Population Aging, Government Policy and the Postwar Japanese Economy

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- 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?

Introduction

Postwar Japanese Growth

Figure: Real GDP per adult

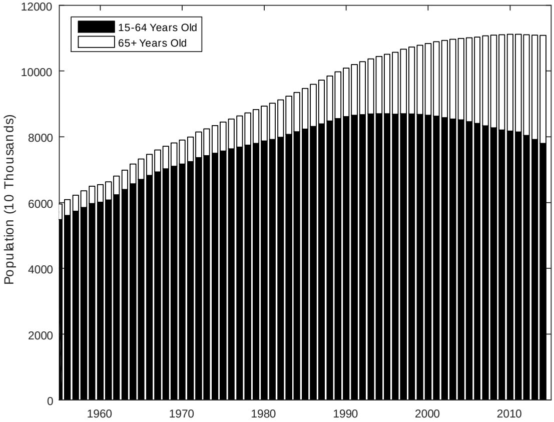

Figure: Population Share 1955-2014

Introduction

Related Studies

- Neoclassical model for postwar Japanese growth
  - Christiano (1989), King and Rebelo (1993): capital destruction and subsistence consumption
  - Hayashi and Prescott (2002), Chen, Imrohoruglu and Imrohoroglu (2006): productivity growth
- Demographic effects on Japanese output
  - Chen, Imrohoruglu and Imrohoroglu (2007), Braun, Ikeda and Joines (2009), Yamada (2012): productivity dominates demographic effects in OLG
- Labor decline
  - Hayashi and Prescott (2002), Yamada (2012): cut in the workweek during the lost decade
  - 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
    - government distortions

The Postwar Japanese Economy

Demographic, Productiviy and Government Variables

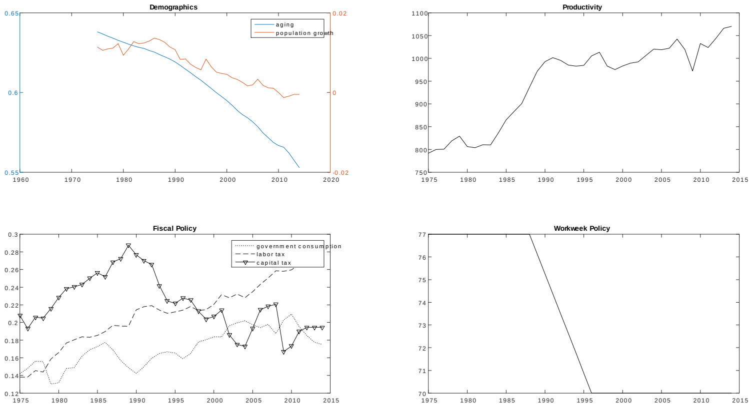

Figure: Exogenous Variables

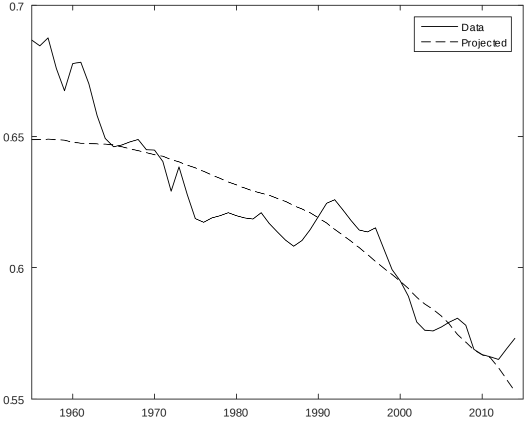

Figure: Aging Effect on Employment Share

- Representative household consists of young and old adults (no kids)
  - a fraction η_t are young and have high employment rate π_y
  - a fraction $1 - \eta_t$ are old and have low employment rate π_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

- Preferences

$$U = \max \sum_t \beta^t \left[\Psi \ln c_t + e_t (1 - \Psi) \ln \left(\overline{h_t} - h_t \right) \right], \tag{1}$$

where

$$e_t = \eta_t \pi_y + (1 - \eta_t) \pi_o$$

- Budget constraint

$$c_t + i_t = (1 - \tau_{l,t}) w_t h_t e_t + (1 - \tau_{k,t}) r_t k_t + \zeta_t, \tag{2}$$

- Capital law of motion

$$(1 + n_t) k_{t+1} = i_t + (1 - \delta) k_t, \tag{3}$$

- Weekly leisure of the workers (e_t)

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

where

$$\begin{aligned} rest_t &= (\overline{\omega} - \omega_t) \times workweek_t \\ weekend_t &= \overline{\omega} \times (7 - workweek_t) \end{aligned}$$

therefore

$$leisure_t = \psi \ln\left(\overline{h_t} - h_t\right) + (1-\psi)\ln\left(\overline{\omega} \times (7 - workweek_t)\right)$$

where

$$\overline{h_t} = \overline{\omega} \times workweek_t, h_t = \omega_t \times workweek_t$$

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

Model

Firm Problem

- Production

$$Y_t = A_t K_t^{\theta} \left(h_t e_t N_t \right)^{1-\theta},$$

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

$$G_t = \tau_{l,t} w_t h_t e_t N_t + \tau_{k,t} r_t K_t - \zeta_t N_t. \tag{4}$$

where assume

$$G_t = g_t Y_t.$$

so that

$$(1 - g_t) y_t = c_t + i_t \tag{5}$$

- Equilibirum conditions

$$
\begin{aligned}
\frac{\Psi}{c_t} &= \mu_t \\
\frac{1-\Psi}{\overline{h_t}-h_t} &= \mu_t(1-\tau_{l,t})w_t \\
(1+n_t)\mu_t &= \beta\mu_{t+1}\left\{(1-\tau_{k,t+1})r_{t+1}+1-\delta\right\} \\
r_t &= \theta\frac{y_t}{k_t} \\
w_t &= (1-\theta)\frac{y_t}{h_t e_t} \\
(1+n_t)k_{t+1} &= i_t+(1-\delta)k_t, \\
y_t &= A_t k_t^{\theta}\left(h_t e_t\right)^{1-\theta} \\
(1-g_t)y_t &= c_t+i_t
\end{aligned}
$$

- Shooting algorithm
  - 8 variables $\{k_{t+1}, \mu_t, h_t, y_t, c_t, i_t, r_t, w_t\}$,8 equilibirum 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 tragectory of capital that satisfies all equilibirum conditions and the terminal condition

Table 7. Parameter Values

θ	Capital Income Share	0.404
β	Subjective Discount Factor	0.956
δ	Capital Depreciation Rate	0.088
Ψ	Preference Weight	0.494

Quantitative Analysis
Benchmark Simulation

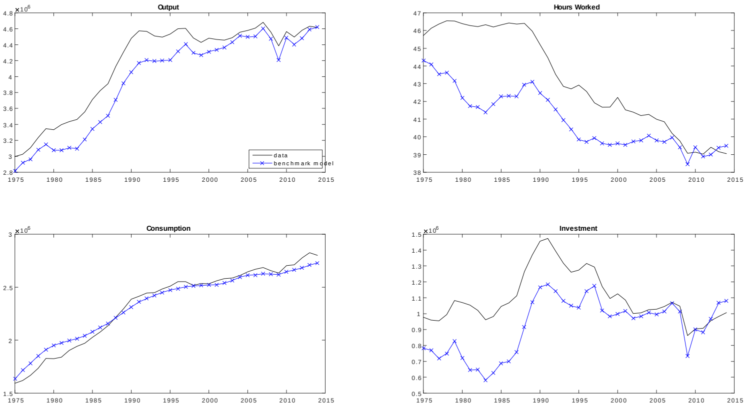

Figure: Simulated Variables: Benchmark

Quantitative Analysis

Counterfactual Simulation: Constant Demographics

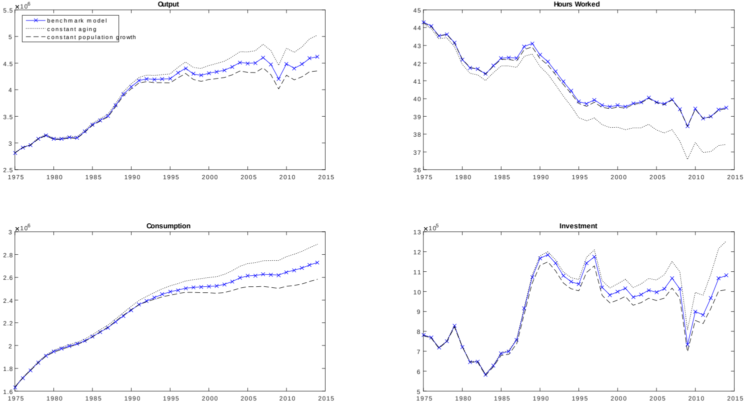

Figure: Simulated Variables: No Demographic Transition

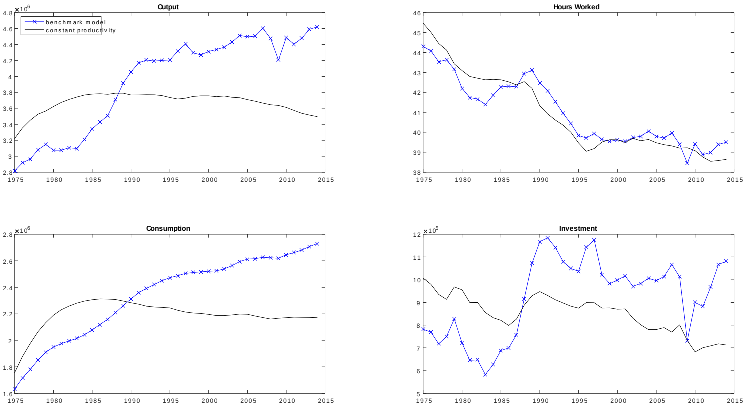

Figure: Simulated Variables: Constant Productivity

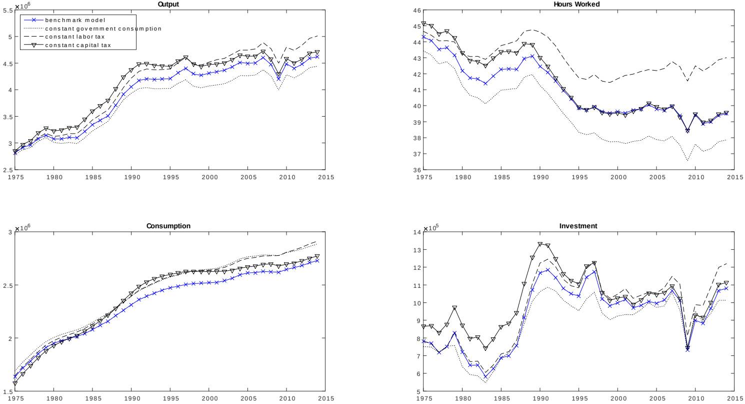

Figure: Simulated Variables: Constant Fiscal Policy

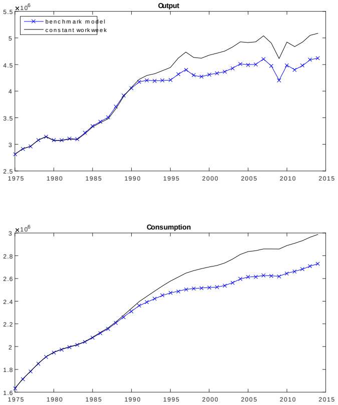

Figure: Simulated Variables: Constant Workweek

- 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 otuput by 3.9%
- Labor income tax reduced output by 8.1%
- Workweek shortening reduced output by 9.6%

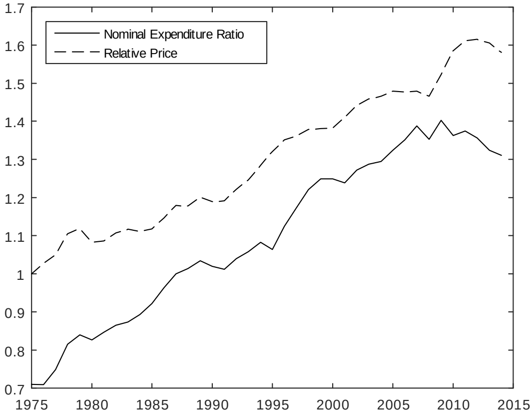

Figure: Structural Change Data

- 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 subsidezes service consumption

- Consumption

$$
\begin{aligned}
c_{y,t} &= \left(\omega_y^{\frac{1}{\varepsilon}} c_{yg,t}^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega_y)^{\frac{1}{\varepsilon}} c_{ys,t}^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}}, \\
c_{o,t} &= \left(\omega_o^{\frac{1}{\varepsilon}} c_{og,t}^{\frac{\varepsilon-1}{\varepsilon}} + (1-\omega_o)^{\frac{1}{\varepsilon}} c_{os,t}^{\frac{\varepsilon-1}{\varepsilon}}\right)^{\frac{\varepsilon}{\varepsilon-1}},
\end{aligned}
$$

- Budget constraint

$$
\begin{aligned}
& \eta_t(c_{yg,t} + (1-s_y)p_t c_{ys,t}) + (1-\eta_t)(c_{og,t} + (1-s_o)p_t c_{os,t}) + i_t \\
= \; & (1-\tau_{l,t})\, w_t h_t e_t + (1-\tau_{k,t})\, r_t k_t + \zeta_t,
\end{aligned}
$$

- Production

$$
\begin{aligned}
y_{g,t} &= A_{g,t} k_{g,t}^{\theta} \left(h_{g,t} e_{g,t} \right)^{1-\theta}, \\
y_{s,t} &= A_{s,t} k_{s,t}^{\theta} \left(h_{s,t} e_{s,t} \right)^{1-\theta}.
\end{aligned}
$$

- Relative price of services

$$
p_t = \frac{A_{g,t}}{A_{s,t}}.
$$

- Government budget constraint

$$\begin{aligned} G_t &= S_t + \widetilde{G_t} \\ &= \tau_{l,t} w_t h_t e_t N_t + \tau_{k,t} r_t K_t - \zeta_t N_t . \end{aligned}$$

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

ε	Consumption Elasticity	0.3
ω_y	Preference Weight Young	0.55
ω_o	Preference Weight Old	0.2
s_y	Subsidy Rate Young	0.1
s_o	Subsidy Rate Old	0.25

- Nominal expenditure share

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

where p_t and η_t from data

- Subsidy share of government consumption

$$\phi_t = \frac{S_t}{C_t} \times \frac{C_t}{G_t}$$

where

$$\begin{aligned} \frac{S_t}{C_t} &= \eta_t \frac{s_y}{1-s_y} \frac{1}{1+\frac{\omega_y}{1-\omega_y}\left((1-s_y)p_t\right)^{\varepsilon-1}} \\ &\quad +(1-\eta_t)\frac{s_o}{1-s_o}\frac{1}{1+\frac{\omega_o}{1-\omega_o}\left((1-s_o)p_t\right)^{\varepsilon-1}}. \end{aligned}$$

and $\frac{C_t}{G_t}$ from data

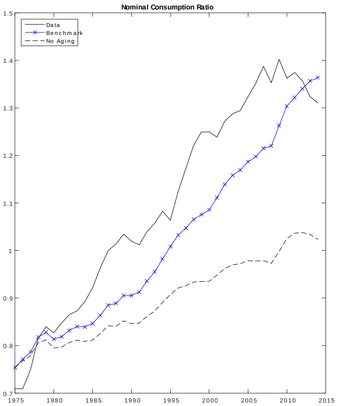

Figure: Structural Change Simulation

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?