Exploring the Relationship Between Population Ageing and Labour Share

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I. Introduction

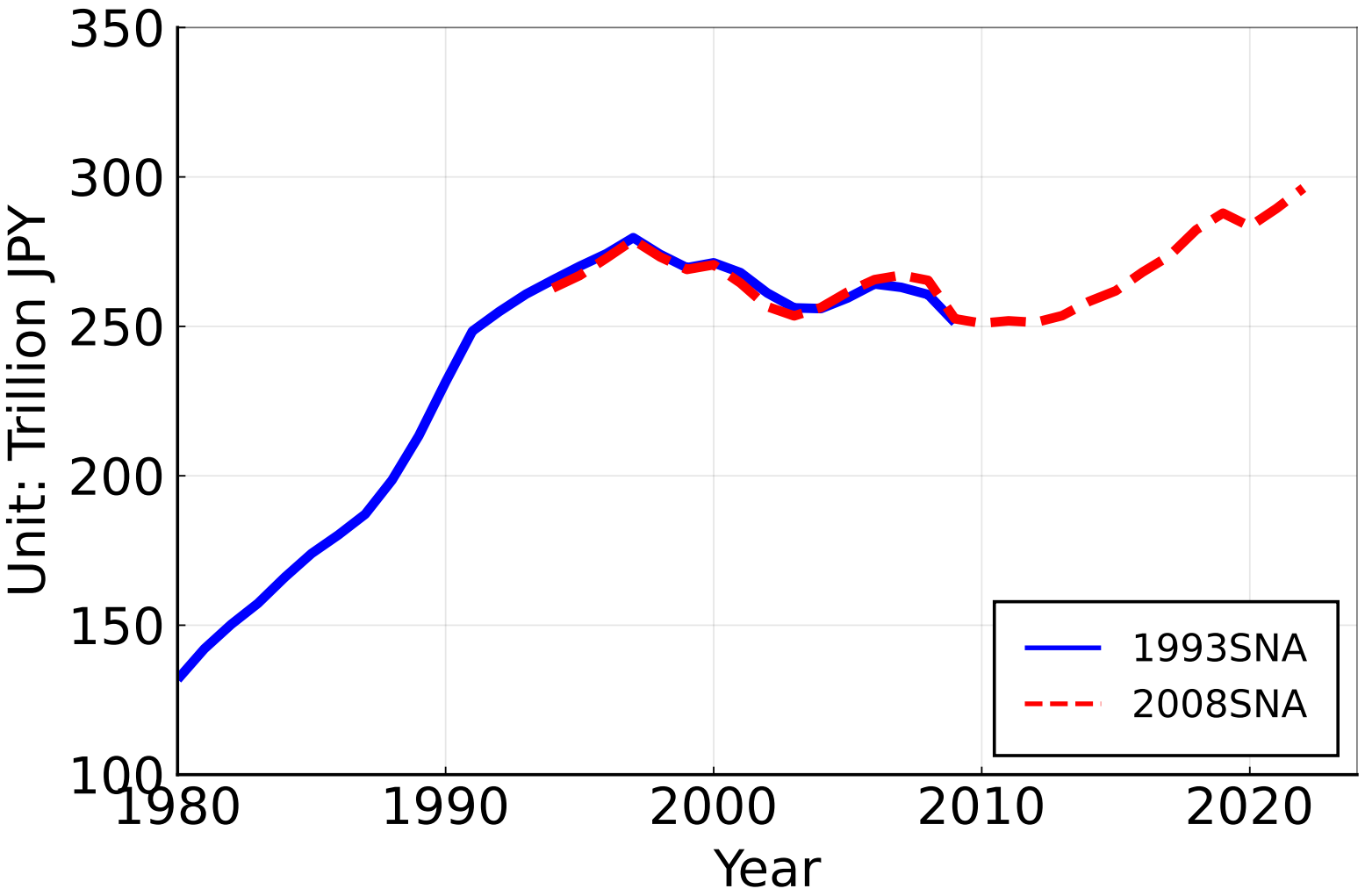
Introduction

- Increase of capital share (= decline of labour share)
  - Piketty (2014): $r > g$
  - Interest in declining labour share has existed for much longer
- Kaldor (1957,1961)'s stylized facts
  1. The shares of national income received by labour and capital are roughly constant over long periods of time
  2. The capital/output ratio is roughly constant over long periods of time
- Cobb-Douglas production function:

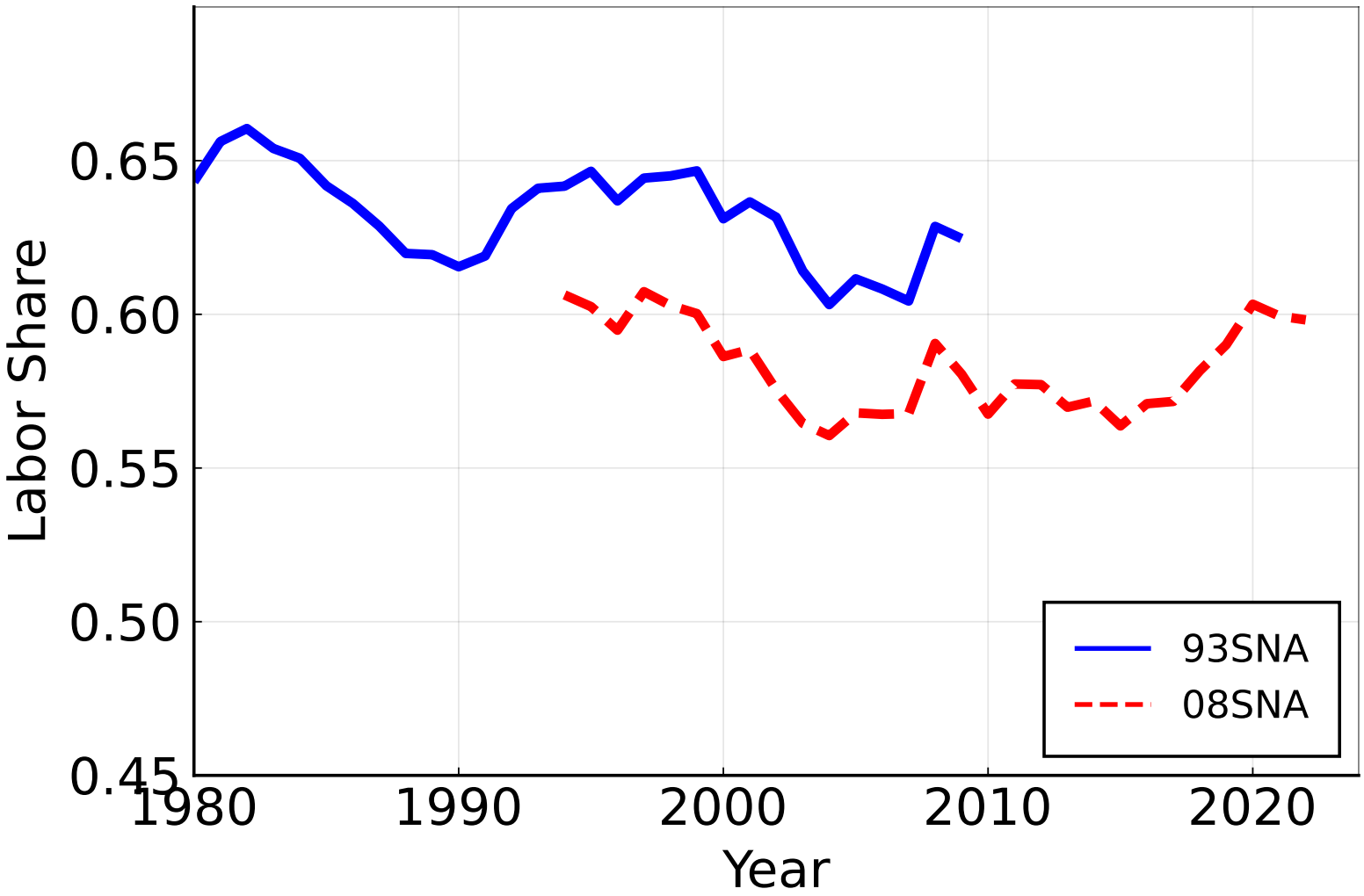
$$Y = ZK^{\alpha}L^{1-\alpha}$$

  - quite important for almost all macroeconomic models
  - however, it could not consider changes in the labour/capital share

Compensation of Employees in Japan: 1980–2022



Compensation of Employees/Adjusted GDP



Compensation of Employees

Compensation of employees in year t:

$$CoE_t = \sum_{\text{Age}} \sum_{\text{Gender}} \sum_{\text{Skill}} EARNINGS_{j,g,e,t}$$

- j: age, g: gender, e: skill
- skill is measured by educational background: college, high school, etc.

Adjustment of CoE and GDP $\Rightarrow$ ▸ APPENDIX

- Earnings of self-employed is included in the compensation of employees: Gollin (2002)

Compensation of Employees (cont'd)

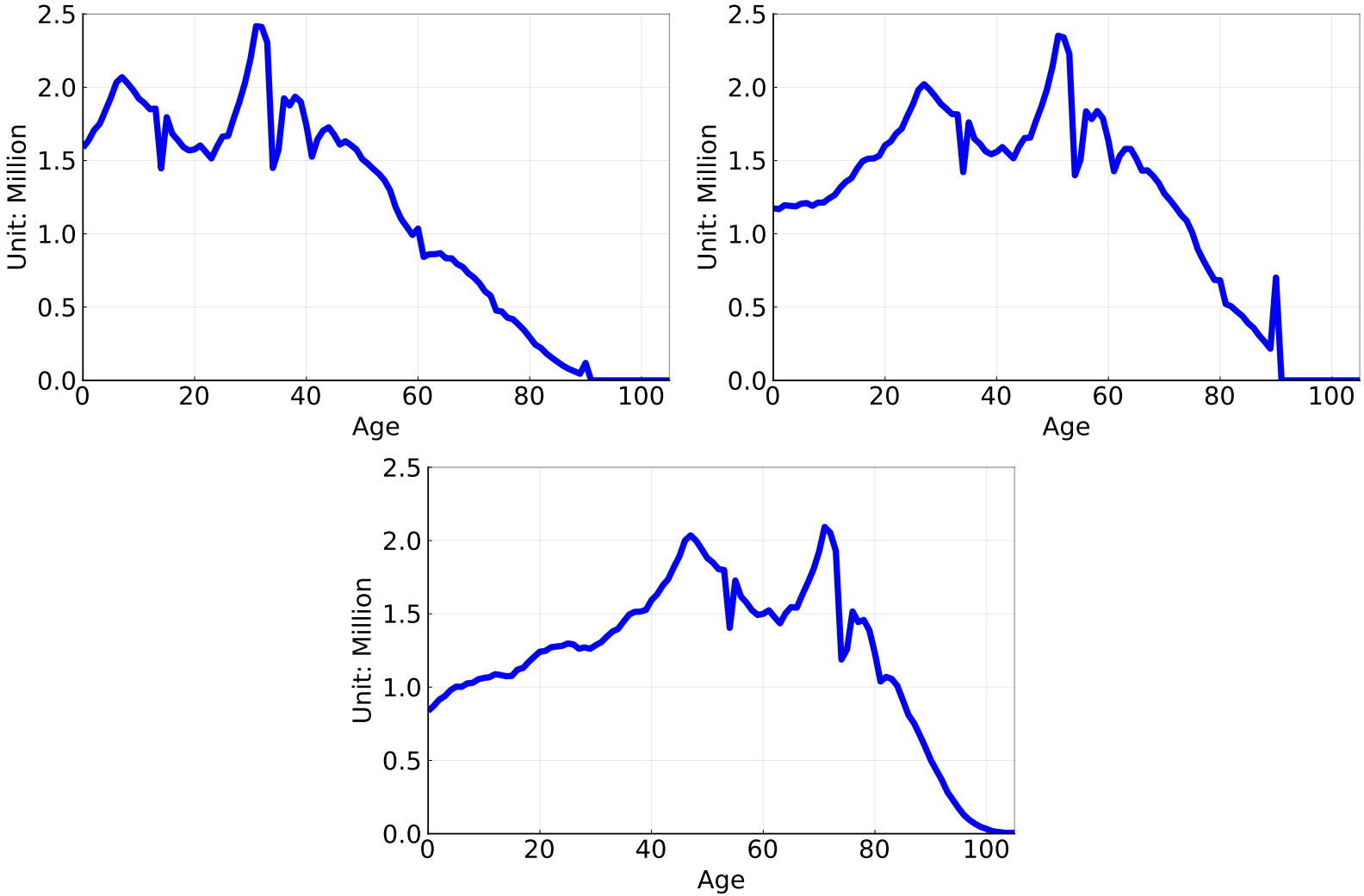
Breakdown of compensation of employees:

- Compensation of employees in year t: CoE_t
  - population of age j, gender g: $\mu_{j,g,t}$
  - $\times$ labour participation rate by age and gender: $p^l_{j,g,t}$
  - $\times$ skill distribution by age and gender: $p^e_{j,g,t}$
  - $\times$ wage by age and gender: $\eta_{j,g,e,t}$
  - $\times$ hours worked by age and gender: $\ell_{j,g,e,t}$

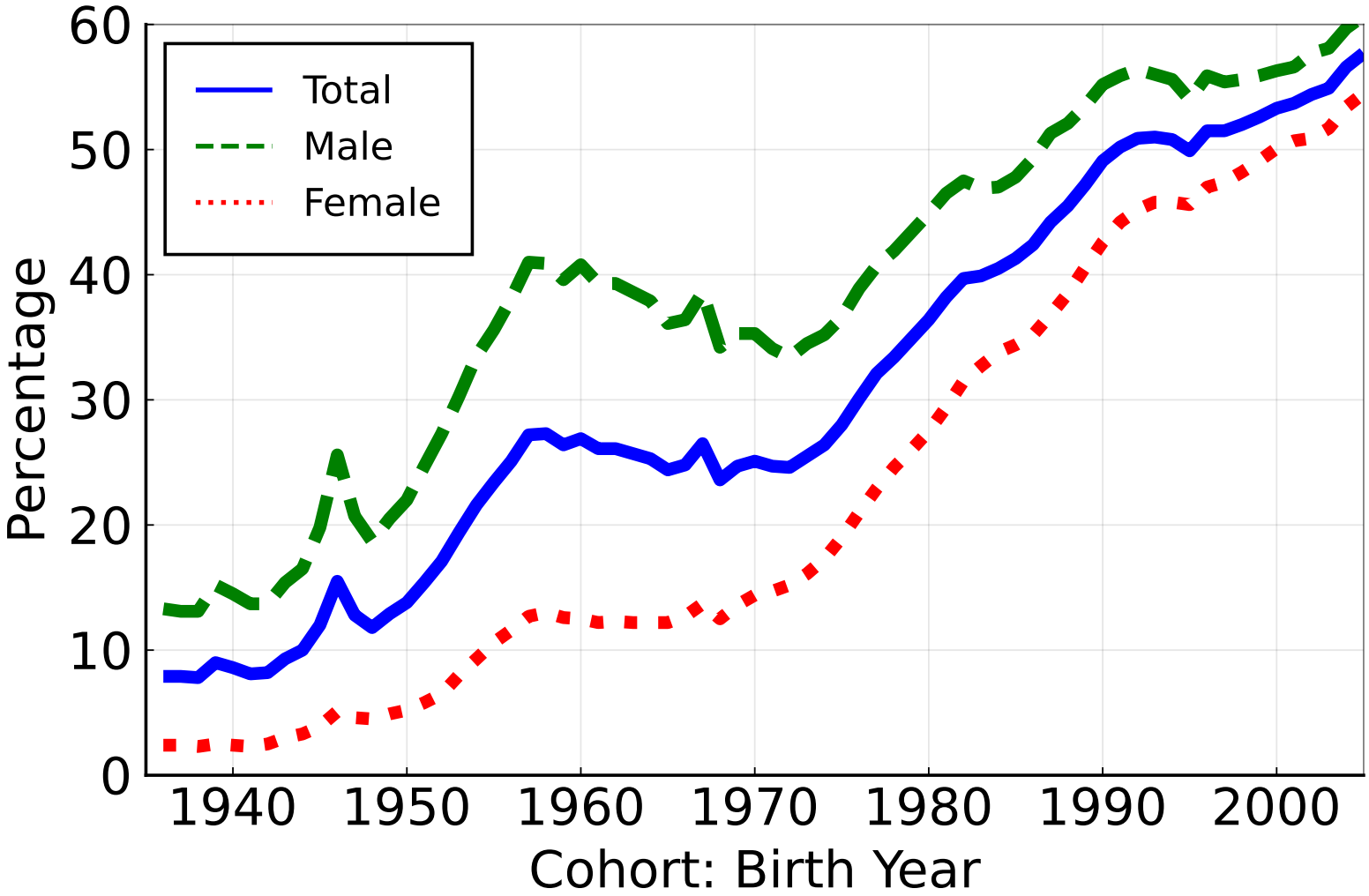
$$CoE_t = \sum_j \sum_j \sum_e \mu_{j,g,t} p^l_{j,g,t} p^e_{j,g,t} \eta_{j,g,e,t} \ell_{j,g,e,t}$$

$\Rightarrow$ **Should be affected by changes in population distribution and population ageing**

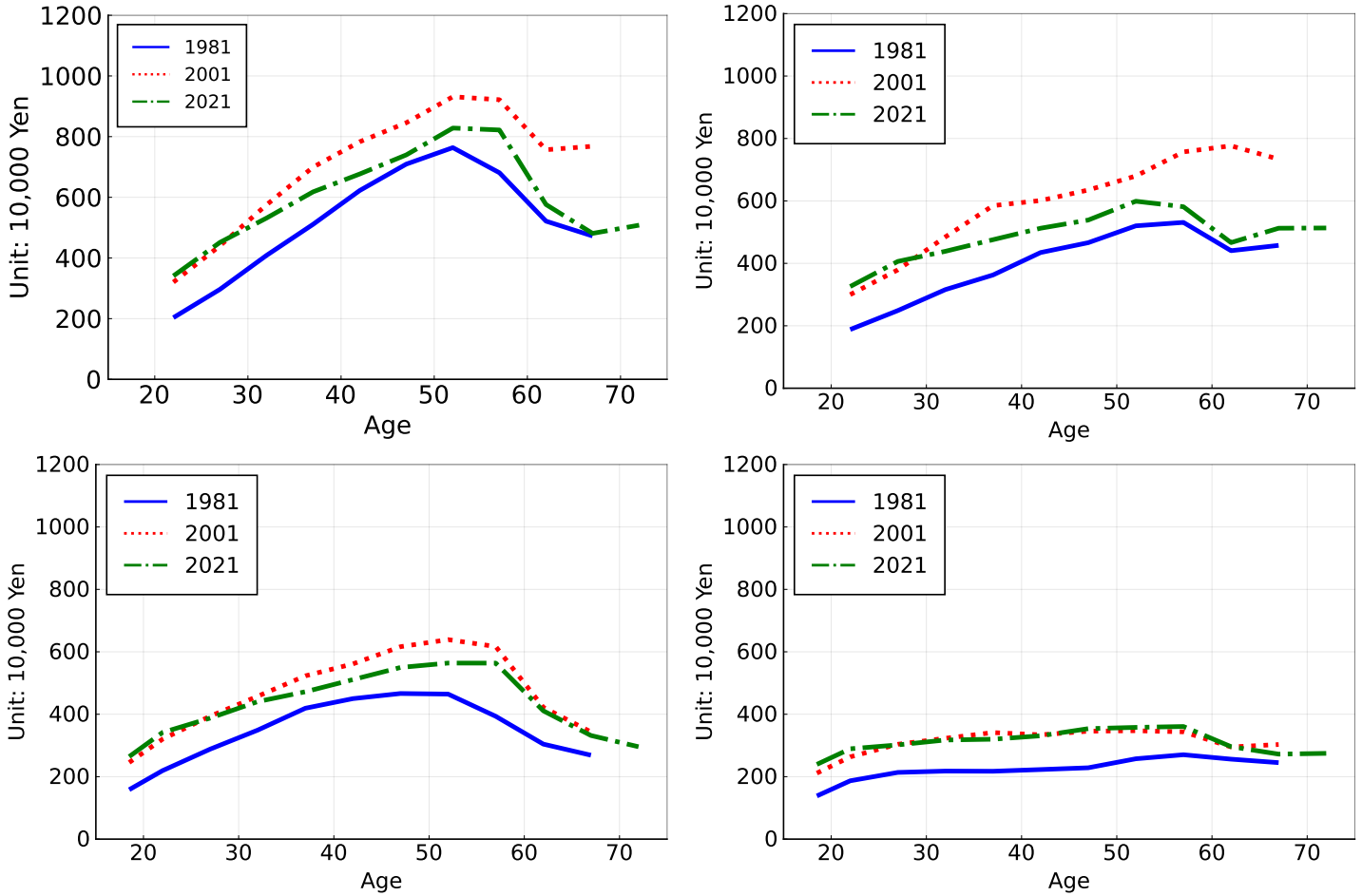
Population Distribution ($\mu_{j,g,t}$): 1980, 2000, 2020



College Enrollment Rate by Cohort ($p^e_{j,g,t}$)



Earnings Curve by Skill ($\eta_{j,g,e,t} \times \ell_{j,g,e,t}$)



- top left: male-high skill, top right: female-high skill, bottom left: male-low skill, bottom right: female-low skill

Research Question and What We Do

Research Question:

Consider the effects of population ageing on labour share

- How does the population ageing reflect in the labour share?
- Potential channels
  1. Labor supply
  2. Skill composition
  3. Capital accumulation
  4. Substitution between capital and labour

What We Will Do:

1. Introduce a new production function into a life cycle model
2. Future projection
3. Policy implications: in progress

II. Literature

Literature Review

- Piketty (2014): $r > g$
  - Utilizes French tax records: Sheds light on early 20th century and 19th century
  - Concentration of wealth
- Elsby et al. (2013), Karabarbounis and Neiman (2014)
  - Document declining labour share in the US (+ various countries)
  - Blanchard et al. (1999): Rising capital share in continental Europe amid high unemployment

Literature Review (cont'd)

Hypothesis (1): Substitution from labor to capital

- Elsby et al. (2013)
  1. Need to adjust self-employed income
  2. Capital substitution mainly in manufacturing and trade sectors
  3. Offshoring: Labor-intensive industries shift overseas
- Karabarbounis and Neiman (2014)
  1. Labor share declined in 42 out of 59 countries
  2. Decline in relative price of investment goods promoted capital investment: ICT progress
  3. Elasticity of substitution between capital and labor estimated at 1.25
- Dao et al. (2017)
  1. Global labor share declined by 5 points (1991-2014, 59 countries)
  2. ICT advancement and globalization
  3. Declining share of labor-intensive industries
- Key Points
  - Requires elasticity of substitution > 1
  - Japanese estimates slightly < 1 (Miyoshi, 2018)

Literature Review (cont'd)

Hypothesis (2): Industry structure

- Autor et al. (2017, 2020): Superstar firms
  1. Decline in aggregate labor share due to rising market share of low-labor-share firms
  2. More pronounced decline in large firms
  3. Expanding market power of superstar firms

Alternative Hypotheses:

- Rognlie (2015): Rising capital share due to housing sector expansion
- Glover and Short (2020): Capital deepening not the cause of labor share decline
- Koh et al. (2020), Aum et al. (2019)
  - US labor share decline fully explained by IPP capitalization
  - Need to reallocate part of IPP income to labor income
- Hubmer (2023)
  - Analysis of consumption patterns using CEX
  - Higher-income households prefer labor-intensive goods/services

III. Production Function

KORV Production Function

- If the production function is Cobb-Douglas type, the labour share is determined from the exogenous parameter α
- **Krusell, Ohanian, Rios-Rull and Violante (2000,ECTA):**

$$Y_t = A_t K_{st}^{\alpha} \left[\mu L_{ut}^{\sigma} + (1-\mu) \left(\lambda K_{et}^{\rho} + (1-\lambda) L_{st}^{\rho} \right)^{\frac{\sigma}{\rho}} \right]^{\frac{1-\alpha}{\sigma}}$$

  - K_s: capital structures, K_e: capital equipment
  - L_u: unskilled labour, L_s: skilled labour
- Why this function?
  - Skilled and unskilled labour are not perfect substitutes
  - The distribution of skilled and unskilled labour is quite different across cohorts, and thus year

IV. Life Cycle Model

Model

- Introduce KORV production function into a life cycle model
- Life cycle model: as simple as possible
  - Auerbach and Kotlikoff (1987): no idiosyncratic shocks
  - Introduce skilled/unskilled labour supply

A Benchmark Model: Overview

A Benchmark OLG Model

- Indivudials maximize their utility over life cycle
- Firms maxmize their profits under KORV production function
- Government balances its budget through consumption tax
- Population ageing
- Dynamic general equilibrium:
  - market clearing: goods, labour, and capital markets
  - government budget balance
  - transition between steady states: 1980-2400
- Calibrate model parameters to mach Japanese economy

Indivudials' Optimization Problem

- Indivudials maximize their utility over life cycle
  - Two types of individuals: skilled and unskilled: $e \in \{s, u\}$
- Bellman equation:

$$V_{j,t}(a, e, \hat{y}) = \max_{c,a'} \left\{ u(c) + \zeta_{j,t} \beta V_{j+1,t+1}(a', e, \hat{y}') \right\}$$

subject to

$$(1 + \tau_t^c)c + a' = (1 - \tau^y) w_t y_{j,e} + ss(\hat{y}) + R_t(a + b) - m_{j,t} - \xi^*$$

  - c: consumption, a': asset, $\zeta_{j,t}$: survival probability, β: discount factor, $\hat{y}$: pension record (*kosei nenkin*)
  - w_t: macroeconomic wage level, R_t: gross rate of return, b: accidental bequest, $y_{j,s}$: earnings, $ss(\hat{y})$: public pension, $m_{j,t}$: medical expenses, ξ^*: lump-sum transfer, τ^c: consumption tax, τ^y: income tax

Production

- **ASSUMPTION:** Allocate a fixed percentage of savings a to capital structures K_s and capital equipment K_e
- KORV production function:

$$Y_t = A_t K_{st}^{\alpha} \left[\mu L_{ut}^{\sigma} + (1-\mu) \left(\lambda K_{et}^{\rho} + (1-\lambda) L_{st}^{\rho} \right)^{\frac{\sigma}{\rho}} \right]^{\frac{1-\alpha}{\sigma}}$$

- Aggregate capital

$$K_t = K_{st} + K_{et} = \sum_j \sum_e \mu_{j,e,t} a_{j,e,t}$$

- Aggregate labor

$$L_t = L_{st} + K_{ut} = \sum_j \mu_{j,e,t} \eta_{j,s} + \sum_j \mu_{j,e,t} \eta_{j,u}$$

Government Budget

$$G_t + (1 + r^d) D_{t-1} + S_t + M_t = T_t^y + T_t^a + T_t^c + D_t + \xi^*$$

- Revenue:
  - T_t^y: labor income tax
  - T_t^a: capital income tax
  - T_t^c: consumption tax (endogenous)
  - D_t: newly issued government bond
  - ξ^*: lump-sum tax/transfer
- Expenditure:
  - G_t: government expenditure (exogenous)
  - D_{t-1}: government bond issued in the last year
  - S_t: public pension expenditures
  - M_t: medical expenditure + long-term care expenditure

Calibration: Japanese Economy

- Set all parameters of the model to match Japanese economy
  - Realized and projected population distribution: IPSS
  - Macroeconomic variables: K/Y, G/Y, and D/Y
  - College enrollment rate: MEXT
  - Medical expenditures, long-term care expenditures: MHLW

Calibration: KORV Production Function

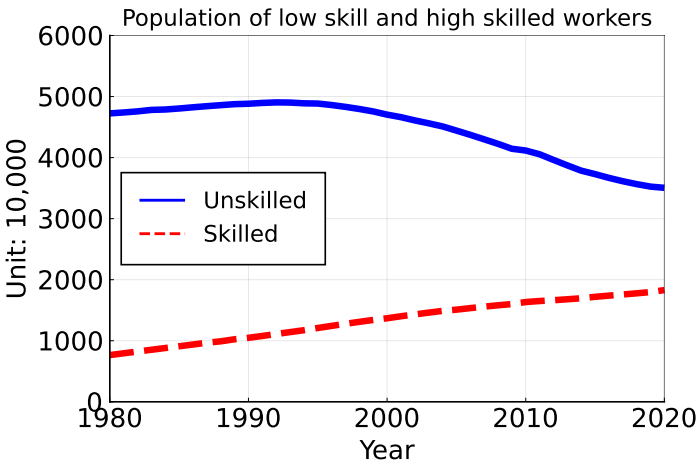
- Borrow the parameters from Maliar, Marliar and Tsener (2020,EL)
  - should update later: estimate from Japanese data

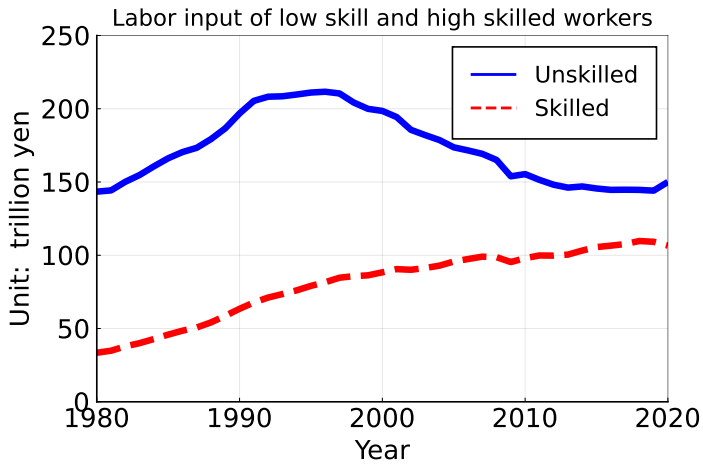
Table: Estimates of parameters of production function in the US.

Parameter	σ	ρ	α	λ	μ
KORV (2000)	.401	-.495	.117	–	–
	(.234)	(.048)	(.007)		
1963–1992	.432	-.489	.183	.536	.402
	(.027)	(.033)	(.003)	(.004)	(.065)
1963–2017	.415	-.325	.190	.534	.406
	(.011)	(.022)	(.002)	(.007)	(.130)
1963–2017 D	.421	-.273	.197	.538	.401
	(.012)	(.023)	(.003)	(.007)	(.017)

V. Results

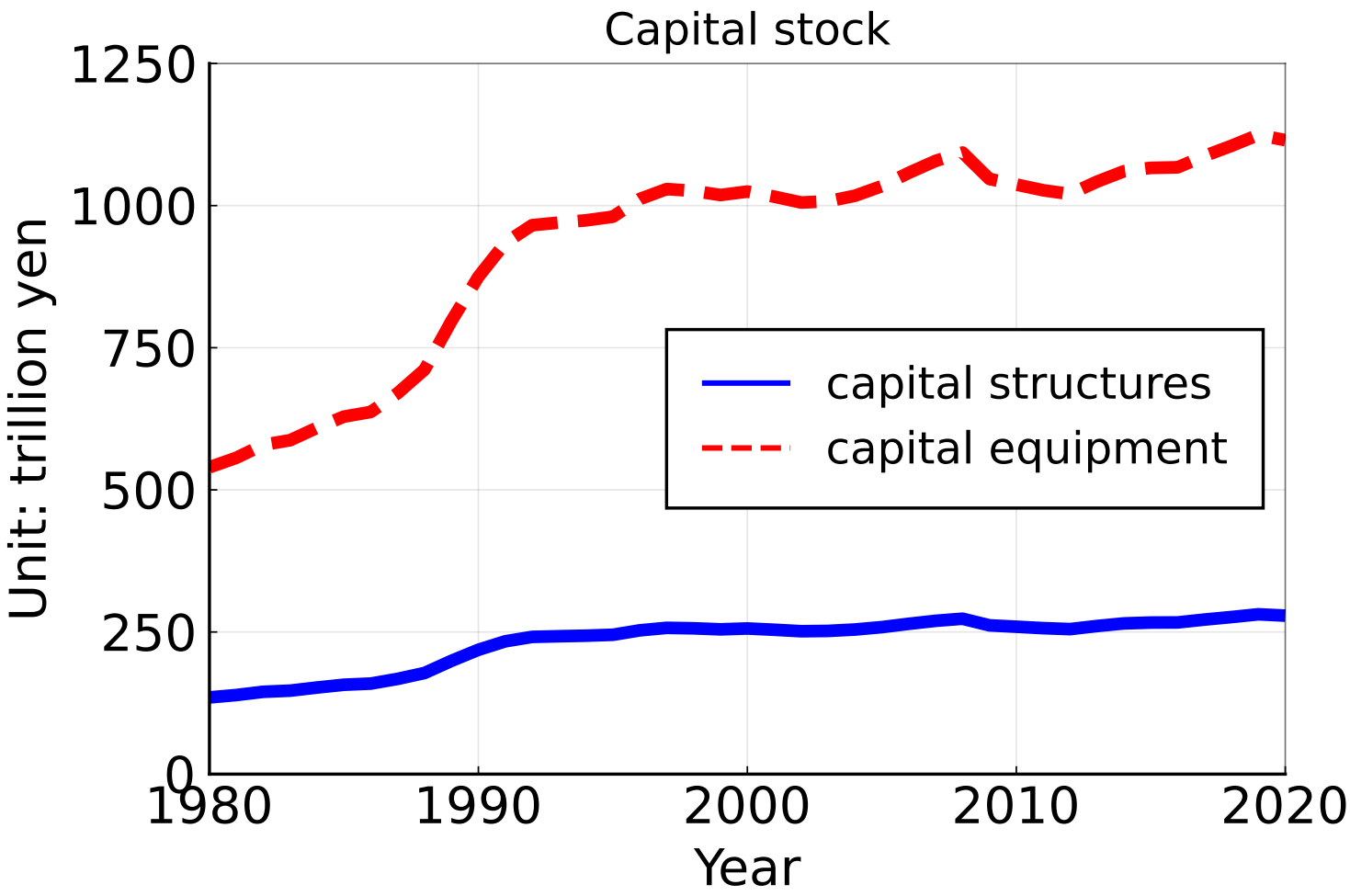
Labour Input: 1980-2020





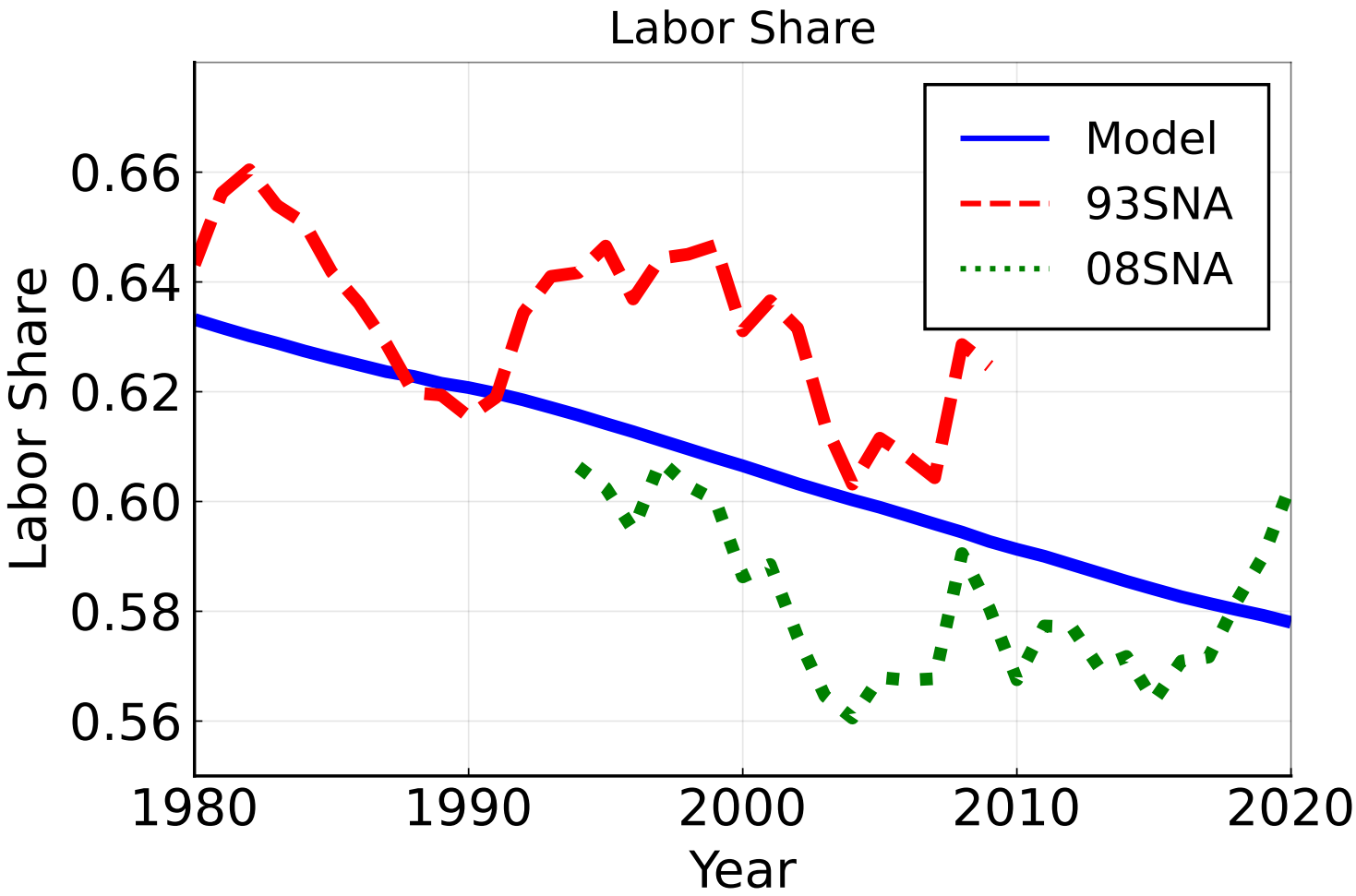
- Left: the number of workers by skill type. Right: high-skilled and low-skilled labour evaluated in monetary terms

Capital Accumulation: 1980-2020



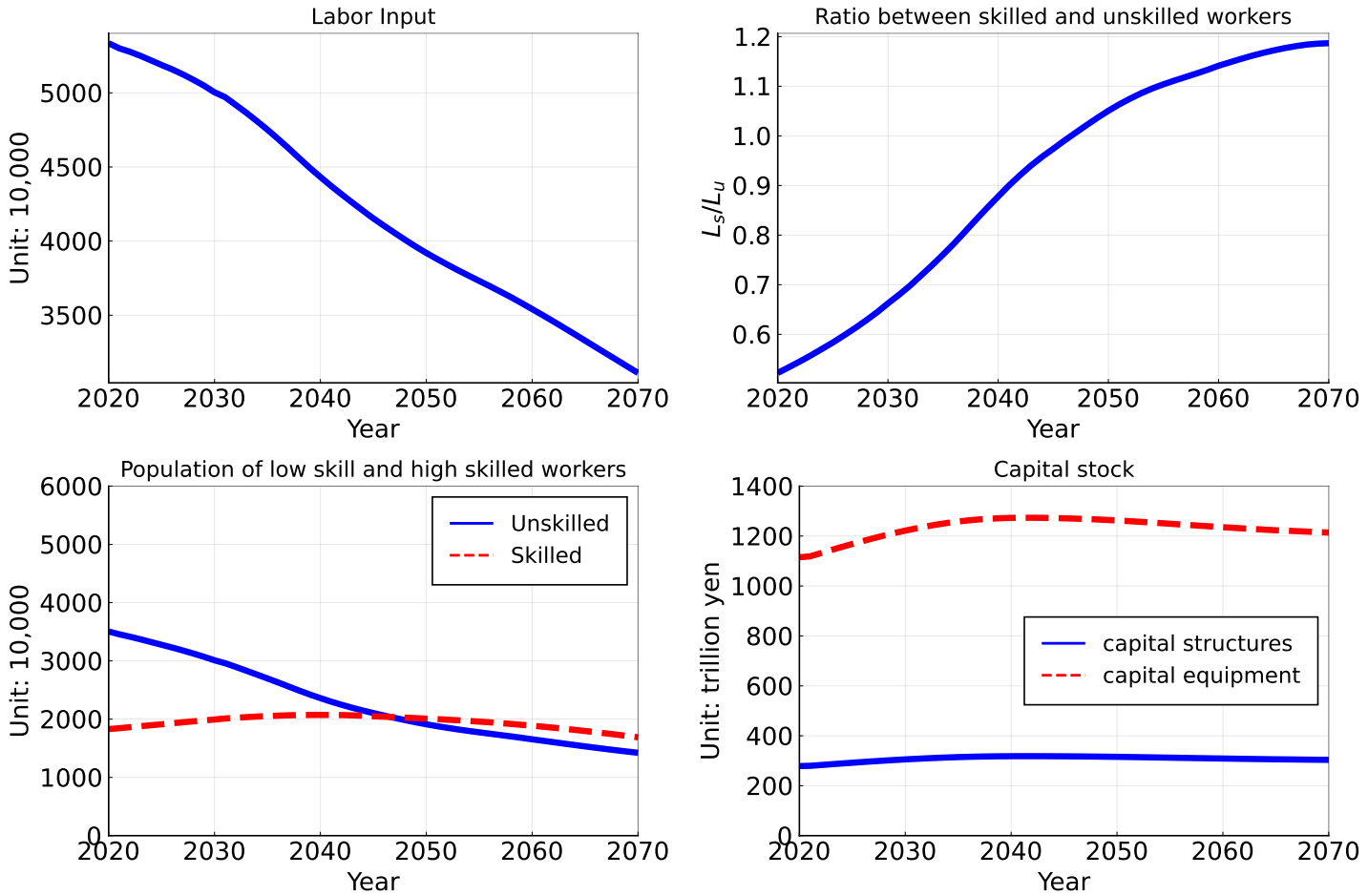
- Capital accumulation from 1980 to 2020.

Labour Share in the Model and Data



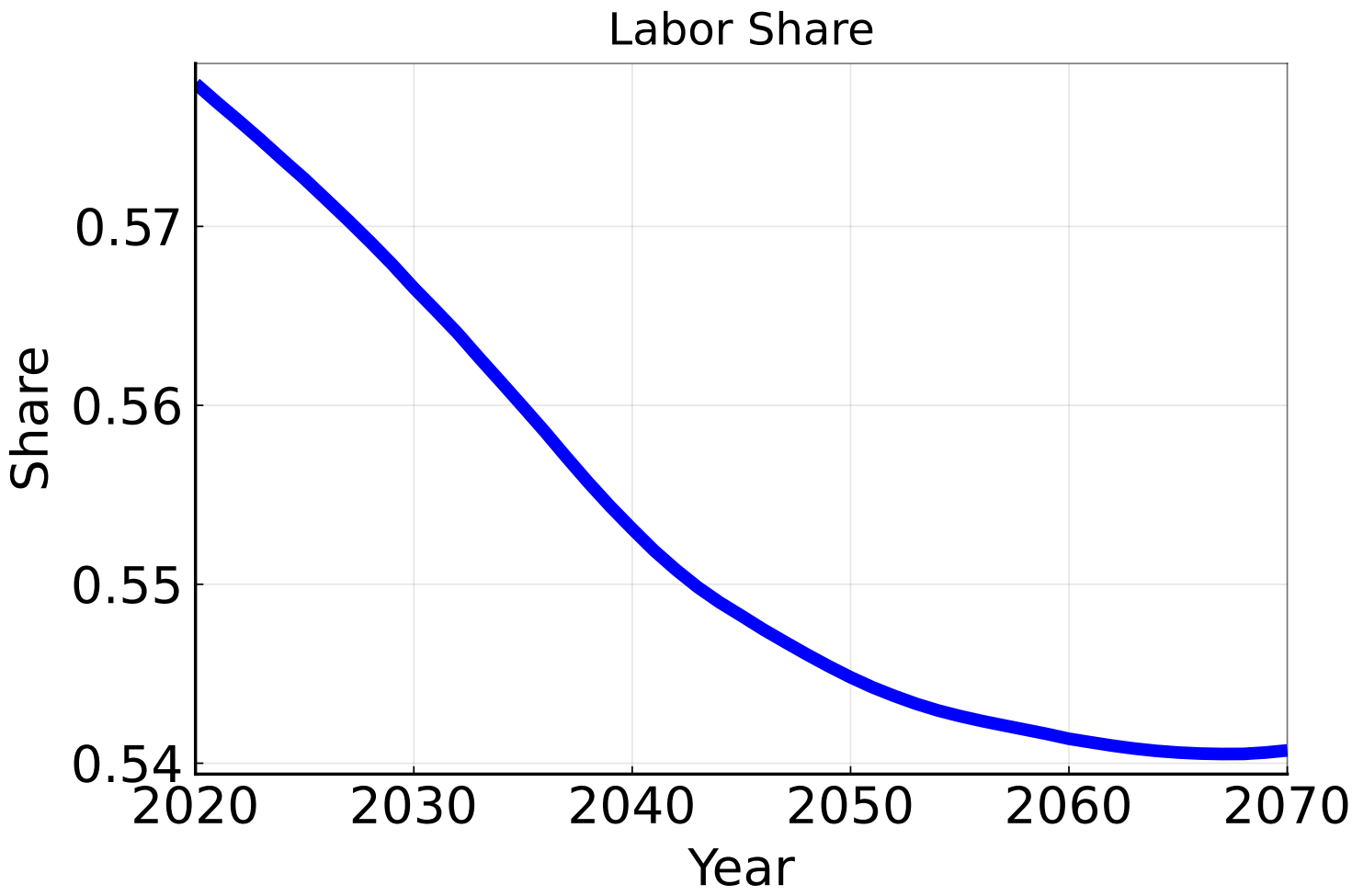
- Labour share from 1980 to 2020.

Projection: Labour and Capital



- Top left: total labour input. Top right: $\frac{L_s}{L_u}$. Bottom left: projection of the number of workers by skill type. Bottom right: capital accumulation.

Labour Share in the Model



- Labour share projection after 2020 based on KORV production function.

VI. Conclusion

Summary/Works in Progress

- Population ageing **declined** labour share
  - Changes in population dynamics and the labour market, as well as differences in capital accumulation, have pushed down the labour share by around 0.05
  - Based on our estimates, the labour share will decline by around 0.025 over the next 40 years
- Works in progress
  - The difference in the impact of redistribution policies, including social security reforms, on social welfare due to the use of different production functions

Merci Beaucoup!

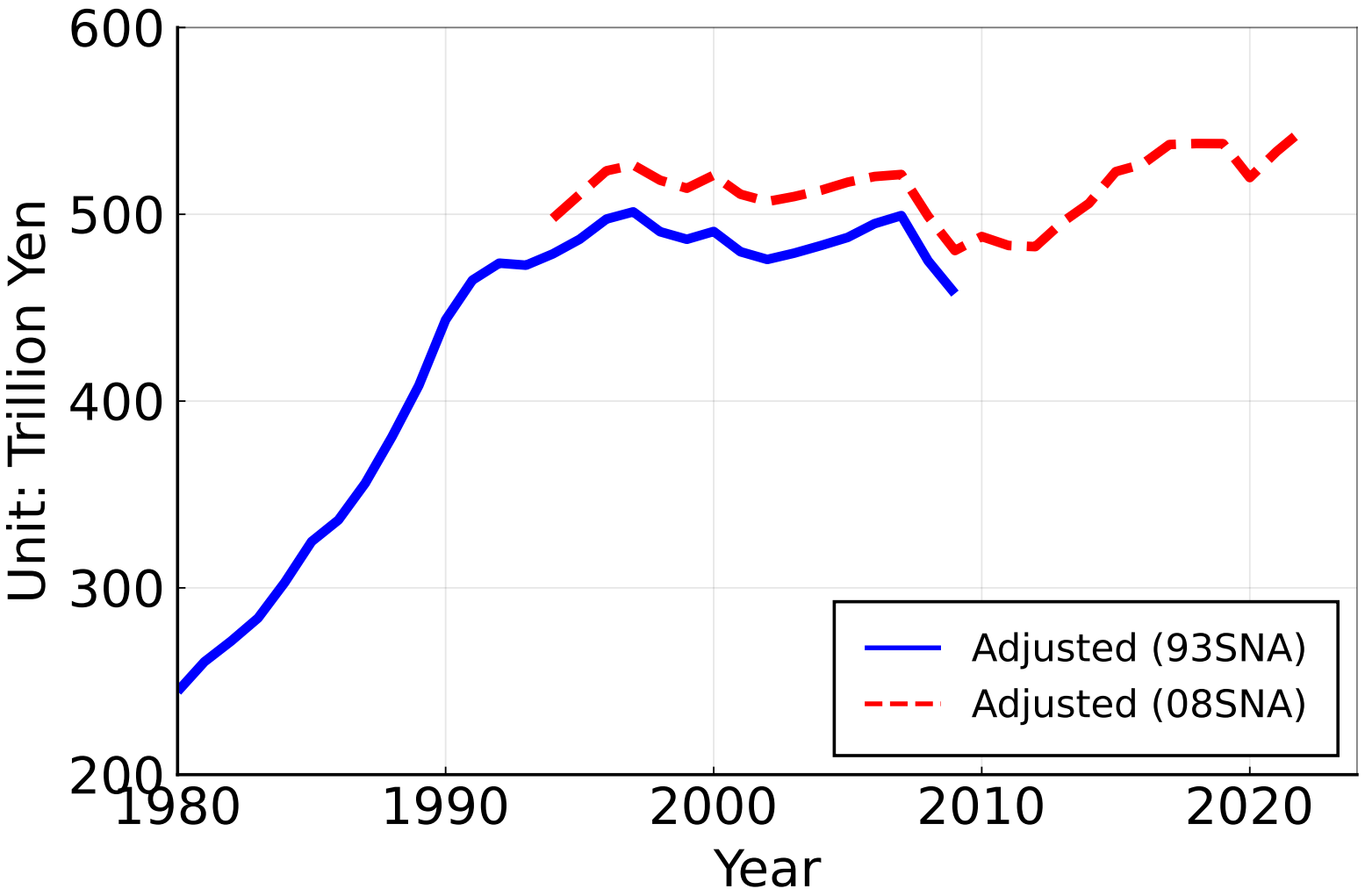
Backup Slides

Gollin (2002)'s Adjstment

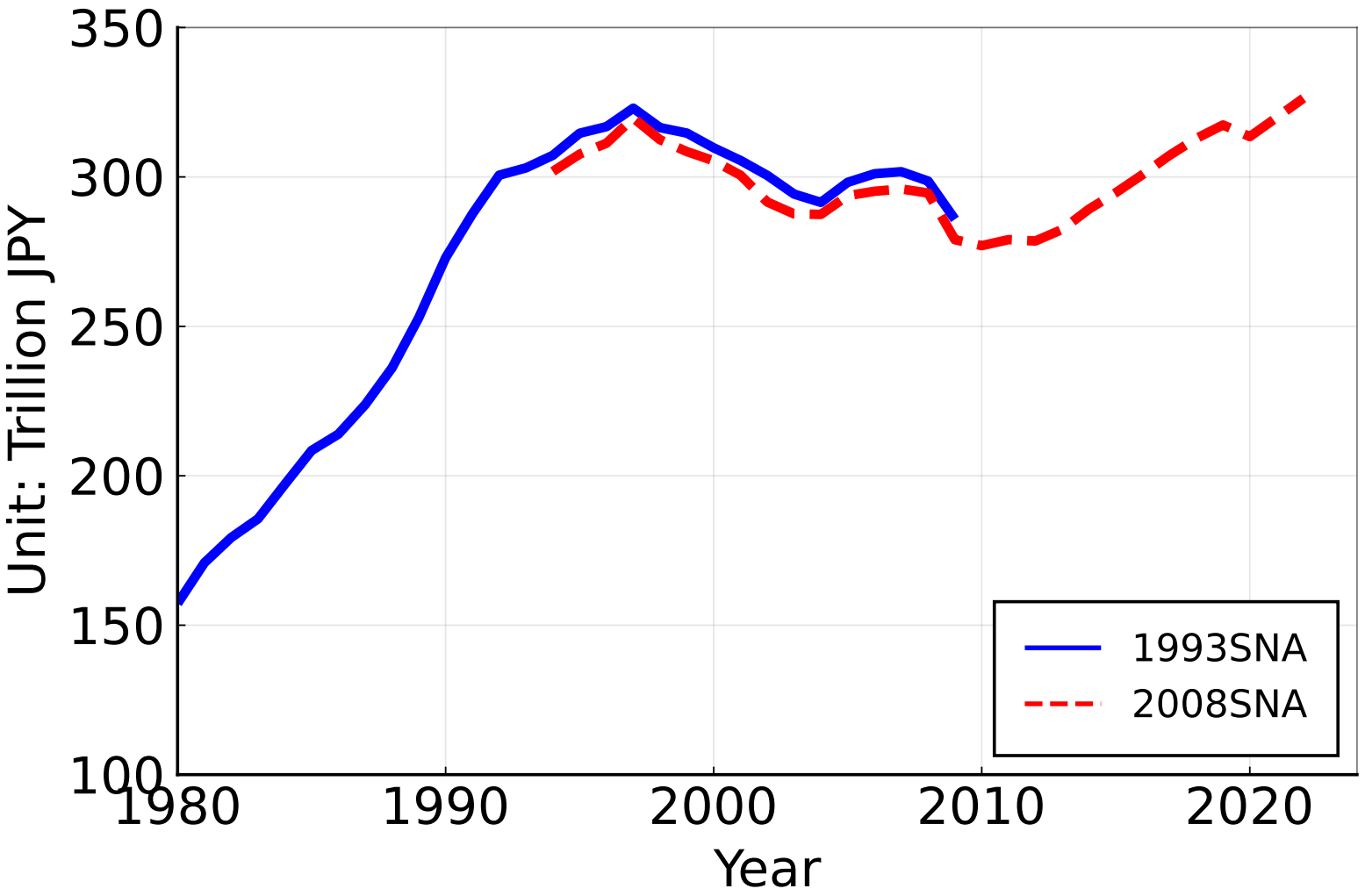
RETURN

- Gollin (2002): Need to adjust self-employed income
  - Explains variations in labour share across countries
  - Self-employed income: Operating surplus+Mixed income
- labour income: Adjusting employee compensation
  1. Add 80% of mixed income to employee compensation
  2. Add 50% of (taxes on production and imports − subsidies) to employee compensation
- Capital income
  - Households: Operating surplus (owner-occupied housing) + Mixed income × 0.2
  - Firms: Non-financial corporations + Financial institutions
  - Government: (Taxes on production and imports − subsidies) × 0.5
- Adjusting capital depreciation
  - Exclude capital depreciation of general government
  - Consistency with the model (Hayashi and Prescott, 2002)

After-adjusted Nominal GDP



After-adjusted Compensation of Employees



Compensation of Employees/National Income