Achieving Fiscal Balance in Japan

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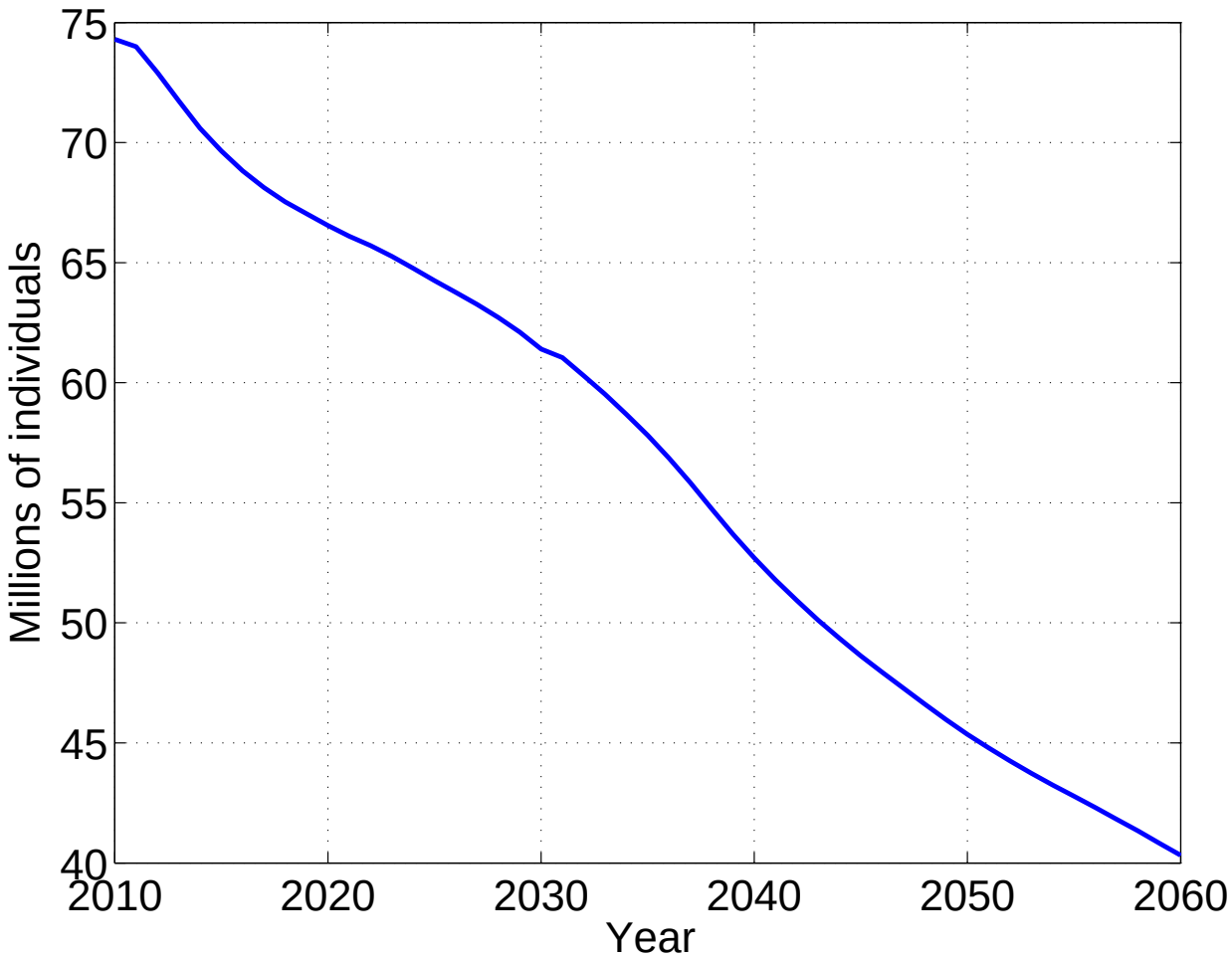
Background of Our Research

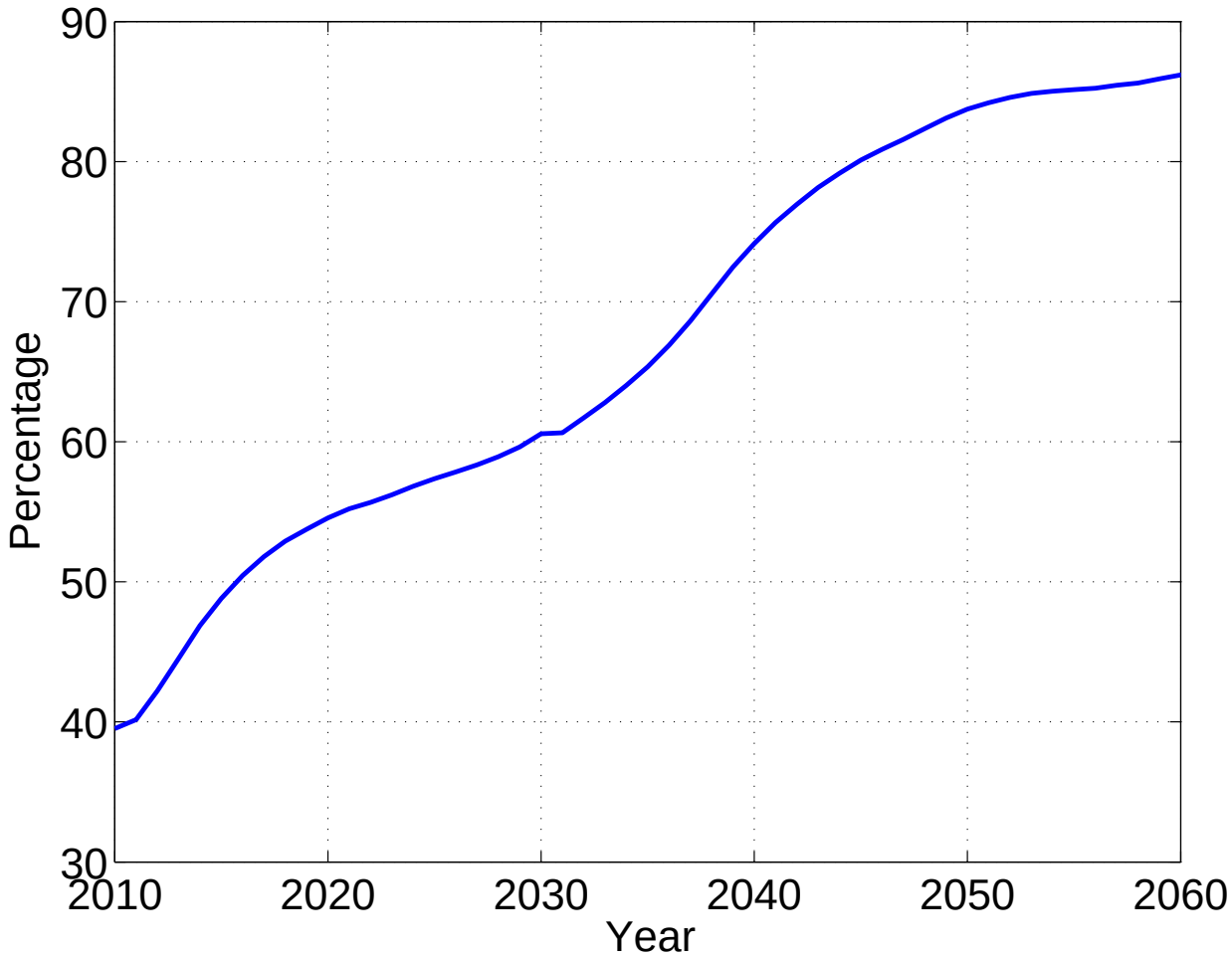
- Several rounds of fiscal stimulus packages since early 1990s have resulted in the highest debt to GDP ratio in the developed world
- Japan has the fastest aging population among the depeloped nations
  - Public pension system
  - Health expenditures

1. How severe demographic and fiscal challenges are
2. How various events and government policies may affect fiscal sustainability

Working Age Population



Old-age Dependency Ratio



What We Do: Develop a Measurement Device

- A large scale overlapping generations model for Japan to evaluate the demographic change and fiscal challenges
  - individuals differ in age, gender, employment status, income, and asset holdings
  - incorporate the Japanese pension rules
  - incorporate estimated age-consumption and age-earnings profiles
- Calculate projections of future government budget balances, JGBs, and the pension fund
- Sensitivity and experiments

What We Do (cont.)

- Conduct "accounting" exercises
- Sensitivity
  - No macroeconomic slide, different wage growth rates, returns on the pension fund and JGBs, different fertility rates, different survival projections
- Policy experiments
  1. Pension rules
  2. Consumption tax
  3. Female labor force participation (FLFP) and compensation

Findings

- Current policy and medium demographic projections lead to significant non-pension and pension deficits, and increasingly large interest burden on the budget
- Further pension reform is needed
- Increasing FLFP is important

(Incomplete) List of Related Research

- İmrohoroğlu and Sudo (2010,2011)
- Braun and Joines (2011)
- Hoshi and Kashyap (2012)
- Hoshi and Ito (2012)
- Hansen and İmrohoroğlu (2011)
- Broda and Weinstein (2005), Doi, Hoshi, and Okimoto (2011)

Government Budget

$$B_{t+1} - F_{t+1} = (1 + r_{b,t})B_t - (1 + r_{f,t})F_t + G_t + TR_t + P_t - T_t - PR_t$$

- B_t: government debt, F_t: pension fund
- G_t: government purchases of goods and services, TR_t: non-pension transfers to individuals,
  P_t: pension benefits to retirees
- T_t: tax revenue, PR_t: pension premium
- $r_{b,t}$: real interest rate on JGBs, $r_{f,t}$: real return of the pension fund

Government Budget (cont.)

$$
\begin{aligned}
T_t &= \tau_{c,t} \sum_{i,j,e} c_{i,j,t} n_{i,j,e,t} + \tau_{a,t} r_{a,t} \sum_{i,j,e} a_{i,t} n_{i,j,e,t} \\
&\quad \tau_{l,t} \sum_{i,j,e} y_{i,j,e,t} n_{i,j,e,t} + \tau_{ls,t} \sum_{i,j,e} n_{i,j,e,t} \\
TR_t &= \sum_{i,j,e} tr_t n_{i,j,e,t} \\
G_t &= \sum_{i,j,e} g_t n_{i,j,e,t} \\
P_t &= \sum_{i,j,e} p_{i,j,e,t} n_{i,j,e,t} \\
PR_t &= \sum_{i,j,e} \tau_{p,t}(y_{i,j,e,t}) n_{i,j,e,t}
\end{aligned}
$$

Pension Benefit

- Pension benefits in Japan follow a three-tiered structure
  1. The basic pension (Kiso Nenkin)
  2. The employees' pension insurance (Kosei Nenkin Hoken)
  3. Optional schemes (like private saving)
- The law of motion for the pension fund:

$$F_{t+1} = (1 + r_{f,t})F_t + PR_t + X_t - P_t$$

- X_t: Contribution from the general government revenues to the payment of basic pension benefits

Model Overview

- A large scale overlapping generations model
- Consider Japanese economy from 2010 to 2100
  - $t = 2010, ..., 2100$
- $\{i, j, e\}$: the age of an adult i, gender j, employment type e
  - $i \in \{1, ..., 91\}$
  - $j \in \{m, f\}$
  - $e \in \{R, C, S, U\}$: employed at a regular job (R), a contingent job (C), self-employed (S), or not working (U)

Demographics

- $\tilde{i}$: the age of an individual, $\tilde{i} \in \{1, ..., 111\}$.
  - enter the economy at adult age I_A
  - live up to $\tilde{I}$ years, but face the survival risk $s_{\tilde{i},j,t}$
  - $i = \tilde{i} - I_A + 1$ if $\tilde{i} \geq I_A$
- $\tilde{n}_{\tilde{i},j,e,t}$: the number of individuals of type $\{\tilde{i}, j, e\}$
- $\phi_{\tilde{i},t}$: the fertility rate

Dependent Children

- Need consumption, income and asset profile to compute tax revenues
- Individual consumption profile depends on the number of dependent children
  - $\tilde{d}_{t,\tilde{i},k}$: the number of dependents of age k that parents of age $\tilde{i}$ support at time t
  - $d_{t,\tilde{i}} = \sum_{k=1}^{I_A-1} \tilde{d}_{t,\tilde{i},k} o_k$: the total number of children for a mother of age $\tilde{i}$ at time t

Labor Force Participation and Earnings

Earnings of type $\{i, j, e\}$ individuals at time t is $y_{i,j,e,t}$.
Employment state: $e \in \{R, C, S, U\}$

- R: regular job (*seishain* or *seiki-koyou*)
- C: non-regular job (*hi-seishain* or *hi-seiki-koyou*)
- S: self-employed
- U: not working (unemployed or not in labor force)

Individuals' Consumption Profiles

- With complete markets:

$$
\begin{aligned}
& c_{i,j,t+i}(1+\tau_{c,t+i}) \\
& = \widehat{\lambda}_{i,t} \sum_{m=i_A}^{I} \frac{1}{\prod_{k=1}^{m}[1+r_{a,t+k}(1-\tau_{a,t+k})]} S_{m,j,t+m} \\
& \sum_{e} \frac{n_{m,j,e,t+m}}{\sum_{e} n_{m,j,e,t+m}} [(1-\tau_{l,t+m}) y_{m,j,e,t+m} - \\
& \tau_{p,t}(y_{m,j,e,t+m}) - \tau_{ls,t} + p_{m,j,t+m} + tr_{m,j,e,t+m}]
\end{aligned}
$$

Earnings, Consumption and Asset Holdings

- Estimate $y_{i,j,e,t}$ from FIES
- Estimate $\tilde{\lambda}_i$ from FIES; $\lambda_{i,t} = \tilde{\lambda}_i(1 + d_{t,i}\tilde{\nu})$
- Use $\widehat{\lambda}_{i,t} = \lambda_{i,t} S_{i,j,t+i} / \prod_{k=1}^{i}[1 + r_{a,t+k}(1 - \tau_{a,t+k})]$. $S_{i,j,t+i} \equiv \prod_{k=1}^{i} s_{k,j,t+k}$

Earnings, Consumption and Asset Holdings

- Now compute $c_{i,j,t+i}$ using permanent income hypothesis as shown above
- Compute the asset holdings at each age using the flow budget constraint:

$$
\begin{aligned}
& c_{i,j,t+i}(1+\tau_{c,t+i}) + s_{i,j,t+i}a_{i+1,t+i+1} \\
& = (1-\tau_{l,t+i})y_{i,j,e,t+i} - \tau_{p,t+i}(y_{i,j,e,t+i}) \\
& -\tau_{ls,t+i} + p_{i,j,t+i} + tr_{i,j,e,t+i} \\
& +[1+r_{a,t+i}(1-\tau_{a,t+i})]a_{i,t+i}
\end{aligned}
$$

Demographics

- Fertility/mortality rate:
  - estimates and projections by the National Institute of Population and Social Security Research (IPSS)
  - $t = 2010, .., 2100$
- Population in 2010: Population Census

GO TO FIGURE Total fertility rates

GO TO FIGURE Life expectancy (male)

GO TO FIGURE Life expectancy (female)

Labor Market

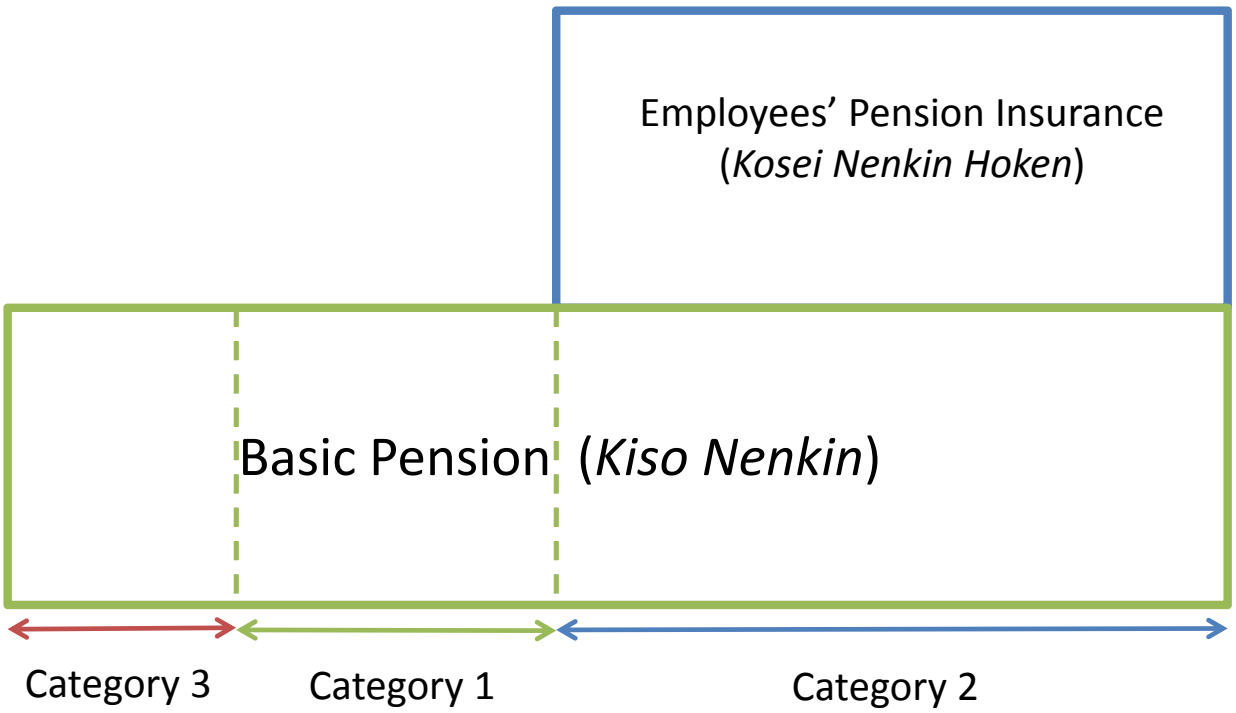
- Labor force participation rate by gender and employment type (LFS):
  1. Regular worker
  2. Contracted worker
  3. Self-employed
  4. Not-in-labor force
- Earnings profile by gender and employment type (BSWS):

GO TO FIGURE Labor force participation rate (male)
GO TO FIGURE Labor force participation rate (female)
GO TO FIGURE Earnings profiles (male)
GO TO FIGURE Earnings profiles (female)

Government Debt and Pension Fund

- Net Government Debt B_t: 678.6 trillion yen.
  - liabilities: 786 tr. yen (central) and 184 tr. yen (local)
  - financial asset: 200 tr. yen (central) and 72 tr. yen (local)
- Initial pension fund F_t: 178.3 trillion yen.
  - includes mutual aid pension (KYOSAI)
  - excludes employees' pension funds (Kosei Nenkin Kikin)
- Interest rates:
  - government bonds r_b: 1%
  - public pension fund r_f: 2%
  - private assets r_a: 3%

Public Pension System in Japan



Public Pension

$$p_{i,j,t} = (1 + x_{t,t-i}) \left[p^b_{i,j,t} + \xi_{t,t-i} \times \overline{y}_{i,j,t} \right], \qquad (1)$$

$p^b_{i,j,t}$: basic pension for a retiree of age i and gender j at time t

$\xi_{t,t-i}$: affects the replacement rate

$\overline{y}_{i,j,t}$: average past earnings

Due to past pension reforms, $\xi_{t,t-i}$ depends on the individual's birth year $t - i$

We set $\xi_{t,t-i}$ to match the total amount of the second-tier payment with the data

$x_{t,t-i}$ is the macroeconomic slide factor that is explained below.

Benefits and Contributions

- Benefits
  1. Kiso Nenkin: max ¥792,000 in 2010; we use ¥590,304 actual average for new recipients
  2. Kosei Nenkin: earnings-related
- Contribution to the pension system: $\tau_p(y)$
  1. Kiso Nenkin: ¥14,980 in 2010, and ¥16,900 in 2017.
     - Contingent job workers and self-employed
  2. Kosei Nenkin Hoken: 16.058% in 2010, and 18.3% in 2017.
     - Regular workers

Macroeconomic Slide

Given inflation rate π_t and growth rate of real wages g_t^w, the slide factor $x_{t,t-i}$ is given by:

$$\begin{aligned} x_{t,t-i} &= (1+g_t^x)x_{t-1,t-1-i}, \qquad (2) \\ g_t^x &= \begin{cases} \max\{g_t^* - s_t, 0\} & \text{if } g_t^* \geq 0, \\ g_t^* & \text{if } g_t^* < 0. \end{cases} \end{aligned}$$

- New recipients (*Shinki-saitei*): $g_t^* = g_t^w + \pi_t$
- Existing recipients (*Ki-saitei*): $g_{t,t-i}^* = \pi_t$

Example: $\pi_t = 1.0\%, g_t^w = 2.0\%$ and $s_t = 0.9\%$
Without macro slide, 3.0% annual increase in benefits for each successive cohort.
With macro slide, $3.0\% - 0.9\% = 2.1\%$.
For current retirees, an increase of only $1.0 - 0.9 = 0.1\%$.

Government Budget

- Tax rates:
  - Consumption tax rate τ_c: 5% in 2010 to 8% in 2014 to 10% in 2015
  - Capital income tax rate τ_a: 35%
  - Labor income tax rate τ_l: 10%
  - Lump-sum tax τ_{ls}: adjust to match total revenue
- Target total tax revenue in 2010:
  - 78.6 trillion yen (cental and local)
- Gov't expenditure and transfers in 2010:
  - G_t: 77.6 trillion yen (cental and local)
  - TR_t: 18.2 trillion yen

Consumption Profile

- Estimate λ_i to match consumption profile
  - Control cohort and year effects following Aguiar and Hurst (2009)

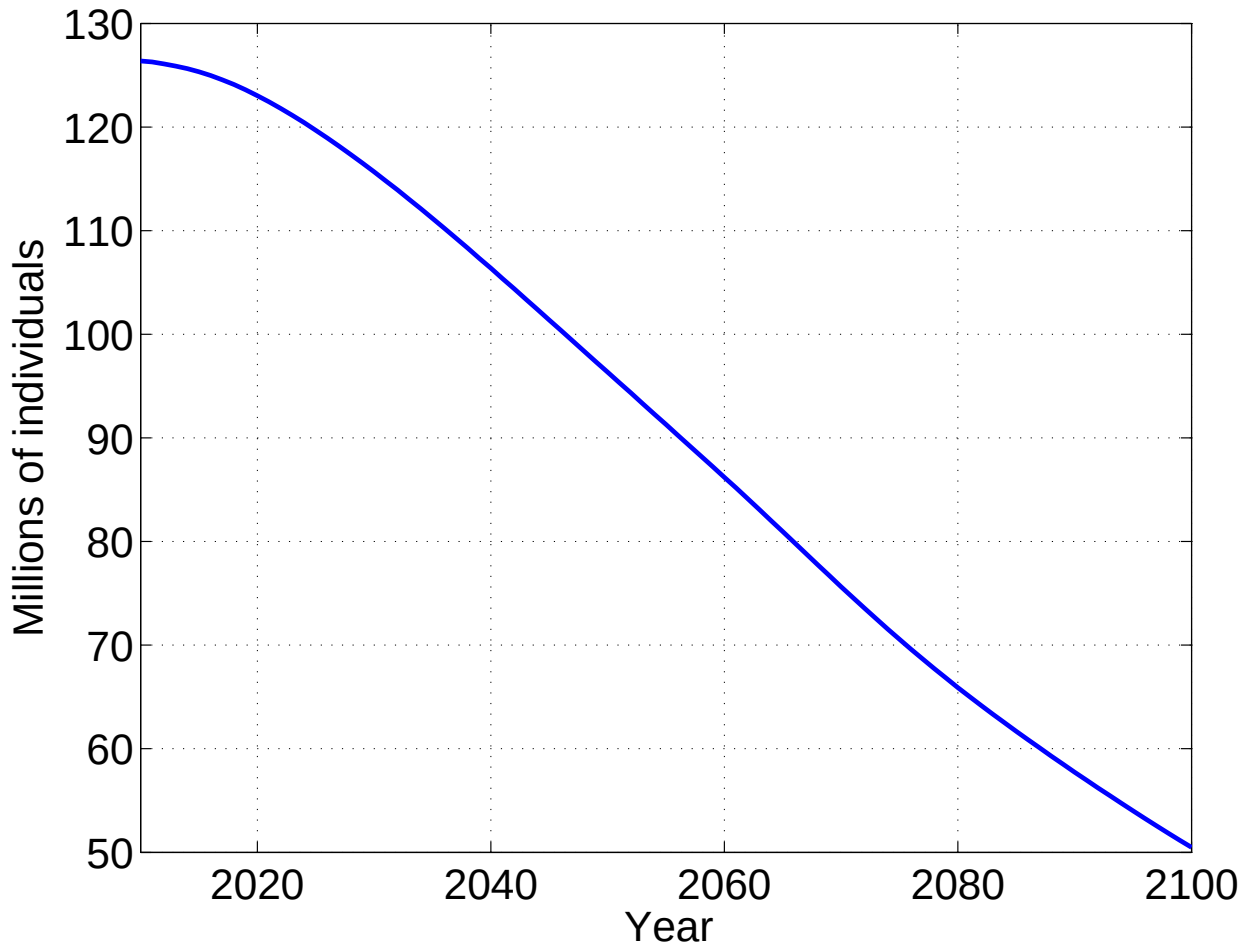
$$\ln C_{it} = \beta_0 + \beta_{\text{age}} D_{it}^{\text{age}} + \beta_c D_{it}^{\text{cohort}} + \beta_t D^{\text{time}} + \beta_{\text{fam}} \mathbf{X}_{it} + \epsilon_{it}$$

GO TO FIGURE Consumption profile

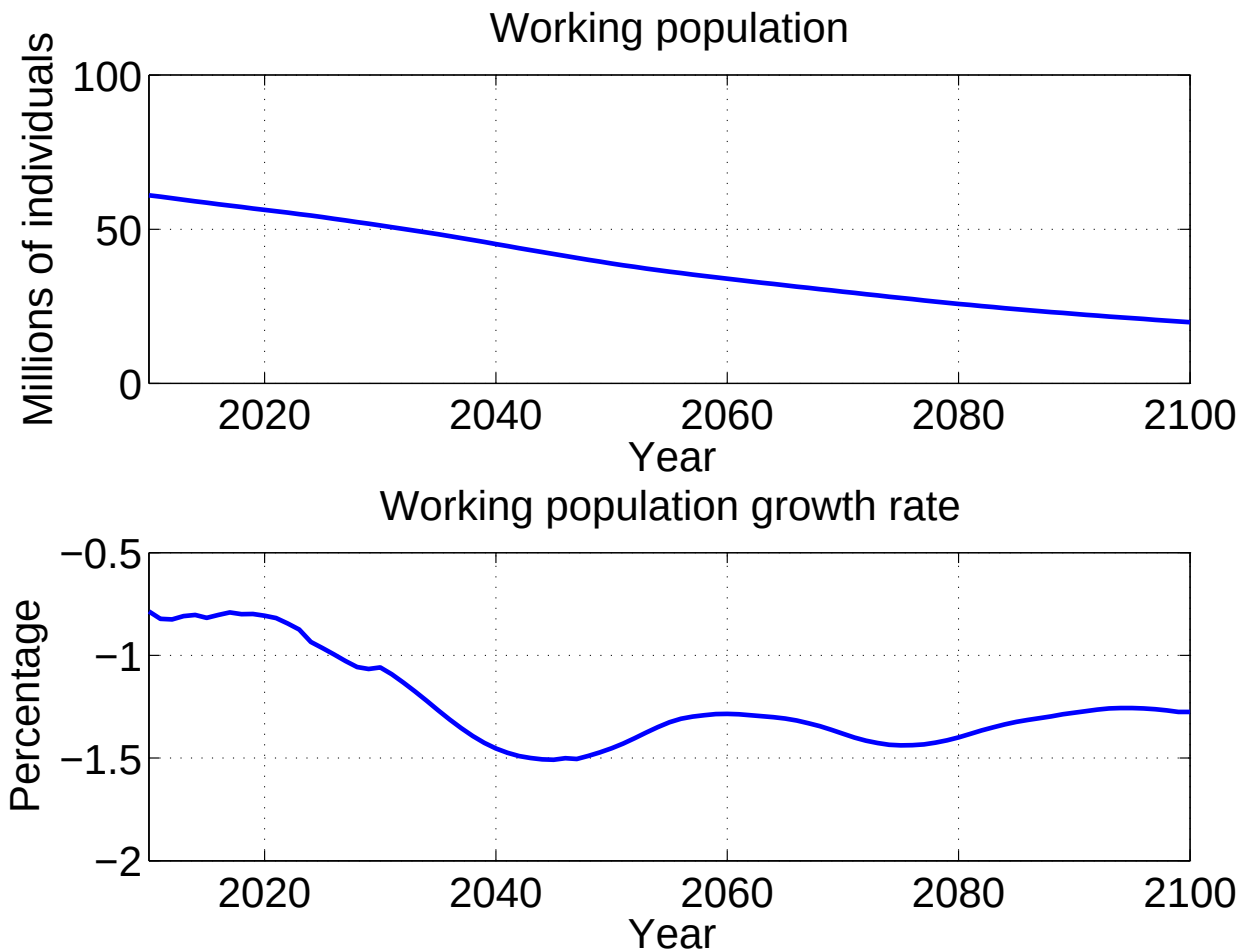
Benchmark Transition

- Total population
- Projected GDP: 2010-2100
- Net government debt: % of GDP
- Source of net borrowing
- Government accounts

Total Population



Working Population

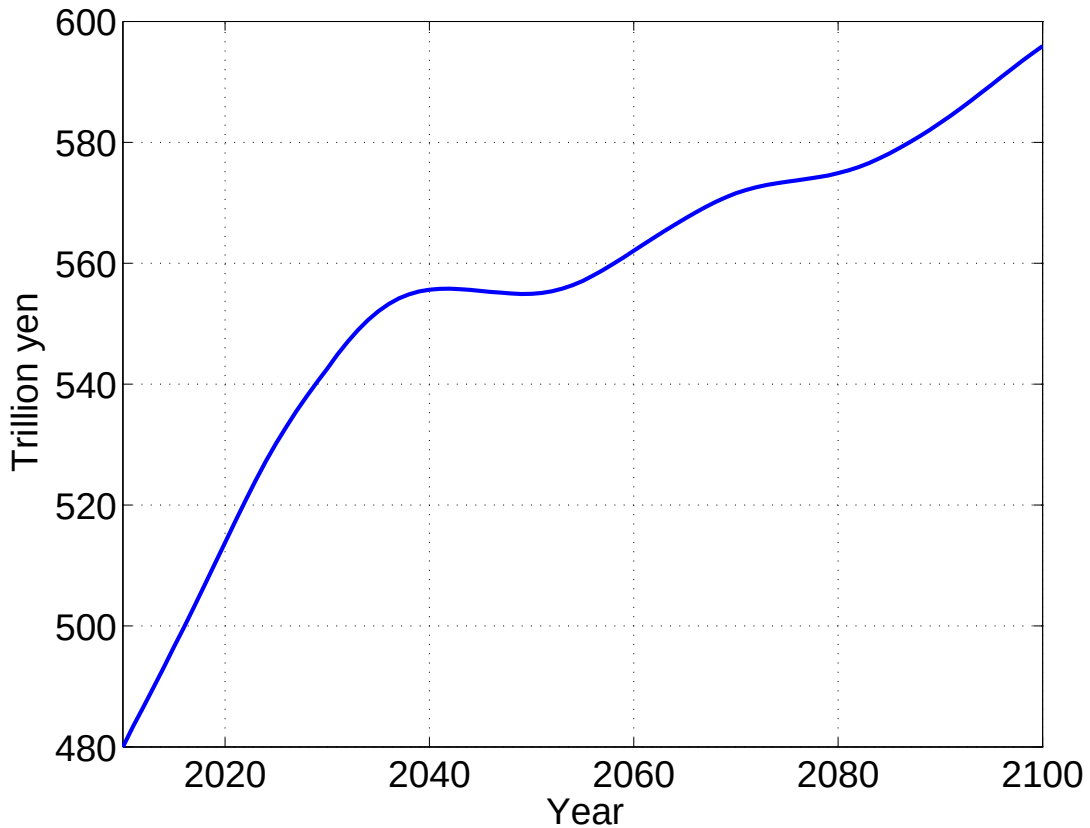


GDP Dynamics

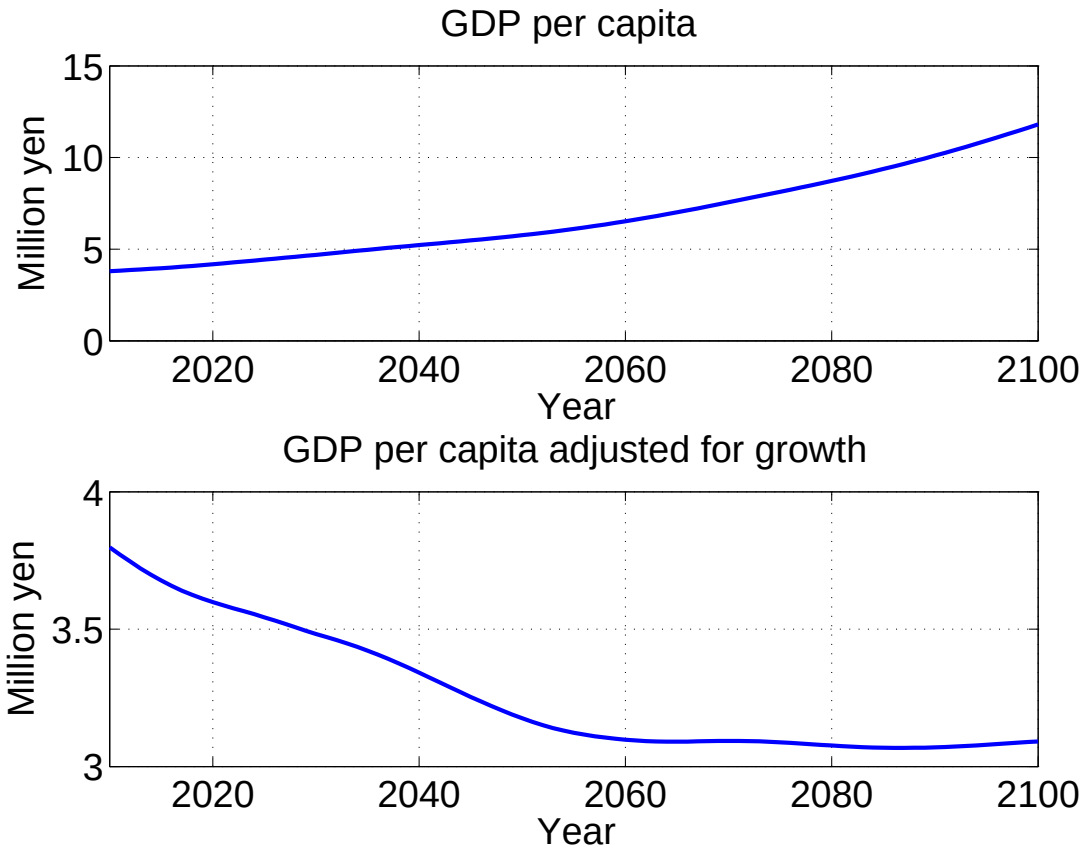
$$GDP_{t+1} = (1 + g_t^w)(1 + g_t^n)GDP_t,$$

g_t^n : working population growth rate
$GDP_{2010} = 480$ trillion yen
$g_t^w = 1.5\% =$ also growth rate of GDP per worker
GDP = (GDP per worker) $\times$ working population
Growth rate of population exceeds growth rate of working population
Therefore GDP per capita grows less than 1.5%

Projected GDP: 2010-2100



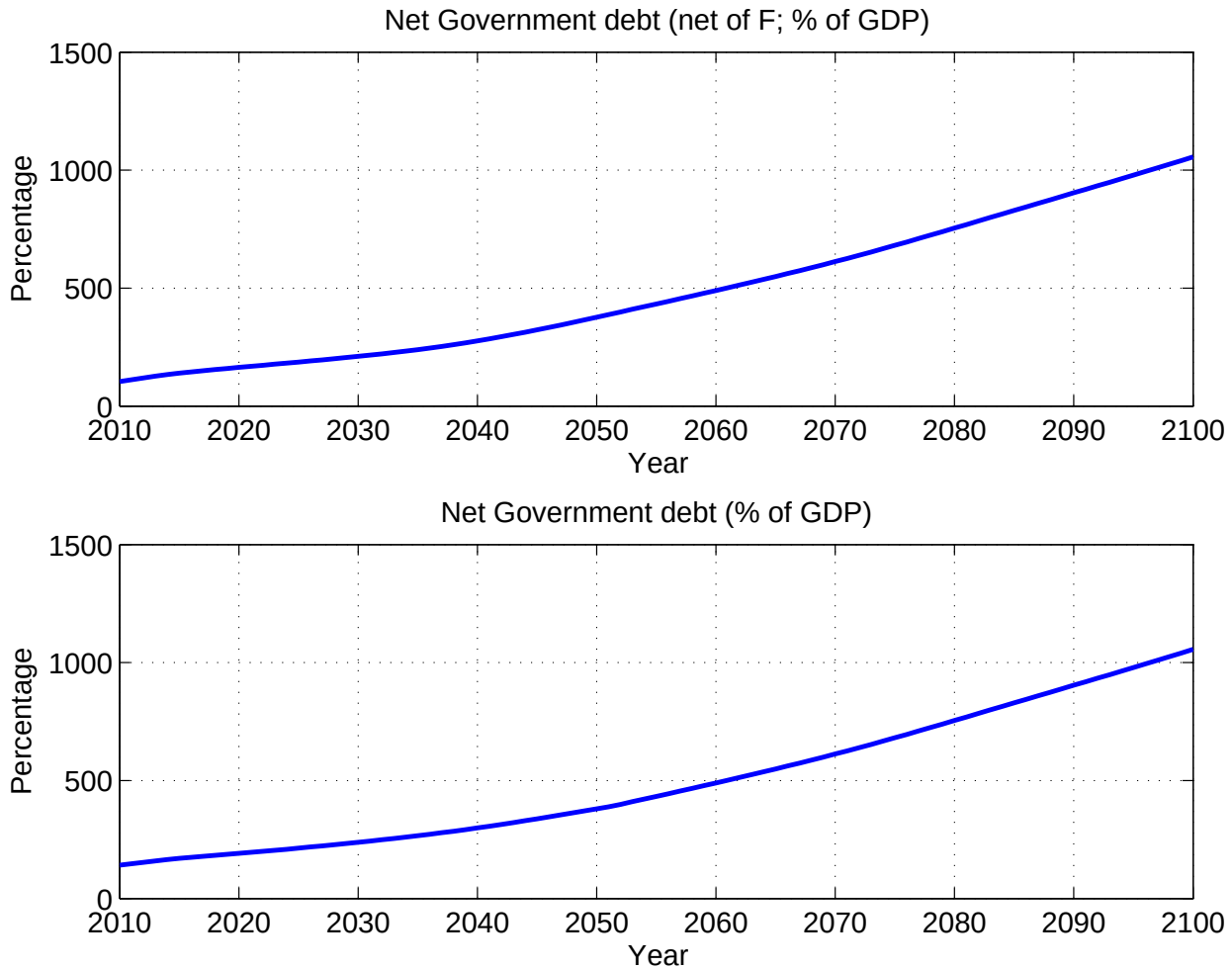
Projected GDP: 2010-2100



Net Government Debt $(B_t - F_t)/Y_t$

- 2020: 164%
- 2030: 211%
- 2040: 276%
- 2050: 377%
- 2060: 490%

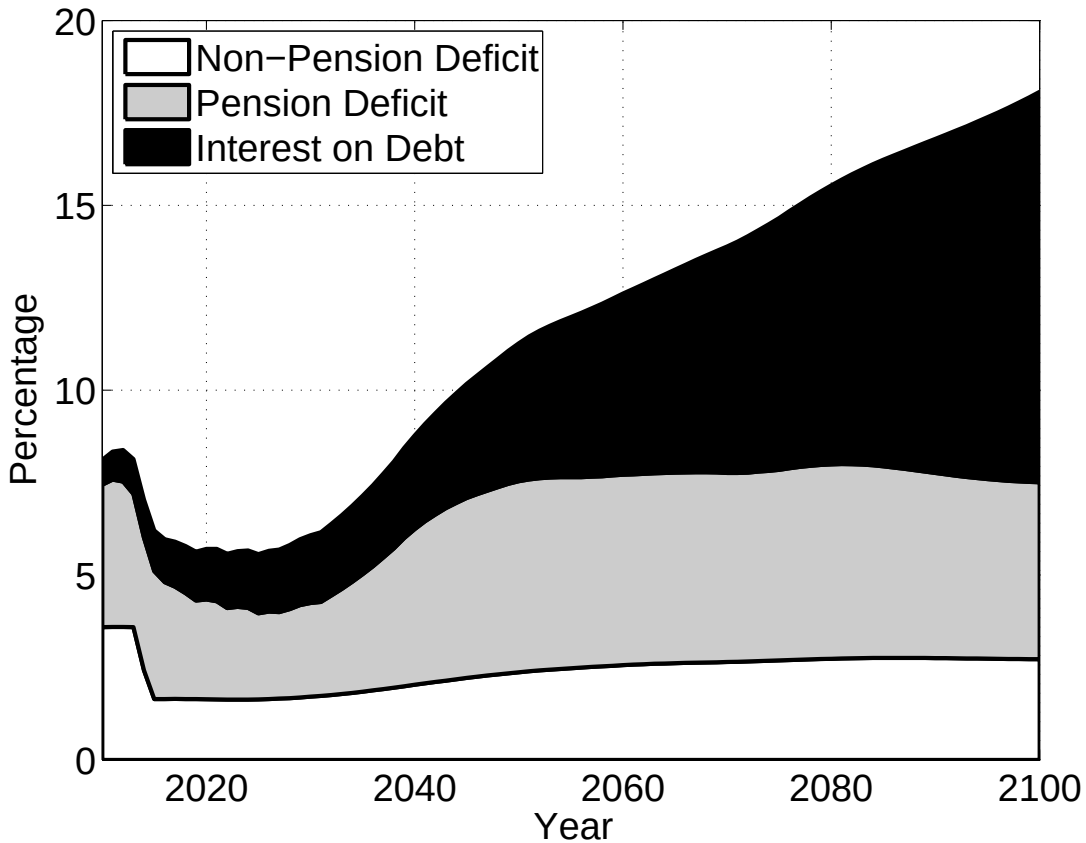
Net Government Debt



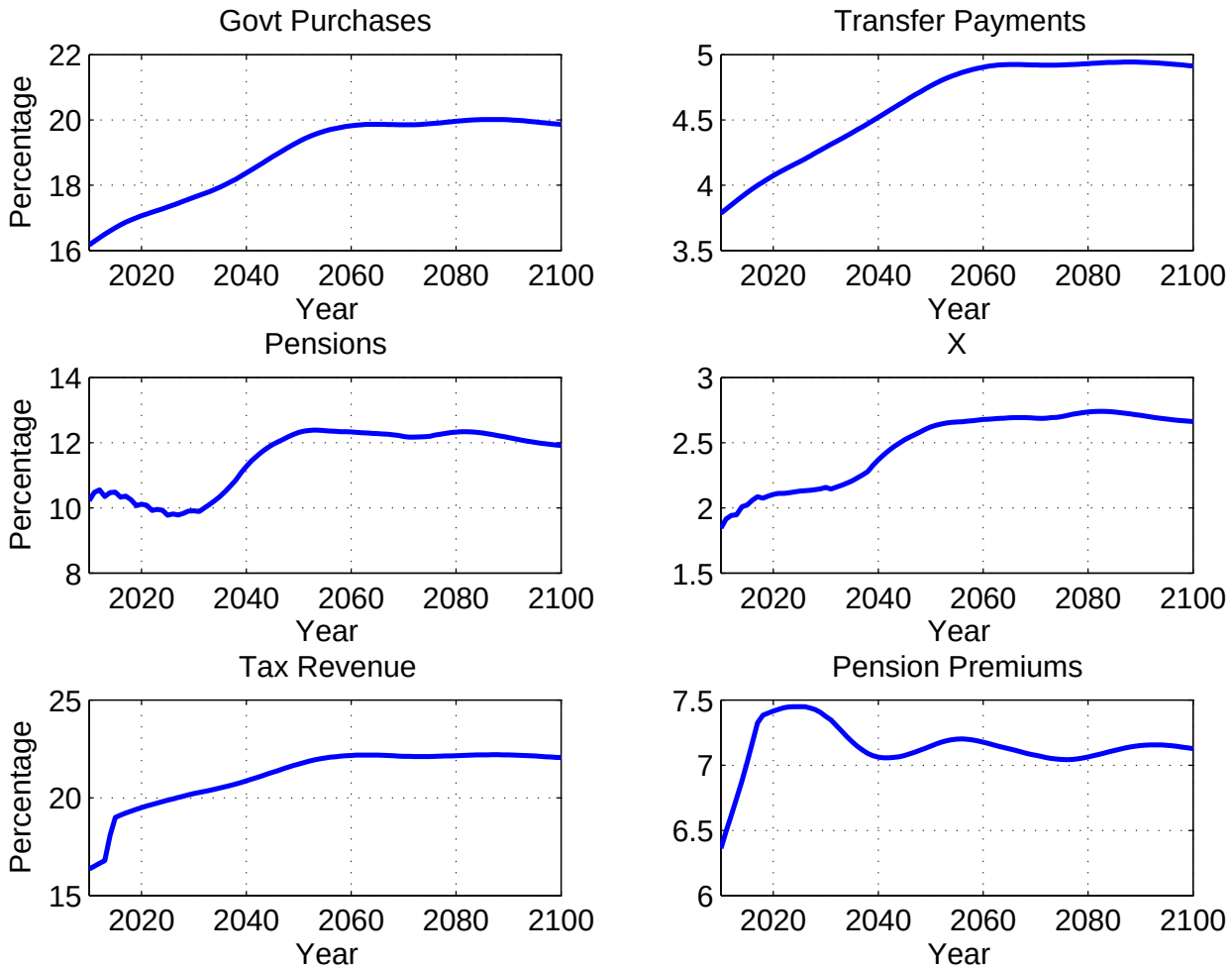
Sources of Net Borrowing

$$\frac{(B_{t+1} - F_{t+1}) - (B_t - F_t)}{Y_t} = \frac{(G_t + TR_t - T_t)}{Y_t}$$
$$+ \frac{(P_t - PR_t)}{Y_t} + \frac{(r_{b,t} B_t - r_{f,t} F_t)}{Y_t}.$$

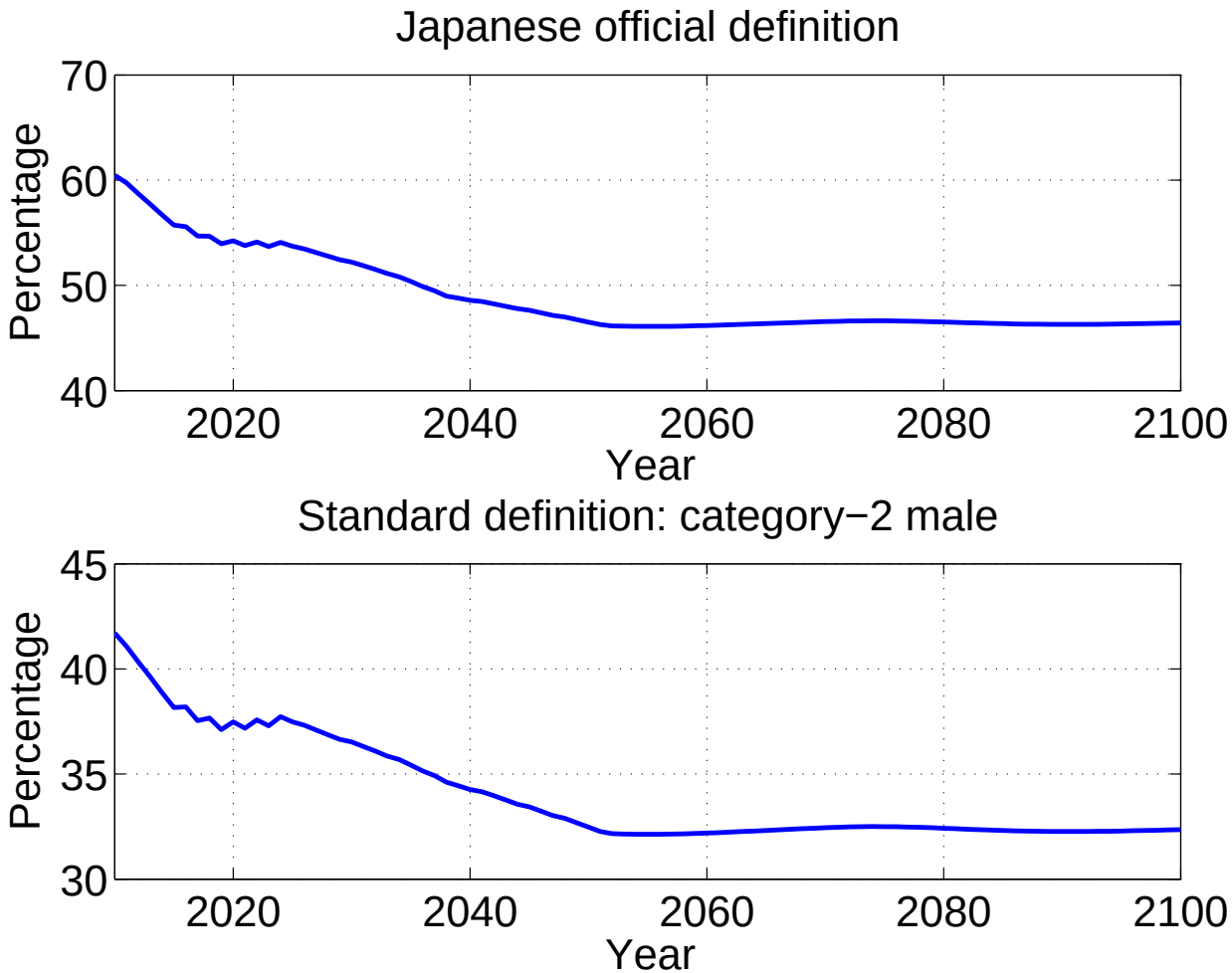
Sources of Net Borrowing



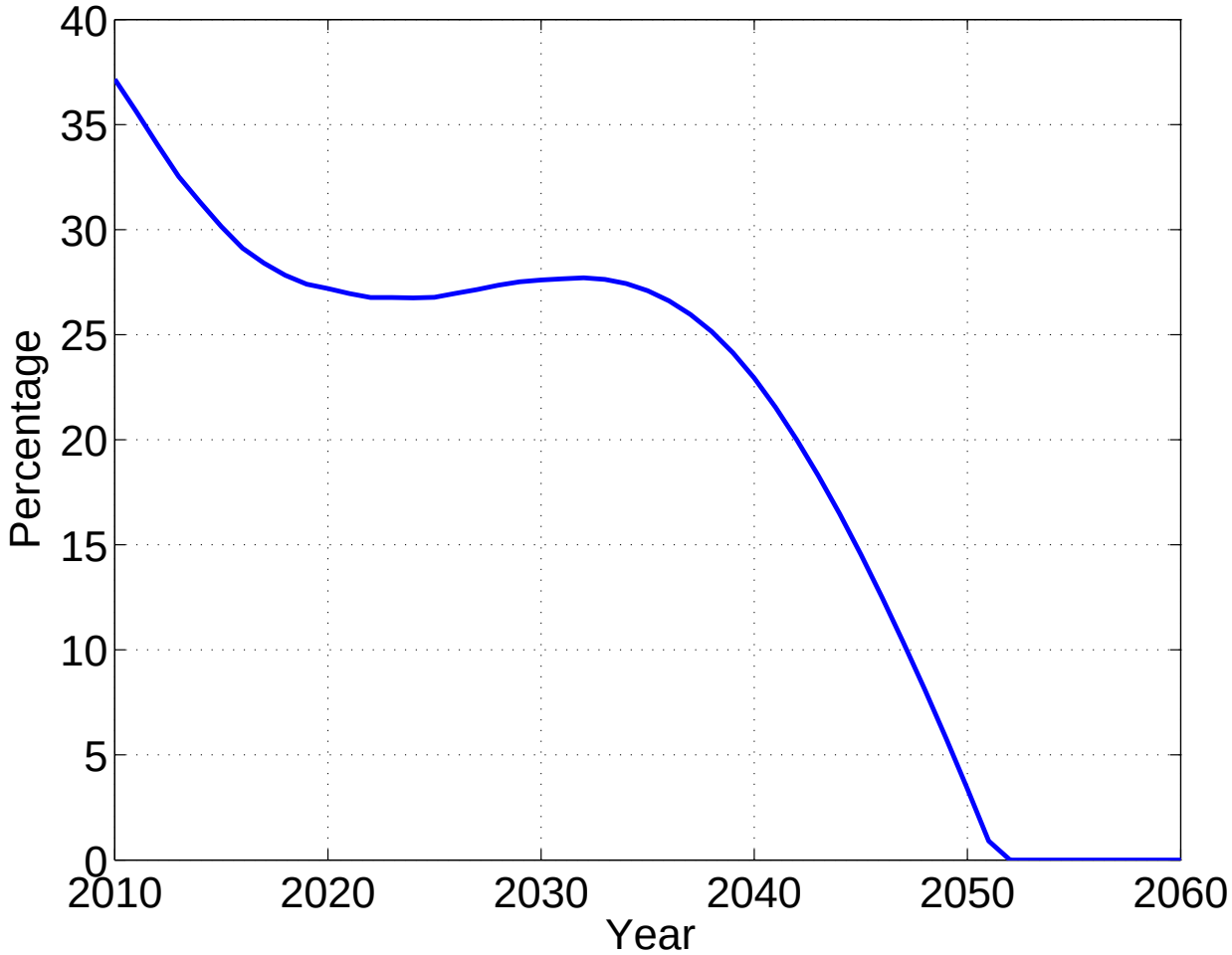
Government Accounts



Replacement Rates



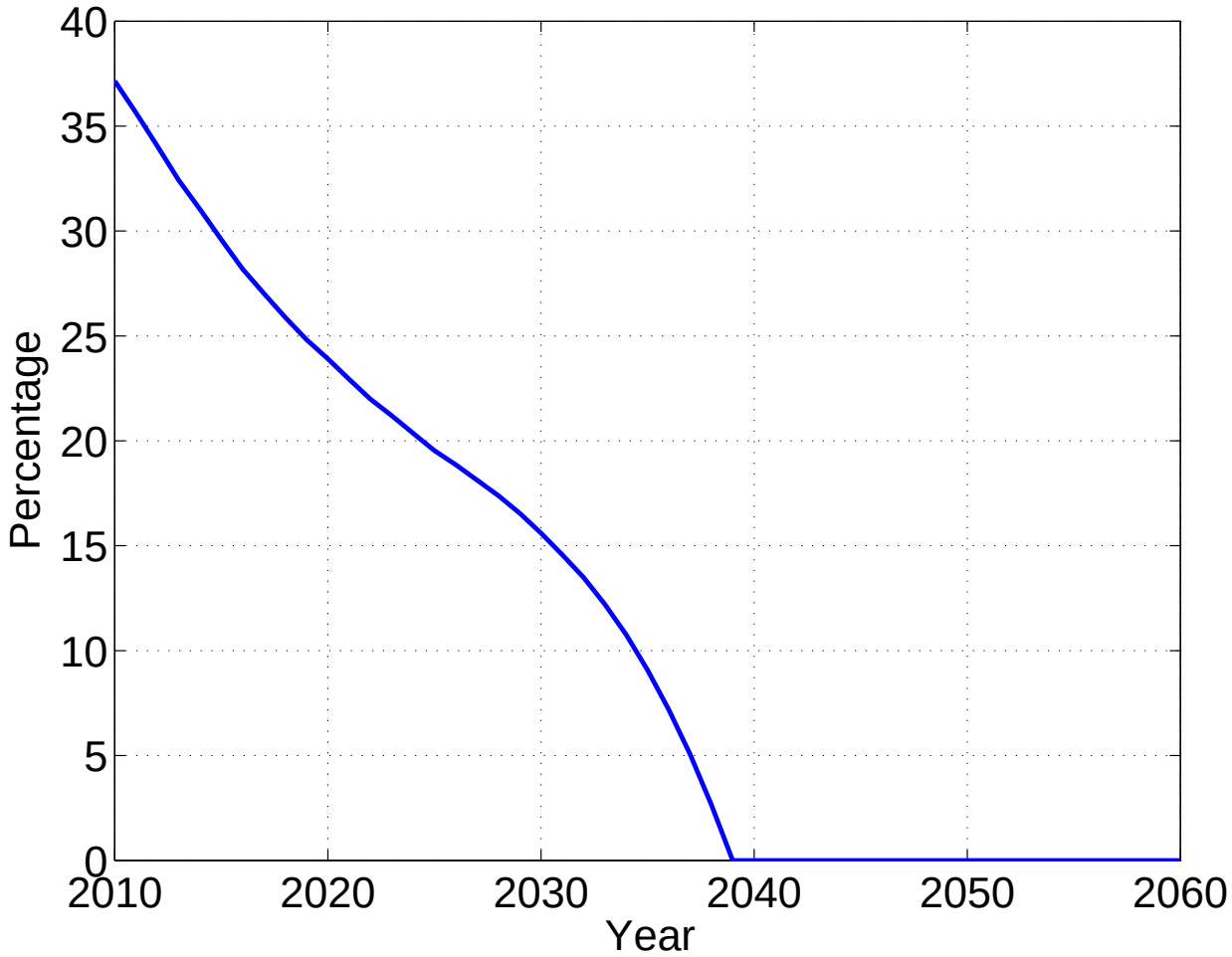
Pension Fund



Sensitivity of Benchmark Scenario

1. No macroeconomic slide
2. Different wage growth rates
3. Returns on the pension fund
4. Returns on the government debt
5. Different fertility projections
6. Different survival projections

Macroeconomic Slide and Pension Fund



Different Wage Growth Rates

	$\frac{(B_t - F_t)}{Y_t}$		
	$g_t^w = 0.5\%$	Baseline ($g_t^w = 1.5\%$)	$g_t^w = 2.5\%$
2010	1.042	1.042	1.042
2020	1.879	1.641	1.427
2030	2.751	2.109	1.593
2040	4.007	2.762	1.863
2050	5.890	3.766	2.358
2060	8.181	4.898	2.880

Wage Growth on Sources of Borrowing (1)

	$g_t^w = 0.5\%$	Baseline ($g_t^w = 1.5\%$)	$g_t^w = 2.5\%$
		$\frac{(G_t + TR_t - T_t)}{Y_t}$	
2010	0.0396	0.0359	0.0316
2020	0.0202	0.0164	0.0127
2030	0.0213	0.0171	0.0135
2040	0.0248	0.0203	0.0167
2050	0.0285	0.0237	0.0201
2060	0.0305	0.0256	0.0221

Wage Growth on Sources of Borrowing (2)

	$g_t^w = 0.5\%$	Baseline ($g_t^w = 1.5\%$)	$g_t^w = 2.5\%$
		$\frac{(P_t - PR_t)}{Y_t}$	
2010	0.0395	0.0386	0.0376
2020	0.0359	0.0270	0.0190
2030	0.0386	0.0253	0.0142
2040	0.0574	0.0421	0.0297
2050	0.0691	0.0517	0.0375
2060	0.0704	0.0515	0.0363

Wage Growth on Sources of Borrowing (3)

	$g_t^w = 0.5\%$	Baseline ($g_t^w = 1.5\%$)	$g_t^w = 2.5\%$
		$\frac{(r_{b,t}B_t - r_{f,t}F_t)}{Y_t}$	
2010	0.0067	0.0067	0.0067
2020	0.0162	0.0137	0.0115
2030	0.0256	0.0183	0.0126
2040	0.0398	0.0253	0.0150
2050	0.0589	0.0373	0.0208
2060	0.0818	0.0490	0.0272

Different Returns on the Pension Fund

	$\frac{(B_t - F_t)}{Y_t}$		
	$r_{f,t} = 1\%$	Baseline ($r_{f,t} = 2\%$)	$r_{f,t} = 3\%$
2010	1.042	1.042	1.042
2020	1.673	1.641	1.607
2030	2.169	2.109	2.034
2040	2.855	2.762	2.634
2050	3.885	3.766	3.576
2060	5.028	4.898	4.664

- Small impact on the overall net debt

Different Returns on Government Debt

$\frac{(B_t - F_t)}{Y_t}$

	Baseline				
$r_{b,t} =$	-1%	0%	1%	2%	3%
2010	1.042	1.042	1.042	1.042	1.042
2020	1.334	1.481	1.641	1.816	2.005
2030	1.451	1.751	2.109	2.535	3.041
2040	1.680	2.151	2.762	3.555	4.582
2050	2.144	2.819	3.766	5.098	6.977
2060	2.637	3.540	4.898	6.964	10.126

Different Fertility Projections

	$\frac{(B_t - F_t)}{Y_t}$		
	Low Fertility	Baseline Fertility	High Fertility
2010	1.042	1.042	1.042
2020	1.638	1.641	1.644
2030	2.085	2.109	2.134
2040	2.729	2.762	2.800
2050	3.812	3.766	3.723
2060	5.144	4.898	4.680

Different Survival Projections

	$\frac{(B_t - F_t)}{Y_t}$		
	Low Survival	Baseline Survival	High Survival
2010	1.042	1.042	1.042
2020	1.641	1.641	1.643
2030	2.096	2.109	2.113
2040	2.725	2.762	2.784
2050	3.690	3.766	3.820
2060	4.477	4.898	4.993

Policy Experiments

1. Pension rules
2. Consumption tax
3. Female labor force participation

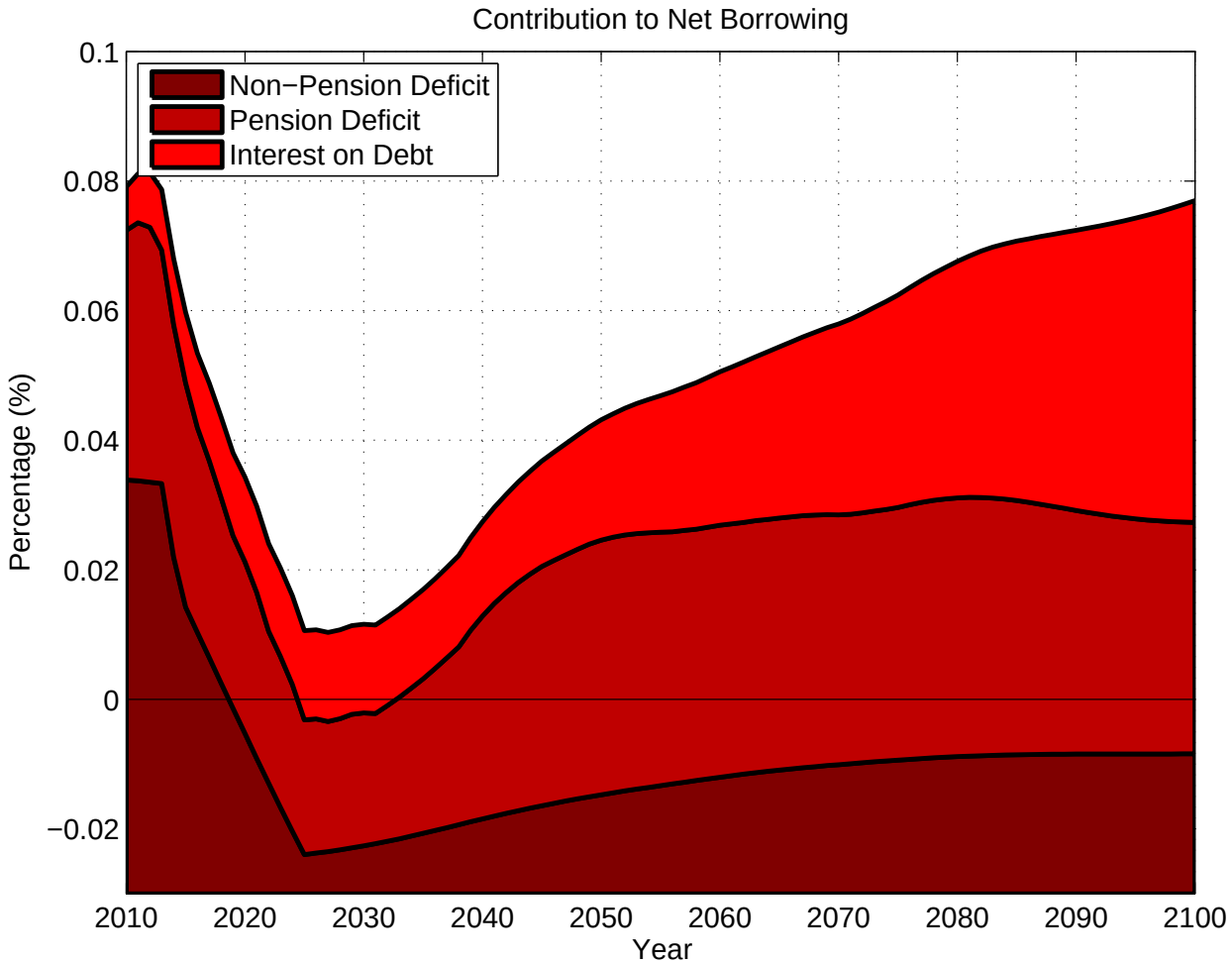
Different Pension Rules

	$\frac{(B_t - F_t)}{Y_t}$				
	Baseline	$i_R = 70$	Benefit cut by 10%	$i_R = 70$ and Benefit cut by 10%	Earnings tax rate up by 5%
2010	1.042	1.042	1.042	1.042	1.042
2020	1.641	1.625	1.518	1.504	1.639
2030	2.109	2.027	1.852	1.779	1.980
2040	2.762	2.478	2.339	2.083	2.417
2050	3.766	3.154	3.117	2.566	3.159
2060	4.898	3.964	3.996	3.147	3.994

Higher Consumption Tax Rates

	$\frac{(B_t - F_t)}{Y_t}$		
	$\tau_{c,t} = 10\%$	$\tau_{c,t} = 15\%$	$\tau_{c,t} = 20\%$
2010	1.042	1.042	1.042
2020	1.641	1.590	1.581
2030	2.109	1.849	1.696
2040	2.762	2.279	1.916
2050	3.766	3.027	2.430
2060	4.898	3.891	3.050

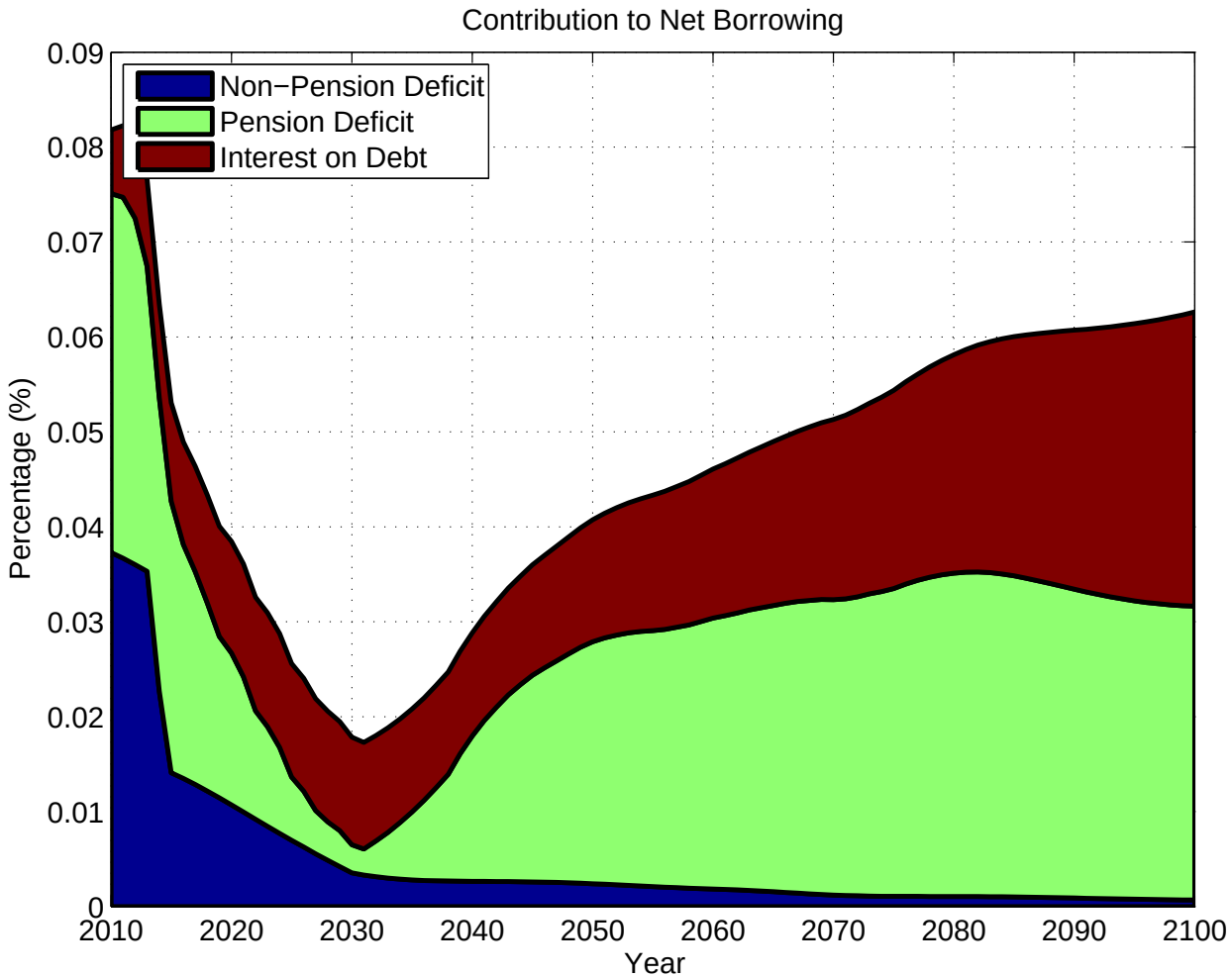
Consumption Tax and Net Borrowing



Female Labor Force Participation

	$\frac{(B_t - F_t)}{Y_t}$			
	Baseline	FLFP (A)	FLFP (B)	FLFP (C)
2010	1.042	1.042	1.042	1.042
2020	1.641	1.513	1.611	1.474
2030	2.109	1.757	1.968	1.591
2040	2.762	2.208	2.453	1.844
2050	3.766	2.940	3.265	2.351
2060	4.898	3.788	4.204	2.960

FLFP and Net Borrowing

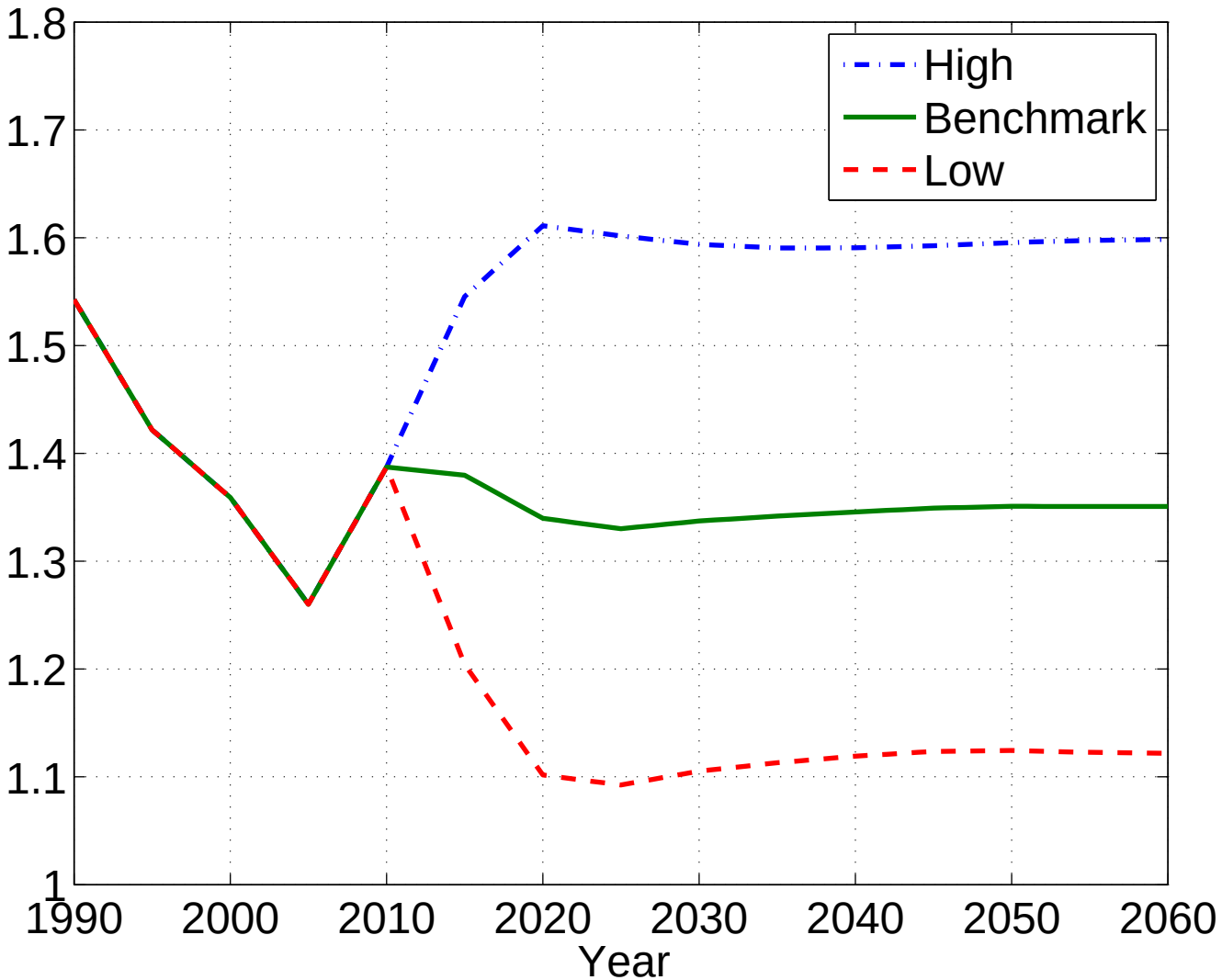


Conclusion

- Significant fiscal risks ahead
- Unfavorable bond yields can make things worse
- Further pension reform (raising retirement age)
- FLFP important
- to do:
  - Immigration
  - Endogenous Consumption/Saving and Labor/Leisure in General Equilibrium
  - Endogenous Female Labor Force Participation

Total Fertility Rates

RETURN



Life Expectancy: Male

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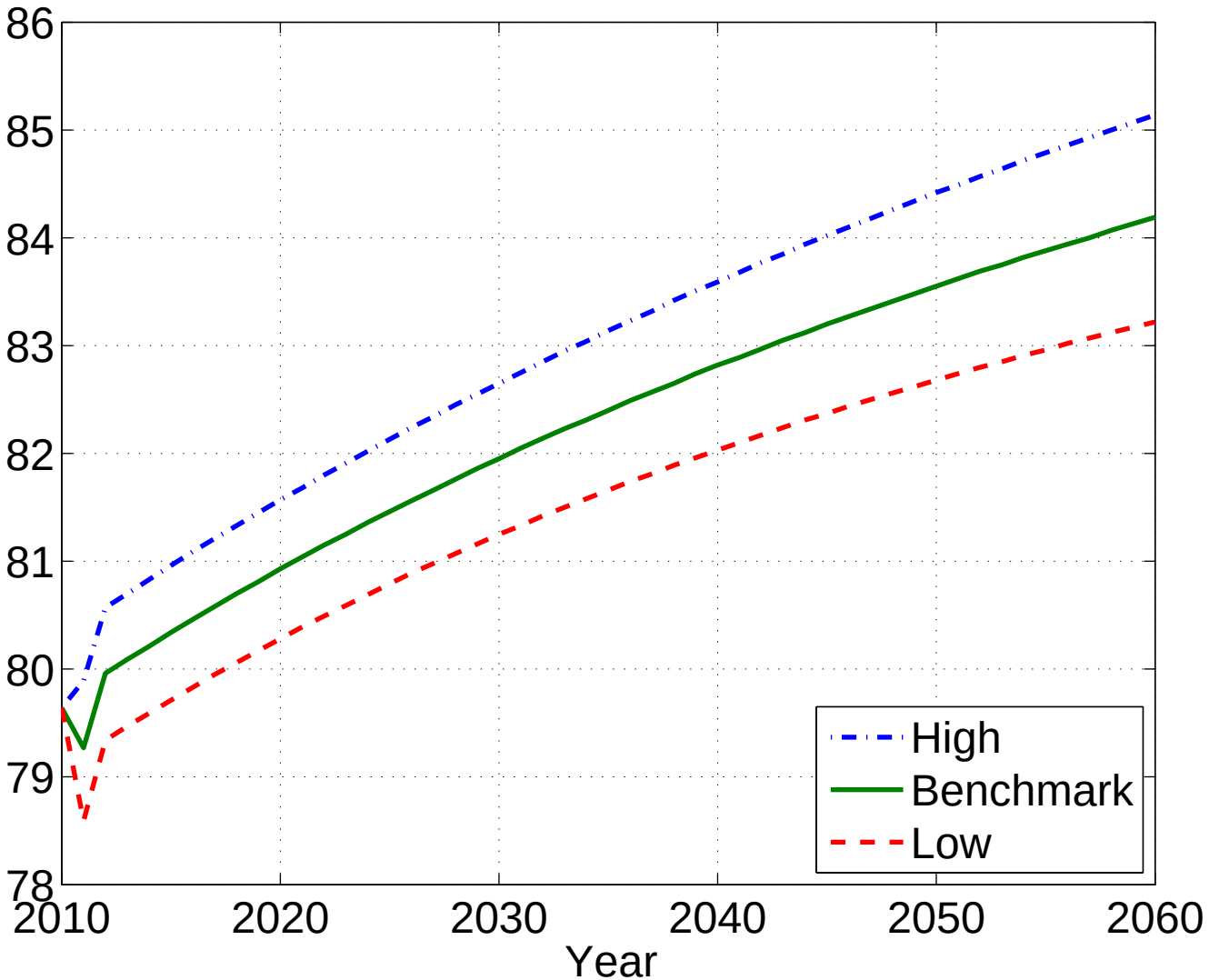

Life Expectancy: Female

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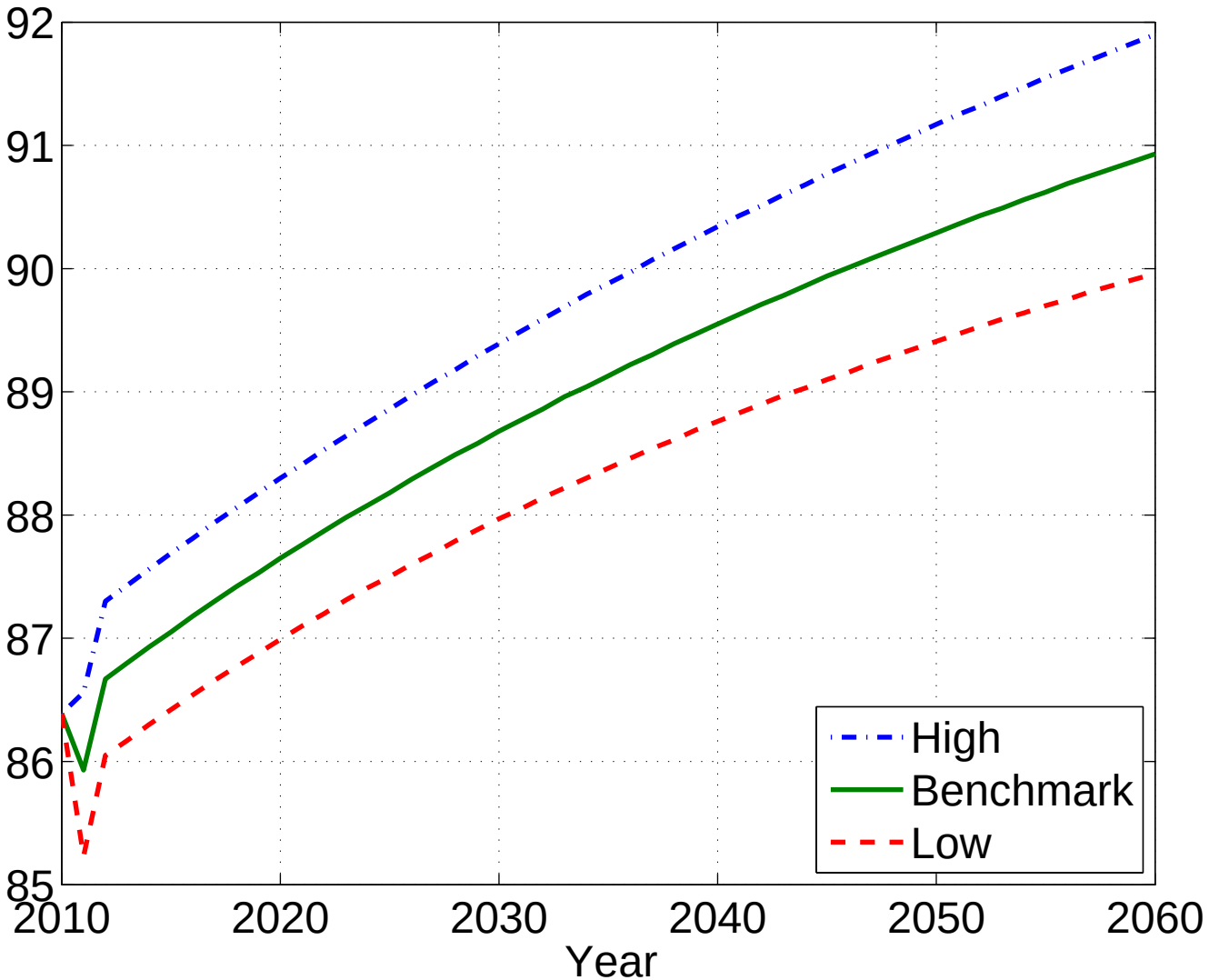

Labor Force Participation Rate

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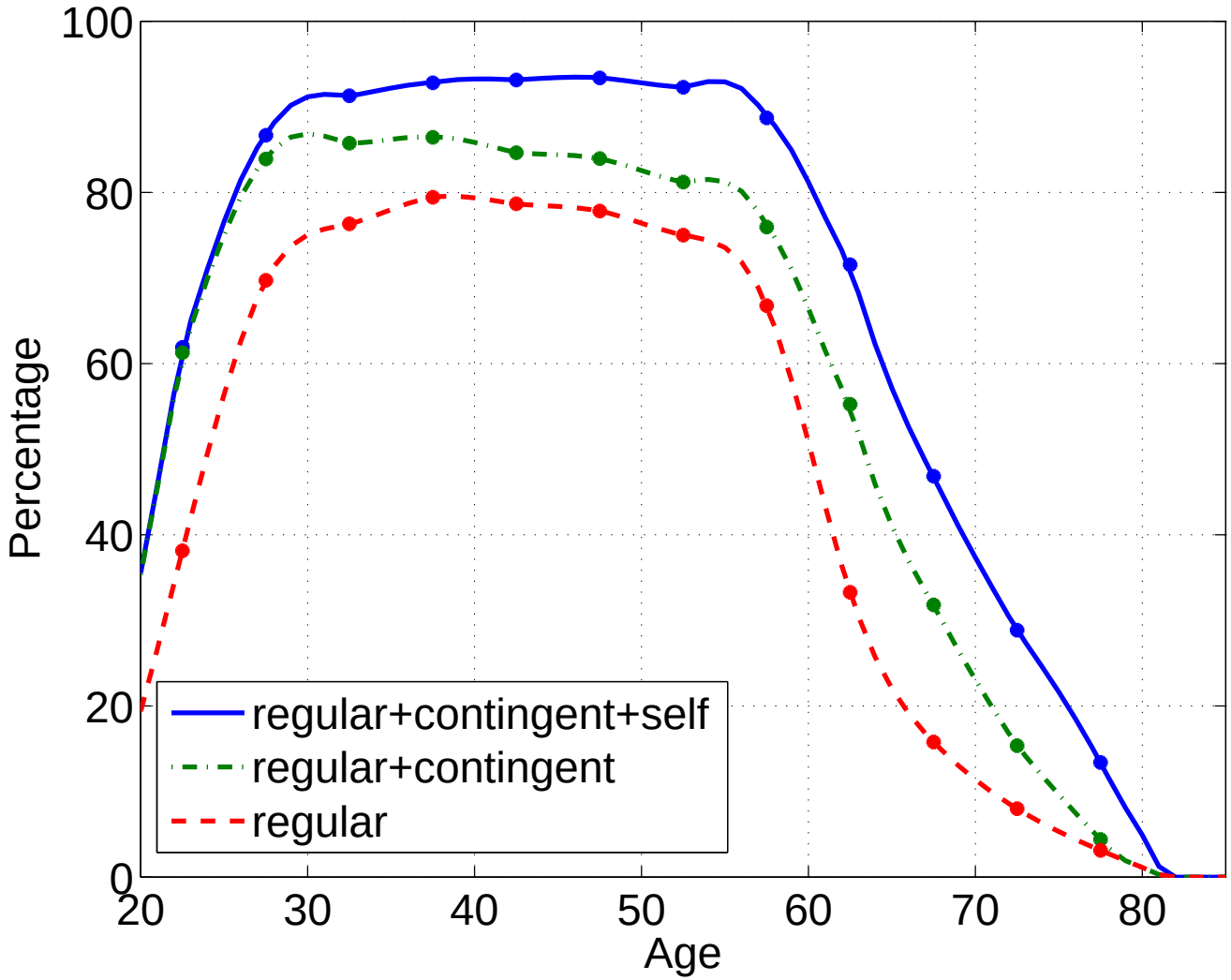

Labor Force Participation Rate

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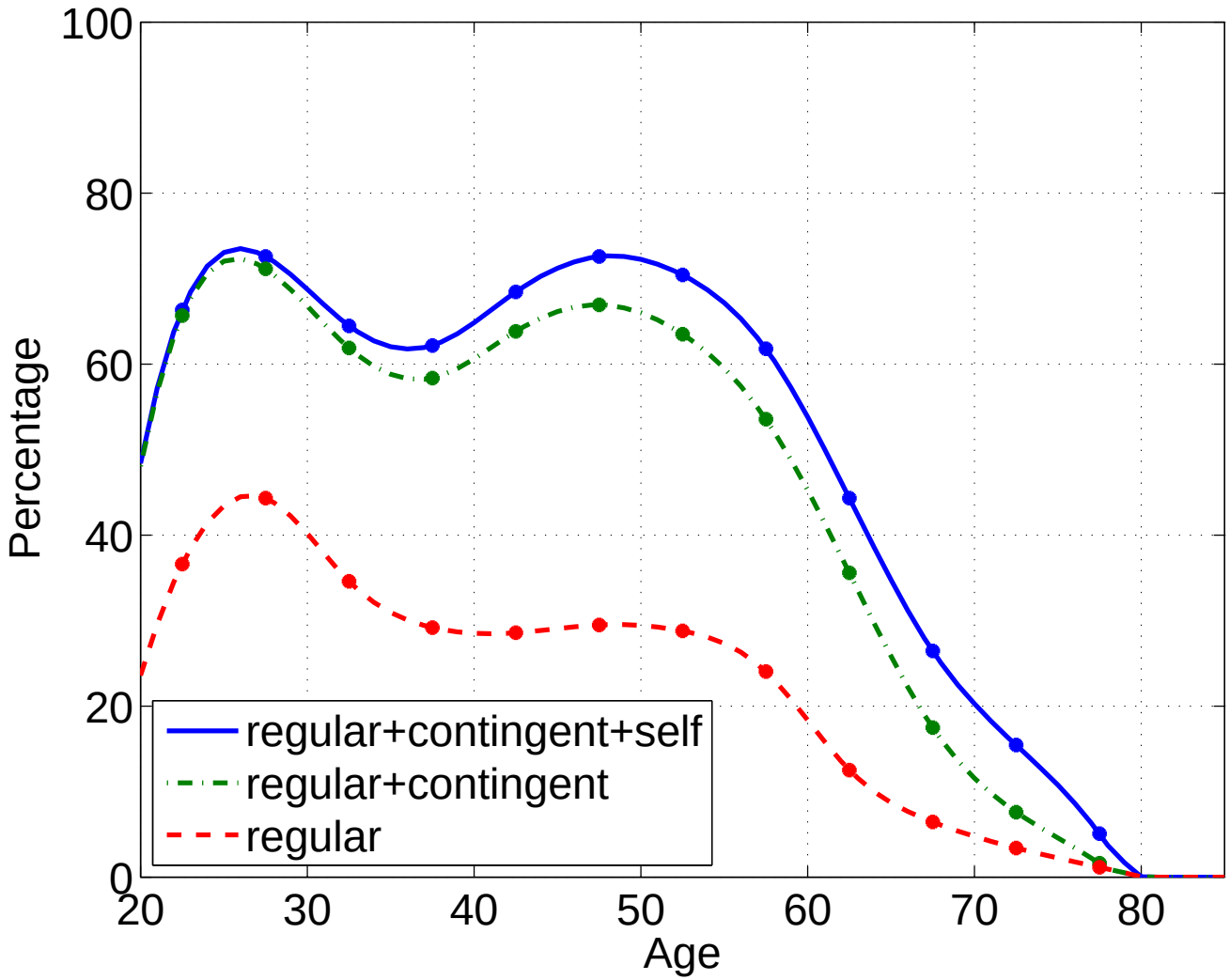

Earnings Profile: Male

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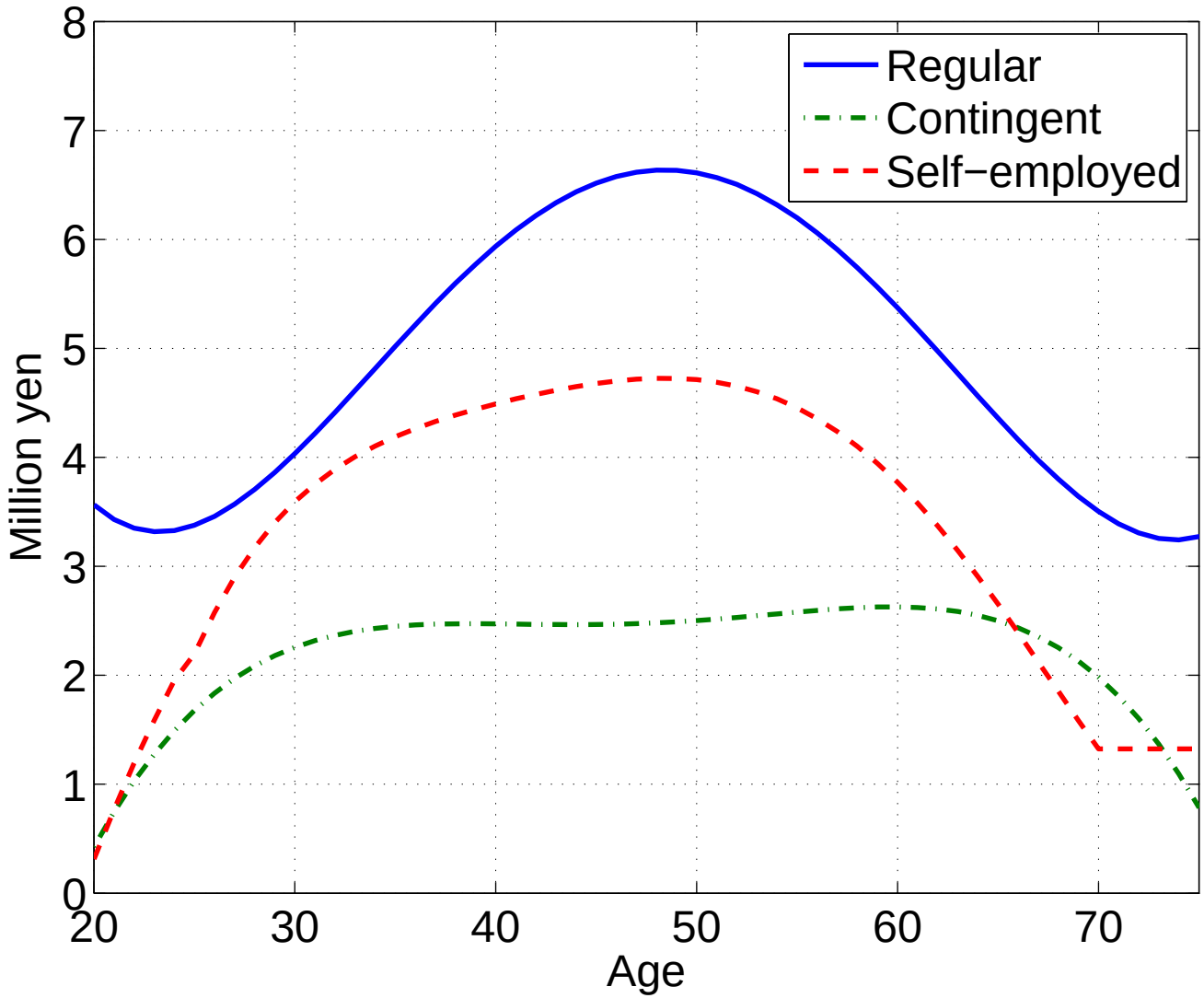

Earnings Profile: Female

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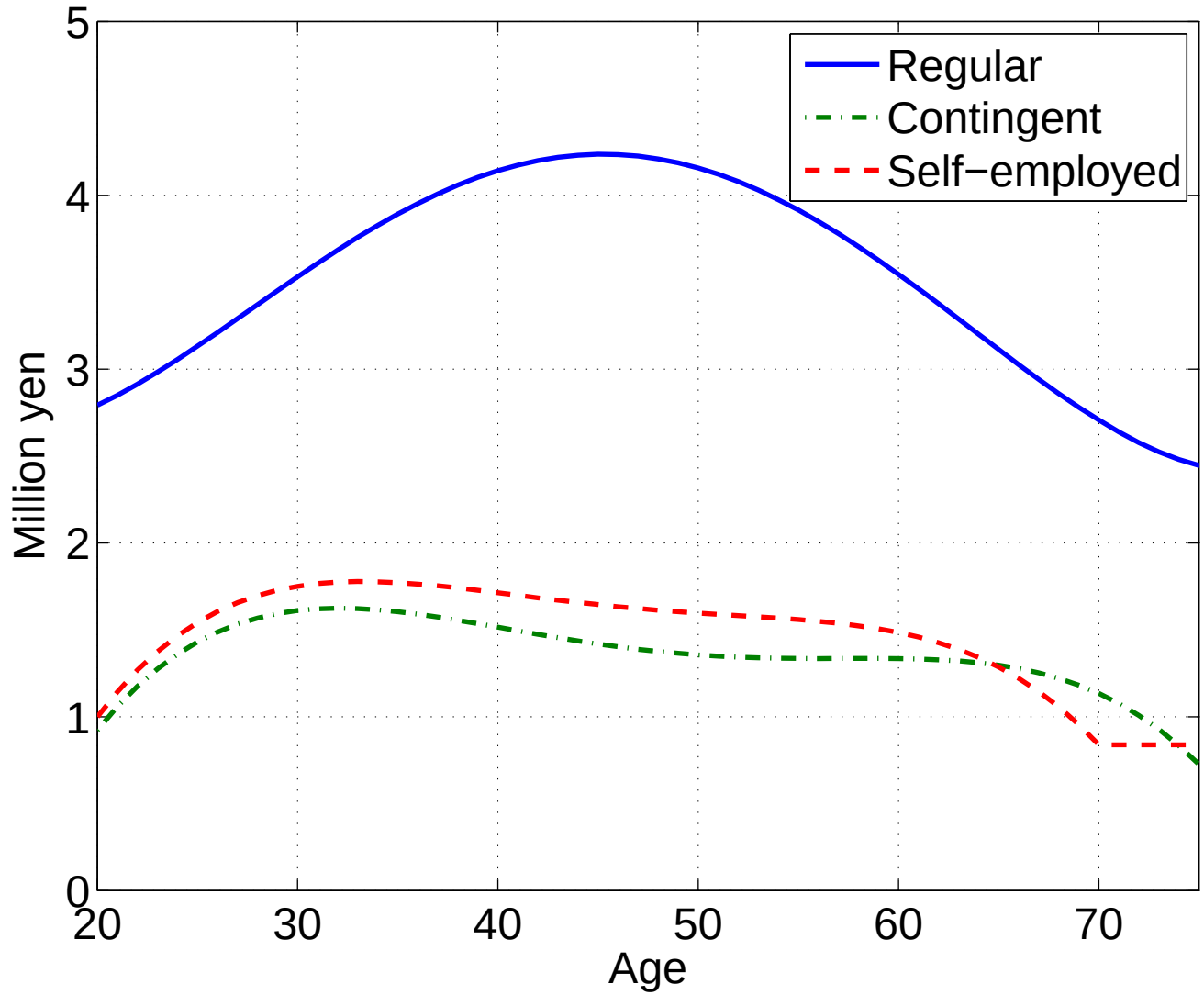

Consumption Profile

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