Optimal Portfolio Choice With Longevity, Critical Illness and Long-Term Care Insurance

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Agenda

Motivation

Rapid population ageing & growing awareness of health risks due to COVID-19
Developing countries: basic public insurance $\rightarrow$ catastrophic medical expenditures

- Government - public insurance system not adequate, how to expand?
- Individuals - retirement risks (longevity, medical, aged care), how to manage them?

Challenging task!

- Survival probabilities, health risks (illness and care), economic environment
- Societal changes: female labour force participation, migration, etc.

Role of retirement insurance?

Annuity Puzzle

Theory - Annuities are part of an optimal portfolio

Practice - Voluntary annuitisation rates are low

Many explanations (e.g., Benartzi et al., 2011) - three key reasons

- **Precautionary savings** due to uncertain health-related expenditures (e.g., De Nardi et al., 2010; Peijnenburg et al., 2017)
- **Health shocks and correlated financial costs** (Laitner et al., 2018; Reichling and Smetters, 2015)
- **Adverse selection** (e.g., Braun et al., 2019; Finkelstein and Poterba, 2004)

Remarks

- Not wise to plan retirement <u>only</u> with retirement income products - health risks matter!
- Limited research considering longevity and health-contingent insurance simultaneously

Our Paper

Predict the **optimal portfolio** for a retiree in a developing retirement system

Based on a new multi-period and multi-state life-cycle model

- Risks: critical illness, long-term care, longevity, stochastic medical and care expenditures.
- Public insurance: pension, medical insurance, welfare assistance (means-tested subsidy)
- Portfolio: annuity, critical illness insurance, long-term care insurance, savings account
- Health state-dependent utility of consumption

Model calibrated to urban China

Key Results

1. **High** annuity demand for retirees with a **low** pension
2. **High** critical illness insurance demand for retirees with an **average** pension
3. **Positive** long-term care insurance demand across economic profiles
4. **Higher** long-term care insurance demand for **females**

Main Contributions

1. First paper to include **critical illness insurance** in a retirement portfolio in a life-cycle model
   - Existing studies only consider longevity and/or long-term care insurance (Ameriks et al., 2019; Horneff et al., 2020; Koijen et al., 2016; Laitner et al., 2018; Peijnenburg et al., 2017; Reichling and Smetters, 2015; S. Wu et al., 2016)
   - Only critical illness insurance (Hambel, 2020)

2. **Predict optimal retirement portfolio choice** for retirees in urban China
   - Males and females, typical wealth and pension levels
   - Comprehensive tests: state-dependent utility, other preferences, health transitions, pricing, and subsidy

Retirement Provision in China: Longevity Insurance

Public - main programs:

- Employee pension (monthly amount CNY 3,000 or USD 400)
- Resident pension (rural and urban, CNY 150 - 1,000)

Private

- Enterprise annuity (in large SOEs)
- "Annuities" - yes, but
  - Short-term investment products
  - Complex and costly
- New policy: Individual Retirement Account (2022)

Retirement Provision in China: Health and care

Health insurance
- Employee **Basic** Medical Insurance + Resident **Basic** Medical Insurance
  - Critical illness: **catastrophic** financial/health shock

Long-term care insurance
- Mainly informal, but pilot programs in 80 cities
  - Different requirements, benefits, and funding models
  - Sustainability

Private
- "Critical illness insurance" (lump sum, age limit, rarely long-term)
- "Long-term care insurance" (short-term investment products)

Retirement Provision in China: Summary

Public insurance
- Large variation (pension income)
- Limited cover (health-related risks)
- Sustainability

Private insurance
- Lack of suitable products for retirees
- Costly

More?

Model: Setting (1/3)

Demographics and socioeconomics

- Male and female urban employee, retired at ages 60 and 55, respectively
- Period(t): from retirement to death (max age 105), 46 or 51 years/periods
- Retires with given retirement savings M_1 and public pension P_t
- Enrolled in public health insurance

Preference

- Health state-dependent utility of consumption via weight η_{H_t} (De Nardi et al., 2010; Finkelstein, Luttmer, et al., 2013; Peijnenburg et al., 2017)

$$u(c_t, H_t) = \eta_{H_t} c_t^{1-\gamma}/(1-\gamma) \tag{1}$$

Model: Setting (2/3)

Health transitions (exogenous)

- 4 health states H_t at period t: 1 - healthy, 2 - critically ill (CI), 3 - long-term care (LTC) dependent (3+ ADLs*), 4 - dead
- Markov process with transition probabilities at period t:
  $\pi_t(H_t = i, H_{t+1} = j) = \text{Prob}(H_{t+1} = j | H_t = i)$
- No recovery from poor health states to healthy

Health costs (exogenous)

- Incur random cost due to critical illness whenever critically ill
  - Distribution of cost: independent of age
- Incur random cost due to long-term care whenever LTC dependent
  - Distribution of cost: age-dependent

Model: Setting (3/3)

Portfolio

- Life annuity
  - Pays fixed amount $Annuity_t$ p.a.

- Critical illness insurance (CII)
  - Pays lump sum CII_t when the insured is critically ill for the first time

- Long-term care insurance (LTCI)
  - Pays fixed amount $LTCI_t$ p.a. when the insured is LTC dependent

- Savings account
  - Real interest rates on savings: 2%

Pricing: discounted expected costs $+$ 15% loading

No stock market: $< 3\%$ participation rate among the old (CHARLS, 2018)

Model: Decision and Transition

At retirement: decide insurance portfolio and pay premiums, one-off choice

Other periods, i.e., from t to $t+1$:

- Begin with end of last period wealth M_t
- Receive pension and annuity income: $+P_t + Annuity_t$
- Depending on health state H_t:
    - $-CostLTC_t + LTCI_t$
    - $-CostCI_t + CII_t$ (if first time)
- Receive subsidy S (means-tested, consumption floor)
- Choose consumption C_t
- Accrue interest R

Final period: choose consumption and leave bequest

Model: Objective

The individual chooses insurance allocation and consumption to maximise their lifetime utility. Bellman function:

$$\left\{ \begin{array}{l} V_t(M_t, H_t) = \max_{c_t, \omega_a, \omega_c, \omega_l} E_t\left\{ u(c_t, H_t) + \beta\left[\sum_{H_{t+1}=1}^{4} \pi_t(H_t, H_{t+1}) V_{t+1}(M_{t+1}, H_{t+1}) \right] \right\} \\ V_t(M_t, 4) = v(M_t) \equiv bM_t^{1-\gamma}/(1-\gamma) \end{array} \right. \text{ s.t.}$$

$$A_t = M_t + P_t + Annuity_t + CII_t + LTCI_t - CostCI_t - CostLTC_t - c_t,$$

$$M_{t+1} = R \cdot A_t,$$

$$A_t \geqslant 0,$$

$$c_t \geqslant S,$$

$$\omega_a, \omega_c, \omega_l \geq 0,$$

$$\omega_a + \omega_c + \omega_l \leqslant 1.$$

- Solved numerically by backward induction with the endogenous grid-points method(Carroll, 2006) + simulations to find optimal allocations

Calibration (1/2)

Data source

- China Health and Retirement Longitudinal Study (CHARLS)
  - Estimate long-term care probabilities, costs (informal care), and insurance pricing
  - Similar to the Health and Retirement Study (HRS) and the Survey of Health, Aging and Retirement in Europe (SHARE)
  - Four waves (2011, 2013, 2015, and 2018)
- Official mortality and health curves
- Hospital data about critical illness expenditures (Fang et al., 2018; D. Wu et al., 2018)
- Preferences parameters (Friedman and Warshawsky, 1990; İmrohoroğlu and Zhao, 2018; X. Wang and C. Wang, 2020)
- Government reports about pension, subsidy

Calibration (2/2)

Health transitions
- Based on official mortality and illness curves and CHARLS data

Health costs
- $CostCI \sim$ Lognormal$\left(11.86,\ 0.92^2\right)$, Mean: CNY 216,000
- $CostLTC(\text{Age}) \sim$ Lognormal$\left(6.13 + 0.02 \times \text{Age},\ 1.46^2\right)$, Mean: CNY 4,400 at age 60

Preferences
- 'Risk aversion' $\gamma = 3$
- Time preference $\beta = 0.999$
- Bequest strength $b = 50$
- Health-dependent utility weights: $\eta_{H_t=\text{CI}} = 1.2$, $\eta_{H_t=\text{LTC}} = 0.7$

Results: Optimal Allocation - Males

Optimal allocation of retirement savings, male

Case	1	2	3	4
Retirement savings	1 million	1 million	150,000	150,000
Pension	3,000	1,000	3,000	1,000
Welfare gain (% of wealth)	**12%**	**32%**	**39%**	**65%**

Welfare gain: 1) use simulations to find equivalent wealth needed (without purchasing insurance) to achieve the same utility (with optimal insurance); 2) calculate the increase relative to the initial wealth

- Optimal portfolio strongly depends on wealth and pension
  - High wealth: demand for CII, LTCI and annuity, and self insurance!
  - Low wealth: demand for CII or annuity depending on pension
- Large welfare gains, especially for low wealth/pension

Results: Optimal Allocation - Males and Females

Optimal allocation of retirement savings, male

Case	1	2	3	4
Retirement savings	1 million	1 million	150,000	150,000
Pension	3,000	1,000	3,000	1,000
Welfare gain (% of wealth)	**12%**	**32%**	**39%**	**65%**

Optimal allocation of retirement savings, female

Case	1	2	3	4
Retirement savings	1 million	1 million	150,000	150,000
Pension	3,000	1,000	3,000	1,000
Welfare gain (% of wealth)	**7%**	**42%**	**25%**	**89%**

Results: Optimal Allocation - The Average

What about the *average* case?

For an individual with an average pension (CNY 3,000) and average wealth (CNY 640,000), interpolate and weight our results:

- Annuity (3%) + CII (48%) + LTCI (14%) + Savings (25%)

Remarks

- Health-related risks alone could solve the annuity puzzle
- Health-related risks addressed, then think about longevity risk

Results: Optimal Allocation - Summary and Discussion

Insurance demand

- Substantial CII demand for retirees with an average pension
- High annuity demand for retirees with a low pension (in line with "full annuitisation")
- Positive LTCI demand across all economic profiles (similar to Ameriks et al., 2020)
- Females: much higher LTCI demand (conservative, e.g., widow)

Welfare gains

- Much larger for poor retirees, role of financial education?

Next...

- Real choices? Only stated preferences (Wan et al., 2022) link
- Collective models

Results: Sensitivity (1/2)

- Health transition
  - Higher transitions between CI and LTC
- Pricing
  - Product priced wrt. separate health assumptions (standalone product) vs the same health transitions matrix (bundled product)
  - Health assumptions for pricing, consistent or inconsistent with the health transitions in the utility function
- Preferences
  - Lower/higher marginal utility of consumption
  - Risk aversion, time preference, bequest motives
- Subsidy
  - Lower/higher monthly subsidy

Results: Sensitivity (2/2)

Main results generally robust

Notable changes

- Health transition `link`
  - Higher transition rates between CI and LTC decrease annuity demand
  - Larger impact for poor retirees
- Pricing `link`
  - Annuity demand increases substantially (for wealthy retirees)
- Preferences `link 1` `link 2`
  - State-dependent utility: moderate; can decrease/increase annuity demand
  - Other preferences: more stable demand for CII and LTCI than for annuity
- Subsidy
  - LTCI demand converted to annuity demand (only for poor retirees)

Conclusion: Takeaways

First paper to include a life annuity, critical illness insurance, and long-term care insurance in a life-cycle model.

- For an individual with health state-dependent utility function, facing random health transitions and random health costs (illness and care).

Key findings:

- High CII demand for retirees with an average pension
- High annuity demand for retirees with a low pension
- Positive LTCI demand across economic profiles, much larger for females
- Potential self-insurance for wealthy retirees
- Larger welfare impact of insurance on poor retirees

Conclusion: Implications

For policymakers and insurers in developing countries

1. Once income is *enough*, policies to reduce illness shocks are more efficient
2. Prepare for coming LTC demand: unique, higher for females
3. Financial education for poor retirees
4. Bundling health and longevity insurance could increase annuity demand

Thank you for your interest in our research!

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Sensitivity - Health Transition

Test three transitions between CI and LTC

1. CI to LTC: twice of the baseline transition

2. LTC to CI: twice of the baseline transition

3. Both transitions higher

Results

- Benchmark results generally robust to transitions between CI and LTC states, larger impact for retirees with low wealth & low pension

- Annuity demand decreases when transitions to CI and LTC states rise

- Largest change of allocation: Annuity (80% - 100%, low wealth & average pension), CII (30% - 35%, high wealth & average pension), LTCI (0 - 20%, low wealth & low pension)

Sensitivity - Pricing

Previous: each insurance priced **separately** wrt. their own health tables

Now: priced with the **same** health transition matrix for all three products

- Health transitions for pricing

    - consistent with health transitions in the utility function
    - inconsistent with health transitions in the utility function

- Tested with the previous three health transition assumptions

Results

- Main results confirmed, robust to pricing and inconsistent health dynamics

- Annuity demand increases substantially: $10\% \rightarrow 35\%$ (high wealth & average pension)
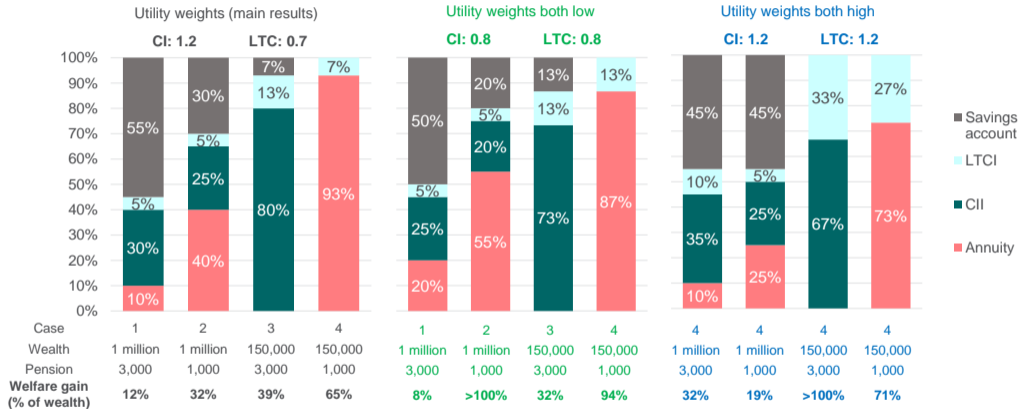
Health State-Dependent Utility (1/2)
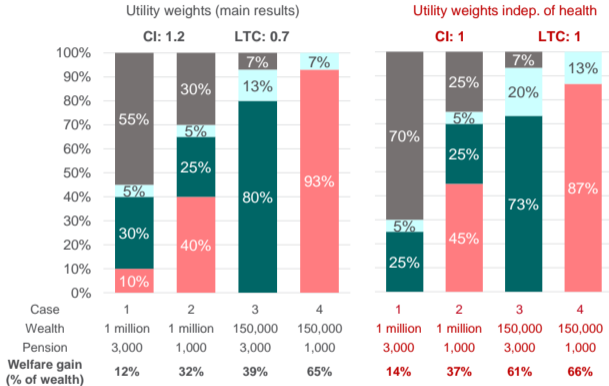
Note: payments can be used in every state

- Moderate impact on percentages

- Optimal portfolio still largely determined by wealth and pension

- Changes reflect different weights:
  - Higher CII demand
  - Lower LTCI demand
  - Higher Annuity demand?

Health State-Dependent Utility (2/2)

- Similar moderate impact. More pronounced for poor retirees

- Higher weights in poor health states → lower annuity demand, vice versa

Sensitivity - Other Preferences

Vary preference parameters

- "Risk aversion": $\gamma = 2, 3, 9$

- Time preference: $\beta = 0.96, 0.999$

- Strength of bequest motives: $b = 0, 10, 50, 100$

Results (group with high wealth & average pension)

- More stable demand for CII and LTCI, than for annuity

- More 'risk averse' $\rightarrow$ higher insurance demand (high wealth and average pension); higher annuity and CII demand, lower LTCI demand (low wealth and low pension)

- More patient $\rightarrow$ more annuity ($0 \rightarrow 10\%$)

- Stronger bequest motives $\rightarrow$ less annuity ($30\% \rightarrow 0$)

Companion Paper

Key findings:

- Large variation in stated demand by individual factors and COVID-19 experience.

- Most preferred retirement insurance: half critical illness insurance + half LTCI + a monthly annuity of ca. 20% of disposable urban income.

- Access to critical illness insurance and LTCI can release the precautionary savings to purchase annuity, and the effect depends on the cover of the health insurance.

- Lower CII demand and higher annuity demand, compared with the theoretical best - underestimation of health-related risks or preference to use annuity as a buffer.

- Higher financial competence and more risk averse linked to higher CII / LTCI demand, but lower annuity demand.

Retirement Provision in China: Longevity Insurance

Public - main programs:

- Employee pension (monthly amount CNY 3,000 or USD 400)

- Resident pension (rural and urban, CNY 150 - 1,000)

Private

- Enterprise annuity (in large SOEs)

- Annuities
  - Short-term wealth management products
  - Complex saving products with guaranteed income, costly

- 2022 Nov: government-supported program (3rd pillar)
  - Individual Retirement Account (IRA), tax benefits (EET)
  - USD 1.7 trillion by 2025

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Retirement Provision in China: Health Insurance

Public - main programs:

- Employee Basic Medical Insurance + Resident Basic Medical Insurance

- Both include:
  - Basic insurance for critical illness
    - Overall, limited reimbursement (e.g., 50%)
    - Many advanced treatments not covered
    - Can have a *large* financial/health shock

Private

- Critical illness insurance (lump sum, age limit, rarely long-term)

- Medical insurance (reimbursement, age limit, rarely long-term; government-supported new programs)

- Mutual-aid programs (e.g., age limit, closed: *Xianghu Bao* from Alibaba)

Retirement Provision in China: Long-Term Care Insurance

Mainly informal care: family and relatives

Public - pilot phase

- About 80 pilot programs: different requirements, benefits, and funding models
  - Based on activities of daily living (ADL), instrumental ADL, cognition
  - Institutional care, community and home-based care
  - Contribution: individuals, employers, government, lottery funds

- Funding to be separated from the public health insurance

Private

- "Long-term care insurance" (mostly short-term investment products)

Retirement Provision in China: Outlook and Summary

Recent reform and regulation directions

- Sustainability: Increasing pension ages + Government employees start to contribute to access pension

- IRA + government-supported medical insurance

- More cooperation between the government and insurers

- More *insurance* products, rather than *investment* products

- More conservative discount rates

Summary

- Public insurance - large variation (pension), lack of cover (health risks), sustainability

- Private insurance - lack of suitable products for retirees, costly