Intergenerational Risk Sharing
and
Aggregate Longevity Risks

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Intergenerational Risk Sharing

• Longevity risk involves very long time horizons
  • Individual level: start saving at 40, may live to 100 => 60 years.

• Longevity risk has aggregate components.
  • Medical innovations may change aggregate longevity
  • Aggregate risks cannot be diversified – best shared widely

• Net exposure to longevity risk varies across cohorts.
  • News about longevity has very different financial effects at different stages of the life cycle.
  • Cohorts differ in ability to respond or self-insure.

➢ Welfare gains from risk sharing across generations.
Key problem: Markets are incomplete

- Future generations cannot participate in financial and insurance markets
  - Private risk sharing limited to current savers. No insurance against risks realized at start of adulthood – e.g. changes in longevity.

  ➢ **Role for government as agent of future generations**
  - Commitment through taxes, public debt, and transfer programs.

- Potential for public – private cooperation
  - Private management often more efficient than public programs.
  ➢ Case for private insurance at the retail level – for insuring idiosyncratic risks – combined with
  ➢ **Government re-insurance against aggregate shocks**
Related Questions

1. **Governments are exposed to longevity risk already: Is more risk-taking efficient?**
   - Public pension & health care programs provide annuities.
   - Quantitative issue: What is the efficient allocation of risk?
   - Related pricing question: What’s the appropriate risk premium?
   - Questions that deserve analysis / provide motivation.

2. **Some longevity bonds have failed: Why?**
   - My view: Plan included private reinsurance – defeats the purpose.
   - Key to intergenerational risk sharing is a risk transfer to future generations – government exposure is essential.
Outline

① Introduction.

② Example – one-time longevity shock.
   • How intergenerational risk sharing works in a simple case.

③ General analysis – results and complicating factors.

④ Policy implications – how can risk sharing be improved?
   • Government-issued longevity bonds.
   • Back-loaded public benefits to retirees (pensions & health)
   • Regulatory support for private sector DB pensions.

• Throughout: aggregate, macro, general-equilibrium view
  • Assume idiosyncratic risks are covered by private markets – as much as possible, subject to information problems
Analytical Framework

- Economic model with overlapping generations
  - Broad stages of the life-cycle: childhood, working-age, retirement.
  - Designed to model retirement saving and arrival of demographic information – stochastic survival, variable-length retirement period
  - Longevity = Length of the retirement period.

- Unified treatment of multiple aggregate risks
  - Demographic risks: longevity, fertility.
  - Economic risks: productivity growth, asset valuation.
  - Health care risk: uncertainty about retiree medical expenses
  - Unified analysis matters because disturbances have macro effects (e.g. expected longevity => saving incentives => capital stock => economic growth)
Applications

• Positive analysis
  ① Assessment of natural risk exposures
    • Starting point: economy without government intervention.
  ② Assessment of existing policy interventions – calibrated policies.

• Normative analysis
  ③ Benchmark for efficiency: the optimal allocation of risk
  ④ Comparison between actual and optimal risk exposures
  ⑤ Study policy alternatives that could improve risk sharing.
Example: One-time longevity shock

- **News:** Current retirees expected to live longer. No change in longevity of other generations – unchanged trend.
- **Assessment of natural exposures:**
  - Simple: Retiree consumption reduced. Other generations’ income and consumption unchanged.
- **Assessment of existing policies:**
  - Insurance through annuitized public pensions and health care.
- **Efficiency benchmark: equal exposure** – *to be discussed*
- **Compare efficient and actual allocation:**
  - Retirees are more exposed to longevity risk than future generations
  - Conclude that more insurance for retirees would be efficient.
- **Study policy improvements:** e.g. longevity bonds.
Systematic analysis

Aggregate longevity risk has multiple dimensions

① Permanence of longevity shocks
   • Longevity news affecting one generation: one-time / temporary.
   • Longevity news affecting all future generations: permanent.
   • Why it matters: less potential for intergenerational sharing when a common shock affects multiple generations

② Timing of longevity shocks
   • News about current retirees’ longevity – immediate shock; vs.
   • News about working cohort’s longevity in retirement – delayed.
   • Why it matters: potential for self-insurance through saving
The Efficiency Benchmark

- Economic analysis: efficient allocations are solutions to utility-maximization problems
  - Efficient allocations maximize weighted sum of generational utilities subject to feasibility constraints (Bohn JME 1999)
  - Optimality condition: Marginal utilities of different generations should be perfectly correlated across states of nature.
  - Condition applies regardless of welfare weights – does not depend on policy decisions or preferences about redistribution.
- Implication when all cohorts have the same risk aversion:
  - Allocation of risk is efficient if all generations are exposed to shocks so their consumption responds by the same percentage.
  - Useful benchmark even if risk aversion varies.
Quantitative assessment

- Calibrated overlapping generations model (Bohn 2009)
- Log-linearized dynamics of consumption are described by elasticity coefficients
  - Consumption elasticity = Percentage change in consumption per one-percent deviation of a driving variable from its mean (“shock”)
  - Application here to longevity shocks
- Basic assessment compares two numbers:
  ① Elasticity of retirement consumption w.r.t. longevity shock; vs.
  ② Elasticity of working-age consumption w.r.t. longevity shock.
- Full efficiency also requires optimal propagation of shocks over time:
  ③ Elasticity of the real capital stock w.r.t. longevity shock such that future workers have same exposure as future retirees.
Reminder: Good news on longevity is bad news

- Living longer is good news (raises utility)
- Longevity insurance is insurance against the cost of living longer – insurance against high marginal utility
  - Payments go from shorter-lived to longer-living cohorts
  - Rising aggregate longevity tends to reduce consumption per unit time – due to the financial burden.
  - Elasticities of consumption flows with respect to longevity are generally negative.
- High exposure to longevity shocks ↔ elasticity with high absolute value.
## Results – temporary shock

1. **Immediate effects** (elasticities with respect to longevity)

<table>
<thead>
<tr>
<th>Immediate (t=0)</th>
<th>Retiree Consumption</th>
<th>Working-age Consumption</th>
<th>Real Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insurance</td>
<td>-1.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Calibrated policies</td>
<td>-0.77</td>
<td>-0.11</td>
<td>-0.16</td>
</tr>
<tr>
<td>Efficient allocation</td>
<td>-0.31</td>
<td>-0.31</td>
<td>-0.53</td>
</tr>
</tbody>
</table>

- Current fiscal policies (as calibrated) provide insurance, but less than efficient.
Results – temporary shock

② Effects after one generational period
- Retirees = Period-0 workers. Working-age = Period-0 children.

<table>
<thead>
<tr>
<th>Period 1</th>
<th>Retiree Consumption</th>
<th>Working-age Consumption</th>
<th>Real Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insurance</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Calibrated policies</td>
<td>-0.07</td>
<td>-0.05</td>
<td>-0.07</td>
</tr>
<tr>
<td>Efficient allocation</td>
<td>-0.17</td>
<td>-0.17</td>
<td>-0.29</td>
</tr>
</tbody>
</table>

➢ Efficiency calls for more burden-sharing over time
Results – temporary shock

② Effects after **two** generational periods

- Retirees = Period-0 children. Working-age = Period-0 unborn.

<table>
<thead>
<tr>
<th>Period 2</th>
<th>Retiree Consumption</th>
<th>Working-age Consumption</th>
<th>Real Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>No insurance</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Calibrated policies</td>
<td>-0.03</td>
<td>-0.02</td>
<td>-0.03</td>
</tr>
<tr>
<td>Efficient allocation</td>
<td>-0.09</td>
<td>-0.09</td>
<td>-0.16</td>
</tr>
</tbody>
</table>

- **Efficient responses converge to zero, but slowly.**
Persistent longevity shocks

- Temporary shock is special: only 1 generation lives longer
- Generally analysis: news about longevity may affect multiple generations
  - Model longevity as autoregressive stochastic process
  - Polar case: Permanent change in longevity.
- Finding: Efficient allocations prescribe less longevity insurance for current retirees when shocks are persistent
  - Intuition: Future generations are affected directly – reduced benefit
  - Also: Lack of risk-sharing triggers excessive saving response by current working-age savers.
- Illustrations: Results for 50% and 100% persistence
Findings for persistent longevity shocks

- Assuming standard pay-go pensions & public debt

<table>
<thead>
<tr>
<th>Type of shock</th>
<th>Retiree Consumption</th>
<th>Working-age Consumption</th>
<th>Real Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary</td>
<td>-0.77</td>
<td>-0.11</td>
<td>-0.16</td>
</tr>
<tr>
<td>50% Persistence</td>
<td>-0.77</td>
<td>-0.26</td>
<td>0.18</td>
</tr>
<tr>
<td>100% Persistence</td>
<td>-0.77</td>
<td>-0.42</td>
<td>0.51</td>
</tr>
</tbody>
</table>

- Retirees unaffected by persistence. Workers save more when their own expected longevity rises
Efficient responses to longevity risk

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<th>Working-age Consumption</th>
<th>Real Capital</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temporary</td>
<td>-0.31</td>
<td>-0.31</td>
<td>-0.53</td>
</tr>
<tr>
<td>50% Persistence</td>
<td>-0.36</td>
<td>-0.36</td>
<td>-0.31</td>
</tr>
<tr>
<td>100% Persistence</td>
<td>-0.45</td>
<td>-0.45</td>
<td>0</td>
</tr>
</tbody>
</table>

> With persistence: *Greater impact on consumption. Less impact on capital accumulation.*
General implications – lessons

① **Retiree exposure to longevity risk is too high**
   - Calibrated 0.77 >> Efficient range 0.31 – 0.45
   - Robust result – applies regardless of persistence
   - Note: Inefficiency would be greater if retirees were more risk averse than younger cohorts (e.g. with habit formation)
     ➢ Equal risk aversion is a conservative assumption in this context

② **Working-age exposure to longevity risk is too low**
   - Calibrated range 0.11 - 0.42 < Efficient range 0.31 – 0.45
   - Robust result but smaller gap than for retirees

③ **Saving responses are sensitive to persistence**
   - Efficient response are negative unless the shock is permanent
   - Actual savings are inefficient in all cases, sometimes positive.
Caveat 1: News about future longevity

- Scenario: Working-age and future generations expected to live longer. No change for current retirees
- Efficient response: current retirees with zero natural exposure should insure later generations
  - Insurance would mean: reduced pension benefits for retirees.
  - Standard defined-benefit pensions do NOT share this risk.
- Quantitative results:
  - Efficient exposure of retirees and workers = -0.14
  - Exposure without insurance: retirees = 0 vs. working-age = -0.31.
- Why is the working-age impact so small? Self-insurance by saving
- Insight: Information structure matters
  - Empirical relevance unclear: Is longevity ever revealed in advance, without observing that retirees live longer?
Caveat 2: Ability to work longer

- **Issue:** assumption of fixed retirement age
  - Good assumption if fixed by law, but not necessarily efficient

- **Scenario:** suppose good news about longevity also reveals an ability to work longer
  - Permanent shock has financial effect similar to a temporary longevity shock – affecting only retirees because the young can work longer – plus an unexpected increase in the workforce
  - Larger workforce reduces the capital-labor ratio, which is positive for capital-owners, negative for workers (BUT: fertility is declining)

- **Insights:**
  1. Burden of a permanent longevity shock can be temporary.
  2. Full analysis would require discussion of multiple shocks – e.g., interaction of changes in longevity, fertility, and labor supply.
Policy Implications

• Given: Retiree generation carries too much exposure to longevity shocks

• How can governments provide more insurance?
  ① Longevity bonds or longevity-linked derivatives
  ② Back-loaded public pensions: more annuitized benefits late in life, less or nothing at younger ages.
  ③ Regulations that support intergenerational risk sharing by private pension funds

• Challenge: better risk sharing without more redistribution
  • A policy change must be Pareto improving ex ante, otherwise it’s redistribution in disguise. In expectation – before shocks are realized – all generations must be better off.
Government-issued longevity bonds

- Proposed policy change: Replace regular public debt securities by longevity bonds
  - Payments linked to a longevity index
    (Set aside specific design issues—see e.g. Blake, Boardman, Cairns).
  - Assume unchanged total amount of public debt – necessary to ensure no redistribution in the period of issue.

- Question: Should governments charge a risk premium?
  Two conditions for Pareto improvement:
  - Risk premium low enough that bond buyers are better off.
  - Risk premium high enough that future taxpayers are better off.

- Insight: Imperfect risk sharing ⇔ Gains from trade
  - Suggests range of Pareto-improving premiums …
Who bears the risk of longevity bonds?

- Example: 30-year zero coupon longevity bond.
  - Payment proportional to longevity one generational period ahead.
  - Buyers: current retirement savers – working age now, retirement age when the bonds mature. Buying directly or via pension funds.

- Private sector longevity bonds:
  - Sellers (their shareholders) are the same generation as the buyers.
  - Risk premiums on private-sector longevity bonds reflect the risk aversion and aggregate risk exposures of current savers.

- Government-issued longevity bonds:
  - Sellers are the taxpayers when the bonds mature = current children and unborn. Government acts as their agent.
  - Pareto optimality requires that sellers are compensated for taking risks correlated with their consumption.
Asset pricing with overlapping generations

- **Risk premium** = covariance(marginal utility, asset return)
  = (relative risk aversion) x (exposure to shock) x (variance of shock).
- **Exposure** = elasticity of consumption with respect to shock
- **Risk premiums in the market** are based on the risk aversion and exposure of current savers = consumption risk in retirement.
- **Compensation for government risk-taking** is based on risk aversion and exposure of taxpayers = consumption risk in working age.

➢ **Risk ratio**: compensation / (market risk premium)
  = (working-age exposure) / (retiree exposure)

- Provided both generations have the same risk aversion.
- Smaller ratio of compensation/premium if retirees are more risk averse than younger cohorts
Risk charges on government longevity bonds

- Recall consumption exposures to longevity risk:
  - Retirees 0.77. Working-age 0.11-0.42, depending on persistence.
  - Longevity bond insures against all types longevity shocks
  - Worst case: risk ratio = 0.42/0.77 ~ 54% for permanent shocks.
  - On the margin, taxpayers are compensated if the government charges about half of the private-issue risk premium
  - Pareto improving range is 54-100% – at 54%, all gains go to current savers; at 100%, all gains go to future taxpayers.

- Complication: large bond issues would change exposures
  - Less longevity risk in the market => lower risk premiums
  - More longevity risk for taxpayers => require more compensation
    - Efficient allocation implies elasticity 0.45, ratio 0.45/0.77 ~ 60%
    - Required compensation ~ 60% of initial private-sector premium
Other policies to enhance intergenerational risk sharing

**Back-loaded public pensions**
- Current setup: retirement financed by mix of public & private funds
  pensions start at retirement and offer ~ constant replacement rate
- Argument in Bohn (2015): optimal public pensions should bunch payments at the end of life – first pay 0, then 100% of consumption.
- Beneficial side effect: more longevity insurance, because survival into high ages is most sensitive to longevity news

**Regulations supporting private DB pensions**
- Voluntary private pension plans cannot provide intergenerational risk sharing because free entry/exit implies zero net transfers
- Mandatory participation in industry or professional plans can relax the participation constraint (Bohn 2012)
- Limited ability to share risk – still case for government reinsurance
Other issues/complications – not in the model

① Heterogeneity across the income distribution
- Low end: retirees rely mostly on public benefits – fully insured against longevity risk.
- High end: retirees control dynastic wealth and leave bequests – longevity risk is shifted to their children.

② International Risk Sharing
- Nation-specific components of longevity risk could be insured.
- But medical knowledge is international; ability to collect is limited.

③ Excessive public debt – limits capacity to offer insurance
- Idea: sovereign wealth funds as suppliers of intergenerational insurance – they operate on behalf of future generations; their assets provide collateral.
Conclusions

- Intergenerational risk sharing promises welfare gains
  - Children & future generations naturally excluded from risk sharing
  - Governments make commitments for future generations by setting fiscal policy – it’s unavoidable, so worth examining systematically

- Findings for aggregate longevity risk
  - Robust: **Retirees are too exposed to longevity risk**
  - Efficient solutions depend on the stochastic process of longevity shocks – persistence of news about longevity & timing.

- Government-issued longevity bonds can improve welfare
  - Governments already bear longevity risk – but not enough
  - Pareto improvement (welfare gains for all) requires compensation for risk imposed on future taxpayers ~ 50-60% of market premium
References

  - Journal of Monetary Economics 56, 805–816.
- Bohn 2012: “Private versus public risk sharing: Should governments provide reinsurance?”
  - Work in progress, UCSB.