Bequest Estimate and Wealth Impact in Japan: Based on a CGE model with realistic demography
(Work-in-progress)

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Japan is at the forefront of population aging ⇒ ↓ labor and production

Source: Authors’ estimations based on local statistics, HFD, HMD, and UN Population Division. Notes: aged group (ages 62+), working group (ages 18-61).
Necessity of using additional resources for generating economic growth (mainly through **physical capital** and human capital)

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Two main questions:

**Can we estimate bequest?**

- Macro and historical: Piketty (2011) for France 1820-2050
- Wealth inequality: general equilibrium models (see literature review by Cagetti and Nardi (2008))

**Can we use bequest to improve economic growth?**

- Shall savings be annuitized?
- Who should receive bequest?
- “The tragedy of annuitization” by Heijdra et al. (2010) ⇒ wealth should not be annuitized and it should be transferred to children
Motivation

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Research goals

1. Provide reliable estimates of bequest flows in Japan (using a CGE model with realistic demography)

2. Give insight on the observed inheritance profiles

3. Give policy recommendations
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The model set-up

- Population
- Economic model
- **Population**

  - Single sex model ("population reconstruction")
    - Inverse projection, (Lee, 1985)
    - Generalized inverse population projection (Oeppen, 1993)

  - Realistic fertility and mortality (exogenous)

  - No migration

  - Information derived from the population reconstruction:
    - Adults, children, expected parents, expected number of sibling, expected number of offspring
Life expectancy

Total fertility rate

Net migration rate

Population distribution

Source: Authors’ calculations. UN Population Division, Ministry of Health and Labor of Japan, and Statistics Bureau of Japan.
**Model:** CGE OLG model with realistic demography

**Assumptions:** Closed economy, perfect annuity market, no borrowing constraints, and competitive markets

- **Firm:** Demands labor \( (H) \) and capital \( (K) \)

- **Government:** Provides goods and services \( (G) \) and levies taxes on \{\( \tau_{ct}, \tau_{l}, \tau_{k}, \tau_{p}, \tau_{b} \)\}. Our government runs an unbalanced social security pension system

- **Individuals:** Maximum life span 120 years, (endog.) work effort, retirement, saving/consumption (child-rearing cost), and bequest. Preferences similar to Braun et al. (2009) and İmrohoroğlu and Kitao (2012)
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★ Economic unit (double-head “pseudo-household”)

▶ Two adults (2 heads)

▶ Dependent children

▶ Economic decisions:
  1. Consumption/saving
  2. Intensive and extensive labor supply (work effort, retirement age)
  3. Bequest

▶ Assumptions:
  1. No economies of scale
  2. All resources are equally distributed within the heads
  3. All individuals are paired with an individual of the same age when they become adults
  4. Exit from marriage can only occur because of death
Calibration

Figure: Capital-output ratio, period 1885-2100, Japan
Model set-up

Economic model

Consumption and labor income, 1984

Consumption and labor income, 1994

Consumption and labor income, 2004
Comparison of our model to JSTAR data
Figure: Inheritance hazard rate, year 2009
Figure: Average bequest received, year 2009
Figure: Assets profile, year 2009
The estimation of bequest in Japan from year 1885 to 2100
U-shaped pattern

- Piketty (2011, QJE): \( r > n + \rho \) logic
- Alternative and complementary reasons from demography:
  - **Decline**
    - Rapid population growth \( \downarrow K/N \)
    - “Tempo effect” postponement of inheritance
    - \( \downarrow \) precautionary saving (\( \downarrow \) variability of the age at death)
  - **Increase**
    - Declining population \( \uparrow K/N \)
    - \( \uparrow \) saving for retirement motive (\( \uparrow e_R \))

Figure: Bequest to output ratio (period 1885-2100), Japan
Figure: Simulated evolution of the bequest profile by bequest motive (selected years), Japan
Counterfactual experiment I/II
Inheritance law change in year 2015

- Three alternatives

1. Offspring-Spouse (O-S) ⇒ 100% - 0%
2. Offspring-Spouse (O-S) ⇒ 50% - 50%
3. Offspring-Spouse (O-S) ⇒ 0% - 100%
Bequest profile, year 2015

Capital-output ratio, period 1885-2100
Counterfactual experiment II/II

“tragedy of annuitization: although full annuitization of assets is privately optimal it may not be socially beneficial due to adverse general equilibrium repercussions” [Heijdra et al. (2010), p. 3]

Thought experiment: mandatory annuitization of 50% of private assets from year 2015 onwards
Conclusions

- Bequest profiles can be estimated using CGE models with realistic demography.

- Inheritance in Japan also presents a U-shaped pattern similar to that in France (≈ 10% before 1950, 5% 1970-2000, 7%-12% from 2050-).

- We provide an alternative and complementary explanation based on demography for the U-shaped pattern given by Piketty (2011).

- We find similar results shown by Heijdra et al. (2010), known as “The tragedy of annuitization” → no annuitization and ↑ share of transfers to children.
Thank you

The authors would like to thank Ronald Lee, Andrew Mason, and Hidehiko Ichimura for valuable comments.
Estimation of bequest
Bequest: Part I/II

\[ p_t(x)p_t(x) \]
\[ 2p_t(x)q_t(x) \]
\[ q_t(x)q_t(x) \]
\[ q_t(x) \]

Figure: Expected bequest given, by partnership status and age

Bequest given at age \( x \) depends on

- Age
- Partnership status \{married, widow/er\}
- Number of eligible offspring
- Assets holding
- Inheritance law
Bequest: Part II

... 

\[ f_t(x + \alpha) \]
\[ f_t(x + \alpha + 1) \]
\[ f_t(x + \alpha + 2) \]
\[ f_t(x + \beta) \]

Figure: Expected bequest received from parent(s), by age

Bequest received at age \( x \) depends on

- Age of the expected parent
- Status of the parent \{married, widow/er\}
- Assets held by parent(s)
- Own marriage status
- Assets held by spouse
- Inheritance law
“Head’s” problem

\[ V(a_x; z) = \max_{c_x, \ell_x} \left\{ u(c_x, 1 - \ell_x; \eta_x^c, \eta_x^\ell) + \beta \left( p_{x+1} V(a_{x+1}; z) + (1 - p_{x+1}) U^B (\tilde{a}_{x+1}) \right) \right\} \]  

s.t.

\[
 a_{x+1} = 
\begin{cases} 
  \left( R_x \left( 1 + \gamma \frac{q_x}{p_x} \right) - \tau_p \right) a_x + (R_x - \tau_b) B_x + (1 - \tau_l)(1 - \varsigma \tau_{s,x}) \omega \epsilon_x \ell_x - (1 + \tau_{c,x}) c_x & \text{if working,} \\
  \left( R_x \left( 1 + \gamma \frac{q_x}{p_x} \right) - \tau_p \right) a_x + (R_x - \tau_b) B_x + (1 - \tau_l) b_x(z) - (1 + \tau_{c,x}) c_x & \text{if retired,} 
\end{cases}
\]

where \( \tilde{a} \) is the effective bequest left (or \((1 - \gamma)(1 - \tau_b)a\)), \( R \) is the compound (real) interest rate net of capital income tax, or \( 1 + r(1 - \tau_k) \), and \( \gamma \in [0, 1] \) is the percentage of private savings that are annuitized.

First-order conditions

- Optimal consumption (Euler equation)

\[
\frac{u_c(x)}{u_c(x+1)} = \beta p_{x+1} \left( R_{x+1} \left( 1 + \gamma \frac{q_{x+1}}{p_{x+1}} \right) - \tau_p \right) \frac{1 + \tau_{c,x}}{1 + \tau_{c,x+1}} + \beta \left( 1 + \tau_{c,x} \right) \frac{\tilde{a}_{x+1}}{a_{x+1}} \frac{U^B_a(x+1)}{u_c(x+1)}
\]

- Optimal work effort

\[
u_{1-\ell}(x)/u_c(x) = \omega \epsilon_x (1 - t_x), \text{ where } t_x = (1 - \tau_l)(1 - \varsigma \tau_{s,x})/(1 + \tau_{c,x})
\]

- Optimal retirement age

\[
z^* = \arg\max_{z \in Z} V(a_{x0}; z)
\]
“Head’s” problem

\[
V(a_x; z) = \max_{c_x, \ell_x} \left\{ u(c_x, 1 - \ell_x; \eta_x^c, \eta_x^\ell) + \beta \left( p_{x+1} V(a_{x+1}; z) + (1 - p_{x+1}) U^B(\tilde{a}_{x+1}) \right) \right\}
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u_{1-\ell}(x)/u_c(x) = \omega \epsilon_x (1 - t_x), \text{ where } t_x = (1 - \tau_l)(1 - \zeta \tau_{s,x})/(1 + \tau_{c,x})
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\[z^* = \arg\max_{z \in Z} V(a_{x_0}; z)\]
Table: Model economy parameters

<table>
<thead>
<tr>
<th>Household heads</th>
<th>Symbol</th>
<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Risk aversion parameter</td>
<td>$\sigma$</td>
<td>{2.5;3.0;3.50}</td>
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<tr>
<td>Weight on consumption</td>
<td>$\phi$</td>
<td>0.35</td>
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</tr>
<tr>
<td>Weight on bequest utility</td>
<td>$\psi_1$</td>
<td>{0;20;40;60}</td>
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<tr>
<td>Curvature of bequest utility</td>
<td>$\psi_2$</td>
<td>0.40</td>
<td>Hayashi and Prescott (2002), Chen et al. (2007), Braun et al. (2009)</td>
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<tr>
<td>Subjective discount factor</td>
<td>$\beta$</td>
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</tr>
<tr>
<td>Age at leaving parent’s home</td>
<td>$\chi_0$</td>
<td>20</td>
<td></td>
</tr>
<tr>
<td>Employee social contribution share</td>
<td>$\zeta$</td>
<td>0.50</td>
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<table>
<thead>
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<th>Technology</th>
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<th>Value</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital share</td>
<td>$\alpha$</td>
<td>0.363</td>
<td>Hayashi and Prescott (2002), Chen et al. (2007), Braun et al. (2009)</td>
</tr>
<tr>
<td>Depreciation rate</td>
<td>$\delta$</td>
<td>5.00%</td>
<td>National accounts</td>
</tr>
<tr>
<td>Future labor-aug. techn. progress</td>
<td>$dA_t/A_t$</td>
<td>1.00%</td>
<td>Braun et al. (2009)</td>
</tr>
<tr>
<td>Labor efficiency profile</td>
<td>$\varepsilon_x$</td>
<td></td>
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<th>Government</th>
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<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Public consumption to output</td>
<td>$G/Y$</td>
<td>0.12</td>
<td>National accounts</td>
</tr>
<tr>
<td>Capital income tax rate</td>
<td>$\tau_k$</td>
<td>0.150</td>
<td>OECD</td>
</tr>
<tr>
<td>Labor income tax rate</td>
<td>$\tau_l$</td>
<td>0.075</td>
<td>OECD</td>
</tr>
<tr>
<td>Property tax rate</td>
<td>$\tau_p$</td>
<td>0.005</td>
<td>OECD</td>
</tr>
<tr>
<td>Bequest tax rate</td>
<td>$\tau_b$</td>
<td>0.100</td>
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