Income Risk, Consumption Inequality, and Macroeconomy in Japan

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6, December 2008

Motivation

- Recently, economic inequality is receiving increasing attention in Japan
  - Many people *believe* that the inequality rises
  - True? Inequality of what? How large?
- Income/Earning inequality:
  - Many data sets are available
  - does not necessarily reflect economic inequality over life cycle
- Consumption inequality
  - Life Cycle Permanent Income Hypothesis(LC-PIH)
  - Useful measure for welfare evaluation and policy implication
  - Limited data set in Japan

Questions

- Explaining economic inequality in Japan based on a dynamic stochastic general equilibrium model
- What kinds of factors affect the evolution of economic inequality in Japan?

What We Do

- A transitional dynamics of economic inequality in Japan between 1980 and 2000
  - there are comparable data on income/earning and consumption inequality only for this period
- Two viewpoints of economic inequality:
  - Life cycle dimension: Age
  - Time series dimension: Time
- Three factors that affects conomic inequality:
  1. Idiosyncratic income risk factor: permanent and transitory shocks
  2. A demographic factor: aging
  3. Macroeconomic factors: TFP, capital share, etc.

Literature Review

1. Empirical research on income/consumption inequality:

Lifecycle Dimension:

- US: Deaton and Paxson (1994), Storesletten et al. (2004)
- Japan: Ohtake and Saito (1998), Abe and Yamada (2006)

Time Series Dimension:

- US: Heathcote, et al. (2004,2008), Krueger and Perri (2005)
- Japan: Kohara and Ohtake (2006), Abe and Inakura (2008)

2. Explaining Japanese economy based on DGE models

- GDP in the "Lost Decade": Hayashi and Prescott (2002)
- Saving rate: Chen et al. (2006,2007), Braun et al. (2007)
- Extend the first moments (e.g. GDP) to the second moments (variance)

Summary of Results

1. Income/consumption inequality of life cycle dimension is well replicated in the model
2. Rising earning inequality between mid 1980s and late 1990s is explained by the OLG model
3. It is difficult to explain consumption inequality in 1980s using the model
4. Counterfactual simulation:
   - TFP growth rate and reduction in work hours have large impact not only on the mean (e.g. GDP and saving rate) but also on the economic inequality
   - Low TFP growth rate generate low economic inequality, especially in the 1990s
5. Even without the demographic factor, the earning/income inequality has positive trend due to the macroeconomic factors

Sketch of Our Model

- A overlapping generations model:
  - A continuum of households exits
  - Households face idiosyncratic income risk
  - Incomplete market and self-insurance
  - Endogenous labor supply
  - Intergenerational and intragenerational heterogeneity
  - Pay-as-you-go social security system
  - Exogenously given macroeconomic variables; TFP, capital share, etc
  - Compute transition path between steady states (1980-2200)

Objective Function

- A continuum of households exist
- Each household enters labor market at 20
  - exits at 65:

$$U_t = E_{20,t}\left\{\sum_{j=20}^{100}\beta^{j-20}\left(\prod_{i=20}^{j-1}\phi_{i,t}\right)\frac{\left[c_{j,t}^{\sigma}(\bar{h}_t - h_{j,t})^{1-\sigma}\right]^{1-\gamma}}{1-\gamma}\right\}$$

  - $\beta > 0$: Discount factor
  - γ: Parameter for intertemporal elasticity of substitution
  - σ: Parameter for the share of consumption and leisure
  - $\bar{h}_t$: Time endowment
  - $h_{j,t} \in [0, \bar{h}_t]$: A labor supply at age j
- Robustness check later!

Budget Constraint: Worker

- Worker:

$$c_{j,t} + a_{j+1,t+1} = (1 + (1 - \tau_t^{\text{cap}})r_t)(a_{j,t} + b_t) + (1 - \tau_t^{\text{ss}})y_{j,t}$$

$$y_{j,t} = w_t \kappa_j e_j h_{j,t}$$

  - $a_{j,t}$: Asset holding, b_t: Accidental bequest
  - $y_{j,t}$: Labor income
  - κ_j: Average productivity for each age
  - e_j: Idiosyncratic income risk
  - τ_t^{cap}: Capital income tax, τ_t^{ss}: Payroll tax for Social Security
  - r_t: Interest rate, w_t: Wage

Budget Constraint: Retiree

- Retiree:

$$c_{j,t} + a_{j+1,t+1} = (1 + (1 - \tau_t^{\text{cap}})r_t)(a_{j,t} + b_t) + \varphi_t w_t H_t$$

  - φ_t: Replacement rate
  - $w_t H_t$: Average labor income of workers

Firm's Behavior

- Production function:

$$Y_t = A_t K_t^{\theta_t} H_t^{1-\theta_t}$$

  - A_t: TFP(Deterministic), θ_t: Capital share

- Factor prices:

$$r_t = \theta_t A_t \left(K_t / H_t\right)^{\theta_t - 1} - \delta_t, \;\; w_t = (1-\theta_t) A_t \left(K_t / H_t\right)^{\theta_t}$$

Government

- The government has three roles:

1. Managing the social security system:
   - Pay-as-you-go
2. Collects capital income tax and using it for government expenditure:
   - The government expenditure yields no utility!
3. Distributes accidental bequests:

Definition: Recursive Competitive Equilibrium

- Given the paths of TFP $\{A_t\}$, the capital share $\{\theta_t\}$, the depreciation rate $\{\delta_t\}$, the capital income tax rate $\{\tau_t^{\text{cap}}\}$, the time endowment $\{\bar{h}_t\}$ and the replacement rate $\{\varphi_t\}$,
- Recursive Competitive Equilibrium consists of
  - A household's optimality
  - A firm's optimality
  - Market clearing conditions
  - The government's budget
  - Accidental bequest
  - Transition law of motion

Fundamental Parameters

- Instantaneous utility function:

$$u\left(c_{j,t}, \bar{h}_t - h_{j,t}\right) = \frac{\left[c_{j,t}^{\sigma}(\bar{h}_t - h_{j,t})^{1-\sigma}\right]^{1-\gamma}}{1-\gamma}$$

  - $\beta = 0.9871$, $\gamma = 2$, $\sigma = 0.55$
- Time endowment:
  - Reduction in work hours length was legally introduced in the late 1980s (Labor Standards Law)
  - 1980-1988: 16 hours $\times$ 5.5 days $\times$ 4 weeks $\times$ 12 months
  - 1993-2200: 16 hours $\times$ 5.0 days $\times$ 4 weeks $\times$ 12 months
- Replacement rate: φ_t
  - 40% of average labor income (Oshio and Yashiro, 1997)

Income Risk and Consumption Inequality

- We consider three types of income shocks, e_j
- Each shock have different implications on consumption inequality
  - Fixed effect: *Uninsurable*, high consumption inequality
  - Transitory shock: *Insurable* through insurance markets or saving (risk-free bond), low consumption inequality
  - Persistent shock: Depend on the persistence parameter

Demographic Structure

- We consider the demographic change from 1980 to 2200.
- Population projection:
  - National Institute of Population and Social Security Research (2002,2006)
  - Survival probability
  - Population growth rate
- Three variants of projection
  - Use medium variant
- Initial population distribution: population distribution in 1980

Exogenous Paths

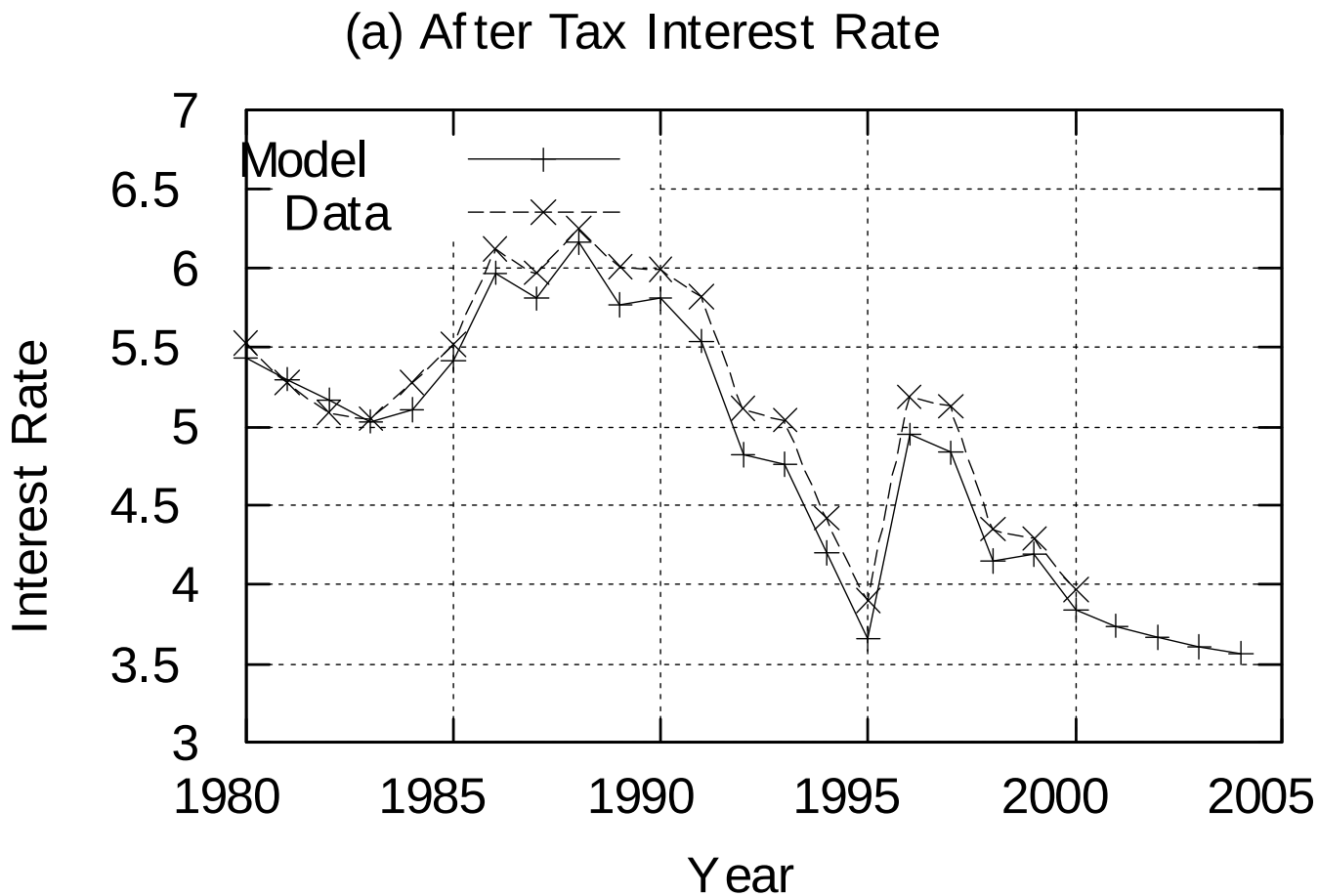
- From Hayashi and Prescott (2002):

	70*s*	80*s*	90*s*
TFP Factor Growth Rate (%)	1.40	2.68	0.57
Adjusted TFP Factor Growth Rate (%)	1.77	2.21	0.67
Depreciation Rate (%)	10.19	8.97	8.40
Capital Share	0.3512	0.3536	0.3627
Capital Income Tax Rate (%)	41.55	47.68	44.92

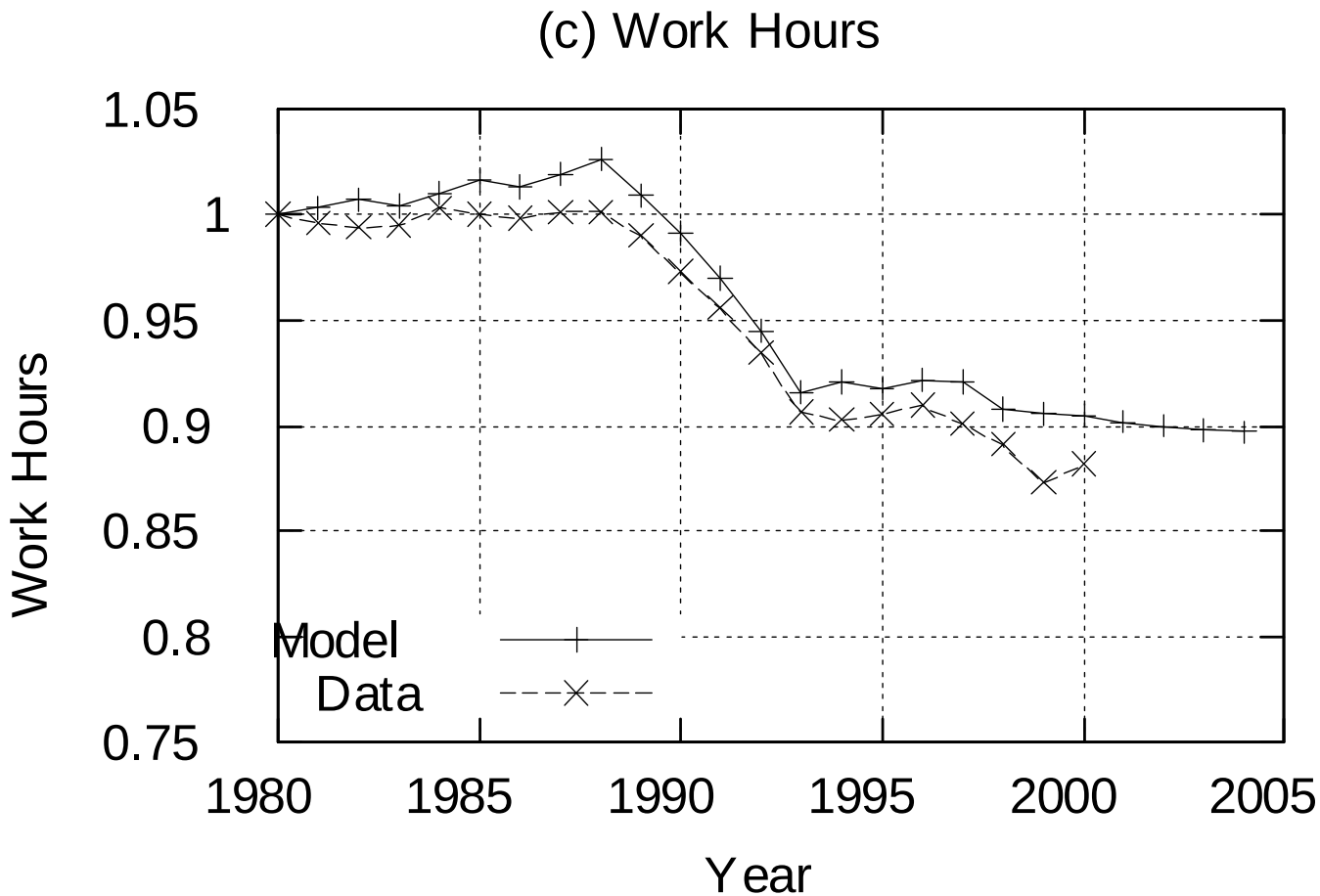
Macroeconomic Variables: Overview

- Before discussing the economic inequality after 1980, we confirm whether the average paths replicates data of Japanese economy
  - After tax interest rate: very good!
  - Capital-output ratio: capital deepening in the lost decade
  - Work hours: reduction in work hours between the late 80s and early 90s
  - Saving rate: good, but there is a discrepancy period
- Using an OLG model with idiosyncratic income risk and exogenously given macroeconomic factors, the model can explain the data (first moment) very clearly.

Macroeconomic Variables: Interest Rate



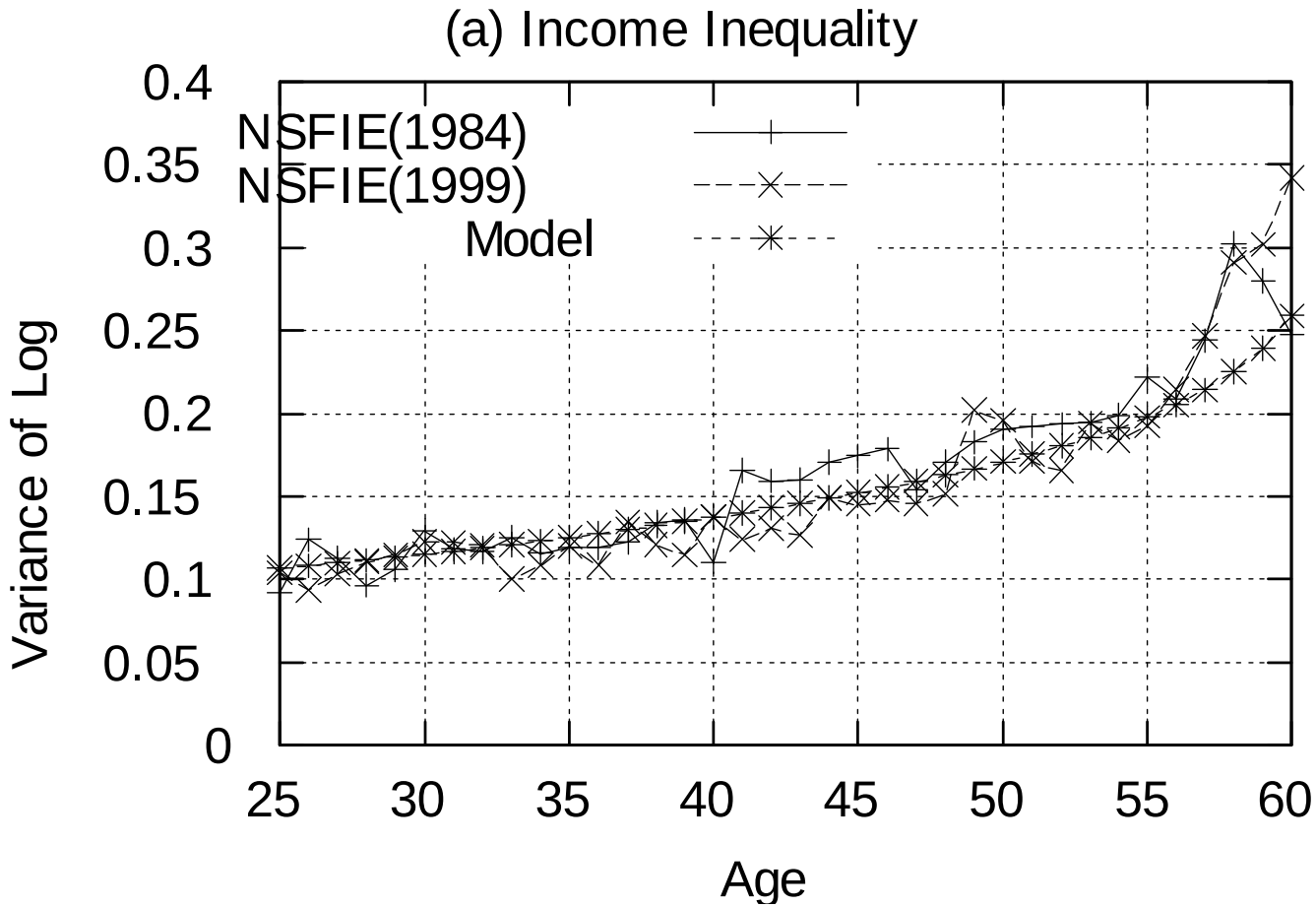
Macroeconomic Variables: Work Hours



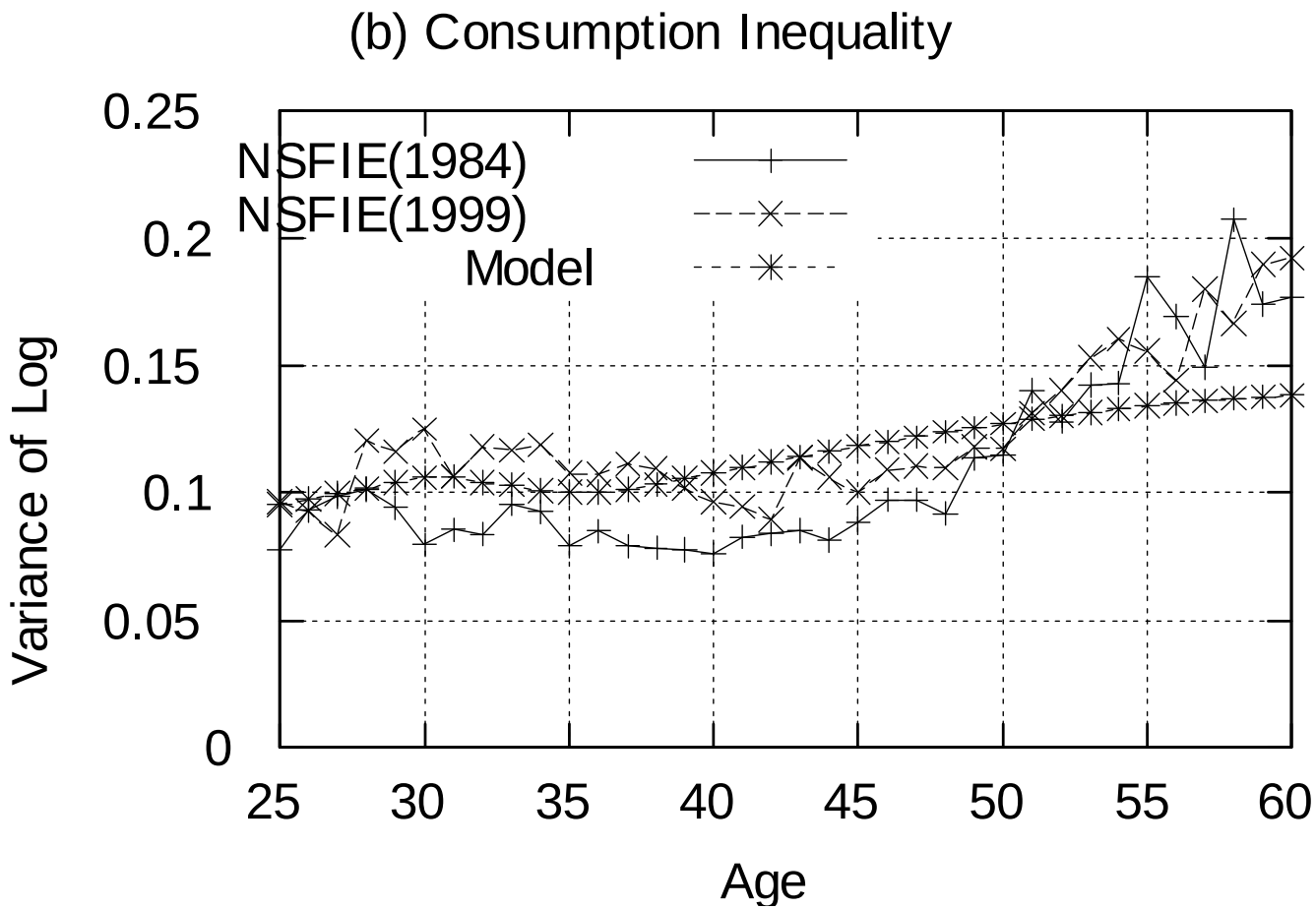
Life Cycle Dimension of Economic Inequality

- The variance of logarithm of income and consumption over age
- Our model replicates the "income inequality" very well without old households
- Consumption inequality
  1. Consumption inequality around 25–40 closely matches the data
  2. Consumption inequalities of old are small

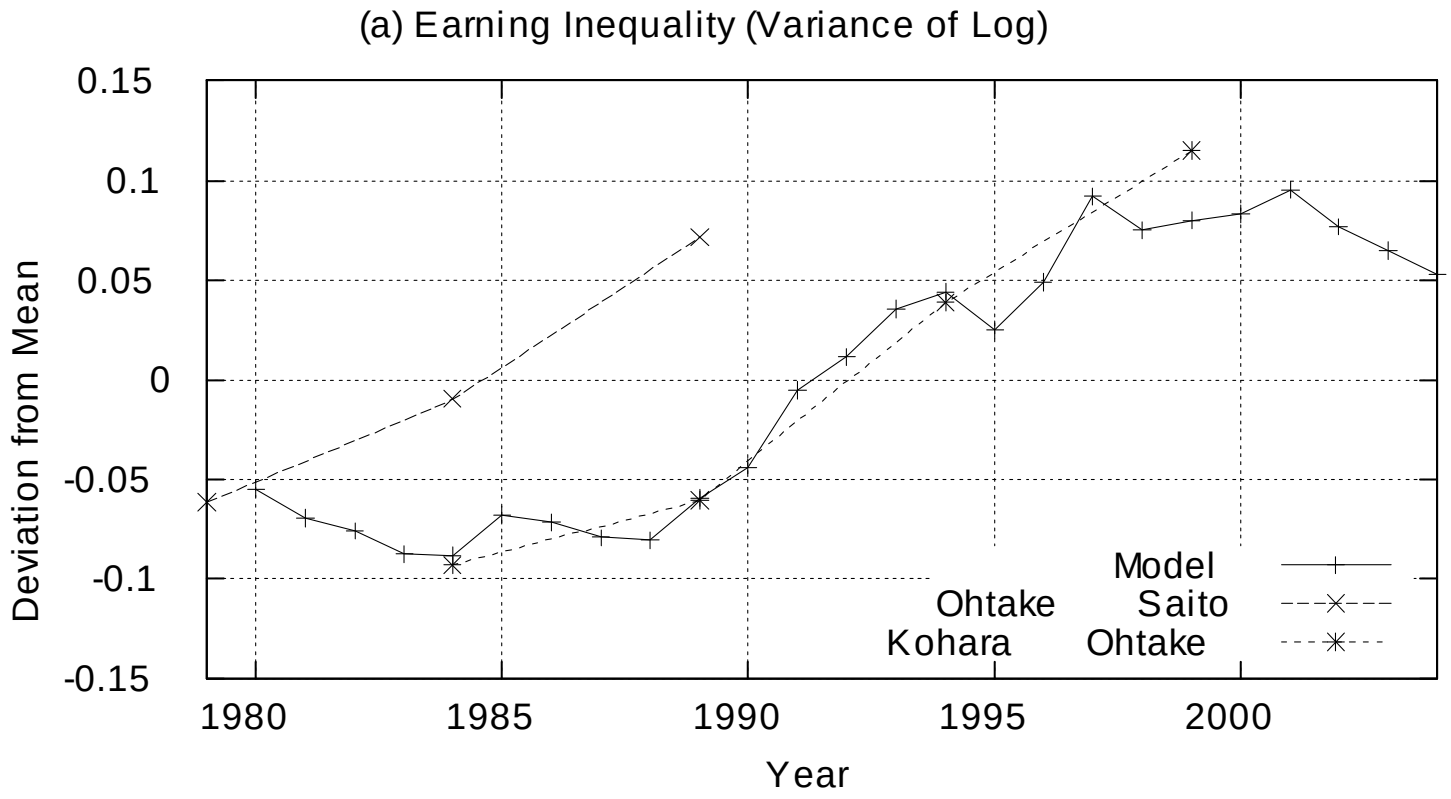
Life Cycle Dimension: Income Inequality



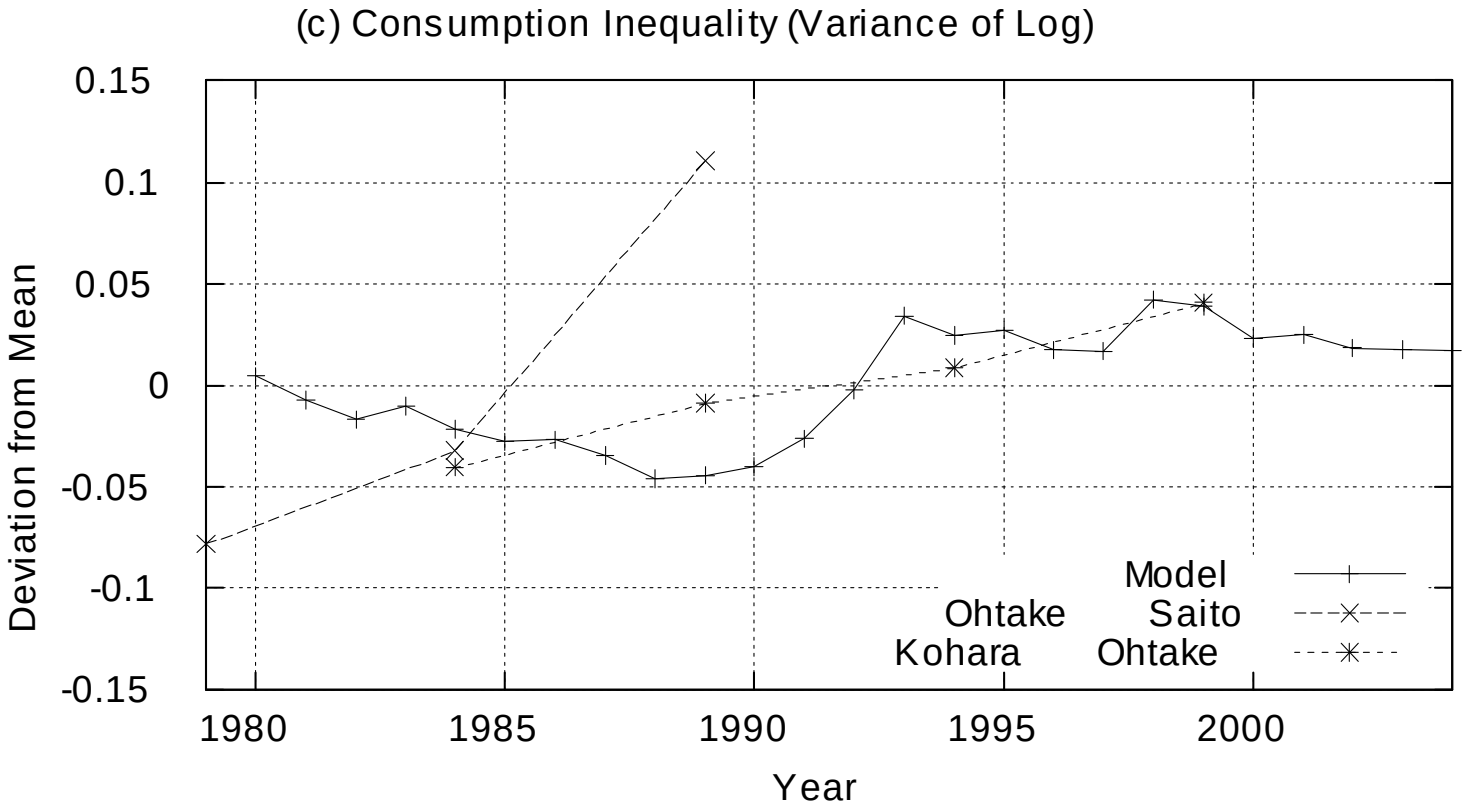
Life Cycle Dimension: Consumption Inequality



Time Series Dimension: Earning Inequality



Time Series Dimension: Consumption Inequality

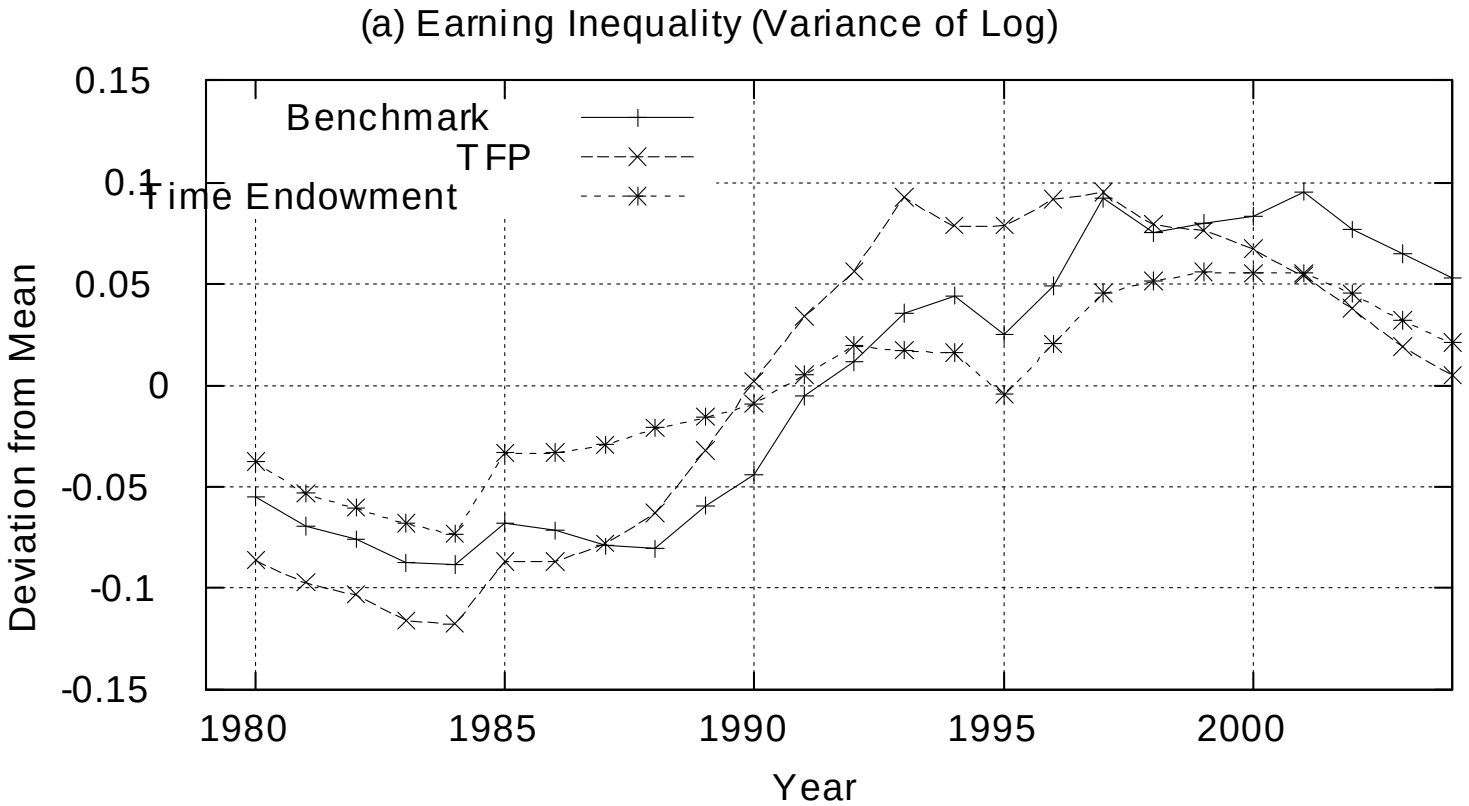


Counterfactual Simulation

- Question: What was occurred if the macroeconomic factors are constant at...

1. TFP factor growth rates: constant at 2%
2. Time endowment: $\bar{h} = 3840$
3. Capital share: $\theta = 0.362$
4. Capital income tax: $\tau^{cap} = 0.45$
   - Small effect on the economic inequality
5. Depreciation rate: $\delta = 0.083$
   - Small effect on the economic inequality

Conuterfactual Simulation: TFP and Time Endowment



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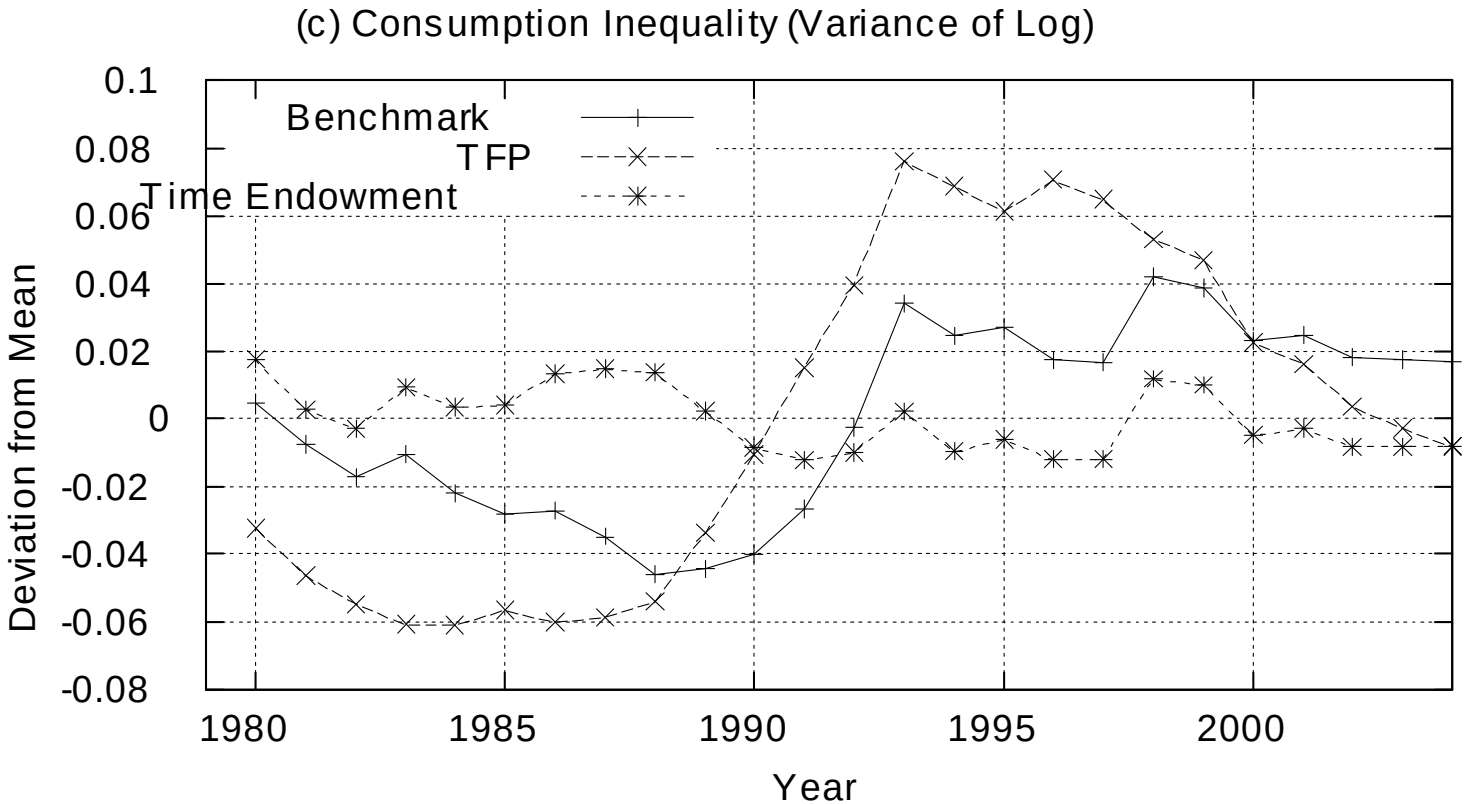
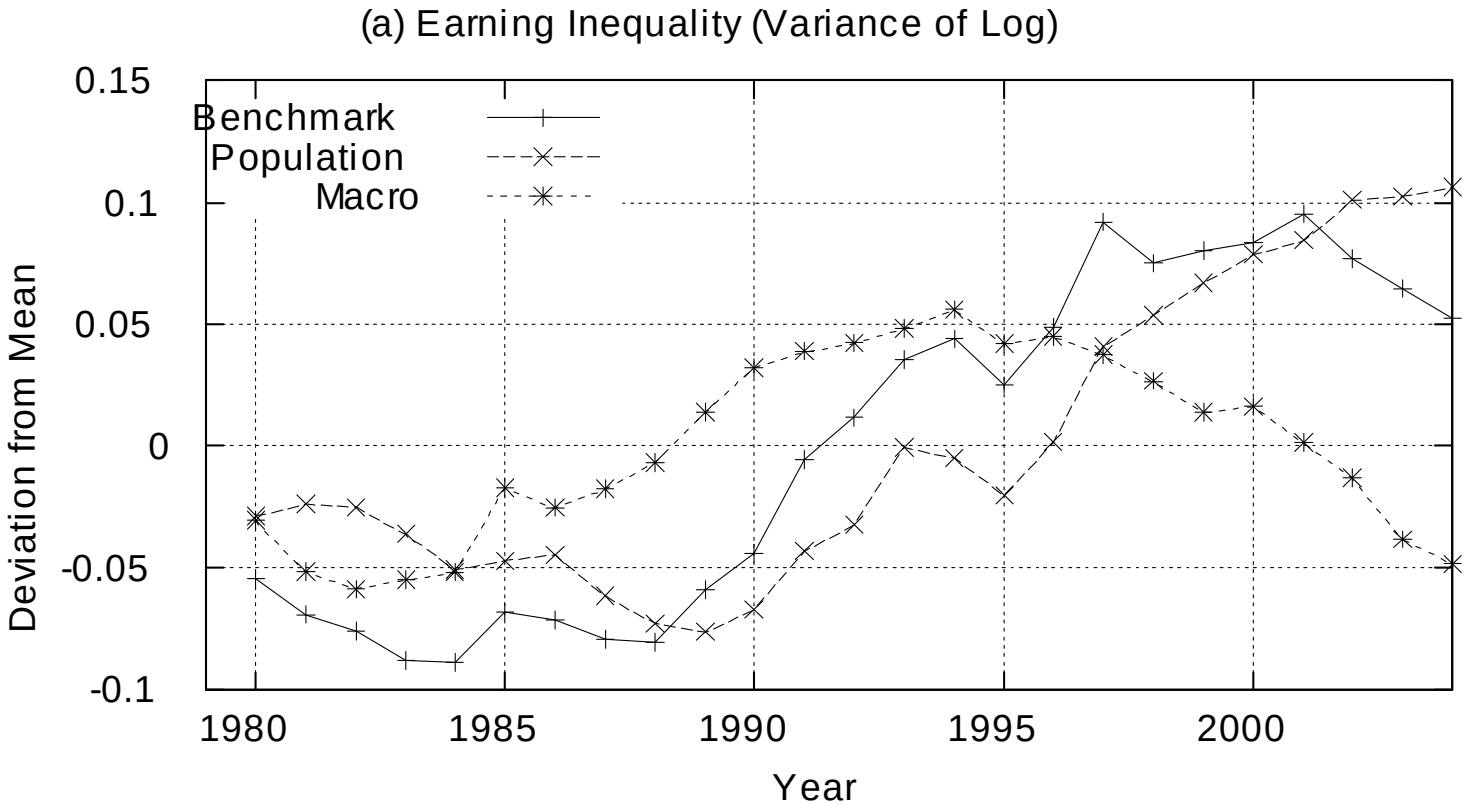


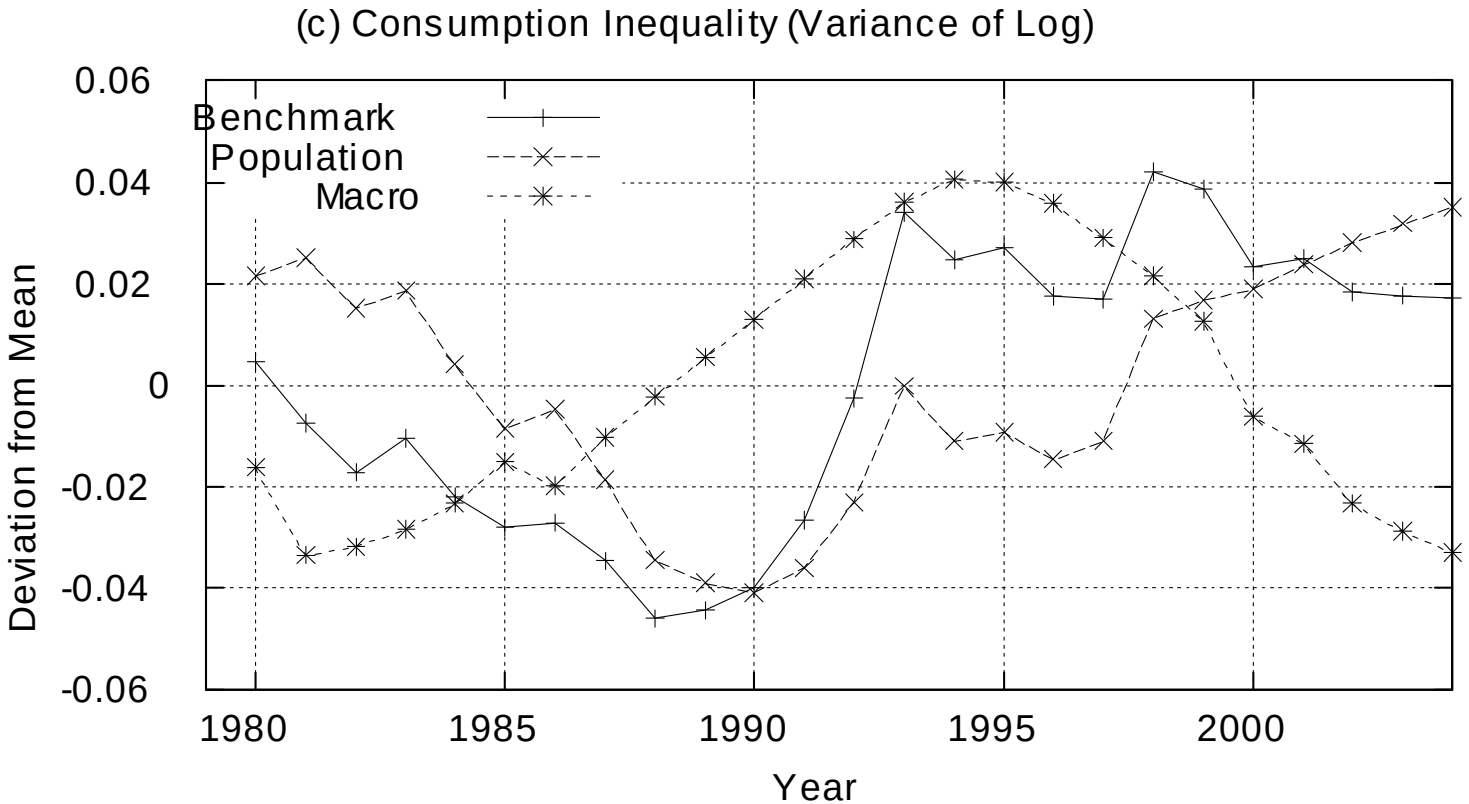
Demographic Factor vs Macroeconomic Factors

- Demographic factor:
  - Constant populatoin distribution
  - No population aging: income inequality path is flattens over the period (consistent with empirical research!)
  - There remains positive trend of the earning inequality
- Macroeconomic factors:
  - Without changing the macroeconomic factors, the time paths are smooth and single peaked

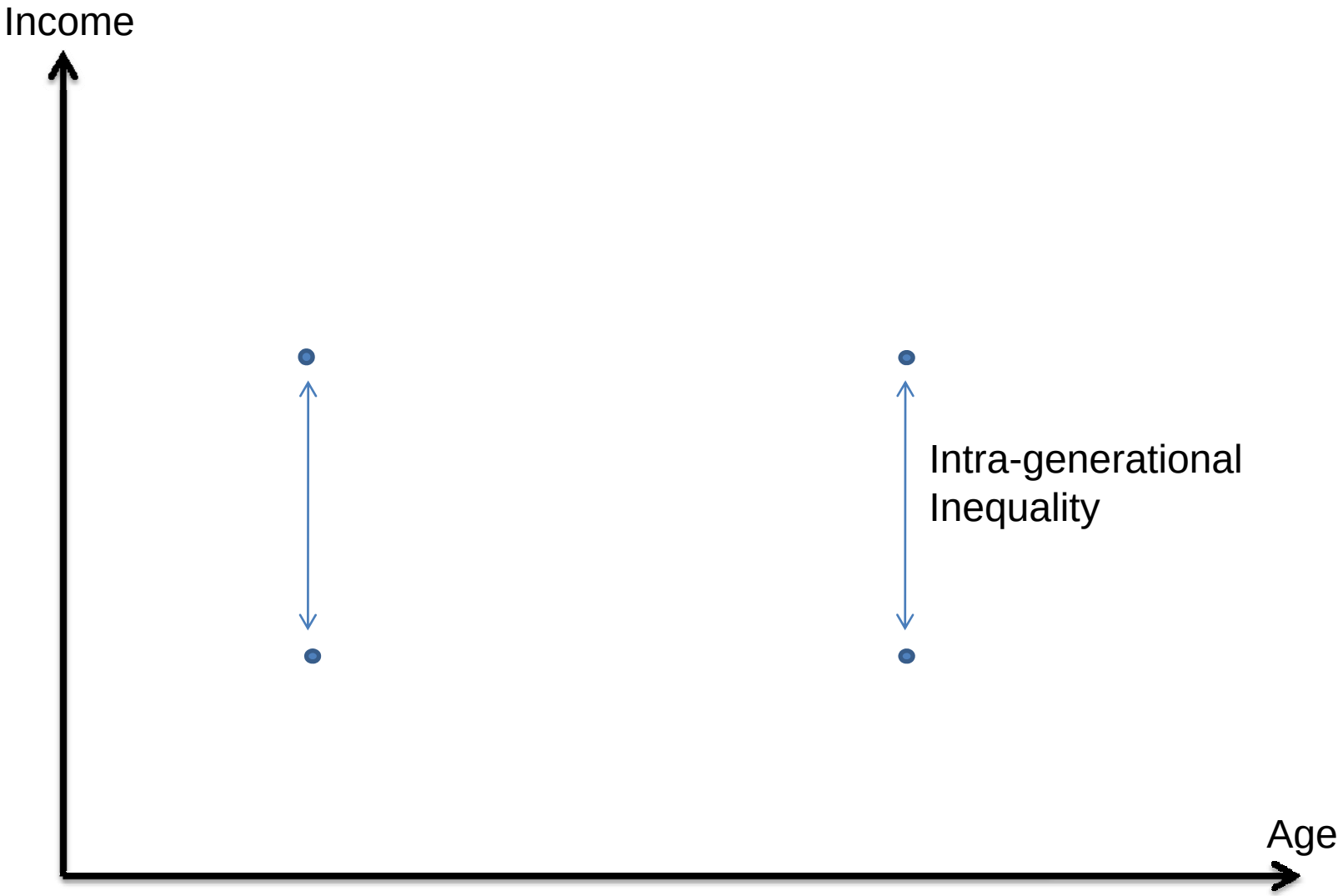
Demographic Factor vs Macroeconomic Factors



Demographic Factor vs Macroeconomic Factors



Intuition: Period t



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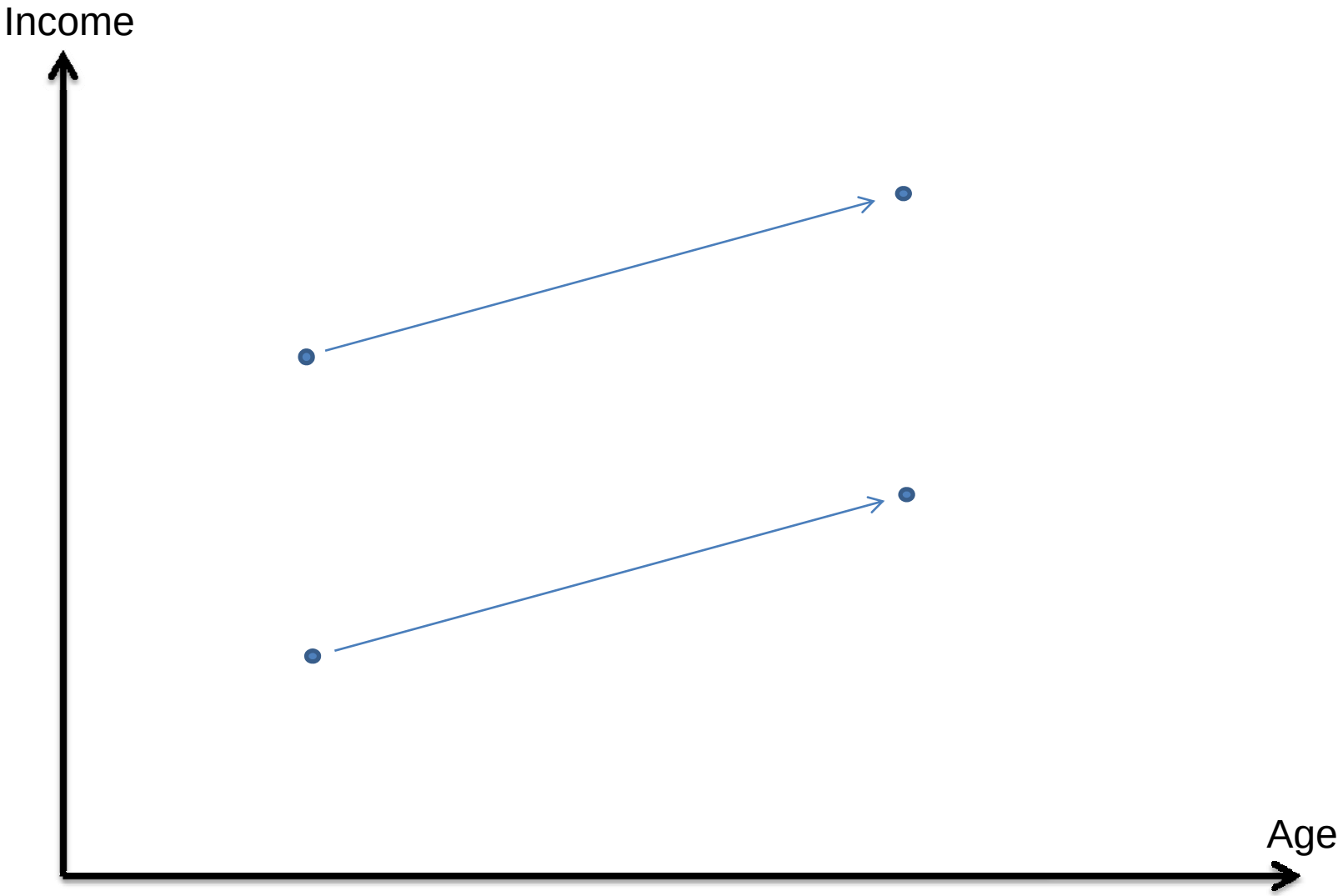


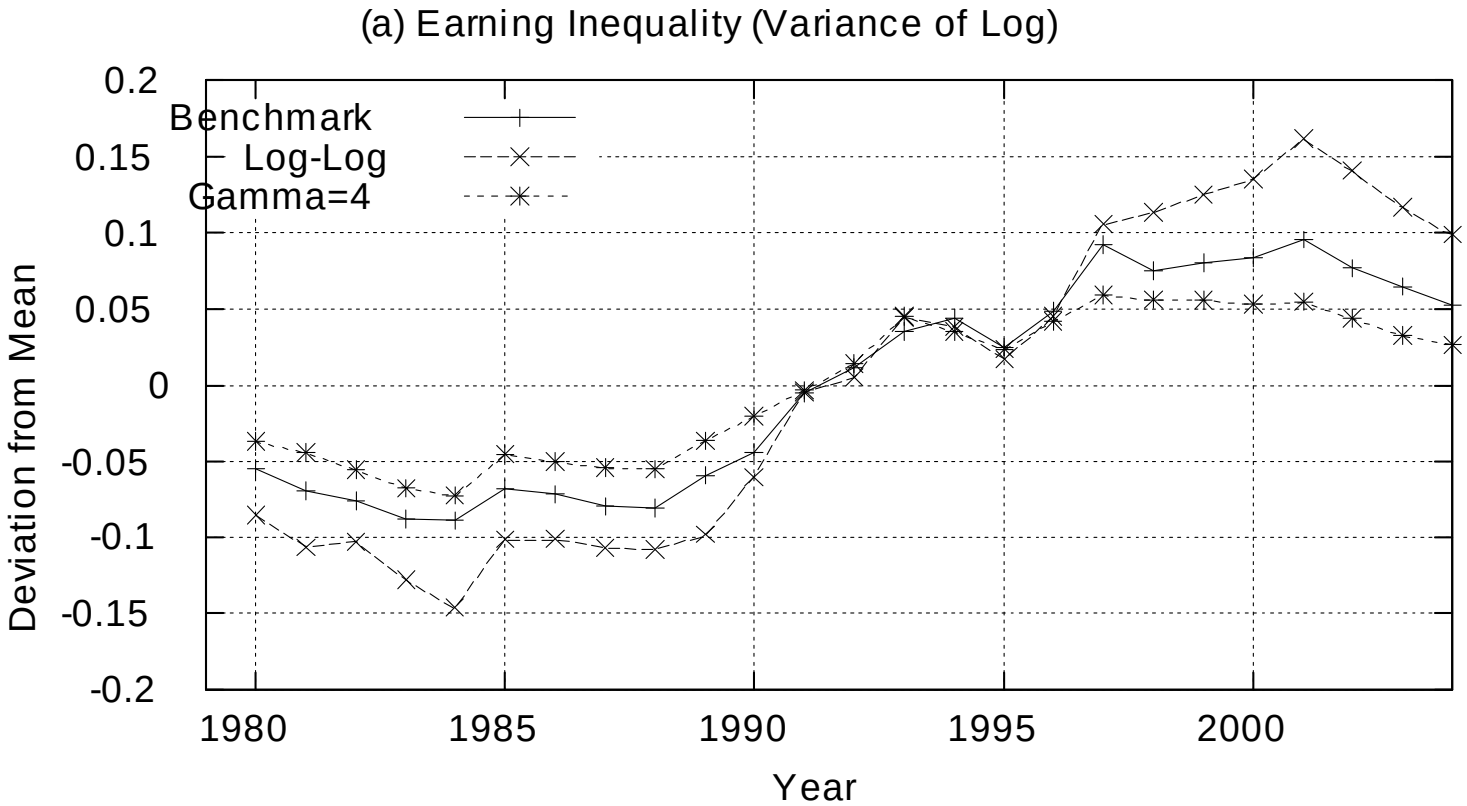
Separability and the Intertemporal Elasticity of Substitution

- To eliminate the effect of time reduction from the marginal utility function
- Separable utility function when $\gamma = 1$:

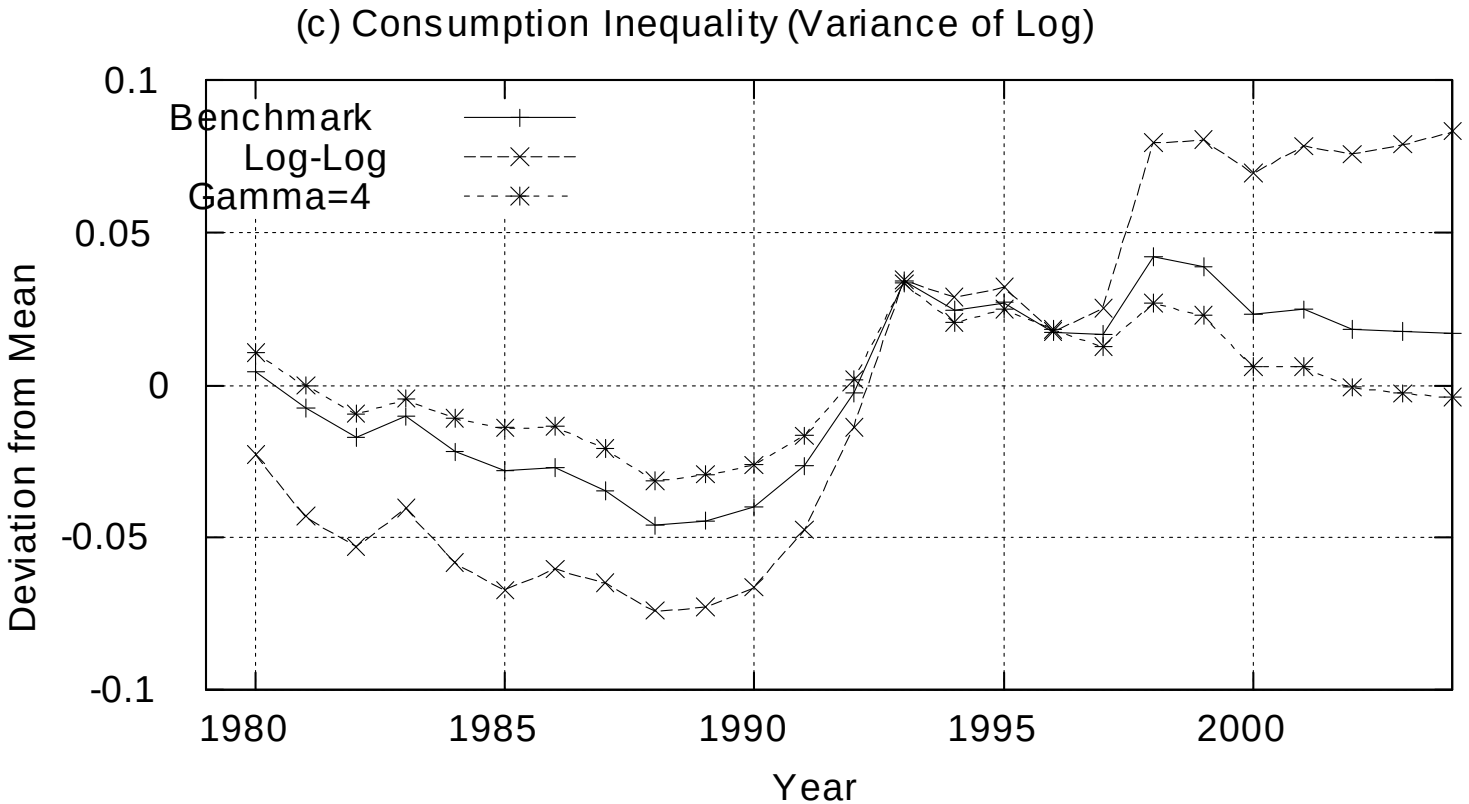
$$u(c_{j,t}, \bar{h}_t - h_{j,t}) = \sigma \log c_{j,t} + (1 - \sigma) \log(\bar{h}_t - h_{j,t})$$

- High IES: $\gamma = 4$

Separability and the IES



Separability and the IES



Concluding Remarks and Future Research

- We consider quantitative impacts of the three factors on the economic inequality between 1980 and 2000 in Japan
  1. Macroeconomic factors
  2. A demographic factor
  3. Idiosyncratic income risk
- The economic inequality in Japan is, at least partially, explained by an OLG model with idiosyncratic income risk
  - In this respect, our result is considered to be an extension of the result obtained by Hayashi and Prescott (2002)
- Future research
  - Liquidity constraint(zero wealth holding)
  - Female labor supply
  - Skill biased technology progress/Human capital accumulation