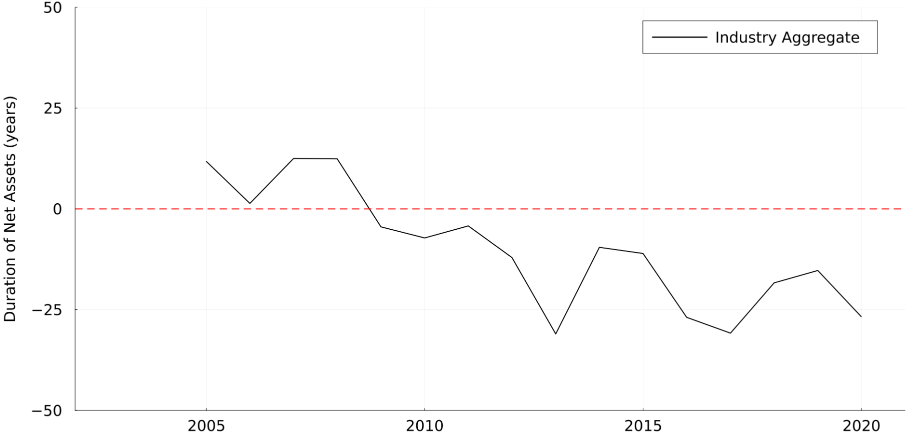


Government Bonds
Corporate Bonds
MBS
Mortgages
Loans
Stocks
Cash
Derivatives
Real Estate
Other
Assets ($ trillion)
0
1
2
3
4
5
2000
2005
2010
2015
2020



Life Insurance
Annuities
Health Insurance
Deposits
Claims
Liabilities ($ trillion)
0
1
2
3
4
5
2000
2005
2010
2015
2020

Duration of Net Assets



Duration gap in 2019: $G = D_A - \frac{L}{A} D_L = -2.85$ implies $D_E = \frac{A}{E} G = -26$ with $A = \$4.24n$, and $E = \$0.47tn$

▸ Constant

2. Funding Franchise

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^{a}_{t,h} = \alpha_h + \beta_h \cdot \Delta r^{T}_{t,h} + \epsilon_{t,h}$$

▸ Term Structure ▸ Lower Rates ▸ Cross-section ▸ Concentration ▸ Net Gain ▸ More

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^a_{t,h} = \alpha_h + \beta_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

Term Structure Lower Rates Cross-section Concentration Net Gain More

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^{a}_{t,h} = \alpha_h + \beta_h \cdot \Delta r^{T}_{t,h} + \epsilon_{t,h}$$

Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

- Interest rates rise, economic spreads rise: $1 - \beta > 0$

▸ Term Structure ▸ Lower Rates ▸ Cross-section ▸ Concentration ▸ Net Gain ▸ More

Recap

- When interest rates fall...

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.
  2. life insurers earn a lower spread on newly issued policies.

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.
  2. life insurers earn a lower spread on newly issued policies.
- What would make them to amplify rather than hedge these two exposures after 2010?

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.
  2. life insurers earn a lower spread on newly issued policies.
- What would make them to amplify rather than hedge these two exposures after 2010?
  - Towers Watson - Life Insurance CFO Survey #30 - June 2012

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.
  2. life insurers earn a lower spread on newly issued policies.

- What would make them to amplify rather than hedge these two exposures after 2010?
  - Towers Watson - Life Insurance CFO Survey #30 - June 2012
    - “Almost all (97%) respondents consider interest rate risk a significant exposure for their company.”

Recap

- When interest rates fall...
  1. life insurers realize a capital loss on their net assets.
  2. life insurers earn a lower spread on newly issued policies.

- What would make them to amplify rather than hedge these two exposures after 2010?
  - Towers Watson - Life Insurance CFO Survey #30 - June 2012
    - ★ "Almost all (97%) respondents consider interest rate risk a significant exposure for their company."
    - ★ "When considering interest rate exposure, respondents cited the level of statutory capital and earnings as the primary metrics for concern."

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^{A}_{t,h} = \alpha_h + \beta_h \cdot \Delta r^{T}_{t,h} + \epsilon_{t,h}$$

Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

- Interest rates rise, economic spreads rise: $1 - \beta > 0$

Term Structure | Lower Rates | Cross-section | Concentration | Net Gain | More

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^A_{t,h} = \alpha_h + \beta_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

  Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

- How does the reserve discount rate react to a change of Treasury market interest rates?

$$\Delta \hat{r}^A_t = \alpha_h + \hat{\beta}_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

- Interest rates rise, economic spreads rise: $1 - \beta > 0$

Term Structure | Lower Rates | Cross-section | Concentration | Net Gain | More

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^A_{t,h} = \alpha_h + \beta_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

  Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

- How does the reserve discount rate react to a change of Treasury market interest rates?

$$\Delta \hat{r}^A_t = \alpha_h + \hat{\beta}_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

  Estimates $\hat{\beta} \approx 0.15$.

- Interest rates rise, economic spreads rise: $1 - \beta > 0$

Term Structure | Lower Rates | Cross-section | Concentration | Net Gain | More

Incomplete Pass-Through: Annuity Rates

- How do the annuity interest rate react to a change of Treasury interest rates?

$$\Delta r^A_{t,h} = \alpha_h + \beta_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

  Estimates $\beta \approx 0.5$ are consistent with Charupat, Kamstra, and Milevsky (2016).

- How does the reserve discount rate react to a change of Treasury market interest rates?

$$\Delta \hat{r}^A_{t} = \alpha_h + \hat{\beta}_h \cdot \Delta r^T_{t,h} + \epsilon_{t,h}$$

  Estimates $\hat{\beta} \approx 0.15$.

- Interest rates rise, economic spreads rise: $1 - \beta > 0$, statutory spreads falls: $\hat{\beta} - \beta < 0$.

▸ Term Structure ▸ Lower Rates ▸ Cross-section ▸ Concentration ▸ Net Gain ▸ More

3. Model

Model of a Life Insurer

- Partial equilibrium model of a life insurer:

Model of a Life Insurer

- Partial equilibrium model of a life insurer:
  - chooses the duration of net assets

Model of a Life Insurer

- Partial equilibrium model of a life insurer:
    - chooses the duration of net assets
    - is subject to variation in economic earnings from issuing new policies

Model of a Life Insurer

- Partial equilibrium model of a life insurer:
  - chooses the duration of net assets
  - is subject to variation in economic earnings from issuing new policies
- Two reduced form financial frictions:

Model of a Life Insurer

- Partial equilibrium model of a life insurer:
  - chooses the duration of net assets
  - is subject to variation in economic earnings from issuing new policies
- Two reduced form financial frictions:
  - cost of operating with a volatile economic capital

Model of a Life Insurer

- Partial equilibrium model of a life insurer:
  - chooses the duration of net assets
  - is subject to variation in economic earnings from issuing new policies
- Two reduced form financial frictions:
  - cost of operating with a volatile economic capital
  - cost of operating with a volatile statutory capital

Model of a Life Insurer

- Static problem with exogenous, stochastic bond market interest rate r
- Life insurer issues annuity, pays interest rate r^A, and earns the spread $r - r^A$

Model of a Life Insurer

- Static problem with exogenous, stochastic bond market interest rate r
- Life insurer issues annuity, pays interest rate r^A, and earns the spread $r - r^A$
- Life insurer chooses the duration of the legacy capital D:

$$\max_D \quad \mathbb{E}\Big[r - r^A - C\big(R_K\big) - \hat{C}\big(R_{\hat{K}}\big)\Big]$$

with reduced form costs $C(R_K) = \frac{\chi}{2} R_K^2$ and $\hat{C}(R_{\hat{K}}) = \frac{\hat{\chi}}{2} R_K^2$.

Model of a Life Insurer

- Static problem with exogenous, stochastic bond market interest rate r
- Life insurer issues annuity, pays interest rate r^A, and earns the spread $r - r^A$
- Life insurer chooses the duration of the legacy capital D:

$$\max_D \quad \mathbb{E}\Big[r - r^A - C\big(R_K\big) - \hat{C}\big(R_{\hat{K}}\big)\Big]$$

with reduced form costs $C(R_K) = \frac{\chi}{2} R_K^2$ and $\hat{C}(R_{\hat{K}}) = \frac{\hat{\chi}}{2} R_K^2$.

- Economic capital return:

$$R_K = \underbrace{-D\big(r - \mathbb{E}\big[r\big]\big)}_{\text{return on legacy capital}} + \underbrace{r - r^A}_{\text{economic earnings}}$$

Model of a Life Insurer

- Static problem with exogenous, stochastic bond market interest rate r
- Life insurer issues annuity, pays interest rate r^A, and earns the spread $r - r^A$
- Life insurer chooses the duration of the legacy capital D:

$$\max_D \quad \mathbb{E}\left[r - r^A - C\left(R_K\right) - \hat{C}\left(R_{\hat{K}}\right)\right]$$

with reduced form costs $C(R_K) = \frac{\chi}{2} R_K^2$ and $\hat{C}(R_{\hat{K}}) = \frac{\hat{\chi}}{2} R_{\hat{K}}^2$.

- Economic capital return:

$$R_K = \underbrace{-D\left(r - \mathbb{E}\left[r\right]\right)}_{\text{return on legacy capital}} + \underbrace{r - r^A}_{\text{economic earnings}}$$

- Statutory capital return:

$$R_{\hat{K}} = \underbrace{-\psi D\left(r - \mathbb{E}\left[r\right]\right)}_{\text{return on legacy statutory capital}} + \underbrace{\hat{r} - r^A}_{\text{statutory earnings}}$$

Duration of Net Assets

- First-order condition:

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

Duration of Net Assets

- First-order condition:

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Without the regulatory friction $\hat{\chi} = 0$, the economic hedging motives prevail:

$$D = 1 - \beta > 0$$

Duration of Net Assets

- First-order condition:

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Without the regulatory friction $\hat{\chi} = 0$, the economic hedging motives prevail:

$$D = 1 - \beta > 0$$

- Without the economic friction $\chi = 0$, the statutory hedging motives prevail:

$$D = \frac{\hat{\beta}-\beta}{\psi} < 0$$

Duration of Net Assets

- First-order condition:

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Without the regulatory friction $\hat{\chi} = 0$, the economic hedging motives prevail:

$$D = 1 - \beta > 0$$

- Without the economic friction $\chi = 0$, the statutory hedging motives prevail:

$$D = \frac{\hat{\beta}-\beta}{\psi} < 0$$

- The annuity interest rate reacts more to the bond market interest rate than the reserve discount rate does!

Duration of Net Assets: Predictions

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

Duration of Net Assets: Predictions

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Reserve discount varies by policy type: $\hat{\beta}^{\text{life}} < \hat{\beta}^{\text{annuity}}$:

$$FL_{i,t} = \frac{(\text{Liabilities in Life Insurance Policies})_{i,t}}{(\text{Liabilities})_{i,t}}$$

Duration of Net Assets: Predictions

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Reserve discount varies by policy type: $\hat{\beta}^{\text{life}} < \hat{\beta}^{\text{annuity}}$:

$$FL_{i,t} = \frac{(\text{Liabilities in Life Insurance Policies})_{i,t}}{(\text{Liabilities})_{i,t}}$$

- Higher statutory leverage increases $\hat{\chi}$.

$$Lev_{i,t} = \frac{(\text{Statutory Assets})_{i,t}}{(\text{Statutory Equity})_{i,t}}$$

Duration of Net Assets: Predictions

$$D = \frac{\chi(1-\beta) + \hat{\chi}\psi(\hat{\beta}-\beta)}{\chi + \psi^2\hat{\chi}}$$

- Reserve discount varies by policy type: $\hat{\beta}^{\text{life}} < \hat{\beta}^{\text{annuity}}$:

$$FL_{i,t} = \frac{(\text{Liabilities in Life Insurance Policies})_{i,t}}{(\text{Liabilities})_{i,t}}$$

- Higher statutory leverage increases $\hat{\chi}$.

$$Lev_{i,t} = \frac{(\text{Statutory Assets})_{i,t}}{(\text{Statutory Equity})_{i,t}}$$

- Larger life insurers have better access to capital and lower χ:

$$LogA_{i,t} = \log\left((\text{Market Value of Assets})_{i,t}\right)$$

Evidence

- What explains the cross section of the duration gaps?

$$
\begin{aligned}
G_{i,t} =& \alpha_t + \\
& \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}
\end{aligned}
$$

Evidence

- What explains the cross section of the duration gaps?

$$G_{i,t} = \alpha_t + \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

	(1)
FL	-12.323***
Lev	-0.020***
$LogA$	-0.135***
Mutual	-1.510***
$MktLev$	-0.000
Year FE	Yes
Life Insurer FE	
N	5,871
R^2	0.332

Evidence

- What explains the cross section of the duration gaps?

$$G_{i,t} = \alpha_t + \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

- What explains the panel of the duration gaps?

$$G_{i,t} = \alpha_i + \alpha_t + \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

Constant

	(1)	(2)
FL	-12.323***	-8.868***
Lev	-0.020***	0.002
$LogA$	-0.135***	0.826
Mutual	-1.510***	
$MktLev$	-0.000	-0.000
Year FE	Yes	Yes
Life Insurer FE		Yes
N	5,871	5,867
R^2	0.332	0.804

Evidence: Ex-ante Exposure

‘

- What explains the dynamics of the duration gaps?

$$
\begin{aligned}
G_{i,t} = & \alpha_i + \alpha_t + \\
& \gamma_{FL} FL_{i,2008} \times Post_t + \\
& \gamma_{Lev} Lev_{i,2008} \times Post_t + \\
& \gamma_{LogA} LogA_{i,2008} \times Post_t + \epsilon_{i,t}
\end{aligned}
$$

where $Post_t = 1$ after 2010.

Evidence: Ex-ante Exposure

‘

- What explains the dynamics of the duration gaps?

$$
\begin{aligned}
G_{i,t} = & \alpha_i + \alpha_t + \\
& \gamma_{FL} FL_{i,2008} \times Post_t + \\
& \gamma_{Lev} Lev_{i,2008} \times Post_t + \\
& \gamma_{LogA} LogA_{i,2008} \times Post_t + \epsilon_{i,t}
\end{aligned}
$$

where $Post_t = 1$ after 2010.

	(1)
$FL \times Post$	-3.670**
$Lev \times Post$	0.004
$LogA \times Post$	0.056
$mutual$	-0.416
$MktLev$	-0.003
Life Insurer FE	Yes
Year FE	Yes
N	3,839
R^2	0.751

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with "VM-22":
  - replaced formula with 7 pages of text and formulas

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day $\Rightarrow$ higher $\hat{\beta}$!

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with "VM-22":
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day $\Rightarrow$ higher $\hat{\beta}$!
- Life insurance policies reserve discount rate changed in 2020 with "VM-20":

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day $\Rightarrow$ higher $\hat{\beta}$!
- Life insurance policies reserve discount rate changed in 2020 with “VM-20”:
  - based on yields on assets and prescribed mean reversion interest rate set by the state insurance commissioners

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day $\Rightarrow$ higher $\hat{\beta}$!
- Life insurance policies reserve discount rate changed in 2020 with “VM-20”:
  - based on yields on assets and prescribed mean reversion interest rate set by the state insurance commissioners
  - $\hat{\beta}$ depends on insurance commissioners

Recent Regulatory Reform

- Annuity reserve discount rate changed in 2018 with “VM-22”:
  - replaced formula with 7 pages of text and formulas
  - based on the Treasury yields over previous quarter or even day $\Rightarrow$ higher $\hat{\beta}$!
- Life insurance policies reserve discount rate changed in 2020 with “VM-20”:
  - based on yields on assets and prescribed mean reversion interest rate set by the state insurance commissioners
  - $\hat{\beta}$ depends on insurance commissioners $\Rightarrow$ make it responsive and be transparent about it!

Literature Review

- Interest rate risk in banking: Begenau, Piazzesi, and Schneider (2020), Drechsler, Savov, and Schnabl (2017, 2021), Di Tella and Kurlat (forthcoming)
- Financial frictions and risk taking of life insurers: Becker and Ivashina (2015), Koijen and Yogo (2021)
- Risk management and accounting: DeMarzo and Duffie (1992), Heaton, Lucas, and McDonald (2010), Sen (2019)
- Overcoming balance sheet opacity: Gomez, Landier, Srear, and Thesmar (2021), Möhlmann (2021), Tsai (2009)
- Stability of life insurance liabilities: Chodorow-Reich, Ghent, and Haddad (2020), Ozdagli and Wang (2019)

Conclusion

When interest rates fall:

1. life insurers realize a capital loss on their net assets

Conclusion

When interest rates fall:

1. life insurers realize a capital loss on their net assets
2. life insurers earn a lower spread on newly issued policies

Conclusion

When interest rates fall:

1. life insurers realize a capital loss on their net assets
2. life insurers earn a lower spread on newly issued policies
3. life insurers want to hedge statutory earnings rather than economic earnings because of statutory regulation

Thank you!

mjh635@nyu.edu

Background

- Life insurers provide insurance against mortality and retirement saving vehicles.

Background

- Life insurers provide insurance against mortality and retirement saving vehicles.
- Assets: transparent!
  - Life insurance companies own assets of about \$7 trillion
  - 37% of life insurer's assets are invested in corporate and foreign bonds
  - Corporate and foreign bond debt \$15 trillion of which 22% are held by life insurers

Background

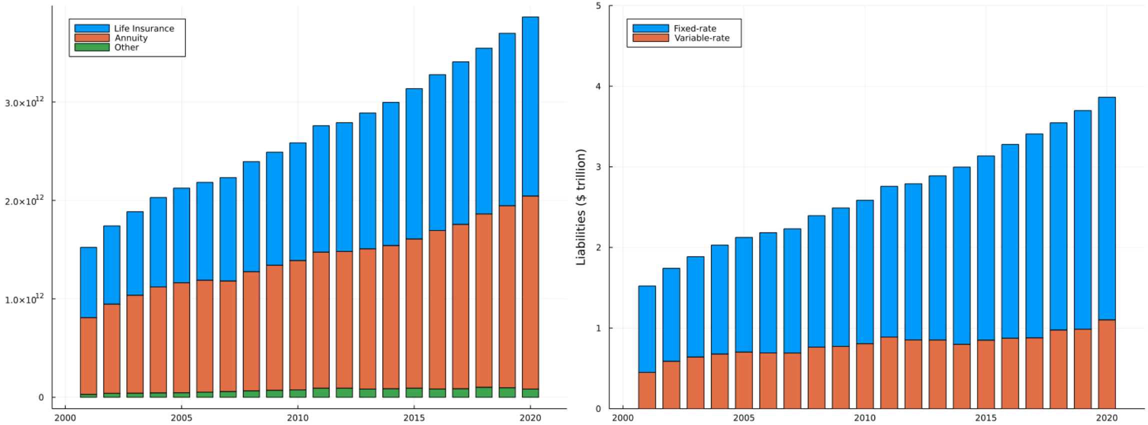
- Life insurers provide insurance against mortality and retirement saving vehicles.
- Assets: transparent!
  - Life insurance companies own assets of about $7 trillion
  - 37% of life insurer's assets are invested in corporate and foreign bonds
  - Corporate and foreign bond debt $15 trillion of which 22% are held by life insurers
- Liabilities: opaque!
  - Household financial assets of $105 trillion: 13% deposits, 43% securities, 30% pension entitlements and life insurance
  - Guaranteed by state guaranty funds in the case of default

Background

- Life insurers provide insurance against mortality and retirement saving vehicles.
- Assets: transparent!
  - Life insurance companies own assets of about \$7 trillion
  - 37% of life insurer's assets are invested in corporate and foreign bonds
  - Corporate and foreign bond debt \$15 trillion of which 22% are held by life insurers
- Liabilities: opaque!
  - Household financial assets of \$105 trillion: 13% deposits, 43% securities, 30% pension entitlements and life insurance
  - Guaranteed by state guaranty funds in the case of default
- Equity: many public/private stock companies, few large mutual companies

back

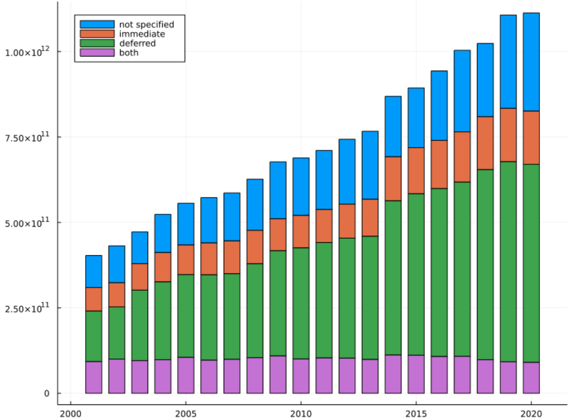
Reserves

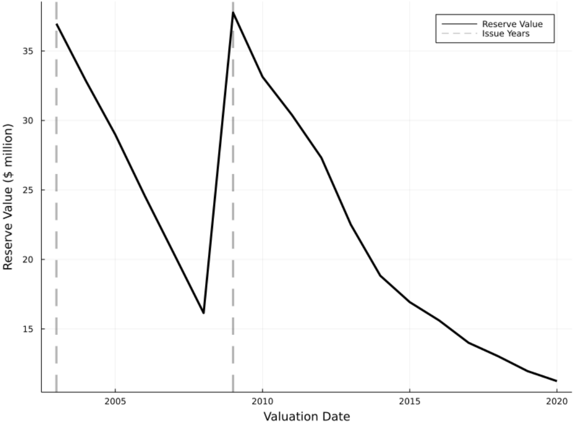


Composition of reserves

return

Reserves





Composition of annuity reserves and the evolution of the A2000 6% Immediate reserve position of the Delaware Life Insurance Company

return

Empirics of Reserve Decay

- Insurer-specific weighted-average decay $\hat{\lambda}_{i,t,S} = \frac{\hat{b}_{i,t,S}}{\hat{V}_{i,t-1,S}}$:

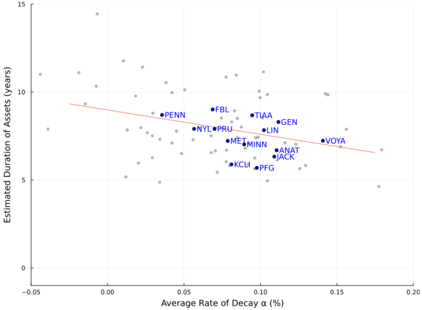
$$\hat{\lambda}_{i,t,S} = \alpha_i + \epsilon_{i,t,S}$$

weighted by the previous size of the reserve position.

- Life-cycle model of average reserve decay:

$$\hat{\lambda}_{i,t,S} = \Psi(t-\tau, S) + \epsilon_{i,t,S}$$

where Ψ is as fixed effect which captures the average decay of a $t-\tau$ year old reserve position of type S.



Asset duration and average decay across life insurance companies

back

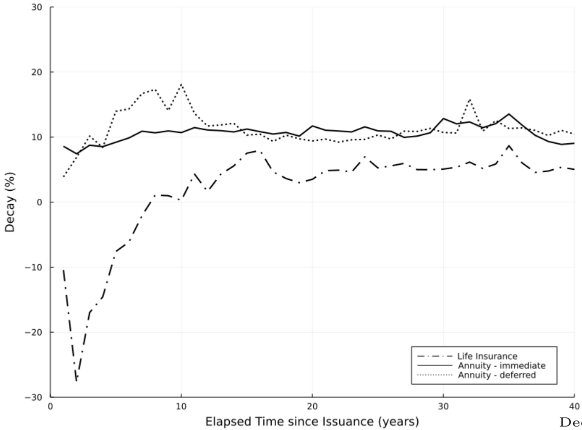
Life-Cycle Reserve Decay

	Rate of Decay $\lambda_{i,t,S,\tau}$					
Decade		0.000	-0.001	-0.010***	-0.000	-0.007***
$\Delta r^T_{t,\tau,10}$			0.171***	0.227***		
$\Delta r^T_{t,t-1,10}$					-0.147***	-0.113***
Life-cycle FE	Yes	Yes	Yes		Yes	
Finer Life-cycle FE				Yes		Yes
N	97,712	97,712	94,707	94,227	97,712	97,120
R^2	0.286	0.286	0.286	0.350	0.286	0.349

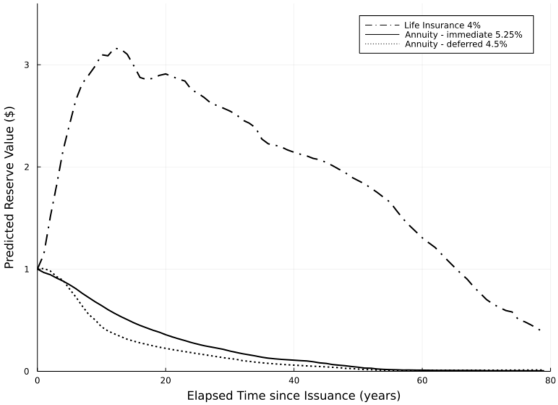
Decay

back

Life-Cycle Reserve Decay

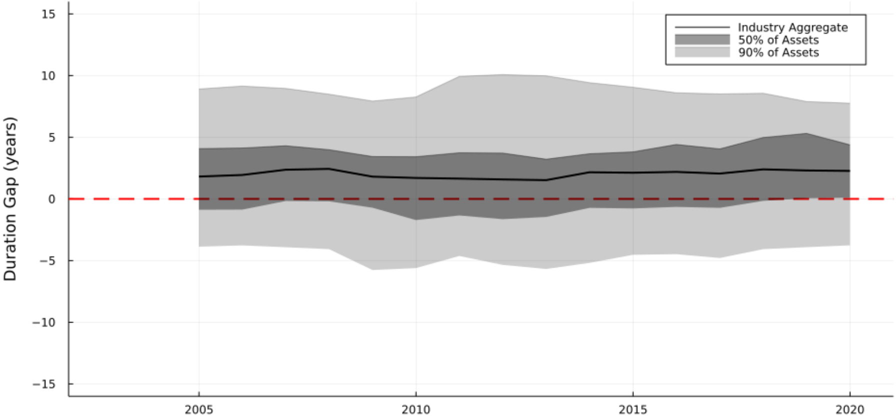


Decay



back

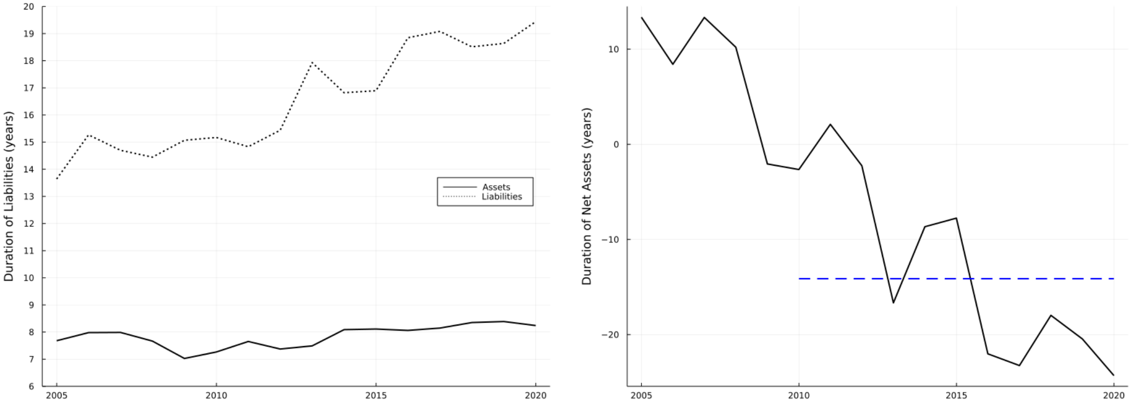
Duration Gap under constant Interest Rates



Duration gap under constant 2004 interest rates $G = D_A - \frac{L}{A} D_L$

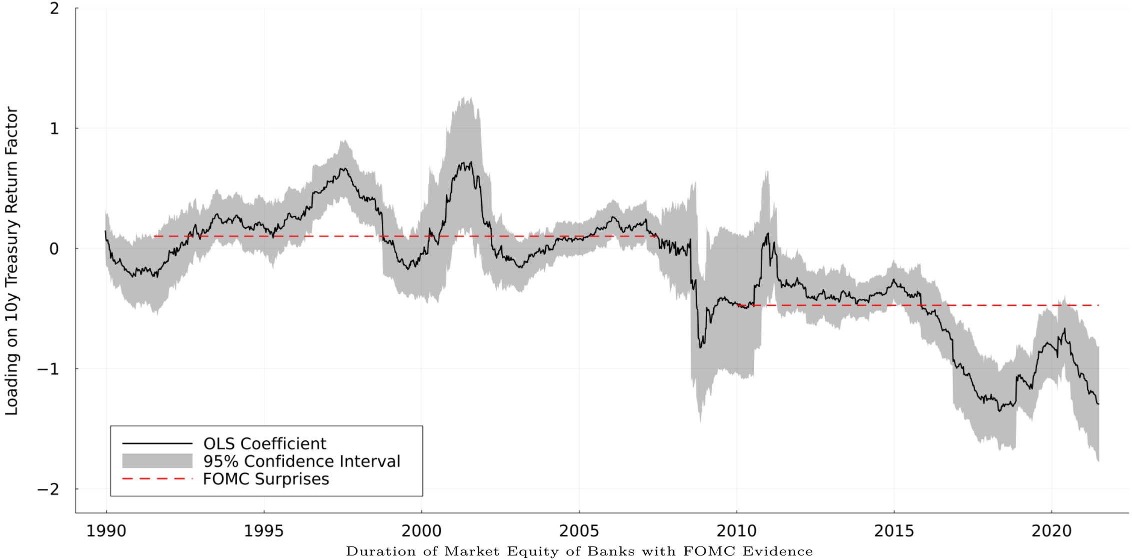
return

Net Assets of publicly-traded Life Insurers



Duration of assets and liabilities of a set of publicly-traded life insurers

return



Loading on 10y Treasury Return Factor
2
1
0
−1
−2
1990
1995
2000
2005
2010
2015
2020
OLS Coefficient
95% Confidence Interval
FOMC Surprises
Duration of Market Equity of Banks with FOMC Evidence

return

	rx_t^L					
	Full	Before	After	Full	Before	After
rx_t^{T}	0.492**	0.017	-0.672**	0.407**	-0.109	-0.658***
	(0.234)	(0.176)	(0.336)	(0.163)	(0.132)	(0.170)
rx_t^{M}				1.588***	0.751***	1.543***
				(0.096)	(0.071)	(0.095)
Intercept	0.004**	0.002**	0.001	-0.001	0.000	-0.000
	(0.002)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
N	257	140	92	257	140	92
R^2	0.017	0.000	0.042	0.525	0.447	0.757

Regressions on FOMC days

back

	rx_t^L					
	Full	Before	After	Full	Before	After
rx_t^{T}	-0.388**	0.293	-0.839**	-0.467***	-0.155	-0.677***
	(0.178)	(0.207)	(0.329)	(0.120)	(0.156)	(0.191)
rx_t^{M}				1.332***	0.836***	1.491***
				(0.063)	(0.078)	(0.096)
Intercept	0.003***	0.002**	0.003*	-0.000	0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)
N	243	133	78	249	134	83
R^2	0.019	0.015	0.079	0.660	0.467	0.787

Regressions on FOMC days excluding outliers

back

	rx_t^L					
	After 2009	After 2010	After 2011		After 2010	
		Until 2021		Until 2019	Until 2020	Until 2021
rx_t^{T}	0.307	-0.658***	-0.855***	-0.526***	-0.552***	-0.658***
	(0.256)	(0.170)	(0.186)	(0.165)	(0.165)	(0.170)
rx_t^{M}	2.127***	1.543***	1.547***	1.520***	1.478***	1.543***
	(0.177)	(0.095)	(0.095)	(0.107)	(0.105)	(0.095)
Intercept	0.001	-0.000	-0.001	-0.001	-0.001	-0.000
	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N	100	92	84	72	80	92
R^2	0.603	0.757	0.780	0.750	0.728	0.757

Regressions on FOMC days with different cut-off dates

back

	rx_t^L					
	Full	Before	After	Full	Before	After
rx_t^{T}	1.044***	0.842**	-0.782*	0.869***	0.262	-1.048***
	(0.349)	(0.347)	(0.463)	(0.329)	(0.286)	(0.302)
rx_t^{M}				0.504	0.689***	1.051***
				(0.400)	(0.169)	(0.395)
Intercept	0.003*	0.001	0.001	0.002	-0.000	-0.000
	(0.002)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
N	241	139	76	241	139	76
R^2	0.008	0.016	0.011	0.277	0.414	0.630

Regressions on FOMC days with different cut-off dates

back

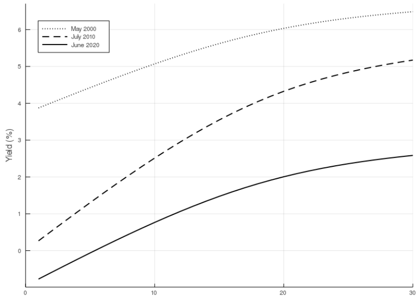
Calculating the Yield Curve

- What term structure of interest rates r rationalizes the observed prices of a menu of policies?

$$V_n^{term} = \sum_{h=1}^{n} e^{-h \cdot r_{t,h}} \cdot 1 \quad V_{age}^{life} = \sum_{h=1}^{\infty} e^{-h \cdot r_{t,h}} \cdot b_{age,h}$$

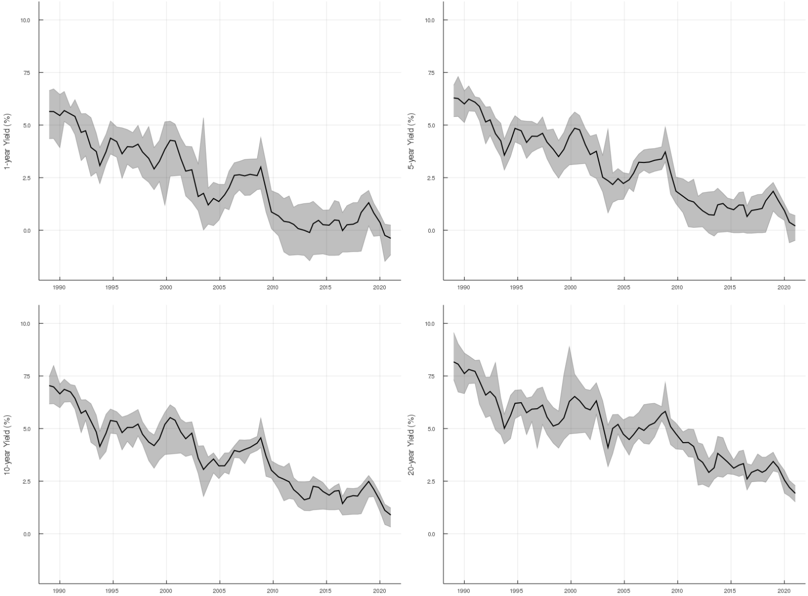
- Parametrize $r_{i,t,h}$ by imposing a B-spline on the forward rates for every insurer i, time t, and policy j:

$$P_{i,j,t} = V_{i,j,t} + \epsilon_{i,j,t}$$



Annuity yield curves

back


1-year Yield (%)
5-year Yield (%)
10-year Yield (%)
20-year Yield (%)
10.0
7.5
5.0
2.5
0.0
1990
1995
2000
2005
2010
2015
2020

return

Incomplete Pass-Through: Reserve Interest Rate

- How does the reserve discount rate react to a change of bond market interest rates?

$$\hat{r}_t = 0.03 + 0.8 \cdot \left(\bar{r}^{\mathrm{NAIC}}_{June(t)-12,June(t)} - 0.03\right)$$

Incomplete Pass-Through: Reserve Interest Rate

- How does the reserve discount rate react to a change of bond market interest rates?

$$\hat{r}_t = 0.03 + 0.8 \cdot \left(\bar{r}^{\mathrm{NAIC}}_{June(t)-12, June(t)} - 0.03\right)$$

- Changes over the 1-year time interval:

$$\Delta r^a_{t,h} = \alpha_h + \beta_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$

$$\Delta \hat{r}_t = \alpha_h + \hat{\beta}_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$

Incomplete Pass-Through: Reserve Interest Rate

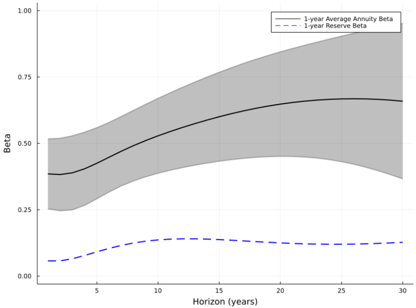
- How does the reserve discount rate react to a change of bond market interest rates?

$$\hat{r}_t = 0.03 + 0.8 \cdot \left(\bar{r}^{\mathrm{NAIC}}_{June(t)-12,June(t)} - 0.03\right)$$

- Changes over the 1-year time interval:

$$\Delta r^a_{t,h} = \alpha_h + \beta_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$

$$\Delta \hat{r}_t = \alpha_h + \hat{\beta}_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$



Pass-through to reserve discount rates

return

Incomplete Pass-Through: Reserve Interest Rate

- How does the reserve discount rate react to a change of bond market interest rates?

$$\hat{r}_t = 0.03 + 0.8 \cdot \left(\bar{r}^{\mathrm{NAIC}}_{June(t)-12, June(t)} - 0.03\right)$$

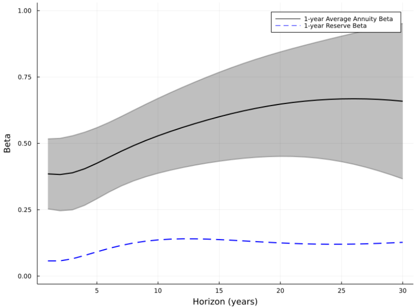
- Changes over the 1-year time interval:

$$\Delta r^a_{t,h} = \alpha_h + \beta_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$

$$\Delta \hat{r}_t = \alpha_h + \hat{\beta}_h \cdot \Delta r^b_{t,h} + \epsilon_{h,t}$$

- Annuities:

$$0.5 = \beta > \hat{\beta} = 0.13$$



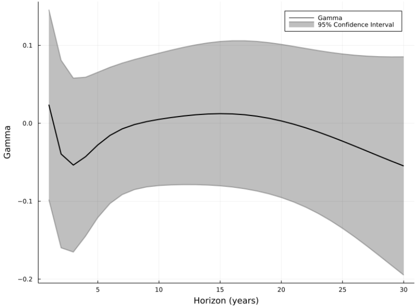
Pass-through to reserve discount rates

return

Incomplete Pass-Through: lower at lower rates?

- How does the annuity interest rate react to a change of bond market interest rates?

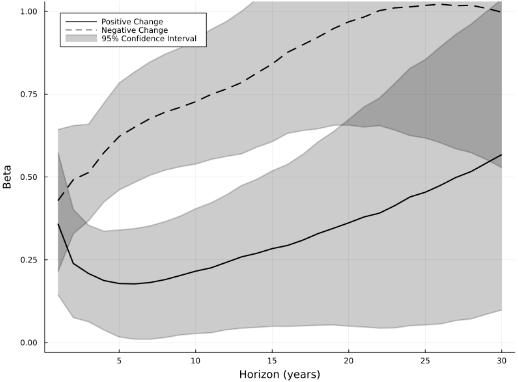
$$\Delta r^a_{t,h} = \alpha_h + \beta_h \cdot \Delta r^b_{t,h} + \gamma_h \cdot \Delta r^b_{t,h} \cdot r^b_{t,h} + \epsilon_{h,t}$$

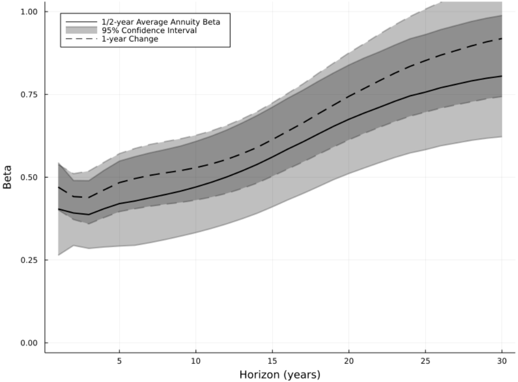


Pass-through to annuity rates at higher interest rates

return

Incomplete Pass-Through





return

Market Concentration and Pass-Through

	Annuity Spread			
	Levels s		Changes Δs	
$r \cdot$ HHI	0.022***	0.033***		
	(0.001)	(0.001)		
$\Delta r \cdot$ HHI			0.060***	0.082***
			(0.006)	(0.006)
Horizon FE	Yes	Yes	Yes	Yes
Rating FE		Yes		Yes
N	13,290	13,290	13,290	13,290
R^2	0.916	0.931	0.319	0.333

Cross-sectional pass-through related to a proxy for the insurance company specific market power: the average of Herfindahl-Hirschman indices of U.S. states weighted by the share of the collected premiums from a state to overall premiums. The regression specification is: $s_{i,t,h} = \gamma \cdot r_{t,h} \mathrm{HHI}_{i,t-1} + \beta_h \cdot r_{t,h} + Rating_{i,t} \cdot r_{t,h} + \epsilon_{i,t,h}$

return

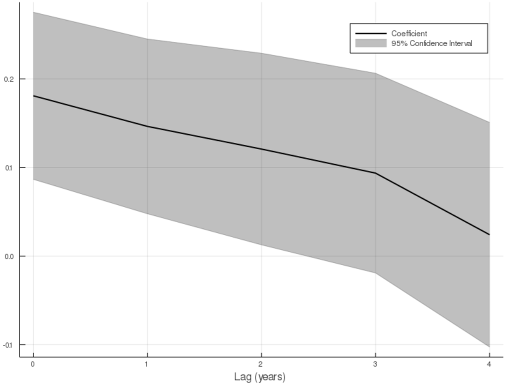
Spread affects future Net Gain from Operations

The annuity spreads $s_{i,t,h}$ predicts the future net gain of operations:

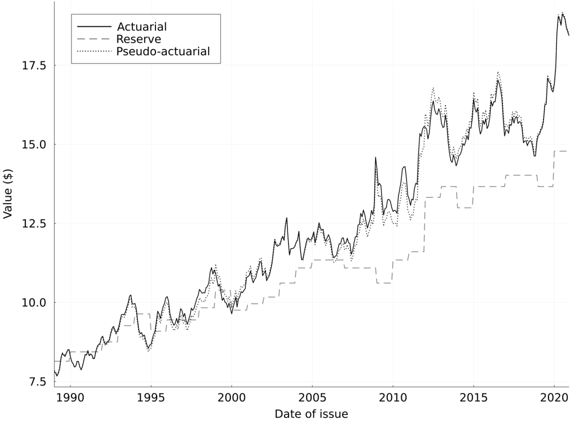
$$NetGain_{i,t+h} = Spread_{i,t} + \epsilon_{i,t}$$

A higher annuity spread implies larger future profits!

◂ return



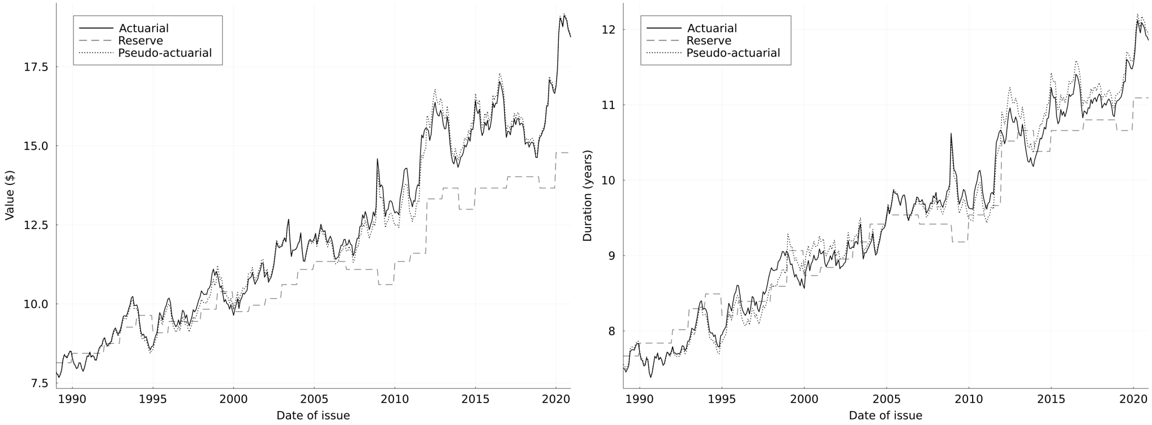
Actuarial vs. Reserve vs. Pseudo-Actuarial



Valuation and duration at issuance for a life annuity for a 65-year-old male

▸ Cash flows and Life-cylce

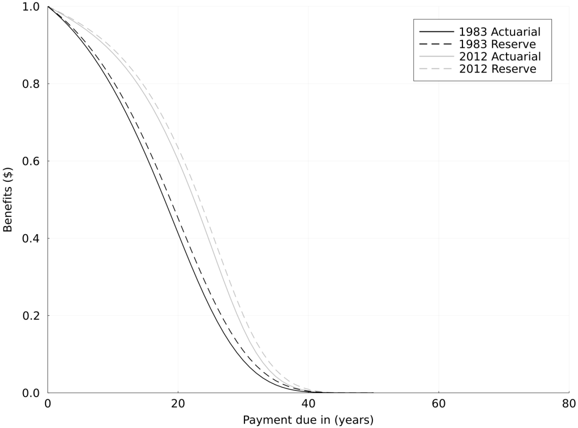
Actuarial vs. Reserve vs. Pseudo-Actuarial

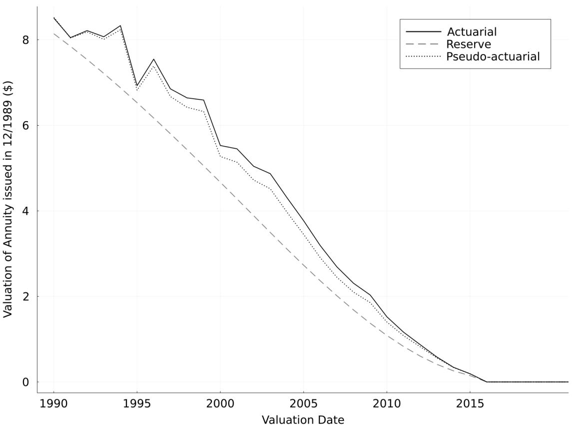


Valuation and duration at issuance for a life annuity for a 65-year-old male

▸ Cash flows and Life-cylce

Actuarial vs. Reserve vs. Pseudo-Actuarial





Comparison of cash flows and and valuations after issuance in December 1989 for a life annuity for a 65-year-old male

return

Indirect Evidence: Supplemental Information

- New York-based life insurance companies have to file the "Analysis of Valuation Reserves" supplement to the annual statement
  - How well does the annual income align with the predicted cash flow?

VALUATION STANDARD	Location in last year's analysis of valuation reserves Line No.	Total	
		Annual Income(a) (000 Omitted)	Reserve
0200014. 83 Table 'A'; 9.50%; Imm.; 1981	200015	56	106,355
0200015. 83 Table 'A'; 7.65%; Imm.; 1984	200017	457	1,634,586
0200016. 83 Table 'A'; 7.65%; Imm.; 1985	200018	1,850	10,263,129
0200017. 83 Table 'A'; 7.65%; Imm.; 1986	200019	1,696	7,104,998
0200018. 83 Table 'A'; 7.65%; Imm.; 1987	200020	2,307	9,379,066
0200019. 83 Table 'A'; 7.65%; Imm.; 1988	200021	2,566	10,575,657
0200020. 83 Table 'A'; 7.65%; Imm.; 1989	200022	3,913	16,526,073
0200021. 83 Table 'A'; 7.65%; Imm.; 1990	200023	4,933	22,012,788
0200022. 83 Table 'A'; 7.50%; Imm.; 1991	200024	2,169	10,523,236
0200023. 83 Table 'A'; 7.00%; Imm.; 1992	200025	2,426	10,323,403
0200024. 83 Table 'A'; 6.00%; Imm.; 1993	200026	2,559	10,382,114
0200025. 83 Table 'A'; 6.50%; Imm.; 1994	200027	4,363	20,934,023
0200026. 83 Table 'A'; 6.50%; Imm.; 1995	200028	5,904	32,589,468
0200027. 83 Table 'A'; 6.00%; Imm.; 1996	200029	5,559	29,913,379

Supplement of the New York Life Insurance Company in 2011

return

Effect of Market Rates on Policyholder Behaviour

- Model with policyholder behaviour:

$$\bar{b}_{i,t,S} = \Psi(t - \tau, S) + \delta \cdot \Delta r_{t,\tau,10} + \epsilon_{i,t,S}$$

- The change in the market interest rate since the issuance of the policy may make the outside option more or less attractive.
- A one-percent increase leads to a 0.16 percent higher rate of decay.
- The policyholder behavior has a marginal effect on the duration of the liabilities!

	$\bar{b}$	
	(1)	(2)
t in decades	0.003***	0.003***
	(0.000)	(0.000)
$\Delta r^{Treasury}_{t,\tau,10}$	-0.008	
	(0.022)	
$\Delta r^{HQM}_{t,\tau,10}$		-0.017
		(0.024)
N	90,954	90,954
R^2	0.355	0.355

return

Evidence under Constant Interest Rates

- Omitted variable bias:
  falling interest rates mechanically increase the
  duration of life insurance policies!
- Evaluate all objects under constant 2004 interest rates.

$$G_{i,t} = \alpha_t + \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

$$G_{i,t} = \alpha_i + \alpha_t + \gamma_{FL} FL_{i,2008} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

return

Evidence under Constant Interest Rates

- Omitted variable bias:
  falling interest rates mechanically increase the duration of life insurance policies!
- Evaluate all objects under constant 2004 interest rates.

$$G_{i,t} = \alpha_t + \gamma_{FL} FL_{i,t} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

$$G_{i,t} = \alpha_i + \alpha_t + \gamma_{FL} FL_{i,2008} + \gamma_{Lev} Lev_{i,t} + \gamma_{LogA} LogA_{i,t} + \gamma \cdot X_{i,t} + \epsilon_{i,t}$$

	(1)	(2)
FL	-6.260***	-4.577**
Lev	-0.022***	-0.005
LogA	-0.057	1.002
mutual	-1.356***	
MktLev	-0.021**	-0.003
Year FE	Yes	Yes
Life Insurer FE		Yes
N	5,868	5,864
R^2	0.298	0.758

return