Aging, Social Security Reform and Factor Price in a Transition Economy

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2, December 2007

Introduction: Motivation

- Rapid aging of the population combined with the diminising number of children
  - Tax burden and intergenerational inequality
  - Source of finance
- Macroeconomic perspective:
  - GDP growth rate
  - Aggregate capital and labor
  - Factor prices (not obvious)
- Microeconomic perspective:
  - Intragenerational and intergenerational heterogeneity
  - Redistribution, insurance and distortion of social security
  - Idiosyncratic income risk

Objectives

- A *transition* path in Japan from 2000 to 2200
  - Dynamic stochastic general equilibrium
  - Stationary equilibrium and transition
  - Quantitative analysis [positive and normative]
- Heterogeneity
  - intergeneratinal
  - intra-cohort
- Four social security reforms⇒Equilibrium path and welfare
  - Reduction of the replacement rate by half
  - Full privatization
  - Finance by capital income tax
  - Finance by consumption tax

Main Results (1)

- There is more capital deepening [Benchmark]
  - The equilibrium wage increases by 6%
  - The interest rate decreases by 1.5%
  - Output per capita decreases by 20% because of the decrease in the aggregate capital and labor supply
  - Welfare measured by expected value declines for 50 years
- Reduction of the replacement rate by half moderates intergenerational inequality

Main Results (2)

- Introduction of consumption tax may not improve welfare
  - No distortion, but...
  - (i) Redistribution and insurance effect of social security decline (payroll tax)
  - (ii) Opportunity: labor supply, borrowing constraint and substitution effect
- Introducing capital income tax improves welfare of young and future generations
  - Redistribution and insurance effect

A Model

- A stochastic overlapping generations model with
  - Idiosyncratic income uncertainty
  - Intergenerational and intragenerational heterogeneity
  - Endogenous labor supply
  - Pay-as-you-go social security system and payroll tax
  - Redistribution effect of social security
  - Compute transition path

Objective Function

A contiuum of households exist.
Each household enters labor market at 20, exits at 65, faces mortality risks, can live at most 100:

$$U_t = E_{20,t}\left\{\sum_{j=20}^{J}\beta^{j-1}\left(\prod_{i=20}^{j-1}\phi_{i,t}\right)u(c_{j,t+j-20}, \bar{\ell}-\ell_{j,t+j-20})\right\}$$

- $c_{j,t+j-20}$: consumption, $\ell_{j,t+j-20}$: labor
- β : discount factor, $\phi_{i,t}$: survival probability

Budget Constraint

Employee:

$$\begin{aligned}(1+\tau_t^c)c_{j,t}+a_{j+1,t+1} &\leq y_{j,t}+(1+(1-\tau_t^a)r_t/\phi_{j,t-1})a_{j,t},\\ y_{j,t} &= (1-\tau_t^{ss})\,w_t\eta_j e_j \ell_{j,t}.\end{aligned}$$

- $a_{j,t}$: asset holding, $y_{j,t}$: labor income, τ_t : each tax
- η_j : average productivity
- r_t : interest rate, w_t : economy-wide wage
- omit uncertainty about long-living [private annuity market]

Retiree:

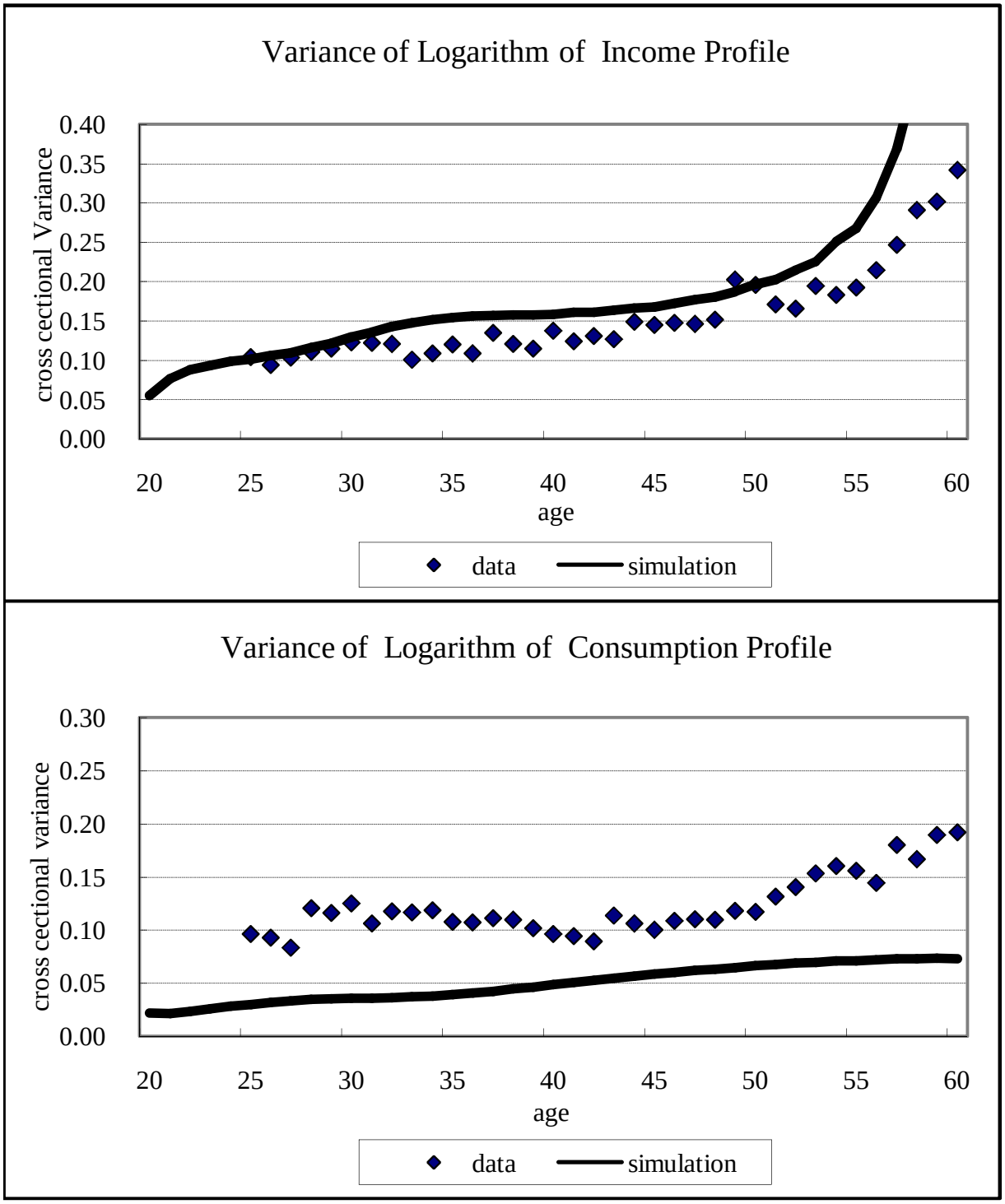
$$(1+\tau_t^c)c_{j,t}+a_{j+1,t+1} \leq w_t b(\tau_t^{ss}, W_{g,t})+(1+(1-\tau_t^a)r_t/\phi_{j,t-1})a_{j,t},$$

- $b(\tau_t^{ss}, W_{g,t})$: replacement rate, $W_{g,t}$: trust fund

Earnings Risk

- Three components of income shocks
  - Fixed effect
  - Persistent shock
  - Transitory shock
- Match the variance profile of log-earnings
  - **Figure 1**

Figure 1: Variance Profiles



Behavior of Firms

- Production function

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

- Aggregation

$$\begin{aligned} K_t &= \sum_{j=20}^{J} \mu_{j,t} \int a_{j,t} d\Phi_t (a_j, e_j) + W_{g,t}, \\ L_t &= \sum_{j=20}^{j_r} \mu_{j,t} \int \eta_j e_j \ell_{j,t} d\Phi_t (a_j, e_j). \end{aligned}$$

  - $\Phi_t(a_j, e_j)$: distribution function
  - μ_t : the population distribution in period t

- Factor prices

$$r_t = \theta A_t \left(K_t / L_t\right)^{\theta-1} - \delta, \;\; w_t = (1-\theta) A_t \left(K_t / L_t\right)^{\theta},$$

PAYG Social Security System

- The government's budget constraint

$$W_{g,t+1} = (1 + r_t) W_{g,t} + (T_t^{SS} + T_t^C + T_t^A) - B_t,$$

- Revenue and Benefits

$$\begin{aligned} T_t^{SS} &: \text{ payroll tax} \\ T_t^C &: \text{ consumption tax} \\ T_t^A &: \text{ capital income tax} \\ B_t &: \text{ social security benefit} \end{aligned}$$

Definition of Recursive Competitive Equilibrium

- Recursive Competitive Equilibrium consists of
  - Household's optimality
  - Firm's optimality
  - Market clearing
  - Government's budget
  - Transition law of motion
- *Detrend* by population growth rate and TFP growth rate

Four Policy Experiments

- A Benchmark:
  - use *medium variant* of the population projection by the National Institute of Population and Social Security Research
  - The replacement rate is targeted at 50%

1. Social security reform I: reduction of the replacement rate by half for 50 years
2. Social security reform II: (almost) full privatization for 50 years
3. The other source of finance I: capital income tax set at 30% (2001)
4. The other source of finance II: consumption tax set at 5% (2001)

Calibration: Fundamental Parameters

- Set initial stationary state in 2000
- Survival probability from Life Table (NIPSSR)
- Instantaneous utility function

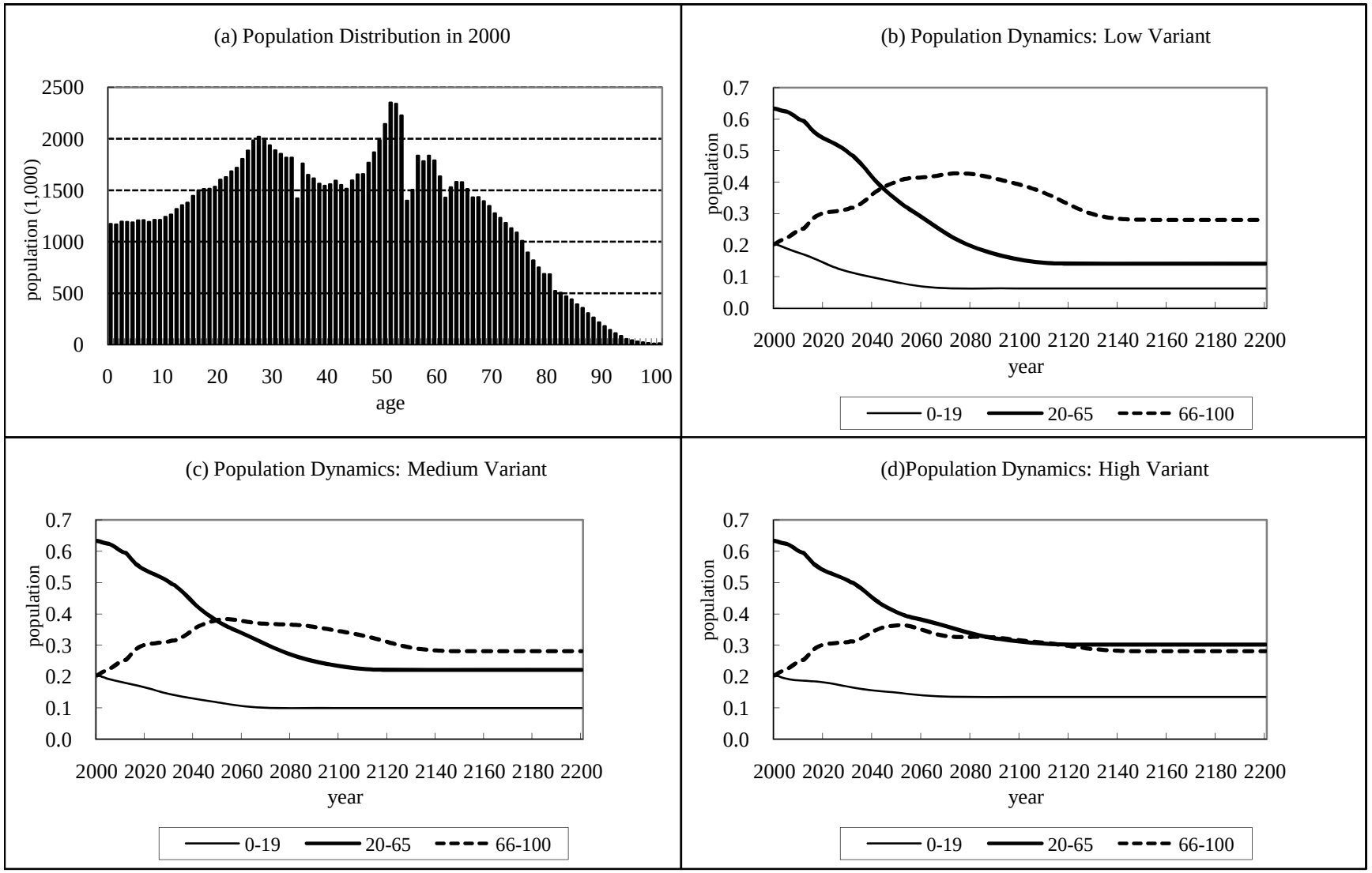
$$u\left(c_{j,t}, \bar{\ell} - \ell_{j,t}\right) = \frac{\left[c_{j,t}^{\sigma}(\bar{\ell} - \ell_{j,t})^{1-\sigma}\right]^{1-\gamma}}{1-\gamma}.$$

  - $\beta = 0.985$, $\gamma = 2$, $\sigma = 0.38$
- Replacement rate:
  - 50% of average earnings
- Production parameters
  - $\theta = 0.312$, $\delta = 0.089$, $A_{t+1}^{\frac{1}{1-\theta}} / A_t^{\frac{1}{1-\theta}} = 1.01 (\forall t)$

Demographic Structure

- We consider the transition path from 2000 to 2200.
- Use the NIPSSR(2002)'s projection
  - from 2001 to 2050
- Three variants of projection
  - Medium variant [Benchmark]
  - High variant
  - Low variant
- Converge to zero population growth (new stationary state)
  - population distribution converges to stationary state in 2160

Figure 2: Population Dynamics in Japan



Main Results: Stationary State

- Macroeconomic variables in 2000 as targets
  - $K/Y = 2.42$, $r \doteqdot 4.0\%$
- SS in 2000 $\Rightarrow$ SS in 2200
  - K/Y increases by 3.11%
  - the interest rate decreases by 39 basis points
- Benchmark $\Rightarrow$ Capital Income Tax by 30%
  - remaining payroll tax rate$\doteqdot$ 5%
  - labor supply *increases*
  - ch$(L)\neq$ch(H)
- Benchmark $\Rightarrow$ Consumption Tax by 5%
  - remaining payroll tax rate$\doteqdot$ 5%
  - labor supply *decreases*

Stationary Equilibrium (Table 3&4)

	Medium Variant	Rep. Rate		Tax Reform		Year
		25%	0.1%	cons.	cap.	2200
K/Y	2.42	2.63	3.03	2.45	2.24	2.49
ch(K/Y): %	–	8.72	25.53	1.54	-7.49	3.11
r (%)	4.01	2.97	1.38	3.81	5.05	3.62
w	1.03	1.07	1.14	1.03	0.99	1.04
τ^{ss} (%)	10.17	5.09	0.02	4.99	5.25	14.04
K/N	3.50	4.10	5.36	3.58	3.14	3.32
L/N	0.97	1.01	1.07	0.97	0.97	0.88
ch(L/N): %	–	3.78	9.97	0.09	0.52	-9.31
ch(hours): %	–	4.35	11.52	-0.04	0.74	1.31
Y/N	1.45	1.56	1.76	1.46	1.40	1.33

Stationary Equilibrium (Table 3)

	Medium Variant	Rep. Rate		Tax Reform	
		25%	0.1%	cons.	cap.
Gini (20-100)	0.596	0.590	0.583	0.605	0.611
Gini (30-65)	0.531	0.549	0.565	0.543	0.548
Gini (20s)	0.586	0.591	0.605	0.643	0.588
Gini (30s)	0.589	0.586	0.589	0.634	0.580
Gini (40s)	0.393	0.420	0.443	0.409	0.424
Gini (50s)	0.263	0.254	0.232	0.267	0.276
Gini (60s)	0.303	0.238	0.171	0.302	0.314

Closed Economy

- Welfare Criteria:

$$Ev_t(a_{20}, s_{20}) = \sum \pi(s) v_t(0, s_{20}),$$

$$EV(a_{20}, s_{20}) = \left(\frac{Ev_t^{\text{Reform}}(a_{20}, s_{20})}{Ev_t^{\text{Bench}}(a_{20}, s_{20})} \right)^{\frac{1}{\sigma(1-\gamma)}}.$$

  - Cohort's value and consumption equivalent
- Benchmark
  - The cohort's welfare decreases for the aging period of 50 years and reaches the lowest point around 2050
- Introducing capital income tax improves welfare of current young and future generations
- Introducing consumption tax does not improves welfare
- **Figure 8**

Figure 8: Welfare Comparison (Cohort at Age 20)

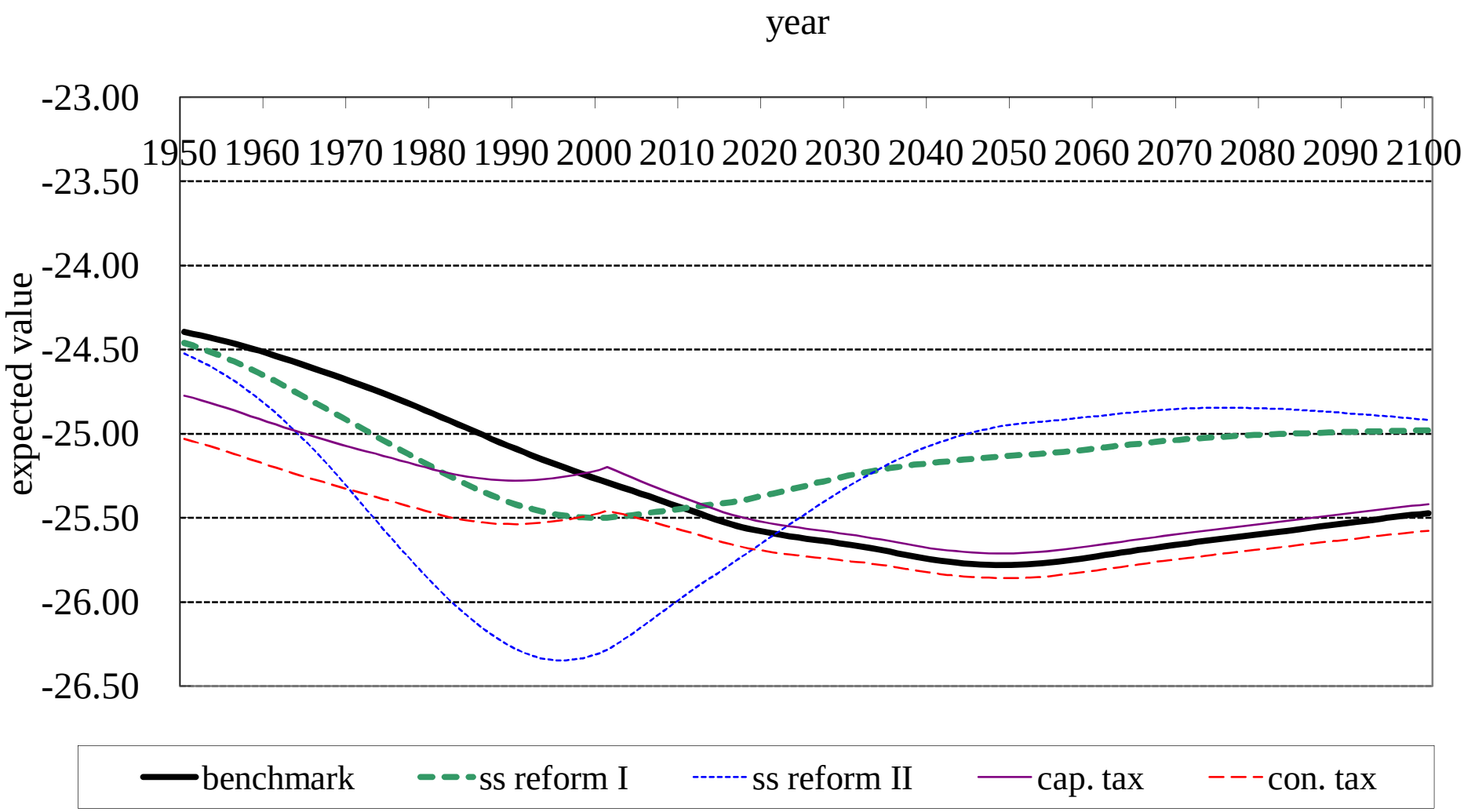
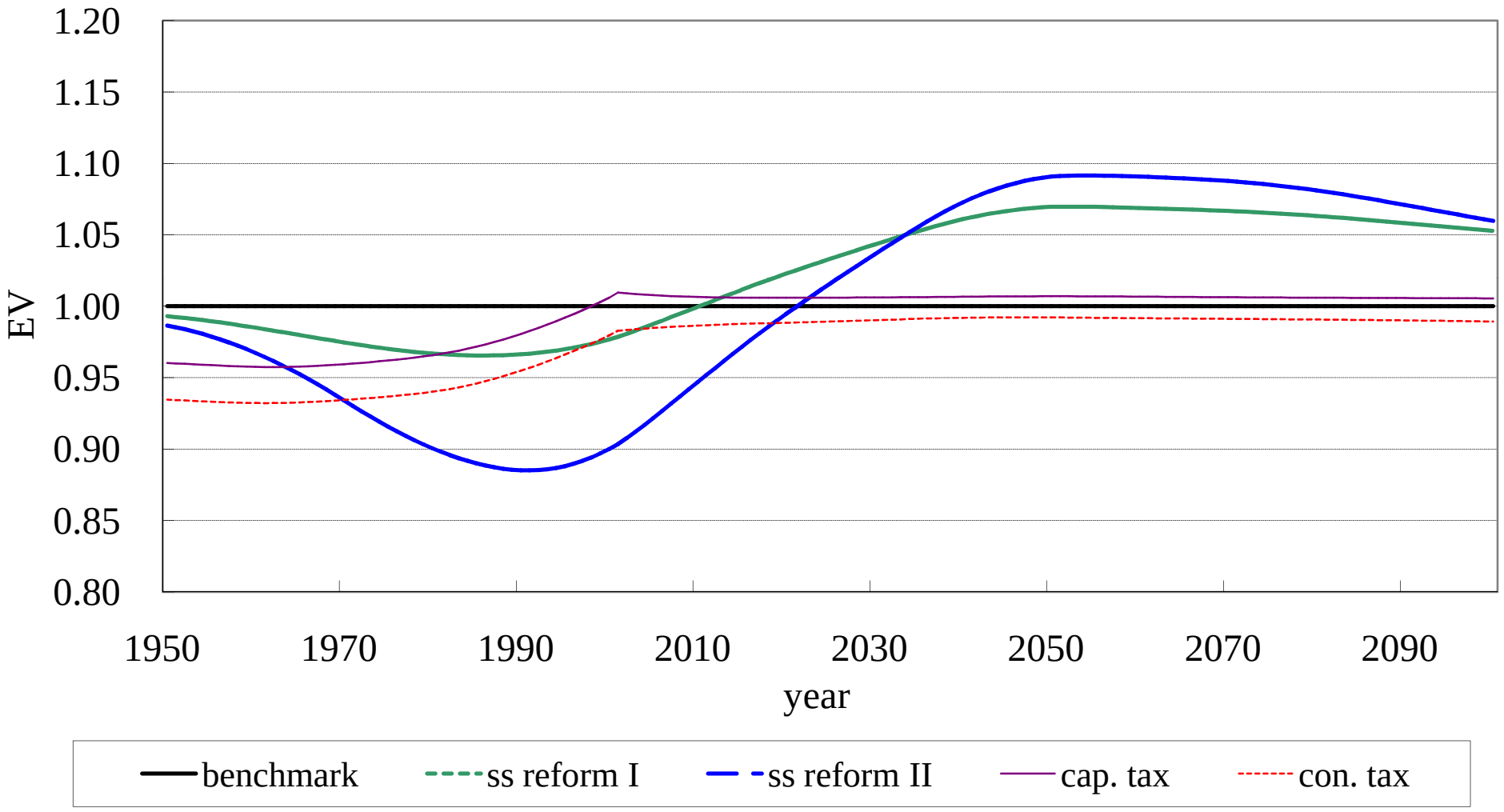


Figure 8: Welfare Comparison (EV)



Small Open Economy

- Lessons from Attanasio, Kitao, and Violante (2007)
  - Equilibrium payroll tax rate does not change so much
  - Welfare implication changes
- Introducing capital income tax improves welfare more
- **Figure 9**

Figure 9: Welfare Comparison (Cohort at Age 20)

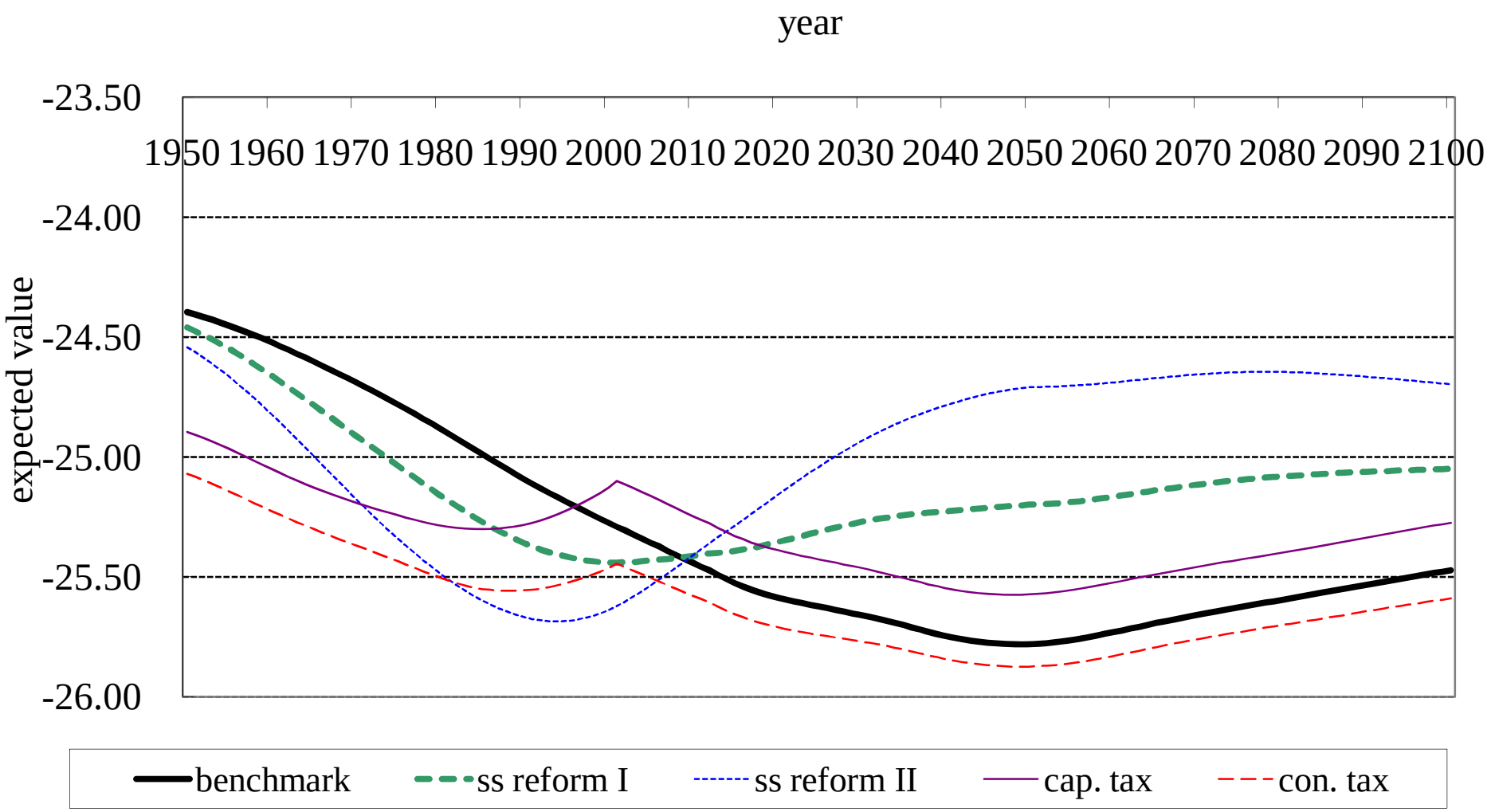
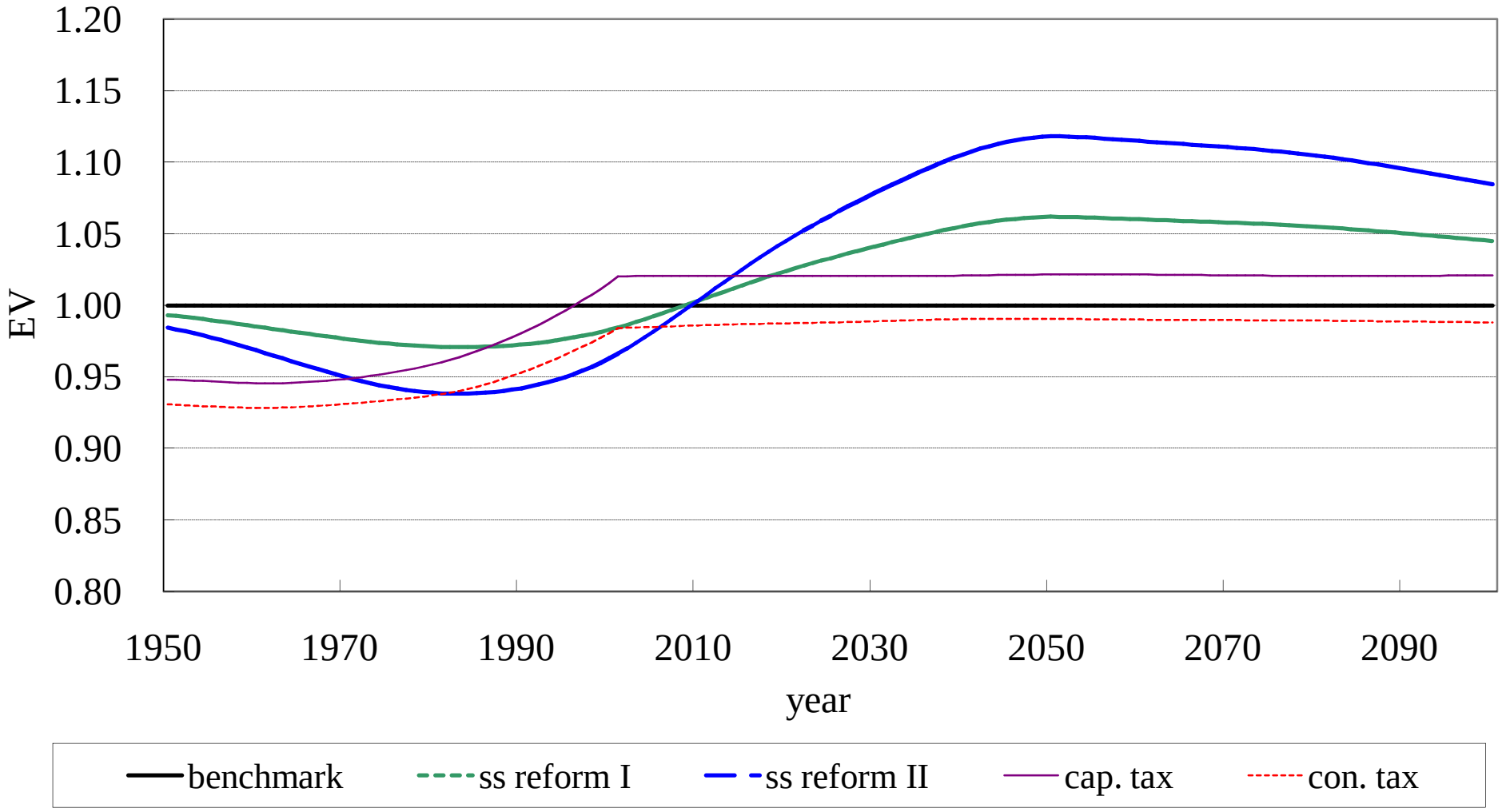


Figure 9: Welfare Comparison (EV)



What causes the differences?

- Consumption tax improves welfare:
  - e.g. Tachibanaki et al. (2006)
  - Intragenerational heterogeneity
  - Borrowing constraint
- Introducing consumption tax does *not necessarily* improve welfare of the economy: Nishiyama and Smetters (2005,JPE)
  - with/without intragenerational heterogeneity
  - redistribution and insurance effect of social security system
- Insurance or Opportunity?: Heathcote, Storesletten, and Violante (2005,JME)
  - The social security offers insurance for life-time income
  - Concentration of labor supply at high productivity (covariance of hourly wage and work hours)

A Benchmark Case, SSR I & II

- **A Benchmark Case**
  - The equilibrium interest rate decrease
  - The equilibrium wage increase up to 5%
  - The payroll tax rate increases up to 18%
  - Output per capita decreases by 20%
- **SSR I (Reduction by Half)**
  - The wage level increases by 10%
  - The payroll tax rate does not exceed 12%
  - Output per capita is flatter than in the benchmark case
- **SSR II (Full Privatization)**
  - The real return on capital becomes negative
  - The equilibrium wage rises over 20%

Figure 3: Benchmark Case (Medium Variant)

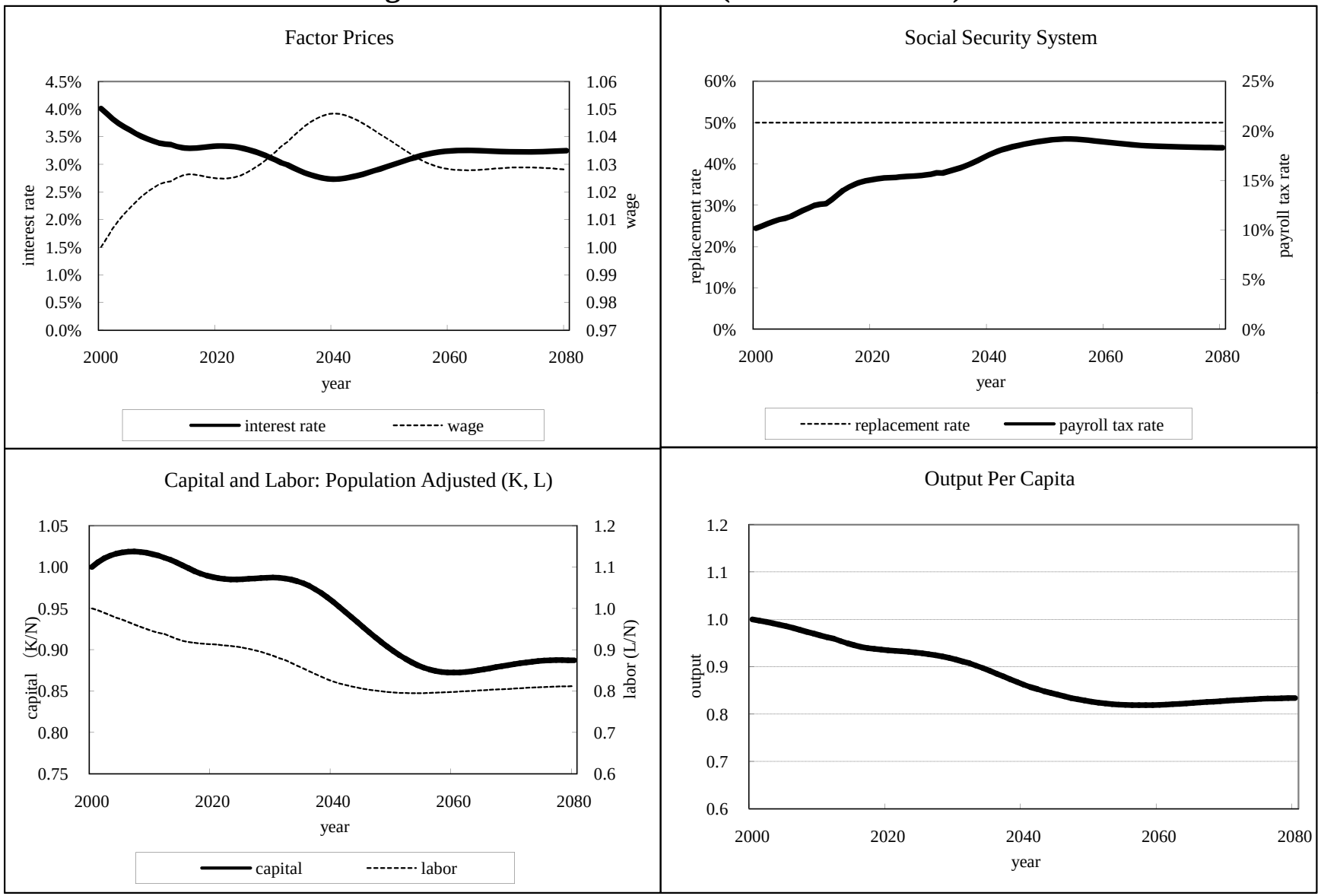


Figure 4: Social Security Reform I (25%)

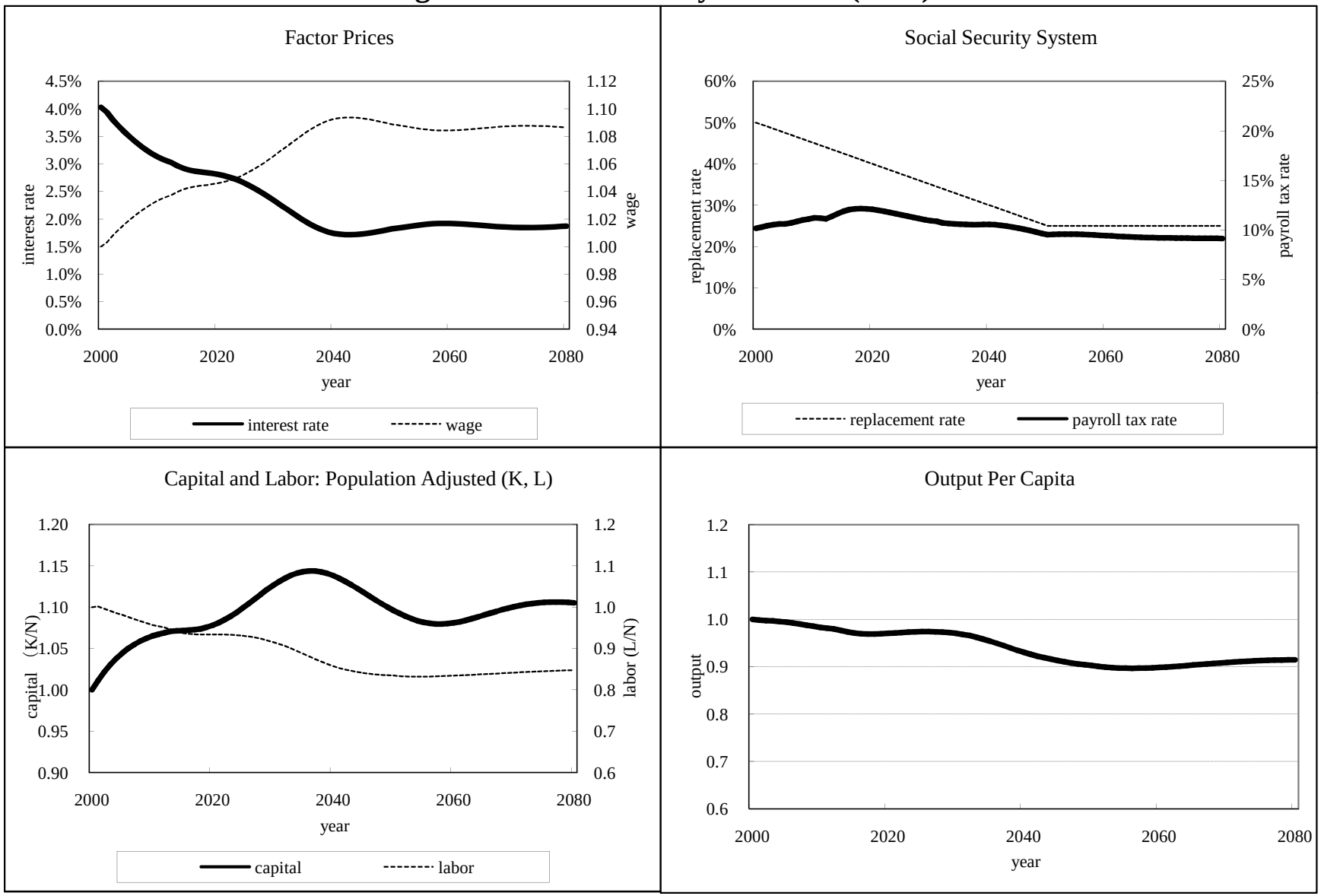
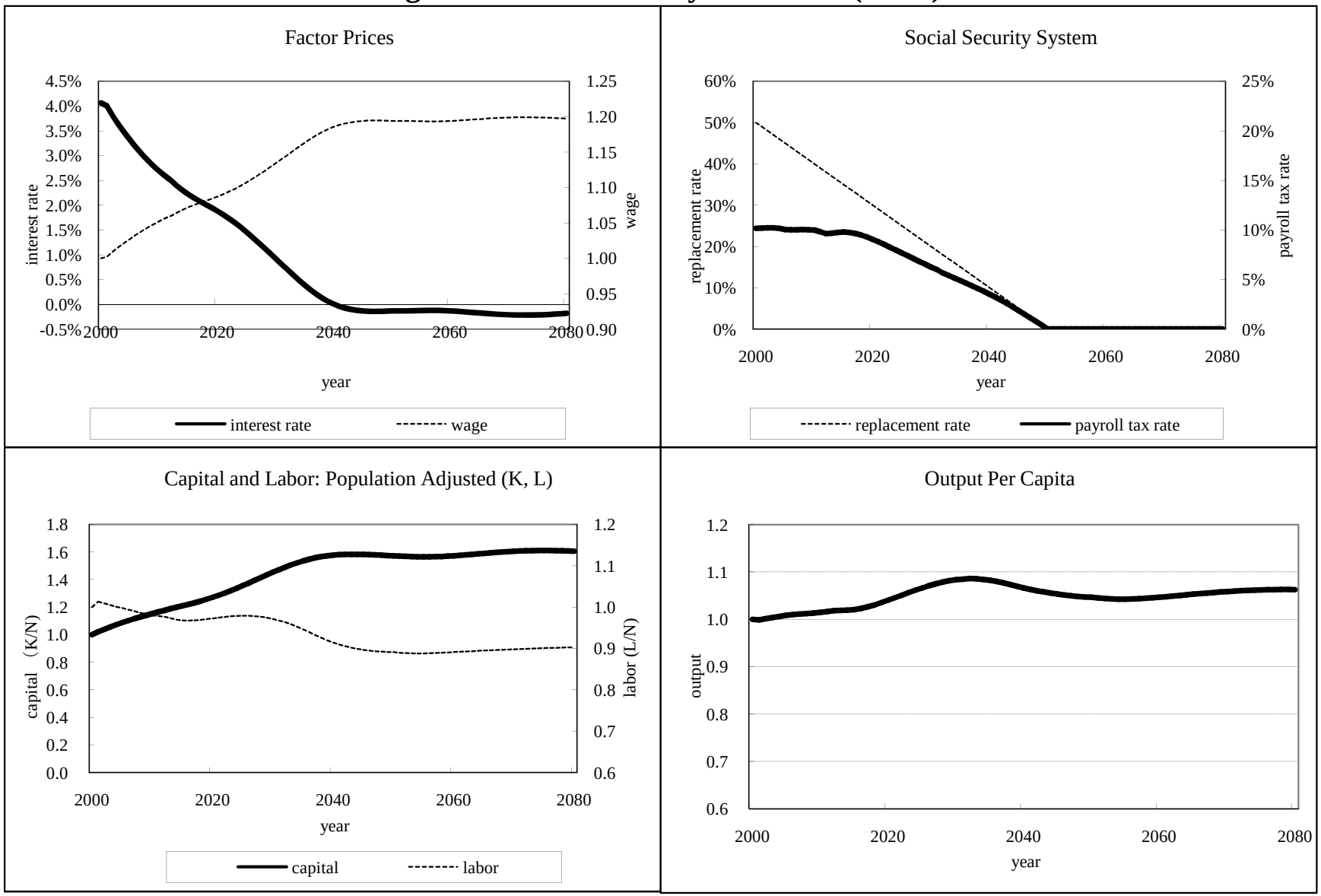


Figure 5: Social Security Reform II (0.1%)



Capital Income Tax and Consumption Tax

- **Capital Income Tax**
  - Dynamic inefficiency?⇐Abel, et al. (1989)
  - Over-accumulation with precautionary saving?⇐Aiyagari (1995)
  - Labor supply incentive?⇐Conesa and Krueger (2006)
  - The maximum payroll tax rate does not exceed 16%
  - Relatively small effect on the factor prices path
  - Per capita output is large relative to the benchmark case
- **Consumption Tax**
  - Factor price pathes are similar to the benchmark case
  - The maximum payroll tax does not exceed 14%

Figure 6: Capital Income Tax

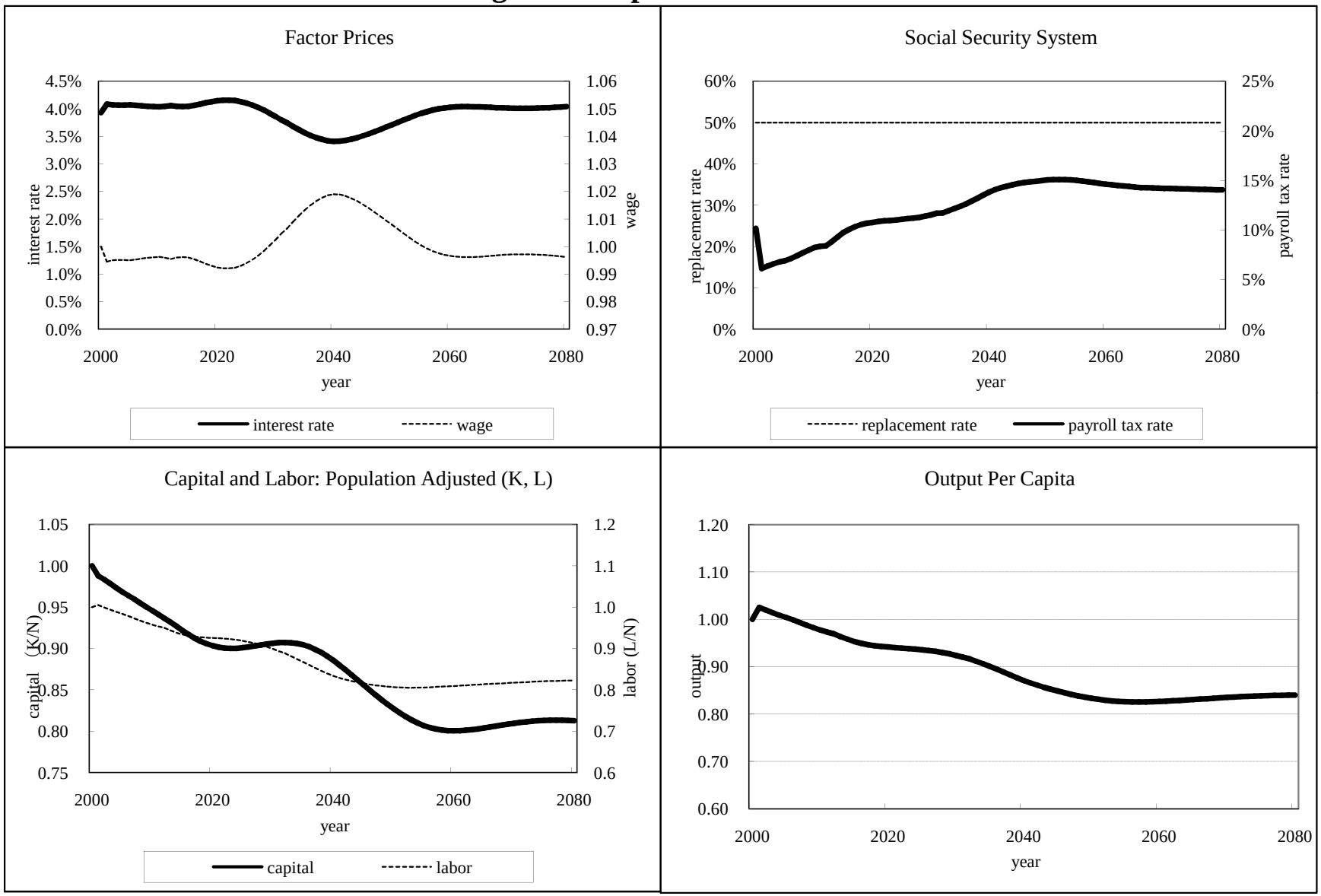
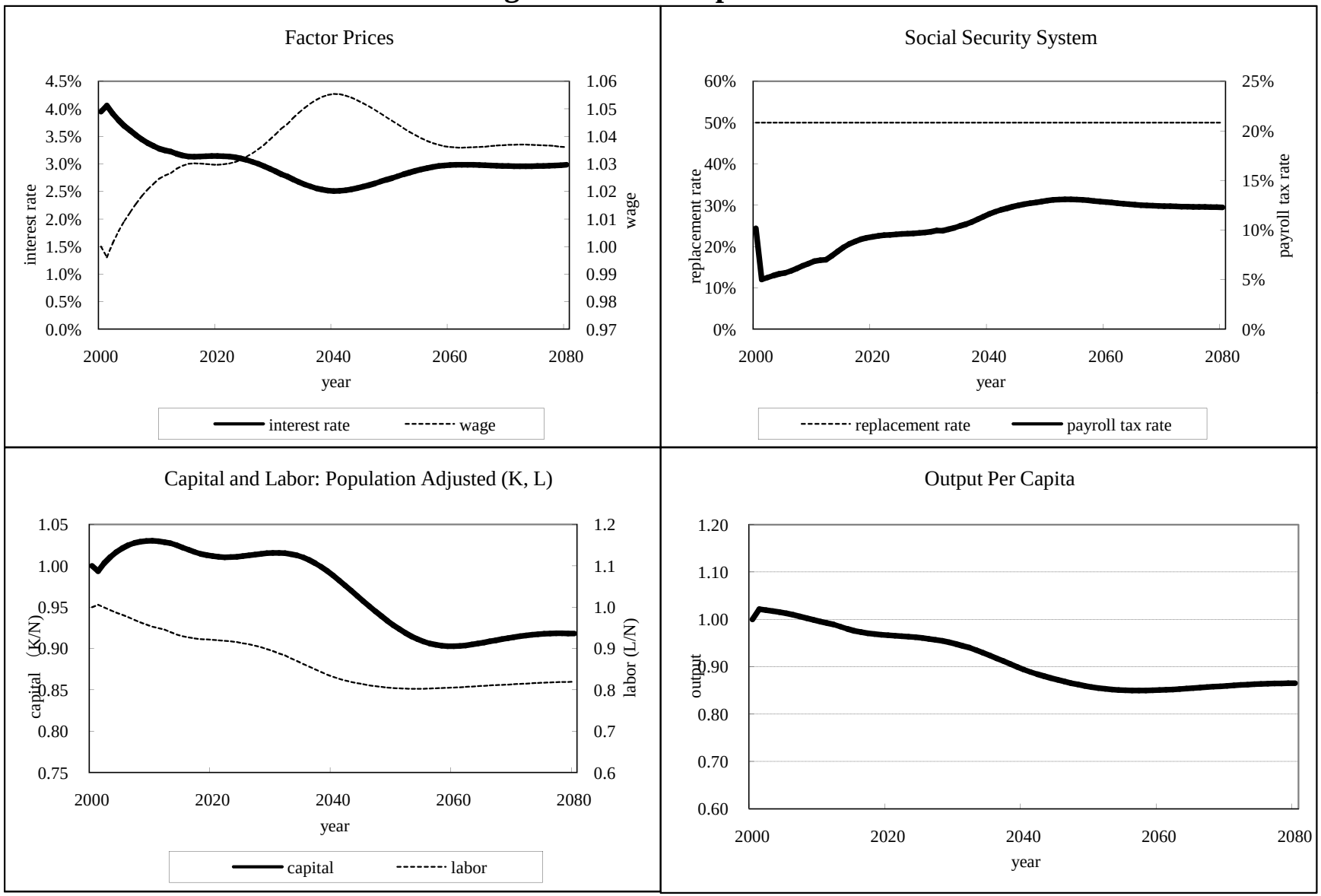


Figure 7: Consumption Tax



Conclusion

- Capital income tax weakly improves the young and future generations' welfare
- Consumption tax should not necessarily improves the welfare because of
  - Heterogeneity
  - Redistribution effect of social security
  - Labor supply incentives
- Partial privatization will improves the welfare of future cohorts
- How to incorporate aggregate risk?
  - Intergenerational risk sharing by a social security system (Krueger and Kubler, 2005 AER)
  - Demographic risk