Fiscal Reform, Government Debt and Female Labor Supply in Japan

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Motivation

Fiscal sustainability in Japan

- High debt-output ratio and sharply raised
- Low female labor participation

Female labor participation $\Rightarrow$ Debt-output ratio

Increasing in female labor force can improve fiscal burden or not?

Data of Japanese Debt-Output Ratio

- Highest debt to output ratio among developed economies

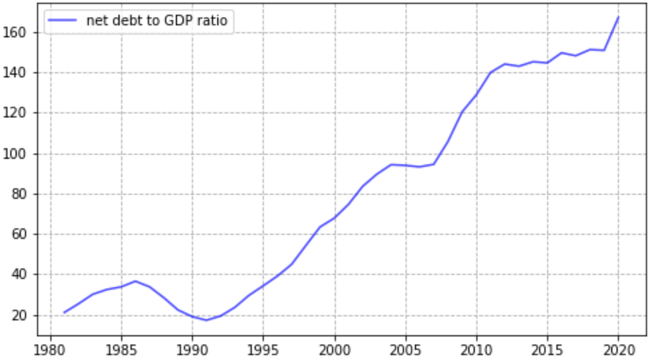


Figure 1: net debt to output ratio (%) (Japanese data)[4]

[4]IMF—World Economic Outlook Databases: October, 2021

Government Expenditure and Transfer

- Debt to output ratio is expected to continue to rise

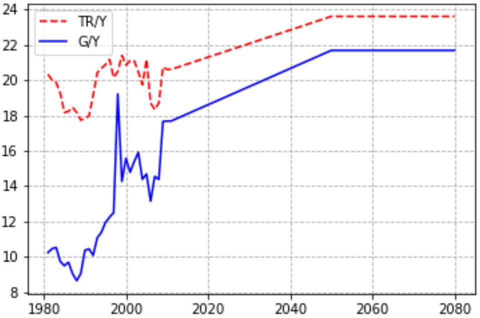


Figure 2: Government expenditure, transfer to output ratios (Fukawa and Sato, 2009)

Data of Market Labor Participation

- Still has a lot of room for female labor force participation to improve.

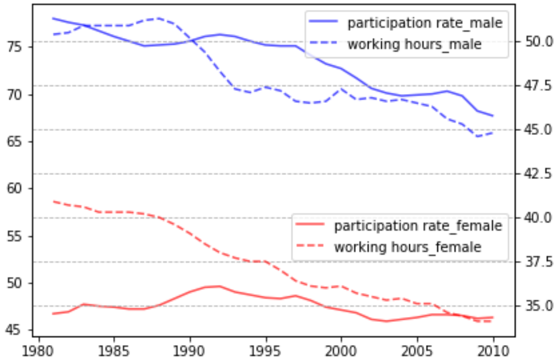


Figure 3: Participation rate (%) and Weekly working hours [5]

[5] Data from Labor Force Survey, Statistics Bureau of Japan,1981-2010

Literature

Female employment and business cycle recoveries

- Fukui, Nakamura and Steinsson (2021): A general equilibrium model of the female convergence process
    - 60-75% of the slowdown in recent business cycle recoveries can be explained by female convergence.

Female labor and structure change

- Ngai and Petrongolo (2017): A multi-sector model and quantitative analysis with American data
    - The rise of services share raises women's relative wage and market time.

Literature (Cont.)

The effect of female labor and fiscal policy on government debt

- Imrohoroglu, Kitao, and Yamada (2016) : Micro data based, large scale overlapping model
  - Net government debt to output ratio is projected to 477.1% in 2060.
  - Higher participation and share of regular employment of female labor force decrease this ratio to 281.2%
- Kitao and Mikoshiba (2020): General equilibrium model of overlapping generations
  - With the JILPT projections of female labor participation and convergence of employment type and efficiency to males', the necessary consumption tax rate decrease by 3.3% in 2045.

Literature (Cont.)

Government fiscal burden in Japan

- Hansen and Imrohoroglu (2016): To stabilize Japanese government debt once the debt to output ratio reaches 250%
  - 250% $\rightarrow$ policy $\rightarrow$ 60%
    $\Downarrow$
    consumption tax and labor income tax:40%-60%

What we do?

Existing literatures

- Exogenously increasing female labor supply

Our model

- Endogenously determined labor choice for females and males
- Home production produced by housework time inputs

Results

- To stabilize government debt to output ratio, the consumption tax rate need to increase to extremely high level. The increase in female labor participation can lower the tax rate required.

Setup

A representitive household

- Infinitely lived with two individuals, female and male
- A home-production sector input female and male labor

A representative firm

- Produce one final goods by capital and labor
- Investable consumption goods

Government

- Collects taxes from consumption, wage and capital income and the interest of bond
- Fiscal policy target in long run: bond-output ratio converge to 60%

Preference and Budget Constraints

Utility function

$$U = \sum_{t=0}^{\infty} \beta^t [\log C_t^M + \alpha \log C_t^H + \phi log(\mu_t + B_{t+1})] \tag{1}$$

- Bond in utility B_{t+1}: based on the Japanese bond demand.

Budget constraints

$$\begin{aligned}(K_{t+1} - K_t) + q_t B_{t+1} = & \underbrace{(1-\tau_{k,t})(r_t - \delta)K_t}_{\text{Capital income}} + \underbrace{[1-(1-q_{t-1})\tau_{b,t}]B_t}_{\text{Bond income}} + \tilde{\Lambda}_t \\ & + \underbrace{(1-\tau_{l,t})(W_t^m l_t^m + W_t^f l_t^f)}_{\text{Wage income}} - (1+\tau_{c,t})C_t^M\end{aligned} \tag{2}$$

- C_t^M, C_t^H: market goods / home production consumption
- l_t^m, l_t^f: male / female labor supply
- $\tilde{\Lambda}_t$: transfer payments received
- B_{t+1}: one-period discount bonds purchased

Home Production

Market and housework time

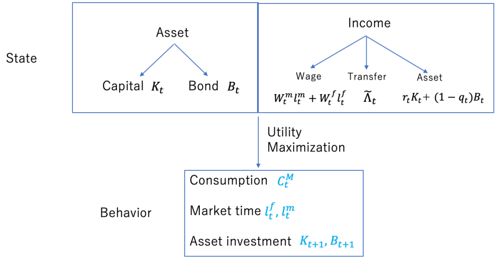
$$l_t^f + h_t^f = 1, \qquad l_t^m + h_t^m = 1 \tag{3}$$

Home production

$$C_t^H = \left[\varepsilon_H (h_t^f)^{\frac{\sigma_H - 1}{\sigma_H}} + (1 - \varepsilon_H)(h_t^m)^{\frac{\sigma_H - 1}{\sigma_H}}\right]^{\frac{\sigma_H}{\sigma_H - 1}} \tag{4}$$

- h_t^m, h_t^f: male / female housework time
- σ_H: elasticity of substitution for housework
- ε_H: weight for female housework time in home production

Utility Maximization



$$V(K_t, B_t) = \max_{\{C_t^M, l_t^f, l_t^m, K_{t+1}, B_{t+1}\}} \log C_t^M + \alpha \log C_t^H + \phi \log(\mu_t + B_{t+1}) + \beta V(K_{t+1}, B_{t+1})$$

subject to

$$\begin{aligned} K_{t+1} - K_t = {} & (1 - \tau_{k,t})(r_t - \delta) K_t + [1 - (1 - q_{t-1}) \tau_{b,t}] B_t + \tilde{\Lambda}_t \\ & + (1 - \tau_{l,t})(W_t^m l_t^m + W_t^f l_t^f) - q_t B_{t+1} - (1 + \tau_{c,t}) C_t^M \end{aligned}$$

Market Goods

Production function

$$Y_t = A_t K_t^{\theta} L_t^{1-\theta} \tag{5}$$

where

$$L_t = \left[\varepsilon_F (l_t^f)^{\frac{\sigma_F - 1}{\sigma_F}} + (1-\varepsilon_F)(l_t^m)^{\frac{\sigma_F - 1}{\sigma_F}}\right]^{\frac{\sigma_F}{\sigma_F - 1}} \tag{6}$$

Total factor productivity

$$A_{t+1} = \gamma_t A_t$$

- γ_t: Technology growth rate at time t

Profit Maximization

Optimal factor demand

$$r_t = \theta A_t K_t^{\theta} (L_t)^{1-\theta} \tag{7}$$

$$W_t^m = (1-\theta) A_t K_t^{\theta} (L_t)^{\frac{1-\theta\sigma_F}{\sigma_F}} \left[(1-\varepsilon_F)(l_t^m)^{-\frac{1}{\sigma_F}} \right] \tag{8}$$

$$W_t^f = (1-\theta) A_t K_t^{\theta} (L_t)^{\frac{1-\theta\sigma_F}{\sigma_F}} \left[\varepsilon_F (l_t^f)^{-\frac{1}{\sigma_F}} \right] \tag{9}$$

Government Budget Constraints

$$G_t + \tilde{\Lambda}_t + B_t = q_t B_{t+1} + \tau_{c,t} C_t^M + \tau_{l,t}(W_t^m l_t^m + W_t^f l_t^f) + \tau_{k,t}(r_t - \delta)K_t + \tau_{b,t}(1 - q_{t-1})B_t \quad (10)$$

- G_t: government expenditure
- $\tilde{\Lambda}_t$: transfer payment
- $W_t^i, i = m, f$: wage rate for females and males
- $l_t^i, i = m, f$: market time for females and males
- B_{t+1}: one period discount government bonds

Debt Sustainability

Government debt

- Borrowing exogeneously determined
- Increasing with no constraint

Debt sustainability rule

- Borrowing constraint

  $\rightarrow$ Upper boundary of bond-output ratio B/Y: 250%

$\Downarrow$ Policy

- Target

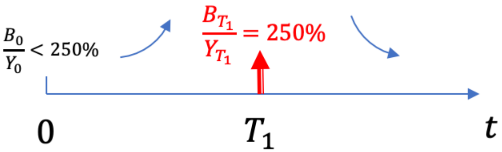
  $\rightarrow$ Bond-output ratio B/Y converge to 60%

Fiscal policies

- Reduce transfer payments (e.g. pensions)
- Increase consumption tax rate
  (+ exogenously increased female labor)

$$G_t + \underbrace{\tilde{\Lambda}_t}_{\Lambda_t} + B_t = q_t B_{t+1} + \tau_{c,t} C_t^M + \tau_{l,t}(W_t^m l_t^m + W_t^f l_t^f) + \tau_{k,t}(r_t - \delta)K_t + \tau_{b,t}(1 - q_{t-1})B_t \tag{11}$$

Reduce Transfer Payments



$$\tilde{\Lambda}_t = \Lambda_t - D_t \tag{12}$$

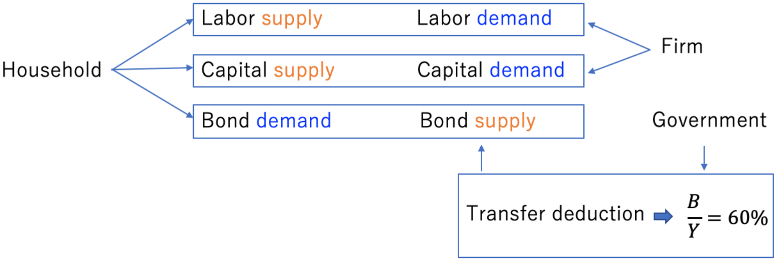
where

$$D_t = \begin{cases} \kappa(B_t - B) & \text{if} \quad t \geq T_1 \\ 0 & \text{otherwise} \end{cases} \tag{13}$$

B is the steady state value of bond when target achieved and $B = 0.6 \cdot Y$

Equilibrium

Given the initial value of k and a sequence $\{\tau_{c,t}, \tau_{l,t}, \tau_{b,t}, \tau_{k,t}, \gamma_t, g_t, \lambda_t\}$, we use the a shooting algorithm to determine the value of c^M and the sequence of endogenous variables $\{c_t^M, l_t^f, l_t^m, y_t, k_{t+1}, b_{t+1}, d_t, q_t, w_t^f, w_t^m, r_t\}$ satisfies



Goods market $$\underbrace{Y_t}_{} = \underbrace{C_t^M + K_{t+1} - K_t}_{\text{Household}} + \underbrace{G_t}_{\text{Government}}$$

Structural parameters

General parameter

Parameter	Description	Value	How to calculate[6]
β	Time preference	0.9677	Equilibrium condition, sample average
ϕ	Relative weight of bond in utility	0.0311	Equilibrium condition, sample average
μ	Preference parameter	0.4	Match bond price data
α	Relative weight of home goods in utility	1.3896	Equilibrium condition, sample average

Female related parameters

Parameter	Description	Value	
σ_H	Elasiticity of substitution in home sector	0.6543	Equilibrium condition
σ_F	Elasiticity of substitution in market sector	1.1426	Equilibrium condition
ε_H	Weight of female in home-production	0.5014	Equilibrium condition
ε_F	Weight of female in market-production in long-run	0.2881	Equilibrium condition

[6]Sample average time period from 1981 to 2010, data from Hansen and Imrohoroglu (2016)

General parameter

$$U = \sum_{t=0}^{\infty} \beta^t [\log C_t^M + \alpha \log C_t^H + \phi log(\mu + B_{t+1})]$$

- β: time preference
- α: relative weight of home goods in utility
- ϕ: relative weight of bond in utility

$$\beta = \frac{(1+\tau_{c,t+1})\gamma_t^{1/(1-\theta)} c_{t+1}^M}{(1+\tau_{c,t}) c_t^M [1 + (1-\tau_{k,t+1})(\theta \frac{y_{t+1}}{k_{t+1}}) - \delta]},$$

$$\alpha = \frac{(1-\theta)(1-\varepsilon_F)(1-\tau_{l,t})(h_t^m)^{\frac{1}{\sigma_H}} (L_t)^{\frac{1-\sigma_F}{\sigma_F}}}{(1-\varepsilon_H)(1+\tau_{c,t})(c_t^M/y_t)(l_t^m)^{\frac{1}{\sigma_F}} (C_t^H)^{\frac{1-\sigma_H}{\sigma_H}}},$$

$$\phi = (\mu + b_{t+1}) \left(\frac{q_t \gamma_t^{1/(1-\theta)}}{\beta(1+\tau_{c,t}) c_t^M} - \frac{\beta[1-(1-q_t)\tau_{b,t+1}]}{(1+\tau_{c,t+1}) c_{t+1}^M} \right).$$

Female Related Parameters

- σ_H: elasiticity of substitution in home production
- σ_F: elasiticity of substitution in market goods production
- ε_H: female labor share in home sector
- ε_F: female labor share in market sector

$$C_t^H = \left[\varepsilon_H (h_t^f)^{\frac{\sigma_H - 1}{\sigma_H}} + (1 - \varepsilon_H)(h_t^m)^{\frac{\sigma_H - 1}{\sigma_H}}\right]^{\frac{\sigma_H}{\sigma_H - 1}}$$

$$L_t = \left[\varepsilon_F (l_t^f)^{\frac{\sigma_F - 1}{\sigma_F}} + (1 - \varepsilon_F)(l_t^m)^{\frac{\sigma_F - 1}{\sigma_F}}\right]^{\frac{\sigma_F}{\sigma_F - 1}}$$

Data: working and wage

Market time[7]

$$(\text{Working age})\frac{\text{Employment}}{\text{Population}} \times \frac{\text{Average weekly working hours}}{\text{Total weekly available hours } (14\text{hours} \times 7\text{days})} \tag{14}$$

Wage ratio[8]

$$\frac{\text{Average monthly wage}}{\text{Average weekly working hours} \times 4} \tag{15}$$

[7] Statistical Survey Department, Statistics Bureau, Ministry of Internal Affairs and Communications 1981-2010.

[8] Statistics and Information Department, Minister's Secretariat, Ministry of Health, Labour and Welfare 1985-2010, five years intervals.

Determination of Parameter ε_H

Optimal housework time

$$h_t^f = \left[\frac{\alpha \varepsilon_H (1+\tau_{c,t}) c_t^M (C_t^H)^{\frac{1-\sigma_H}{\sigma_H}}}{(1-\tau_{l,t}) w_t^f} \right]^{\sigma_H} \tag{16}$$

$$h_t^m = \left[\frac{\alpha (1-\varepsilon_H)(1+\tau_{c,t}) c_t^M (C_t^H)^{\frac{1-\sigma_H}{\sigma_H}}}{(1-\tau_{l,t}) w_t^m} \right]^{\sigma_H} \tag{17}$$

Relative to female housework time

$$\frac{h_t^m}{h_t^f} = \left(\frac{\varepsilon_H}{1-\varepsilon_H} \frac{w_t^m}{w_t^f} \right)^{\sigma_H} \tag{18}$$

Determination of Parameters ε_H (Cont.)

σ_H: Time difference in 1995-2000, 1995-2005, 1995-2010, 2000-2005, 2000-2010 with Eqs. (18)

$$\sigma_H = \frac{\ln \frac{h_T^m}{h_T^f} - \ln \frac{h_0^m}{h_0^f}}{\ln \frac{w_T^f}{w_T^m} - \ln \frac{w_0^f}{w_0^m}}, \quad \varepsilon_{H,t} = \frac{\left(\frac{h_t^m}{h_t^f}\right)^{-\frac{1}{\sigma_H}} \frac{w_t^f}{w_t^m}}{1 + \left(\frac{h_t^m}{h_t^f}\right)^{-\frac{1}{\sigma_H}} \frac{w_t^f}{w_t^m}} \tag{19}$$

σ_H takes the average value of these five time differences and ε_H takes the average of $\varepsilon_{H,t}$ in the sample period, $t \in [1985, 2010]$.

Determination of Parameter ε_F

Optimal market time

$$l_t^m = \left(\frac{(1-\varepsilon_F)(1-\theta)A_t K_t^{\theta} L_t^{\frac{1-\theta\sigma_F}{\sigma_F}}}{w_t^m} \right)^{\sigma_F} \tag{20}$$

$$l_t^f = \left(\frac{\varepsilon_F(1-\theta)A_t K_t^{\theta} L_t^{\frac{1-\theta\sigma_F}{\sigma_F}}}{w_t^f} \right)^{\sigma_F} \tag{21}$$

Relative to male market time

$$\frac{l_t^f}{l_t^m} = \left(\frac{\varepsilon_F}{1-\varepsilon_F} \frac{w_t^m}{w_t^f} \right)^{\sigma_F} \tag{22}$$

Determination of Parameters ε_F (Cont.)

σ_F: Time difference in initial five years 1985-1990 with (22)

$$\sigma_F = \frac{\ln \frac{l_T^f}{l_T^m} - \ln \frac{l_0^f}{l_0^m}}{\ln \frac{w_T^f}{w_T^m} - \ln \frac{w_0^f}{w_0^m}} \tag{23}$$

We takes ε_F as time varing parameter after 1990, $\varepsilon_{F,t}$ with $t \in [1990, 2010]$

$$\varepsilon_F = \frac{\left(\frac{l_t^m}{l_t^f}\right)^{-\frac{1}{\sigma_F}} \frac{w_t^f}{w_t^m}}{1 + \left(\frac{l_t^m}{l_t^f}\right)^{-\frac{1}{\sigma_F}} \frac{w_t^f}{w_t^m}} \tag{24}$$

Steady State

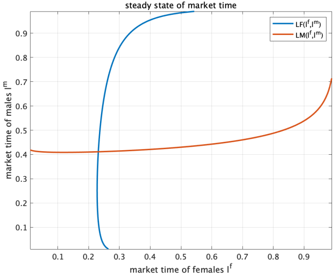


Figure 4: steady state of market time

Labor market equilibrium condition $LF(l^f, l^m)$, $LM(l^f, l^m)$, steady state value $(l^f, l^m) = (0.2204, 0.4151)$

$$LF(\bar{l}^f, \bar{l}^m) = 1 - \bar{l}^f - \bar{h}^f = 1 - \bar{l}^f - \left[\frac{\alpha(1+\tau_c)\varepsilon_H(\bar{c}^M/\bar{y})}{(1-\tau_l)\varepsilon_F(1-\theta)} \left(\frac{C^H(\bar{l}^m, \bar{l}^f)^{\frac{1-\sigma_H}{\sigma_H}}}{L(\bar{l}^m, \bar{l}^f)^{\frac{1-\sigma_F}{\sigma_F}}} \right) (\bar{l}^f)^{\frac{1}{\sigma_F}} \right]^{\sigma_H} \tag{25}$$

Data Matching: Market time

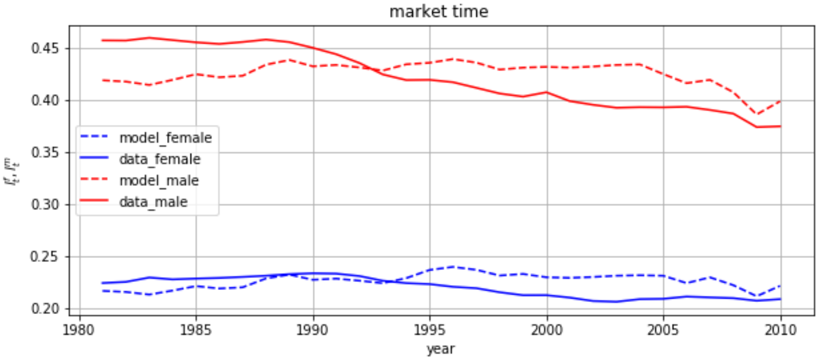
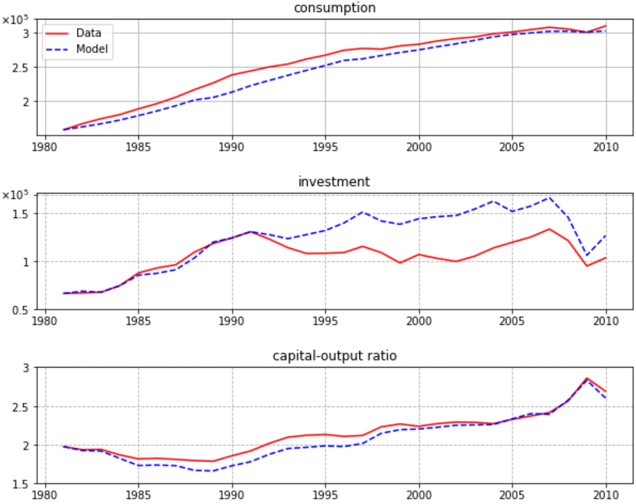
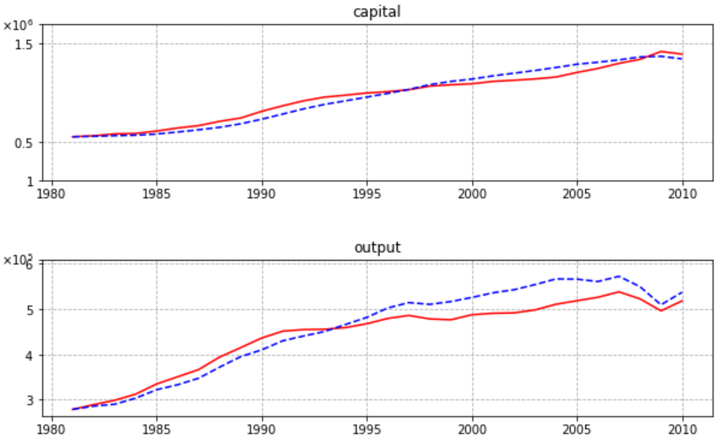


Figure 5: Market time for male and female

Data Matching: Consumptions

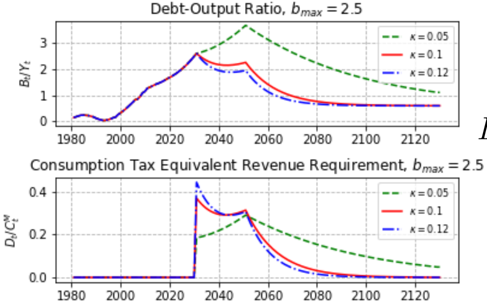


Data Matching: Outputs



Experiment: Transfer Deduction

Determination of transfer deduction κ

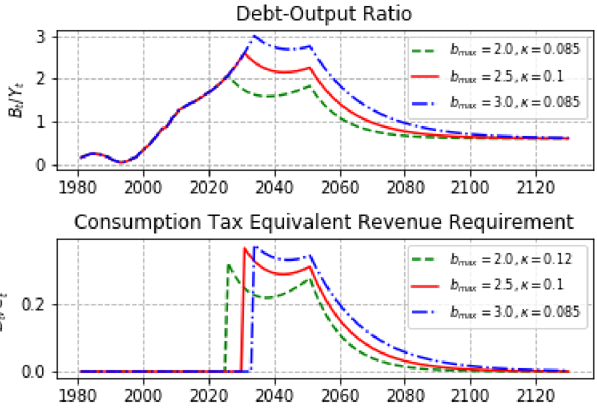


$$\tilde{\lambda}_t = \lambda_t - D_t$$

$$D_t = \begin{cases} \kappa(B_t - B) & \text{if } \; t \geq T_1 \\ 0 & \text{otherwise} \end{cases} \tag{13}$$

Experiment: Upper Boundary

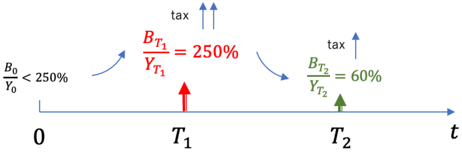
- $(\frac{B}{Y})_{\max} = 200\%, 250\%, 300\%$



Increase Consumption Tax

$$G_t + \underbrace{\tilde{\Lambda}_t}_{\Lambda_t} + B_t = q_t B_{t+1} + \tau_{c,t} C_t^M + \tau_{l,t}(W_t^m l_t^m + W_t^f l_t^f) + \tau_{k,t}(r_t - \delta)K_t + \tau_{b,t}(1 - q_{t-1})B_t \quad (26)$$

- Benchmark: Increase consumption tax rate



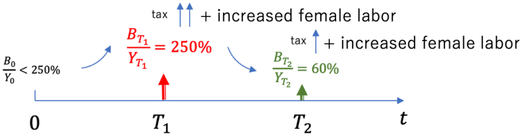
$$\tau_{c,t} = \begin{cases} \tau_{c,t} & t < T_1 \\ \bar{\tau}_c + \pi & T_1 \leq t < T_2 \\ \bar{\tau}_c & t \geq T_2 \end{cases} \quad (27)$$

$$\tilde{\Lambda}_t = \Lambda_t \quad \text{for all } t$$

Increase Female Market Time

Increase consumption tax rate

- Experiment 1: + increased female market time to A=110%, which is 57% of male's.



$$\tau_{c,t} = \begin{cases} \tau_{c,t} & t < T_1 \\ \bar{\tau}_c + \pi_i & T_1 \leq t < T_2 \\ \bar{\tau}_c & t \geq T_2 \end{cases} \tag{28}$$

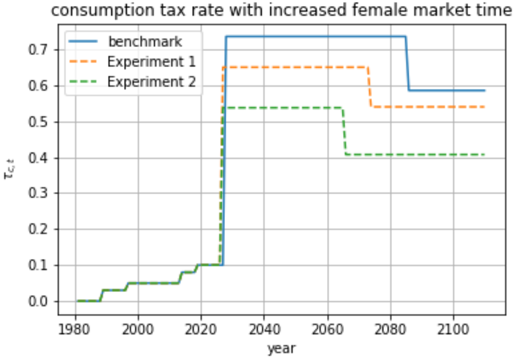
$$l_t^f = A \cdot \bar{l}^f \qquad t \geq T_1$$

- Experiment 2: + increased female market time A=150%, which is 76% of male's.

Results

- Consumption tax rate required when $T_1 \leq t \leq T_2$:
  - Benchmark
    $\tau_{c,t} = 73\%$
  - Experiment 1
    $\tau_{c,t} = 67\%$
  - Experiment 2
    $\tau_{c,t} = 54\%$
- Consumption tax rate required when $t \geq T_2$:
  - Benchmark
    $\bar{\tau}_c = 58\%$
  - Experiment 1
    $\bar{\tau}_c = 54\%$
  - Experiment 2
    $\bar{\tau}_c = 41\%$

Consumption Tax Comparation



Conclusion

In this paper we build a neoclassical growth model with endogenously determined male and female labor choice, and analyze the effects of fiscal policies under this state.

- Consistent with actual data
- Higher tax rate is required
- Exogenously increased female market time lower tax requirement

Working on progress

- Female labor stimulated policy
- Effect of change in ε_F