The Cost of Financial Frictions for Life Insurers

Ralph S. J. Koijen    Motohiro Yogo

University of Chicago and NBER

Federal Reserve Bank of Minneapolis

1The views expressed herein are not necessarily those of the Federal Reserve Bank of Minneapolis or the Federal Reserve System.
Theories of insurance markets

- **Traditional theories**: Market equilibrium determined by the demand side.
  - Life-cycle demand (Yaari 1965).
  - Informational frictions (Rothschild and Stiglitz 1976).
  - Assumes efficient capital markets on the supply side.
Theories of insurance markets

- **Traditional theories**: Market equilibrium determined by the demand side.
  - Life-cycle demand (Yaari 1965).
  - Informational frictions (Rothschild and Stiglitz 1976).
  - Assumes efficient capital markets on the supply side.

- **Modern view**: Insurance companies are financial institutions.
  - Vulnerable to balance sheet shocks.
  - Pricing affected by financial frictions and statutory reserve regulation.
Evidence on individual annuities and life insurance

   - Term and life annuities: Average markup of −25%.
   - Universal life insurance: Average markup of −52%.

2. Larger price reductions for
   - Policies with looser statutory reserve requirements.
   - Insurance companies with more adverse balance sheet shocks.

3. Firesale of policies complements conventional channels of recapitalization:
   - Direct capital injection from the holding company.
   - Reduction of required capital by shifting to safer assets.
Evidence on individual annuities and life insurance

   - Term and life annuities: Average markup of −25%.
   - Universal life insurance: Average markup of −52%.

2. Larger price reductions for
   - Policies with looser statutory reserve requirements.
   - Insurance companies with more adverse balance sheet shocks.

3. Firesale of policies complements conventional channels of recapitalization:
   - Direct capital injection from the holding company.
   - Reduction of required capital by shifting to safer assets.

4. Exploit exogenous variation in required reserves across policies to identify the shadow cost of financial frictions.
   - Nearly $5 per dollar of excess reserve in January 2009.
Example: Allianz Life Insurance Company

- 20-year term annuity: Guaranteed payment of $1 for 20 years.
- Allianz priced it at
  - $11.84 in January 2009.
Example: Allianz Life Insurance Company

- 20-year term annuity: Guaranteed payment of $1 for 20 years.
- Allianz priced it at
  - $11.84 in January 2009.
- Economic profit: $11.84 − $14.56 = −$2.72
Example: Allianz Life Insurance Company

- 20-year term annuity: Guaranteed payment of $1 for 20 years.
- Allianz priced it at
  - $11.84 in January 2009.
- Economic profit: $11.84 − $14.56 = −$2.72
- Statutory reserves (liabilities) recorded at accounting value.

\[
\begin{array}{|c|c|}
\hline
A & L \\
\hline
$11.84 & $11.47 \\
\hline
\end{array}
\]

- Sale creates statutory capital: $11.84 − $11.47 = $0.37
Example: Allianz Life Insurance Company

- 20-year term annuity: Guaranteed payment of $1 for 20 years.
- Allianz priced it at
  - $11.84 in January 2009.
- Economic profit: $11.84 − $14.56 = −$2.72
- Statutory reserves (liabilities) recorded at accounting value.

\[
\begin{array}{c|c}
A & L \\
\hline
$11.84 & $11.47 \\
\end{array}
\]

- Sale creates statutory capital: $11.84 − $11.47 = $0.37
- Cost of statutory capital: $2.72/$0.37 = $7.35
Annual premiums for individual annuities and life insurance

![Graph showing annual premiums for annuities and life insurance from 1994 to 2009. The green line represents annuities, and the red line represents life insurance. Premiums for annuities trended upwards significantly from 1999 to 2009, while life insurance premiums showed fluctuations.](image-url)
Data on annuity and life insurance prices

- **Annuities**: January 1989–July 2011 (semiannual)
  - Over 30,000 observations
  - Over 100 insurance companies.
  - Types of policies:
    1. Term annuities: 5- to 30-year maturities.
    2. Life annuities: Male and female, 50- to 90-years old.
    3. Guaranteed annuities: Male and female, 50- to 90-years old, 10- or 20-year guarantees.

- **Universal life insurance**: January 2005–July 2011 (semiannual)
  - Nearly 4,000 observations
  - Over 50 insurance companies.
Data on annuity and life insurance prices

- **Annuities**: January 1989–July 2011 (semiannual)
  - Over 30,000 observations
  - Over 100 insurance companies.
  - Types of policies:
    1. Term annuities: 5- to 30-year maturities.
    2. Life annuities: Male and female, 50- to 90-years old.
    3. Guaranteed annuities: Male and female, 50- to 90-years old, 10- or 20-year guarantees.

- **Universal life insurance**: January 2005–July 2011 (semiannual)
  - Nearly 4,000 observations
  - Over 50 insurance companies.

- Calculate the actuarial value for each type of policy.
  - Mortality tables from the American Society of Actuaries.
  - Zero-coupon Treasury yield curve.

- Merged with A.M. Best data on balance sheets and ratings.
Average markup on term annuities
Average markup on life annuities

- Life annuities: Age 50
- Life annuities: Age 60
- Life annuities: Age 70
- Life annuities: Age 80
Average markup on universal life insurance
Default risk

- Policies backed by the state guaranty fund.
- What if it fails?
  - Lower bound on the recovery rate: 84%.
    - Only 16% of life insurers’ assets are risky.
    - Asset deficit of 5–10% in past cases of insolvency.
Default risk

Policies backed by the state guaranty fund. What if it fails?

- Lower bound on the recovery rate: 84%.
  - Only 16% of life insurers’ assets are risky.
  - Asset deficit of 5–10% in past cases of insolvency.

- Risk-neutral default probabilities implied by term annuities in January 2009:
  - Must be upward sloping.
  - 100% for maturity greater than 15 years.
  - Inconsistent with default probabilities implied by CDS.
Default risk

1. Policies backed by the state guaranty fund.
   What if it fails?
   - Lower bound on the recovery rate: 84%.
     - Only 16% of life insurers’ assets are risky.
     - Asset deficit of 5–10% in past cases of insolvency.
   - Risk-neutral default probabilities implied by term annuities in January 2009:
     - Must be upward sloping.
     - 100% for maturity greater than 15 years.
     - Inconsistent with default probabilities implied by CDS.

2. No discounts on life annuities during the Great Depression.
   - Inconsistent with default story.
   - Consistent with our explanation based on statutory reserve regulation.
Default probabilities implied by term annuities in January 2009

<table>
<thead>
<tr>
<th>Insurance company</th>
<th>Maturity (years)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>5</td>
</tr>
<tr>
<td><strong>Panel A: Markup (percent)</strong></td>
<td></td>
</tr>
<tr>
<td>Allianz Life Insurance of North America</td>
<td>-1.1</td>
</tr>
<tr>
<td>American General Life Insurance</td>
<td>-4.0</td>
</tr>
<tr>
<td>Aviva Life and Annuity</td>
<td>-1.4</td>
</tr>
<tr>
<td>Genworth Life Insurance</td>
<td>-1.6</td>
</tr>
<tr>
<td>Lincoln Benefit Life</td>
<td>-3.0</td>
</tr>
<tr>
<td>MetLife Investors USA Insurance</td>
<td>-13.4</td>
</tr>
<tr>
<td><strong>Panel B: Default probabilities implied by term annuities (annual percent)</strong></td>
<td></td>
</tr>
<tr>
<td>Allianz Life Insurance of North America</td>
<td>2.5</td>
</tr>
<tr>
<td>American General Life Insurance</td>
<td>9.2</td>
</tr>
<tr>
<td>Aviva Life and Annuity</td>
<td>3.1</td>
</tr>
<tr>
<td>Genworth Life Insurance</td>
<td>3.5</td>
</tr>
<tr>
<td>Lincoln Benefit Life</td>
<td>6.8</td>
</tr>
<tr>
<td>MetLife Investors USA Insurance</td>
<td>33.1</td>
</tr>
<tr>
<td><strong>Panel C: Default probabilities implied by credit default swaps (annual percent)</strong></td>
<td></td>
</tr>
<tr>
<td>Allianz Life Insurance of North America</td>
<td>1.6</td>
</tr>
<tr>
<td>American General Life Insurance</td>
<td>6.9</td>
</tr>
<tr>
<td>Aviva Life and Annuity</td>
<td>3.3</td>
</tr>
<tr>
<td>Genworth Life Insurance</td>
<td>28.7</td>
</tr>
<tr>
<td>Lincoln Benefit Life</td>
<td>3.1</td>
</tr>
<tr>
<td>MetLife Investors USA Insurance</td>
<td>7.9</td>
</tr>
</tbody>
</table>
Statutory reserve regulation

- **Standard Valuation Law**: “Present value” formula for calculating required reserves for each type of policy.
- Discount rate for annuities:

  \[ 0.03 + 0.8(y_t - 0.03) \]

  where \( y_t \) is a moving average of the Moody’s composite bond yield.
Statutory reserve regulation

- **Standard Valuation Law**: “Present value” formula for calculating required reserves for each type of policy.

- **Discount rate for annuities**:
  
  \[ 0.03 + 0.8(y_t - 0.03) \]

  where \( y_t \) is a moving average of the Moody’s composite bond yield.

- **Discount rate for life insurance**:
  
  \[ 0.03 + 0.35(\min\{y_t, 0.09\} - 0.03) + 0.175(\max\{y_t, 0.09\} - 0.09) \]
Discount rates for annuities and life insurance

![Graph showing trends of discount rates for annuities and life insurance over time. The graph compares annuities, life insurance, and 10-year Treasury rates.](image-url)
Reserve to actuarial value for annuities

Term annuities

Ratio of reserve to actuarial value

5 years | 10 years | 20 years | 30 years

Date
Insurance company sells $i = 1, \ldots, I$ different types of policies:

- $P_{i,t}$: Price
- $V_{i,t}$: Actuarial value
- $\hat{V}_{i,t}$: Reserve value
- $Q_{i,t}(P)$: Demand function with $Q_{i,t}'(P) < 0$
- $C_t$: Fixed cost
Structural model of insurance pricing

- Insurance company sells \( i = 1, \ldots, I \) different types of policies:
  - \( P_{i,t} \): Price
  - \( V_{i,t} \): Actuarial value
  - \( \hat{V}_{i,t} \): Reserve value
  - \( Q_{i,t}(P) \): Demand function with \( Q_{i,t}'(P) < 0 \)
  - \( C_t \): Fixed cost

- Profit:
  \[
  \Pi_t = \sum_{i=1}^{I} (P_{i,t} - V_{i,t})Q_{i,t} - C_t
  \]

- Firm value:
  \[
  J_t = \Pi_t + \frac{1}{R}E_t[J_{t+1}]
  \]
• Assets:

\[ A_t = R_{A,t} A_{t-1} + \sum_{i=1}^{l} P_{i,t} Q_{i,t} - C_t \]

• Statutory reserves:

\[ L_t = R_{L,t} L_{t-1} + \sum_{i=1}^{l} \hat{V}_{i,t} Q_{i,t} \]
Assets:

\[ A_t = R_{A,t} A_{t-1} + \sum_{i=1}^{l} P_{i,t} Q_{i,t} - C_t \]

Statutory reserves:

\[ L_t = R_{L,t} L_{t-1} + \sum_{i=1}^{l} \hat{V}_{i,t} Q_{i,t} \]

Leverage constraint:

\[ \frac{L_t}{A_t} \leq \phi \]
• Assets:

\[ A_t = R_{A,t} A_{t-1} + \sum_{i=1}^{l} P_{i,t} Q_{i,t} - C_t \]

• Statutory reserves:

\[ L_t = R_{L,t} L_{t-1} + \sum_{i=1}^{l} \hat{V}_{i,t} Q_{i,t} \]

• Leverage constraint:

\[ \frac{L_t}{A_t} \leq \phi \iff K_t = \phi A_t - L_t \geq 0 \]

• Choose \( P_{i,t} \) to maximize

\[ \mathcal{L}_t = J_t + \lambda_t K_t \]
Optimal insurance pricing

- **Price of policy** $i$:

\[
P_{i,t} = V_{i,t} \left(1 - \frac{1}{\epsilon_{i,t}}\right)^{-1} \left(\frac{1 + \lambda_t \tilde{V}_{i,t}/V_{i,t}}{1 + \lambda_t \phi}\right)
\]

- **Bertrand price**
- **Financial frictions**

where $\epsilon_{i,t}$ is the elasticity of demand.

- **Shadow cost of financial frictions**:

\[
\lambda_t = \lambda_t + \frac{1}{R} E_t \left[ \frac{\partial J_{t+1}}{\partial K_t} \right] = - \frac{\partial \Pi_t}{\partial K_t}
\]
Optimal insurance pricing

- **Price of policy** $i$:

\[
P_{i,t} = V_{i,t} \left(1 - \frac{1}{\epsilon_{i,t}}\right)^{-1} \left(1 + \frac{\lambda_t \hat{V}_{i,t}/V_{i,t}}{1 + \lambda_t \phi}\right)
\]

Bertrand price \quad \text{Financial frictions}

where $\epsilon_{i,t}$ is the elasticity of demand.

- **Shadow cost of financial frictions**:

\[
\overline{\lambda}_t = \lambda_t + \frac{1}{R} E_t \left[ \frac{\partial J_{t+1}}{\partial K_t} \right] = -\frac{\partial \Pi_t}{\partial K_t}
\]

- Model predicts deeper discounts for
  1. Policies with looser statutory reserve requirements (i.e., lower $\hat{V}_{i,t}/V_{i,t}$).
  2. Insurance companies that are more constrained (i.e., higher $\overline{\lambda}_t \phi$).
Empirical specification

- Policy $i$, firm $j$, and time $t$:

$$\log \left( \frac{P_{i,j,t}}{V_{i,t}} \right) = -\log \left( 1 - \frac{1}{\epsilon_{i,j,t}} \right) + \log \left( \frac{1 + \bar{\lambda}_{j,t} \hat{V}_{i,t}/V_{i,t}}{1 + \bar{\lambda}_{j,t} L_{j,t}/A_{j,t}} \right) + e_{i,j,t}$$

- Elasticity of demand:

$$\epsilon_{i,j,t} = 1 + \exp \{-\beta' y_{i,j,t}\}$$

- Shadow cost:

$$\bar{\lambda}_{j,t} = \exp \{\gamma' z_{j,t}\}$$

- Explanatory variables:
  - Insurance company: AMB rating, leverage ratio, asset growth, and log assets.
  - Dummies and interactions for policy type and date.
Identifying assumptions

- Identification if demand is correctly specified.
  - Average markup must be nonnegative in the absence of financial frictions.
Identifying assumptions

1. Identification if demand is correctly specified.
   - Average markup must be nonnegative in the absence of financial frictions.

2. Identification even if demand is potentially misspecified.
   - Linear approximation to the pricing model:
     \[
     \log \left( \frac{P_{i,j,t}}{V_{i,t}} \right) \approx \alpha_{j,t} + \frac{1}{1/\lambda_{j,t} + L_{j,t}/A_{j,t}} \left( \frac{\hat{V}_{i,t}}{V_{i,t}} - \frac{L_{j,t}}{A_{j,t}} \right) + u_{i,j,t}
     \]

   - Standard Valuation Law generates relative shifts in supply that are orthogonal to demand:
     \[
     \text{Cov} \left( \frac{\hat{V}_{i,t}}{V_{i,t}}, u_{i,j,t} \right) = 0
     \]
Shadow cost of financial frictions

![Graph showing shadow cost and 95% confidence interval over time from Jan 2000 to Jan 2009.](image)
## Shadow cost of financial frictions in January 2009

<table>
<thead>
<tr>
<th>Insurance company</th>
<th>A.M. Best rating</th>
<th>Leverage ratio</th>
<th>Asset growth (percent)</th>
<th>Shadow cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>MetLife Investors USA Insurance</td>
<td>A+</td>
<td>0.97</td>
<td>-10</td>
<td>13.62</td>
</tr>
<tr>
<td>Allianz Life Insurance of North America</td>
<td>A</td>
<td>0.97</td>
<td>-3</td>
<td>10.62</td>
</tr>
<tr>
<td>Lincoln Benefit Life</td>
<td>A+</td>
<td>0.87</td>
<td>-45</td>
<td>8.95</td>
</tr>
<tr>
<td>OM Financial Life Insurance</td>
<td>A-</td>
<td>0.95</td>
<td>-4</td>
<td>8.41</td>
</tr>
<tr>
<td>Aviva Life and Annuity</td>
<td>A</td>
<td>0.95</td>
<td>12</td>
<td>4.46</td>
</tr>
<tr>
<td>Presidential Life Insurance</td>
<td>B+</td>
<td>0.91</td>
<td>-6</td>
<td>4.37</td>
</tr>
<tr>
<td>EquiTrust Life Insurance</td>
<td>B+</td>
<td>0.95</td>
<td>13</td>
<td>4.13</td>
</tr>
<tr>
<td>Integrity Life Insurance</td>
<td>A+</td>
<td>0.92</td>
<td>3</td>
<td>3.86</td>
</tr>
<tr>
<td>United of Omaha Life Insurance</td>
<td>A+</td>
<td>0.91</td>
<td>-3</td>
<td>3.67</td>
</tr>
<tr>
<td>Genworth Life Insurance</td>
<td>A</td>
<td>0.90</td>
<td>0</td>
<td>3.14</td>
</tr>
<tr>
<td>North American for Life and Health Insurance</td>
<td>A+</td>
<td>0.94</td>
<td>24</td>
<td>2.43</td>
</tr>
<tr>
<td>American National Insurance</td>
<td>A</td>
<td>0.87</td>
<td>-2</td>
<td>1.84</td>
</tr>
<tr>
<td>American General Life Insurance</td>
<td>A</td>
<td>0.87</td>
<td>5</td>
<td>1.40</td>
</tr>
</tbody>
</table>
Change in Annuity Policies Issued from 2007 to 2009

- Financially constrained companies that lowered prices also sold more policies.
- Consistent with supply curve shifting down.
Conventional channels of recapitalization in 2008–2009

- Financially constrained companies also
  - Received large capital injection from their holding company:
    - Issuance of surplus notes.
    - Reduction of stockholder dividends.
  - Reduced required risk-based capital by shifting to safer assets.

---

Inflow of capital surplus funds

Change in cash and short-term investments
Fully specified model for welfare analysis

- Continuum of one-period consumers:
  1. Has quasi-linear utility over life annuities and wealth.
  2. Implies constant-elasticity demand for life annuities:

\[ Q_t = X_t P_t^{-\epsilon} \]

where \( X_t \) is a stochastic demand shock.
  3. Faces a search cost to be matched with an insurance company.

- Continuum of insurance companies:
  1. Constant returns on assets and liabilities, equal to the riskless interest rate.
  2. Fixed cost creates operating leverage.
  3. Heterogeneity in initial excess reserves, and therefore, financial constraints.

- Equilibrium price dispersion: Lucky consumers get matched with a financially constrained company and pay a lower price.
Optimal insurance price and firm value in the calibrated model
Welfare cost of deviations from actuarially fair pricing
A simple modification to statutory reserve regulation (i.e., $\hat{V} = \phi V$) can eliminate firesales.
Broader implications

Household finance:

- Literature mostly about frictions on the demand side.
  - Household borrowing constraints, asymmetric information, moral hazard, and near rationality.
- Financial and regulatory frictions on the supply side are also important for market equilibrium and social welfare.
Household finance:

- Literature mostly about frictions on the demand side.
  - Household borrowing constraints, asymmetric information, moral hazard, and near rationality.
- Financial and regulatory frictions on the supply side are also important for market equilibrium and social welfare.

Macro models with financial frictions:

- Micro evidence necessary.
- We quantify the cost of financial frictions for life insurers.
- Extend our empirical approach to other types of financial institutions.
Average markup under the U.S. agency yield curve

30-year term annuities

Life annuities: Age 50

Universal life insurance: Age 30
### Summary statistics for annuity and life insurance prices

<table>
<thead>
<tr>
<th>Type of policy</th>
<th>Sample begins</th>
<th>Number of Observations</th>
<th>Insurance companies</th>
<th>Markup (percent)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Term annuities:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 years</td>
<td>January 1993</td>
<td>762</td>
<td>83</td>
<td>6.7</td>
</tr>
<tr>
<td>10 years</td>
<td>January 1989</td>
<td>1,022</td>
<td>98</td>
<td>6.8</td>
</tr>
<tr>
<td>15 years</td>
<td>July 1998</td>
<td>452</td>
<td>62</td>
<td>4.2</td>
</tr>
<tr>
<td>20 years</td>
<td>July 1998</td>
<td>448</td>
<td>62</td>
<td>3.8</td>
</tr>
<tr>
<td>25 years</td>
<td>July 1998</td>
<td>368</td>
<td>53</td>
<td>3.4</td>
</tr>
<tr>
<td>30 years</td>
<td>July 1998</td>
<td>350</td>
<td>50</td>
<td>2.8</td>
</tr>
<tr>
<td><strong>Life annuities:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life only</td>
<td>January 1989</td>
<td>11,879</td>
<td>106</td>
<td>9.8</td>
</tr>
<tr>
<td>10-year guaranteed</td>
<td>July 1998</td>
<td>7,885</td>
<td>66</td>
<td>5.5</td>
</tr>
<tr>
<td>20-year guaranteed</td>
<td>July 1998</td>
<td>7,518</td>
<td>66</td>
<td>4.2</td>
</tr>
<tr>
<td>Universal life insurance</td>
<td>January 2005</td>
<td>3,989</td>
<td>52</td>
<td>-4.2</td>
</tr>
</tbody>
</table>
Estimated model of insurance pricing

<table>
<thead>
<tr>
<th>Explanatory variable</th>
<th>Average marginal effect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating: A to A−</td>
<td>3.26 (21.58)</td>
</tr>
<tr>
<td>Rating: B++ to B−</td>
<td>8.13 (10.70)</td>
</tr>
<tr>
<td>Leverage ratio</td>
<td>-2.14 (-24.43)</td>
</tr>
<tr>
<td>Asset growth</td>
<td>0.10 (0.00)</td>
</tr>
<tr>
<td>Log assets</td>
<td>1.88 (36.81)</td>
</tr>
</tbody>
</table>

Interaction effects for life annuities:
- Rating: A to A−: -2.37 (-19.96)
- Rating: B++ to B−: -7.75 (-9.90)
- Leverage ratio: 26.84 (28.43)
- Asset growth: -1.90 (-5.27)
- Log assets: -1.46 (-28.59)
- Female: 0.28 (4.74)
- Age 55: 0.27 (1.10)
- Age 60: 0.61 (1.61)
- Age 65: 0.84 (9.28)
- Age 70: 1.15 (12.79)
- Age 75: 1.47 (5.05)
- Age 80: 1.82 (7.65)
- Age 85: 2.37 (8.36)
- Age 90: 3.30 (6.46)

Interaction effects for life insurance:
- Rating: A to A−: -23.69 (-5.15)
- Leverage ratio: 29.25 (4.15)
- Asset growth: -25.93 (-5.22)
- Log assets: -12.75 (-7.57)
- Female: 0.17 (0.00)
- Age 30: 2.43 (0.84)
- Age 40: 0.65 (0.00)
- Age 60: 0.20 (0.00)
- Age 70: 0.68 (0.00)
- Age 80: 0.78 (0.05)
- Age 90: 24.09 (6.27)

$R^2$ (percent): 48.53
Observations: 29,756
## Parameters in the calibrated model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Riskless interest rate</td>
<td>$R - 1$</td>
<td>0.5%</td>
</tr>
<tr>
<td>Ratio of reserve to actuarial value</td>
<td>$\hat{V}/V$</td>
<td>0.71</td>
</tr>
<tr>
<td>Elasticity of demand</td>
<td>$\epsilon$</td>
<td>11</td>
</tr>
<tr>
<td>Standard deviation of demand shocks</td>
<td>$\sigma$</td>
<td>28%</td>
</tr>
<tr>
<td>Size of the fixed cost</td>
<td>$c$</td>
<td>1%</td>
</tr>
<tr>
<td>Sensitivity of the fixed cost to demand shocks</td>
<td>$\omega$</td>
<td>4.02</td>
</tr>
<tr>
<td>Maximum leverage ratio</td>
<td>$\phi$</td>
<td>0.97</td>
</tr>
</tbody>
</table>
Reserve to actuarial value for universal life insurance
Asset growth and the leverage ratio for life insurers

![Graph showing asset growth and leverage ratio over years.]

- **Asset growth (percent)**
- **Leverage ratio**

The graph illustrates the trend of asset growth and leverage ratio from 1989 to 2009, with notable fluctuations over the years.
Price change versus asset growth in January 2009

Term annuities

Life annuities

10-year guaranteed annuities

20-year guaranteed annuities
Average markup on life annuities in 1929–1938

- Life annuities: Age 50
- Life annuities: Age 60
- Life annuities: Age 70
- Life annuities: Age 80
Reserve to actuarial value for life annuities in 1929–1938

- **Male aged 50**
- **Male aged 60**
- **Male aged 70**
- **Male aged 80**

<table>
<thead>
<tr>
<th>Date</th>
<th>Jan 1929</th>
<th>Jan 1931</th>
<th>Jan 1933</th>
<th>Jan 1935</th>
<th>Jan 1937</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male aged 50</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male aged 60</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male aged 70</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male aged 80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>