# 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?

- Notable example: European Investment Bank 2004.
- 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)

| Immediate (t=0) | Retiree Consumption | Working-age Consumption | Real Capital |
|---|---|---|---|
| No insurance | -1.00 | 0.00 | 0.00 |
| Calibrated policies | -0.77 | -0.11 | -0.16 |
| Efficient allocation | -0.31 | -0.31 | -0.53 |

- *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.

| **Period 1** | **Retiree Consumption** | **Working-age Consumption** | **Real Capital** |
|---|---|---|---|
| No insurance | 0.00 | 0.00 | 0.00 |
| Calibrated policies | -0.07 | -0.05 | -0.07 |
| Efficient allocation | -0.17 | -0.17 | -0.29 |

➢ *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.

| **Period 2** | **Retiree Consumption** | **Working-age Consumption** | **Real Capital** |
|---|---|---|---|
| No insurance | 0.00 | 0.00 | 0.00 |
| Calibrated policies | -0.03 | -0.02 | -0.03 |
| Efficient allocation | -0.09 | -0.09 | -0.16 |

➢ *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

| **Type of shock** | **Retiree Consumption** | **Working-age Consumption** | **Real Capital** |
|---|---|---|---|
| Temporary | -0.77 | -0.11 | -0.16 |
| 50% Persistence | -0.77 | -0.26 | 0.18 |
| 100% Persistence | -0.77 | -0.42 | 0.51 |

➢ Retirees unaffected by persistence. Workers save more when their own expected longevity rises

# Efficient responses to longevity risk

| Type of shock | Retiree Consumption | Working-age Consumption | Real Capital |
|---|---|---|---|
| Temporary | -0.31 | -0.31 | -0.53 |
| 50% Persistence | -0.36 | -0.36 | -0.31 |
| 100% Persistence | -0.45 | -0.45 | 0 |

- 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

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