Financial Economics of Insurance
Introduction to Modern Insurance$^1$

Ralph S.J. Koijen$^a$  Motohiro Yogo$^b$

$^a$University of Chicago, Booth School of Business, NBER, and CEPR

$^b$Princeton University and NBER

---

$^1$Based upon work supported by NSF grant 1727049.
Motivation for this course

- Insurance is an active field at the intersection of finance, IO, public economics, and health economics.
- Lots of research on health insurance based on Rothschild and Stiglitz (1976).
- The goal of this course is to
  1. Learn about a large share of the insurance sector that is not health insurance.
  2. Develop a unified framework to study the impact of financial and regulatory frictions on insurance pricing, contract design, reinsurance, portfolio choice, and risk management.
Our sponsors

- NSF grant 1727049.
- Workshop in 2022: Macro Finance Research Program of the Becker Friedman Institute at the University of Chicago.

Important economic functions of insurers

1. Diversify most important sources of idiosyncratic risk.
   - Life insurers: Annuities, life insurance, and accident and health.
   - Property-casualty insurers: Homeowners insurance and catastrophe insurance.

2. Smooth aggregate risk across cohorts (intergenerational risk sharing).
   - Replacing defined benefit plans and Social Security.

3. Tax efficient investing.

4. Provide long-term stable funding for macro investment and growth.
   - Largest institutional investors of corporate bonds.
## Liabilities of financial institutions in 2017

<table>
<thead>
<tr>
<th>Sector</th>
<th>Trillion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>Life insurance</td>
<td>6.5</td>
</tr>
<tr>
<td>Property and casualty insurance</td>
<td>1.2</td>
</tr>
<tr>
<td>Banks</td>
<td>16.9</td>
</tr>
<tr>
<td>Private defined contribution</td>
<td>6.2</td>
</tr>
<tr>
<td>Private defined benefit</td>
<td>3.2</td>
</tr>
</tbody>
</table>
Evolution of life insurers’ liabilities

- Decline of defined benefit plans and Social Security.
- Growth of life insurers’ liabilities since the 1980s.
  - Private retirement solution: Coincides with the growth of defined contribution plans.
- Evolution from life insurance to annuities, especially variable annuities in the separate account.
Insurance and pension liabilities

- Life insurance
- Property & casualty insurance
- Private defined contribution
- Private defined benefit

Share of household net worth over the years from 1945 to 2015.
### Composition of life insurers’ liabilities in 2017

<table>
<thead>
<tr>
<th>Liability</th>
<th>Trillion $</th>
</tr>
</thead>
<tbody>
<tr>
<td>General account</td>
<td></td>
</tr>
<tr>
<td>Life insurance</td>
<td>1.2</td>
</tr>
<tr>
<td>Annuities</td>
<td>1.2</td>
</tr>
<tr>
<td>Pension funds</td>
<td>0.7</td>
</tr>
<tr>
<td>Other (including accident &amp; health)</td>
<td>0.8</td>
</tr>
<tr>
<td>Separate account (variable annuities)</td>
<td>2.7</td>
</tr>
</tbody>
</table>
Composition of life insurers’ liabilities

The diagram illustrates the share of household net worth dedicated to different types of liabilities over time. The categories shown include:

- Other
- Life insurance
- Pension funds
- Annuities (general account)
- Separate account (variable annuities)

The x-axis represents the years from 1945 to 2015, while the y-axis shows the share of household net worth. The data suggests an increase in the share of household net worth dedicated to life insurance, pension funds, and annuities over the decades, with separate accounts (variable annuities) showing fluctuations.
General account assets

- Life insurers are the largest institutional investors of corporate bonds.
- Substitution from loans to securities since the 1980s.
- Insurers use derivatives for risk management.
- Also sophisticated forms of leverage.
  - Shadow insurance (Koijen and Yogo 2016).
  - Securities lending (Foley-Fisher et al. 2016).
Composition of general account assets

![Life insurance chart](chart1)

![Property & casualty insurance chart](chart2)
Institutional ownership of corporate bonds

The chart shows the share of corporate bonds outstanding held by different institutional owners from 1945 to 2015. The categories include Government-sponsored enterprises, Mutual funds, Banks, Pension funds, and Insurance. The chart illustrates how the share of bonds held by each category has fluctuated over time, with some periods showing increases and decreases in ownership by these institutions.
Leverage of financial institutions

The diagram shows the leverage of financial institutions over time, with different lines representing Life insurance, Life insurance (general account), Property & casualty insurance, and Banks. The y-axis represents liabilities to assets, and the x-axis represents years from 1945 to 2015.
Life insurers’ leverage

- Nearly constant until 1980s, consistent with the nature of traditional business.
- Declining and more volatile since 1980s due to variable annuities that are harder to manage.
- Caveat: Leverage based on US balance sheets alone may be misleading since global insurers could move leverage offshore.
- Reasons for high leverage in banking also apply to insurance.
  1. Taxes: Insurance premiums are tax deferred.
  2. Insurance liabilities cheaper than market debt because of guaranty funds.
  3. Moral hazard due to guaranty funds and other agency problems.
Property-casualty insurers’ leverage

- Lower level and more volatile due to tail risk.
  - A large loss wipes out internal capital, and external capital slow to flow in.
  - Higher leverage coupled with higher prices and lower quantities.
- Recent issues:
  - New sources of capital such as hedge funds, pension funds, and sovereign wealth funds.
  - New markets such as climate risk and cyber risk.
    - Difficult to underwrite because of uncertainty in the loss distribution.
    - Stifles innovation if firms unwilling to adopt new technologies that cannot be insured.
Ownership structure

1. Mutual companies.
   - Policyholders are also equity holders, bearing underwriting and investment risk.
   - Alignment of incentives.

2. Stock companies.
   - Policyholders are debt holders.
   - Outside equity holders bear underwriting and investment risk.
   - Access to external finance facilitates growth, especially into new markets.
   - Incentives of equity holders may not be aligned with policyholders.
Life insurers’ liabilities by ownership structure

The graph shows the liabilities of life insurers by ownership structure from 2000 to 2015. The liabilities are measured in trillion dollars. Stock companies' liabilities show a steady increase over the years, while mutual companies' liabilities remain relatively stable with a slight upward trend.
Composition of life insurers’ liabilities by ownership structure

![Graph showing the composition of life insurers' liabilities by ownership structure, with data for 2000 to 2015 for both mutual and stock companies. The graph indicates the share of liabilities for health & accident, life insurance, annuities (general account), and separate account (variable annuities).]
Insurance products

1. Life insurance.
   - Term life insurance.
   - Universal life insurance.

2. Fixed annuities.
   - Term annuities: Constant payoffs at fixed maturity.
   - Life annuities: Payoffs contingent on survival.

3. Variable annuities: Minimum return guarantees are essentially put options.
Example: MetLife Series VA

- Sold by MetLife Insurance Company USA.
- American Funds Growth Allocation Portfolio: Mutual fund with a target equity allocation of 70–85%.
- Annual base contract expense of 1.3%.
- Guaranteed Lifetime Withdrawal Benefit: Optional minimum return guarantee with
  - Annual fee of 0.5%.
  - Rollup rate (guaranteed return) of 5%.
  - Withdrawal rate of 5%.
Example of a guaranteed living withdrawal benefit
Example of a guaranteed living withdrawal benefit

![Graph showing withdrawal at 5%, account value, and rollup rate of 5% over time.](image)

- **Withdrawal at 5%**: The shaded area represents the guaranteed withdrawal benefit at 5% annually.
- **Account value**: The dashed line indicates the account value over time.
- **Rollup rate of 5%**: The solid line shows the rollup rate of 5% applied to the account value.
Example of a guaranteed living withdrawal benefit
1. US financial statements filed with the NAIC. In addition to balance sheets,
   - Schedule D: Security holdings.
   - Schedule DB: Derivatives.
   - Schedule S: Reinsurance.
   Cleaned up versions available through A.M. Best and SNL Financial.

2. Financial statements for European (Solvency II) and global insurers available as separate products from A.M. Best.

3. Insurance prices.
   - Compulife Software: Life insurance.
   - Morningstar Annuity Intelligence: Variable annuities.
Data

  ▶ Thomson Reuters eMAXX: Global bond holdings.
  ▶ ECB Securities Holdings Statistics: Complete security holdings of euro-area institutions including insurers.

5. Other useful sources.
  ▶ LIMRA.
Institutions

- Insurance regulated at the state level, firmly established by the McCarran-Ferguson Act of 1945.
- National Association of Insurance Commissioners (NAIC) founded in 1871.
  - Coordinates product, accounting, and capital standards.
- State guaranty associations, first established in New York in 1941.
  - Like deposit insurance that protects policyholders in case of default.
  - Works through ex-post assessments on surviving companies.
- Rating agencies: A.M. Best Company, Moody’s, and S&P.
Accounting standards

- Accounting standards differ between state (statutory accounting principles) and consolidated (GAAP).
- However, gaps and inconsistencies across states and countries.
  - Problematic for risk monitoring of global insurers.
  - Great for identification!
- European Union: Solvency II attempts to make reporting and capital standards uniform across countries.
**Risk-based capital**

- Insurance regulators and rating agencies use the risk-based capital ratio.

\[
\text{RBC} = \frac{\text{Assets} - \text{Reserves}}{\text{Required capital}}
\]

- Regulators monitor risk-based capital and take corrective action.
  1. Company action level of 2: Insurer must submit a plan of corrective actions.
  2. Regulatory action level of 1.5: Regulator examines the insurer and orders corrective actions.
  3. Authorized control level of 1: Regulator has the authority to place the insurer under regulatory control.
  4. Mandatory control level of 0.7: Regulator places the insurer under regulatory control.
Theories of insurance markets

1. Demand-side theories of idiosyncratic risk.
   - Yaari (1965): Life-cycle theory.

2. Demand-side theories of aggregate risk.

3. Supply-side theories with financial frictions and market power.