Population Aging, Government Policy and the Postwar Japanese Economy

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27 December 2016
Japan has gone through rapid population aging over the past few decades

- decline in the share of working age population (15-64) among adults (15+)
- decline in adult population growth rate

How important is population aging and related government policies in accounting for postwar Japanese growth?
Figure: Real GDP per adult
Introduction
Population Aging

![Population Share 1955-2014](chart)

**Figure:** Population Share 1955-2014
Introduction
Related Studies

- Neoclassical model for postwar Japanese growth
  - Christiano (1989), King and Rebelo (1993): capital destruction and subsistence consumption

- Demographic effects on Japanese output

- Labor decline
  - Braun, Ikeda and Joines (2009): reduction in family size
This paper constructs a parsimoneous neoclassical growth model with young and old adults quantitatively decomposes Japanese growth 1975-2014 into the effects of population aging, productivity, and government distortions.
The Postwar Japanese Economy
Demographic, Productivity and Government Variables

Figure: Exogenous Variables
Figure: Aging Effect on Employment Share
Representative household consists of young and old adults (no kids)

- a fraction $\eta_t$ are young and have high employment rate $\pi_y$
- a fraction $1 - \eta_t$ are old and have low employment rate $\pi_o$
- head of household allocates resources among the family
- The number of households $N_t$ increases over time at the rate $n_t$

Firm hires labor and capital to produce output

Government taxes the household by labor and capital income tax and lumpsum tax
Model
Household Problem

- **Preferences**
  \[ U = \max \sum \beta^t \left[ \Psi \ln c_t + e_t (1 - \Psi) \ln (\bar{h}_t - h_t) \right], \quad (1) \]

  where
  \[ e_t = \eta_t \pi_y + (1 - \eta_t) \pi_o \]

- **Budget constraint**
  \[ c_t + i_t = (1 - \tau_{l,t}) w_t h_t e_t + (1 - \tau_{k,t}) r_t k_t + \zeta_t, \quad (2) \]

- **Capital law of motion**
  \[ (1 + n_t) k_{t+1} = i_t + (1 - \delta) k_t, \quad (3) \]
Model
Household Problem

- Weekly leisure of the workers ($e_t$)

\[
leisure_t = \psi \ln(rest_t) + (1 - \psi) \ln(weekend_t)
\]

where

\[
rest_t = (\bar{\omega} - \omega_t) \times workweek_t
\]

\[
weekend_t = \bar{\omega} \times (7 - workweek_t)
\]

therefore

\[
leisure_t = \psi \ln(\bar{h}_t - h_t) + (1 - \psi) \ln(\bar{\omega} \times (7 - workweek_t))
\]

where

\[
\bar{h}_t = \bar{\omega} \times workweek_t, h_t = \omega_t \times workweek_t
\]

- weekend is exogenous and does not affect choices (due to seperability)
Model
Firm Problem

- **Production**

\[ Y_t = A_t K_t^\theta (h_t e_t N_t)^{1-\theta}, \]

so

\[ \pi_t N_t = Y_t - w_t h_t e_t N_t - r_t K_t, \]

or in per family terms

\[ \pi_t = y_t - w_t h_t e_t - r_t k_t. \]
Government budget constraint

\[ G_t = \tau_{l,t} w_t h_t e_t N_t + \tau_{k,t} r_t K_t - \zeta_t N_t. \]  \hspace{1cm} (4)

where assume

\[ G_t = g_t Y_t. \]

so that

\[ (1 - g_t) y_t = c_t + i_t \]  \hspace{1cm} (5)
Equilibrium conditions

\[
\frac{\Psi}{c_t} = \mu_t \\
\frac{1 - \Psi}{h_t - h_t} = \mu_t (1 - \tau_{l,t}) w_t \\
(1 + n_t) \mu_t = \beta \mu_{t+1} \{(1 - \tau_{k,t+1}) r_{t+1} + 1 - \delta\} \\
r_t = \theta \frac{y_t}{k_t} \\
w_t = (1 - \theta) \frac{y_t}{h_t e_t} \\
(1 + n_t) k_{t+1} = i_t + (1 - \delta) k_t, \\
y_t = A_t k_t^\theta (h_t e_t)^{1-\theta} \\
(1 - g_t) y_t = c_t + i_t
\]
Quantitative Analysis
Algorithm

- **Shooting algorithm**
  - 8 variables \(\{k_{t+1}, \mu_t, h_t, y_t, c_t, i_t, r_t, w_t\}\), 8 equilibrium conditions for 1975-2014
  - specify initial and terminal conditions
    - initial capital = data in 1975
    - terminal capital = steady state capital given constant productivity growth, taxes etc. after terminal period
  - search for the trajectory of capital that satisfies all equilibrium conditions and the terminal condition
## Table 7. Parameter Values

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \theta )</td>
<td>Capital Income Share</td>
</tr>
<tr>
<td>( \beta )</td>
<td>Subjective Discount Factor</td>
</tr>
<tr>
<td>( \delta )</td>
<td>Capital Depreciation Rate</td>
</tr>
<tr>
<td>( \Psi )</td>
<td>Preference Weight</td>
</tr>
</tbody>
</table>
Figure: Simulated Variables: Benchmark
Quantitative Analysis

Counterfactual Simulation: Constant Demographics

Figure: Simulated Variables: No Demographic Transition
Quantitative Analysis
Counterfactual Simulation: Constant Productivity

Figure: Simulated Variables: Constant Productivity
Quantitative Analysis

Counterfactual Simulation: Constant Fiscal Policy

Figure: Simulated Variables: Constant Fiscal Policy
Quantitative Analysis

Counterfactual Simulation: Constant Workweek

Figure: Simulated Variables: Constant Workweek
Quantitative Analysis

Summary

- Productivity growth is by far the most important driver of growth
- Population aging increases hours worked but reduces total labor and hence output by 8.4%
- Population shrinking reduced capital dilution and increased output by 5.9%
- Government consumption increased output by 3.9%
- Labor income tax reduced output by 8.1%
- Workweek shortening reduced output by 9.6%
Figure: Structural Change Data
• Representative household consumes goods and services
  • old relatively prefers services more than young
  • government subsidizes service consumption

• Firm produces goods and services

• Government taxes the household by labor and capital income tax and lumpsum tax and subsidizes service consumption
Consumption

\[ c_{y,t} = \left( \omega_y \frac{\varepsilon - 1}{\varepsilon} c_{yg,t} + (1 - \omega_y) \frac{\varepsilon - 1}{\varepsilon} c_{ys,t} \right)^{\frac{\varepsilon}{\varepsilon - 1}}, \]

\[ c_{o,t} = \left( \omega_o \frac{\varepsilon - 1}{\varepsilon} c_{og,t} + (1 - \omega_o) \frac{\varepsilon - 1}{\varepsilon} c_{os,t} \right)^{\frac{\varepsilon}{\varepsilon - 1}}, \]

Budget constraint

\[ \eta_t (c_{yg,t} + (1 - s_y)p_t c_{ys,t}) + (1 - \eta_t) (c_{og,t} + (1 - s_o)p_t c_{os,t}) + i_t \]
\[ = (1 - \tau_{l,t}) w_t h_t e_t + (1 - \tau_{k,t}) r_t k_t + \zeta_t, \]
• Production

\[ y_{g,t} = A_{g,t} k_{g,t}^\theta (h_{g,t} e_{g,t})^{1-\theta}, \]
\[ y_{s,t} = A_{s,t} k_{s,t}^\theta (h_{s,t} e_{s,t})^{1-\theta}. \]

• Relative price of services

\[ p_t = \frac{A_{g,t}}{A_{s,t}}. \]
Government budget constraint

\[ G_t = S_t + \tilde{G}_t \]
\[ = \tau_{l,t} w_t h_t e_t N_t + \tau_{k,t} r_t K_t - \zeta_t N_t. \]

where

\[ S_t = \eta_t s_y p_t c_{ys,t} + (1 - \eta_t) s_o p_t c_{os,t}. \]
Table 8. Parameter Values II

<table>
<thead>
<tr>
<th>( \varepsilon )</th>
<th>Consumption Elasticity</th>
<th>0.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \omega_y )</td>
<td>Preference Weight Young</td>
<td>0.55</td>
</tr>
<tr>
<td>( \omega_o )</td>
<td>Preference Weight Old</td>
<td>0.2</td>
</tr>
<tr>
<td>( s_y )</td>
<td>Subsidy Rate Young</td>
<td>0.1</td>
</tr>
<tr>
<td>( s_o )</td>
<td>Subsidy Rate Old</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Population Aging and Structural Transformation
Quantitative Exercise

- Nominal expenditure share

\[ \frac{p_t c_{s,t}}{c_{g,t}} = \frac{\left( \eta_t \frac{1-s_o}{1-s_y} \frac{\omega_o}{\omega_y} \left( \left( 1 - s_o \right) p_t \right)^{\varepsilon-1} + 1 + 1 - \eta_t \right)}{\left( \eta_t \frac{1+\frac{1-\omega_o}{\omega_o} \left( \left( 1 - s_o \right) p_t \right)^{1-\varepsilon}}{1+\frac{1-\omega_y}{\omega_y} \left( \left( 1 - s_y \right) p_t \right)^{1-\varepsilon} + 1 - \eta_t \right)} \frac{p_t}{\left( \frac{\omega_o}{1-\omega_o} \left( \left( 1 - s_o \right) p_t \right)^{\varepsilon} \right)}. \]

where \( p_t \) and \( \eta_t \) from data
Subsidy share of government consumption

\[ \phi_t = \frac{S_t}{C_t} \times \frac{C_t}{G_t} \]

where

\[ \frac{S_t}{C_t} = \eta_t \frac{s_y}{1 - s_y} \frac{1}{1 + \frac{\omega_y}{1 - \omega_y} ((1 - s_y)p_t)^{1-1}} \]

\[ + (1 - \eta_t) \frac{s_o}{1 - s_o} \frac{1}{1 + \frac{\omega_o}{1 - \omega_o} ((1 - s_o)p_t)^{1-1}}. \]

and \( \frac{C_t}{G_t} \) from data
Population Aging and Structural Transformation
Quantitative Exercise

Figure: Structural Change Simulation
Conclusion

- A parsimoneous model can capture the effects of demographics, government policy and productivity

- Population aging harms growth through
  - decline in labor participation
  - increase in social security tax burden

- Population aging contributes to structural transformation by
  - increasing the share of services relative to goods
  - increase in government expenditure
Extensions

- OLG?: intertemporal inequality
- Non-separable utility?: intratemporal inequality
- Variable employment rate?: should amplify the result
- Population aging and productivity?: endogenous growth?