Demographic Change and Government Debt: The Impact of Bond Purchases by the Bank of Japan

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Introduction

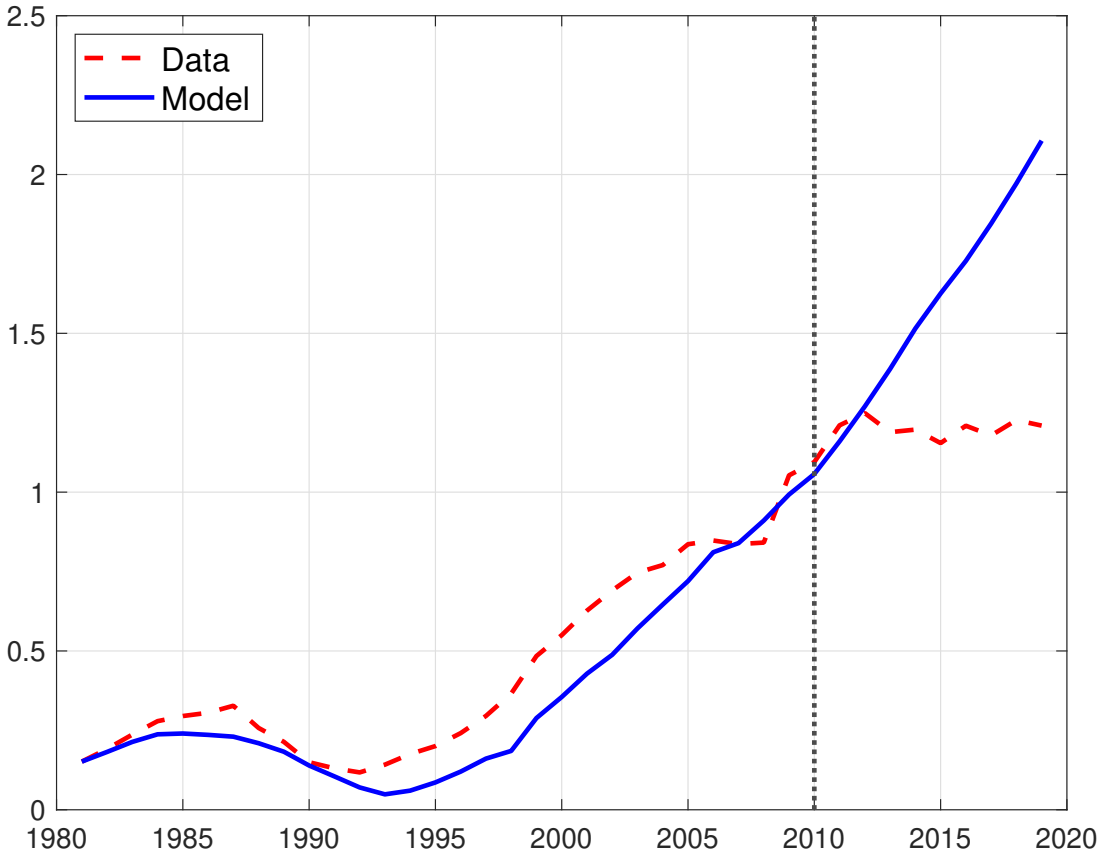


Figure: Net Debt to GNP Ratio

Introduction

- Hansen and Imrohoroglu (2016) use general equilibrium growth model to evaluate the fiscal implications of aging in Japan.
- Government expenditures from 2011 to 2050 attributable to an aging population estimated by Fukawa and Sato (2009).
- Finding: Projected expenditures will lead to Japanese debt relative to output to exceed 250 percent in 2021.
- Tax increase in the range of 30 to 40 percent of aggregate consumption needed to achieve fiscal sustainability.

This Paper

- Why has Japan been successful in stabilizing debt?
- Consider more recent data (2011-2019).
- Factors:
  - Spending temporarily below forecasts from Fukawa and Sato (2009).
  - Interest rates on government debt below that in Hansen and Imrohoroglu (2016).
  - BOJ purchases of government debt means interest payments returned to government.

BOJ Purchases of JGB's

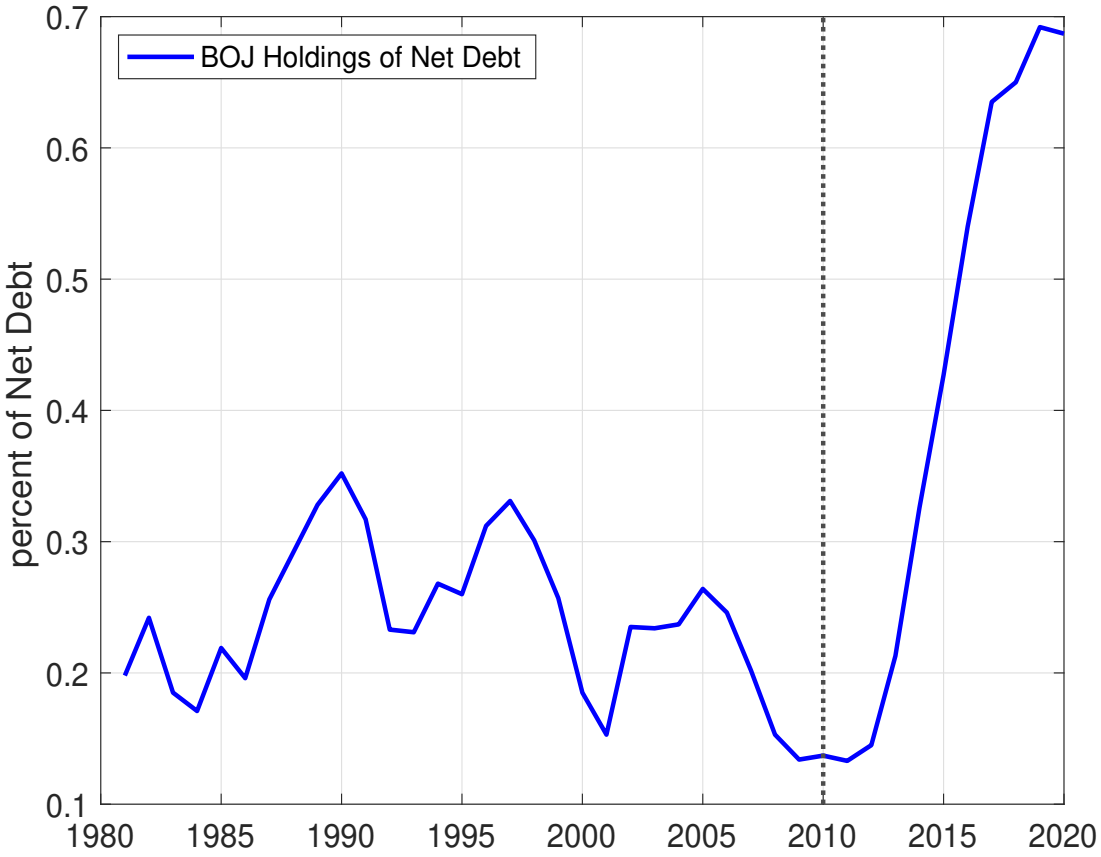


Figure: BOJ Holdings of JGBs

Outline of Presentation

1. Related Literature
2. Government Expenditures and Total Factor Productivity: Assumed vs. Reality
3. Model (modified to allow for BOJ purchases of JGB's)
4. Data and Calibration (income tax rates different)
5. Results
6. Conclusion (stabilization is temporary)

Related Literature

- Implications of Fukawa and Sato (2009)
  - Increases in health care and pension spending resulting from aging.
  - A 7 percent increase in government spending to output from 2010 to 2050.
  - Imrohoroglu and Sudo (2011), Hansen and Imrohoroglu (2016 and 2018)
- Literature associated with Broda and Weinstein (2005)
  - Use spending estimates that are considerably more optimistic.
  - Find that current tax rates are close to being sufficient to stabilize debt.
  - Doi (2008), Doi, Hoshi and Okimoto (2011) and Bamba and Weinstein (2021).

Related Literature (continued)

- Life cycle model with details of Japanese pension and health care programs to endogenously compute the fiscal costs associated with an aging Japan.
  - Imrohoroglu, Kitao and Yamada (2016), Braun and Joines (2015) and Kitao (2015).
  - Find spending increases due to aging similar to Fukawa and Sato (2009).

Total Factor Productivity

$TFP_t = Y_t/(K_t^{\theta} h_t^{1-\theta})$, where $\theta = 0.3783$

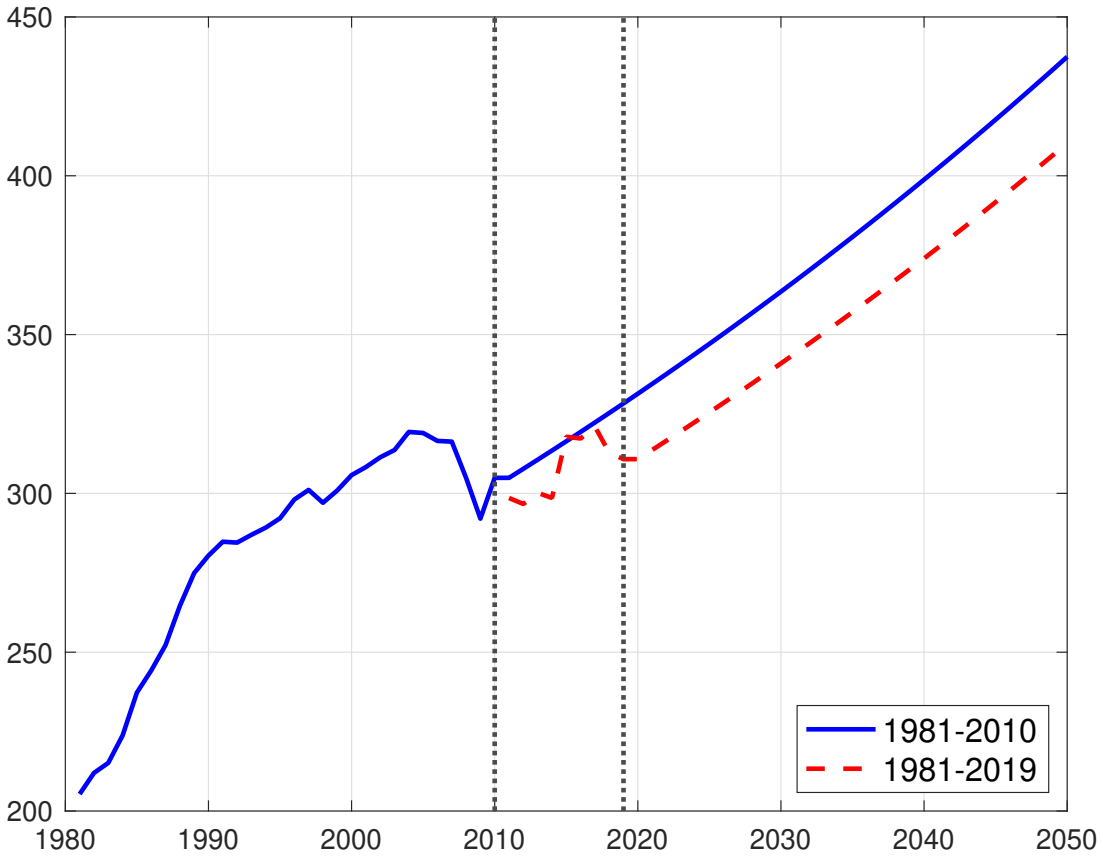
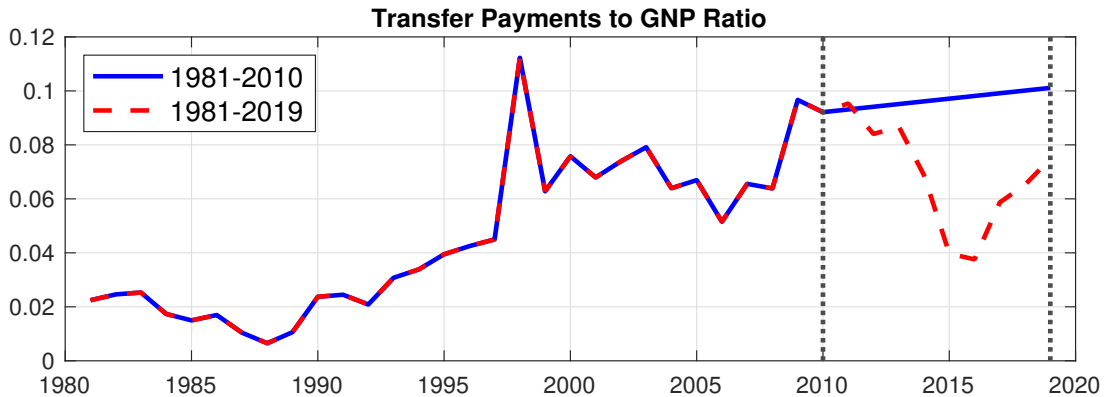


Figure: Total Factor Productivity

TFP–continued

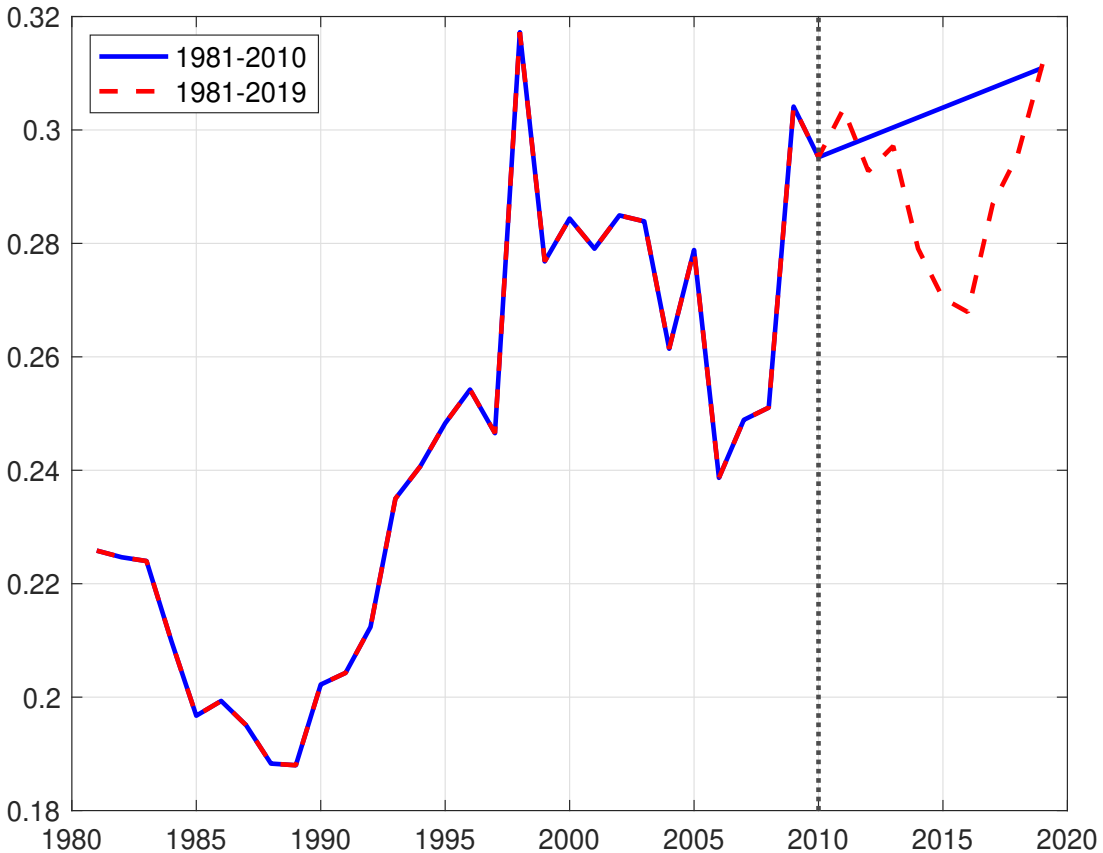
- Higher than anticipated TFP growth cannot explain success in stabilizing debt.

Government Purchases and Transfer Payments



- Purchases were higher than forecasted in 2011-2019.
- Transfer payments were lower than forecasted.

Total Government Spending



- Japan spent less from 2012 to 2018 than predicted.
- 2019 implies lower spending may have been temporary.

Model Features

- One sector neoclassical growth model. No uncertainty.
- Bonds in utility function.
  - Captures convenience yield as in Krishnamurthy and Vissing-Jorgensen (2012).
- BOJ is agency external to the model that purchases JGB's and returns interest payments to government.
  - Balance sheet of central bank not modeled.
  - Inflation not modeled.
- Government collects tax revenue, purchases goods (G_t), makes transfer payments (TR_t), and issues debt (B_{t+1}) to satisfy its budget constraint.

Model Features–continued

- Exogenous variables:
  - A_t TFP, γ_t associated growth factor.
  - N_t population, η_t associated growth factor.
  - G_t and TR_t
  - Tax rates, $\tau_{c,t}$, $\tau_{k,t}$, $\tau_{h,t}$ and τ_b
  - λ_t fraction of government debt held by central bank.
- Endogenous variables:
  - B_{t+1} government bonds, q_t associated price.
  - D_t lumps sum tax to retire debt when B_t / Y_t becomes too large.
  - h_t, K_{t+1}, C_t and Y_t.
  - W_t and r_t – wage rate and return to capital.

Government Budget

- $B_{t+1} = B^h_{t+1} + B^c_{t+1}$.
- $B^h_t = (1 - \lambda_t)B_t$ and $B^c_t = \lambda_t B_t$
- Government budget constraint:

$$\begin{aligned} G_t + TR_t + B_t &= \eta_t q_t B_{t+1} + \tau_{c,t} C_t + \tau_{h,t} W_t h_t \\ &\quad + \tau_{k,t}(r_t - \delta)K_t \\ &\quad + (\tau_{b,t}(1 - \lambda_t) + \lambda_t)(1 - q_{t-1})B_t \\ &\quad + D_t. \end{aligned}$$

Debt Sustainability Rule

Let $\overline{b} = \overline{B}_t / \overline{Y}_t$ be the steady state bond to output ratio:

$$D_t = \begin{cases} \kappa(B_t - \overline{B}_t) & \text{if } B_s / Y_s \geq b_{\max} \text{ for some } s \leq t, \\ 0 & \text{otherwise.} \end{cases}$$

$\kappa > 0$ is chosen to be as small as possible so that $B(t)/Y(t)$ converges to $\overline{b}$.

Household's Problem

Given K_0 and B_0^h, choose $\{C_t, h_t, K_{t+1}, B_{t+1}^h\}_{t=0}^{\infty}$ to

$$\max \sum_{t=0}^{\infty} \beta^t N_t [\log C_t - \alpha \frac{h_t^{1+1/\psi}}{1+1/\psi} + \phi \log(\mu_t + B_{t+1}^h)]$$

subject to

$$\begin{aligned}(1+\tau_{c,t})C_t \quad + \quad & \eta_t K_{t+1} + q_t \eta_t B_{t+1}^h = (1-\tau_{h,t}) W_t h_t \\ & + \left[(1+(1-\tau_{k,t})(r_t-\delta)\right] K_t \\ & + \left[1-(1-q_{t-1})\tau_{b,t}\right] B_t^h + TR_t - D_t,\end{aligned}$$

and $\mu_t = \mu A_t^{1/(1-\theta)}$.

Technology

A stand-in firm operates a constant returns to scale Cobb-Douglas production technology:

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

Capital depreciates at the rate δ .

Equilibrium

Given all exogenous sequences and a debt sustainability rule $\{\kappa, \overline{b}, b_{\max}\}$, a competitive equilibrium consists of an allocation $\{C_t, h_t, K_{t+1}, B_{t+1}\}_{t=0}^{\infty}$, factor prices $\{W_t, r_t\}_{t=0}^{\infty}$ and the bond price $\{q_t\}_{t=0}^{\infty}$ such that

- the allocation solves the household's problem,
- the allocation and factor prices satisfy: $W_t = (1-\theta)A_t K_t^{\theta} {h_t}^{-\theta}$ and $r_t = \theta A_t K_t^{\theta-1} {h_t}^{1-\theta}$,
- the government budget is satisfied,
- the value of κ is sufficiently large to guarantee convergence of B_t / Y_t to $\overline{b}$,
- the market for bonds clears, $(1-\lambda_{t+1})B_{t+1} = B_{t+1}^h$
- and the goods market clears: $C_t + [\eta_t K_{t+1} - (1-\delta)K_t] + G_t = Y_t$.

Calibration Strategy

- Use methodology from Cooley and Prescott (1995) and more directly, Hayashi and Prescott (2002).
- Following Hansen and Imrohoroglu (2016), calibrate using data from 1981 to 2010.
- Calibration would be identical to that paper except different tax rates are used and this affects other parameters.
  - Income tax rates computed using different method.
  - τ_c was supposed to increase to 10% in 2015. Instead was increased in 2020.

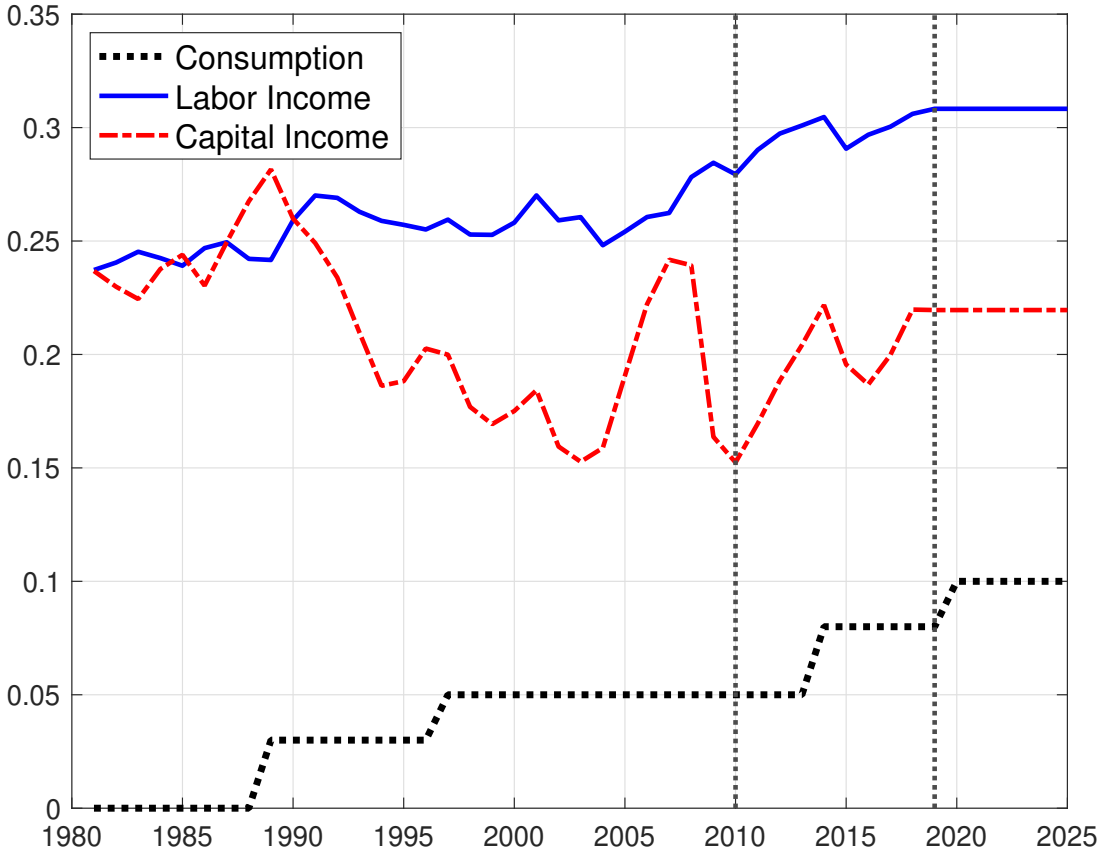
Data

- National income accounts are constructed as in Hayashi and Prescott (2002).
- Y_t is Gross National Product, investment includes net exports with net factor payments from abroad.
- N_t is working age population aged 20-69. Official projections used to extend to 2050 after which constant.
- h_t is employment multiplied by average weekly hours divided by 98.
- G_t includes all in kind transfers such as health care.
- TR_t is mostly pensions and other net transfers minus net indirect taxes.

Tax Rates

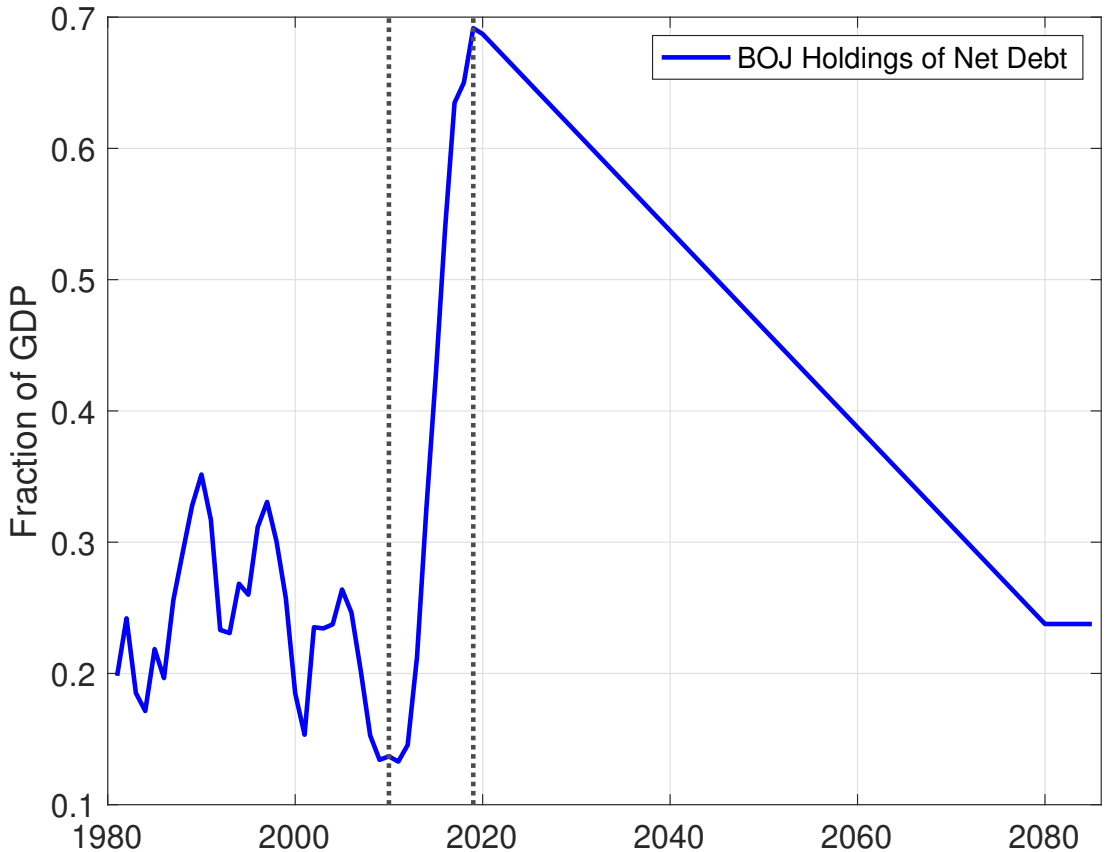
- REV_{τ_h} is revenue from labor income taxes.
- REV_{τ_k} is revenue from corporate income taxes.
- $REV_{\tau_h} = \tau_h Wh = \tau_h(1-\theta)Y$
- $REV_{\tau_k} = \tau_k(r - \delta K) = \tau_k(\theta - \delta \frac{K}{Y}))Y$
- $\tau_{b,t} = 0.2$ for all t.

Tax Rates



- τ_h and τ_k are constant at 2019 values from 2020 and beyond.

BOJ Holdings of Net Debt



Preference Parameters

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

$$\alpha_t = \frac{h_t^{-1/\psi}(1-\tau_{h,t})(1-\theta)y_t}{(1+\tau_{c,t})c_t h_t}$$

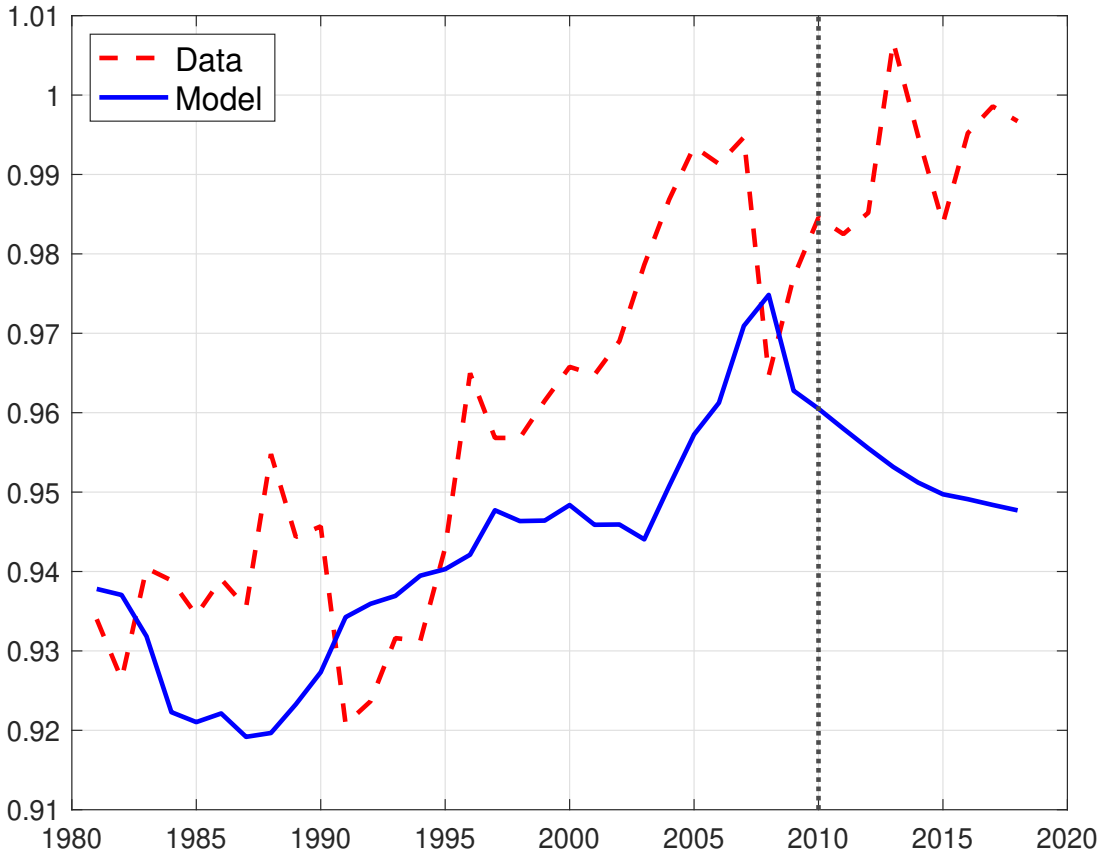
$$\phi_t = \eta_t(\mu + b_{t+1}^h)\left[\frac{q_t \gamma_t^{1/(1-\theta)}}{(1+\tau_{c,t})c_t} - \frac{\beta_t\left[1-(1-q_t)\tau_{b,t+1}\right]}{(1+\tau_{c,t+1})c_{t+1}}\right].$$

- Need to recalibrate due to new tax rates.
- Need empirical counterpart to q.

Bond Prices

F_t is GNP deflator and P_t is interest payments.

$$q_t = \frac{B_{t+1}/F_t}{(B_{t+1} + P_{t+1})/F_{t+1}}.$$

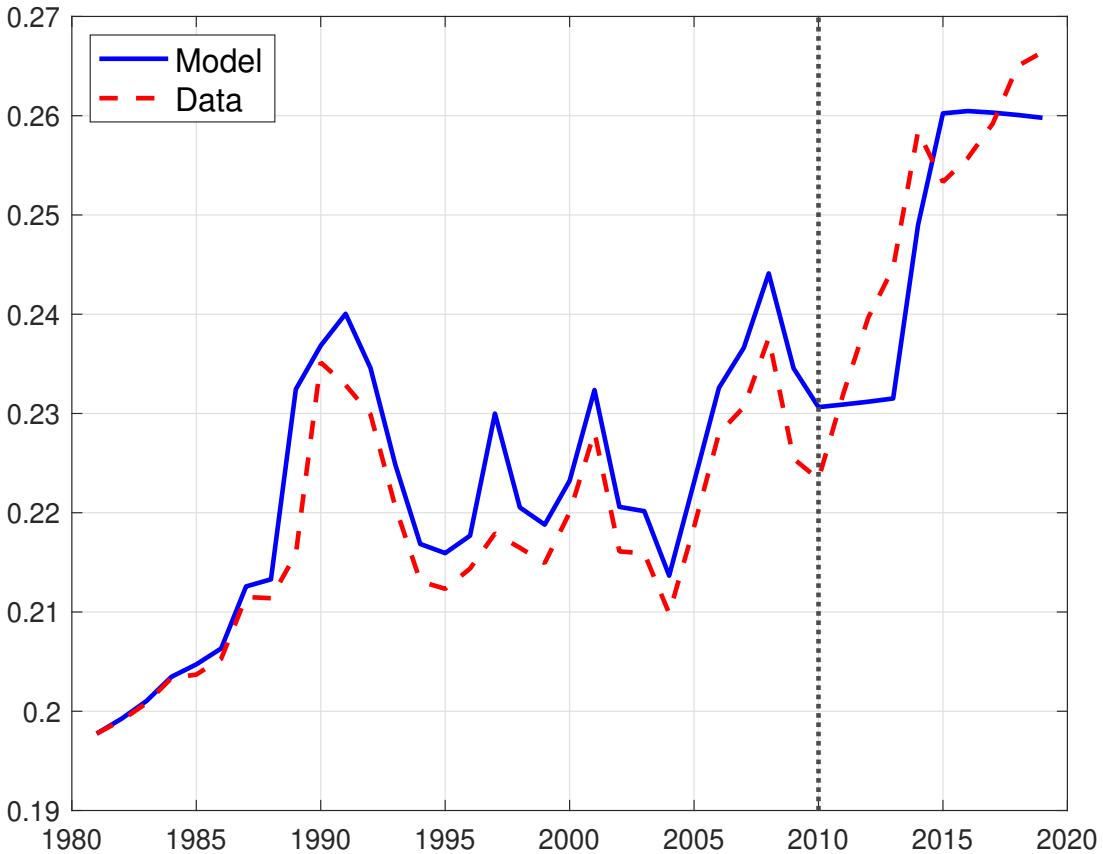


Parameter Values

Table: Calibration of Structural Parameters

Parameter	Value	
γ	$1.015^{1-\theta}$	
η	1	
θ	0.3783	Sample Average, 1981-2010
δ	0.0842	Sample Average, 1981-2010
β	0.9502	Sample Average, 1981-2010
α	24.4438	Sample Average, 1981-2010
ψ	0.5	Chetty et al (2012)
ϕ	0.1273	Sample Average, 1981-2010
μ	1.1	Fit q_t for 1981-2010

Government Revenue



Revenue from 2011 to 2019 is from forecasted tax rates.

Interest Payments on Government Debt

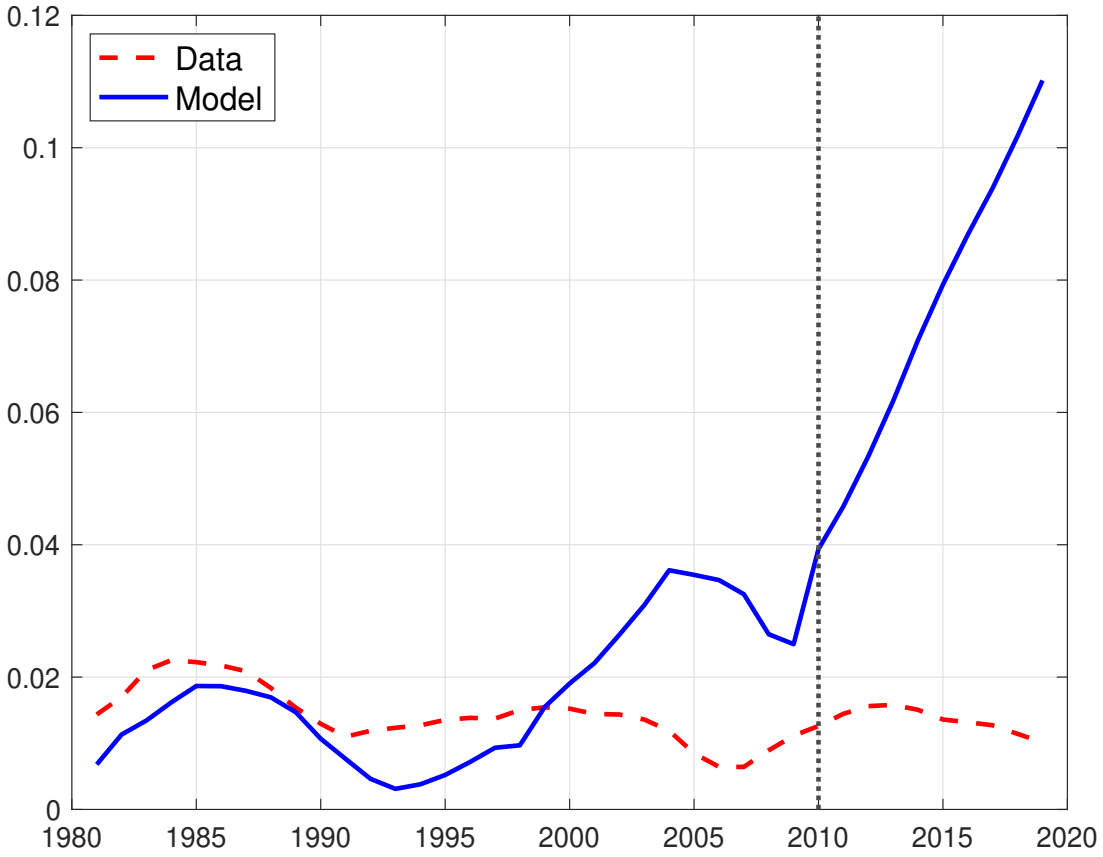


Figure: Net Interest Payments (% of GNP)

Experiments

- Experiment 0 – Forecasts of TFP, government expenditures and tax rates used for 2011-2019.
- Experiment 1 – Actual values of above in place of assumed values.
- Experiment 2 – Recalibrate ϕ using average from 2005-2019 when interest rates were low.
- Experiment 3 – BOJ holdings of debt introduced.
- Experiment 3A – Same as Experiment 3 except λ stays constant at 2020 level.
- $\phi = 0.127$ in Ex. 0 & 1, $\phi = 0.167$ in Ex. 2, and $\phi = 0.143$ in Ex. 3.

Government Spending

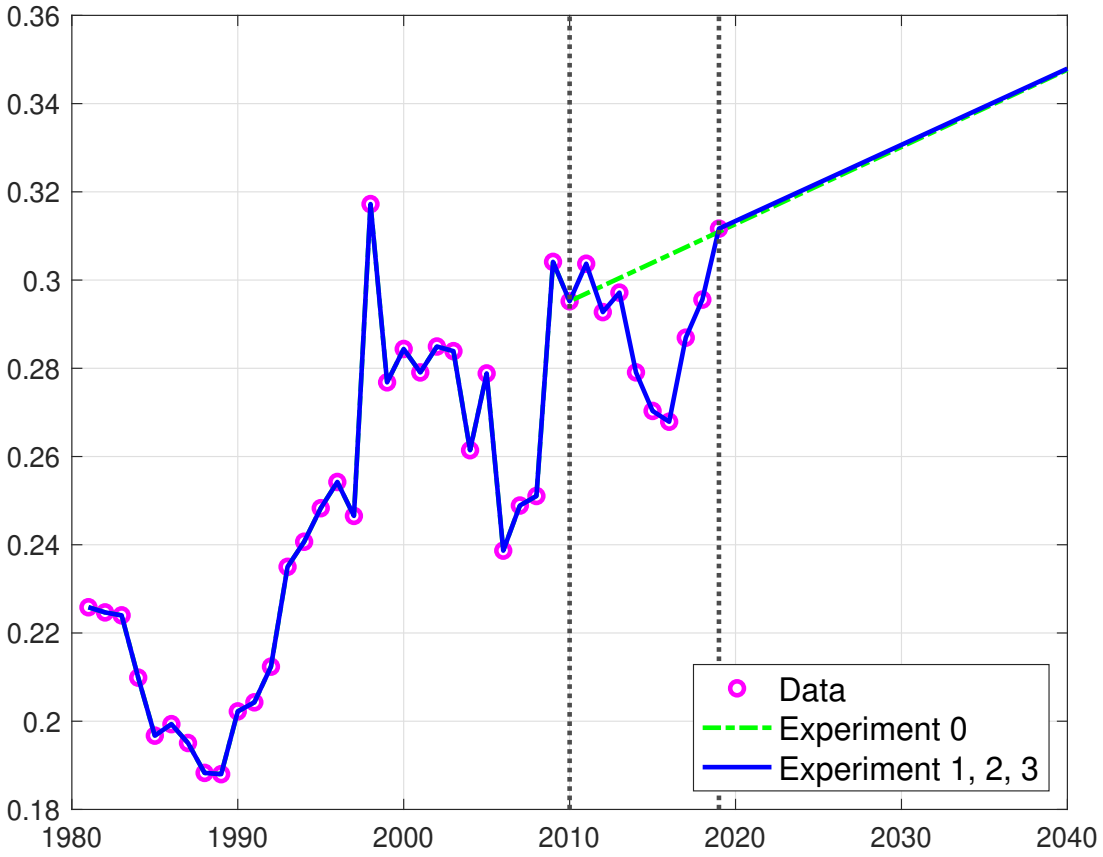


Figure: (G + TR) to GNP Ratios: 1981-2040

Debt to Output Ratios (Experiment 0)

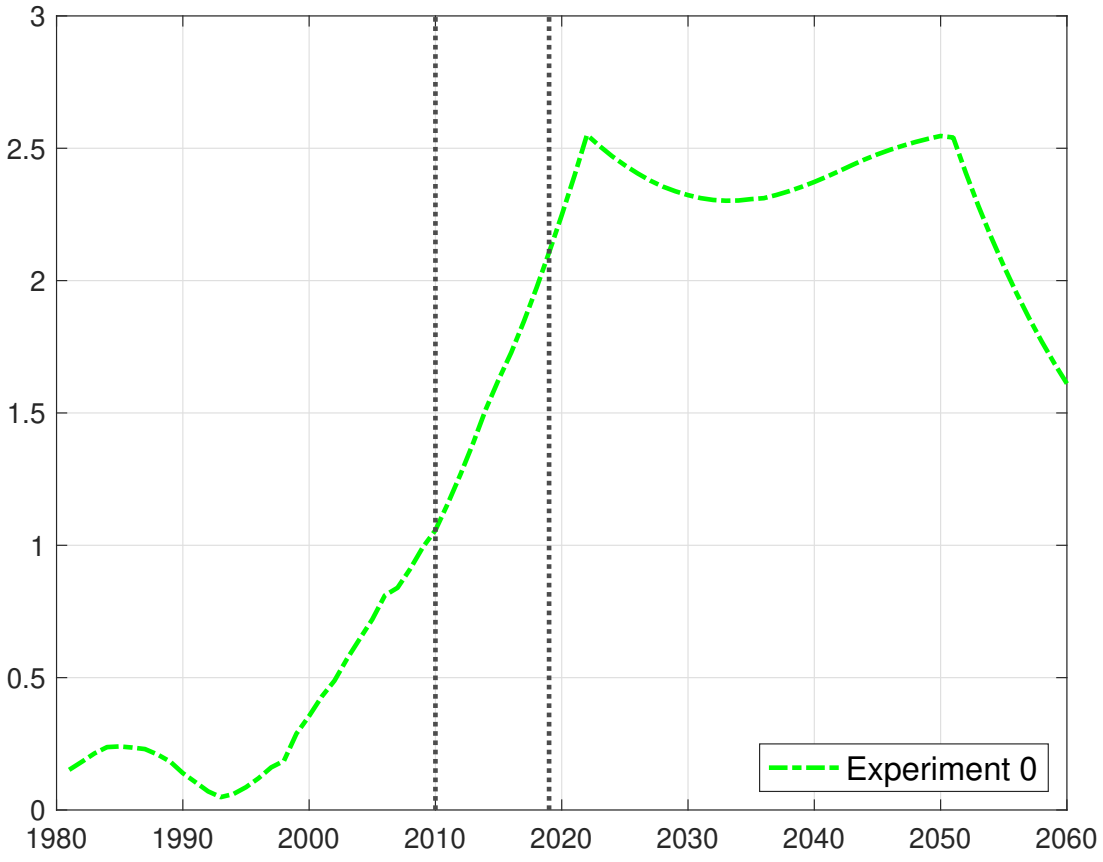


Figure: Debt to GNP Ratios: 1981-2060

B/Y reaches 250% in 2022.

Debt to Output Ratios (Experiment 1)

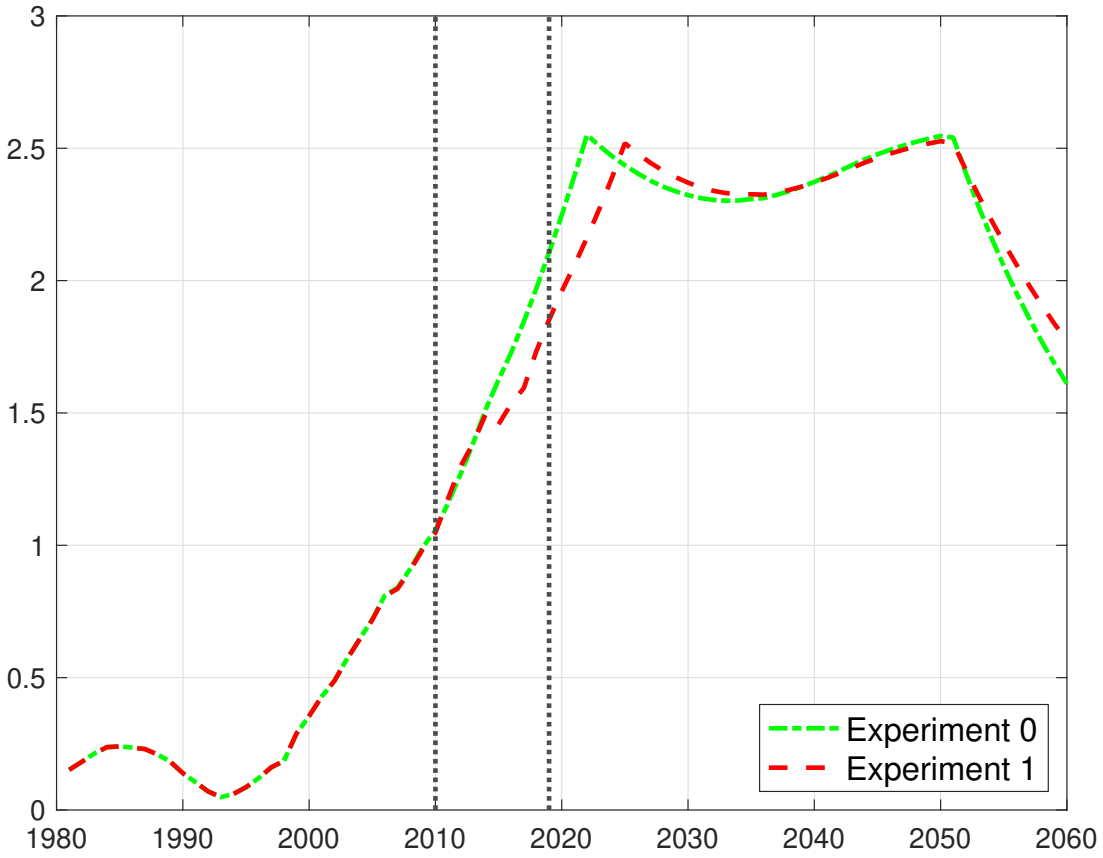


Figure: Debt to GNP Ratios: 1981-2060

B/Y reaches 250% in 2025.

Debt to Output Ratios (Experiment 2)

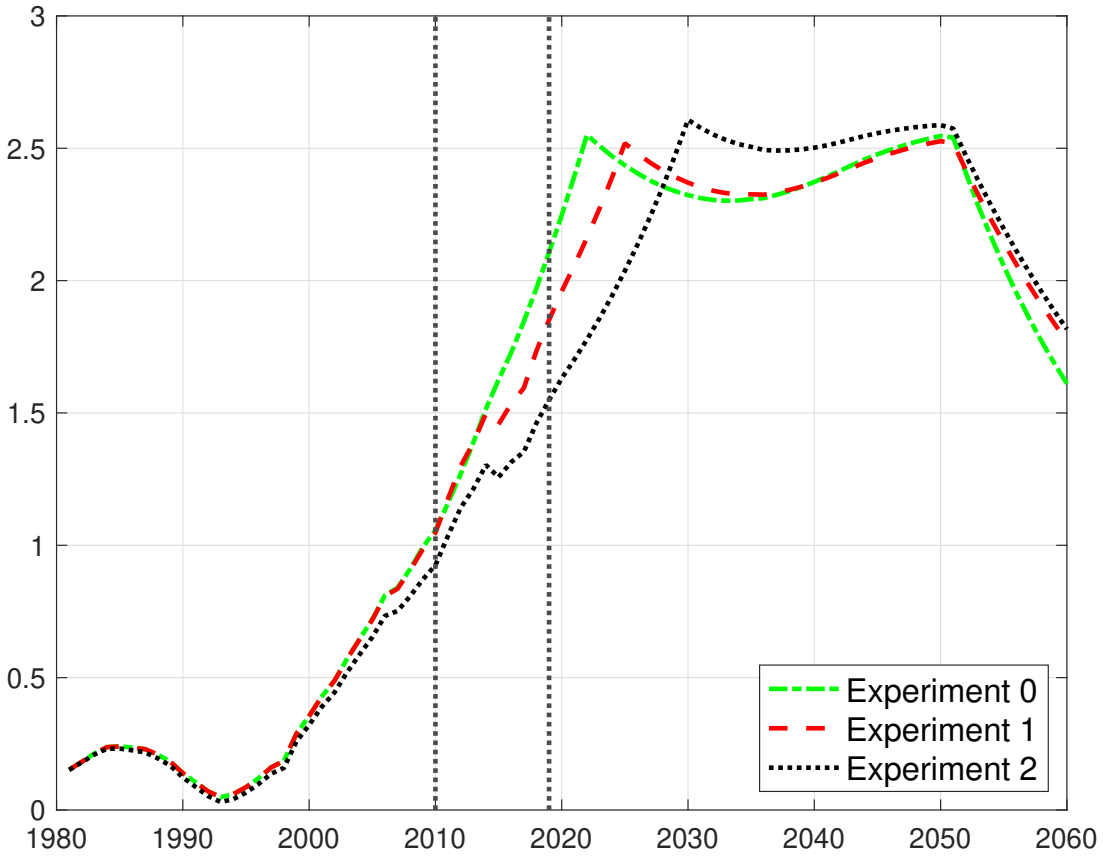


Figure: Debt to GNP Ratios: 1981-2060

B/Y reaches 250% in 2030.

Debt to Output Ratios (Experiment 3)

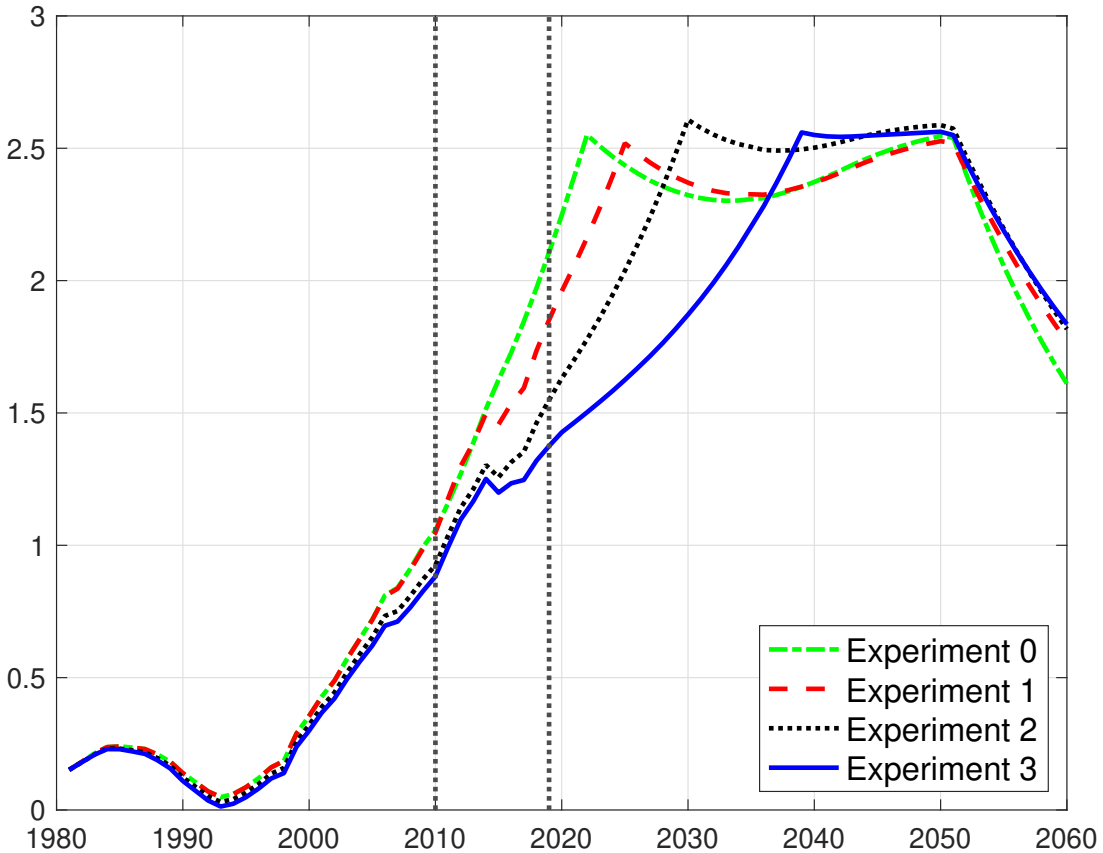
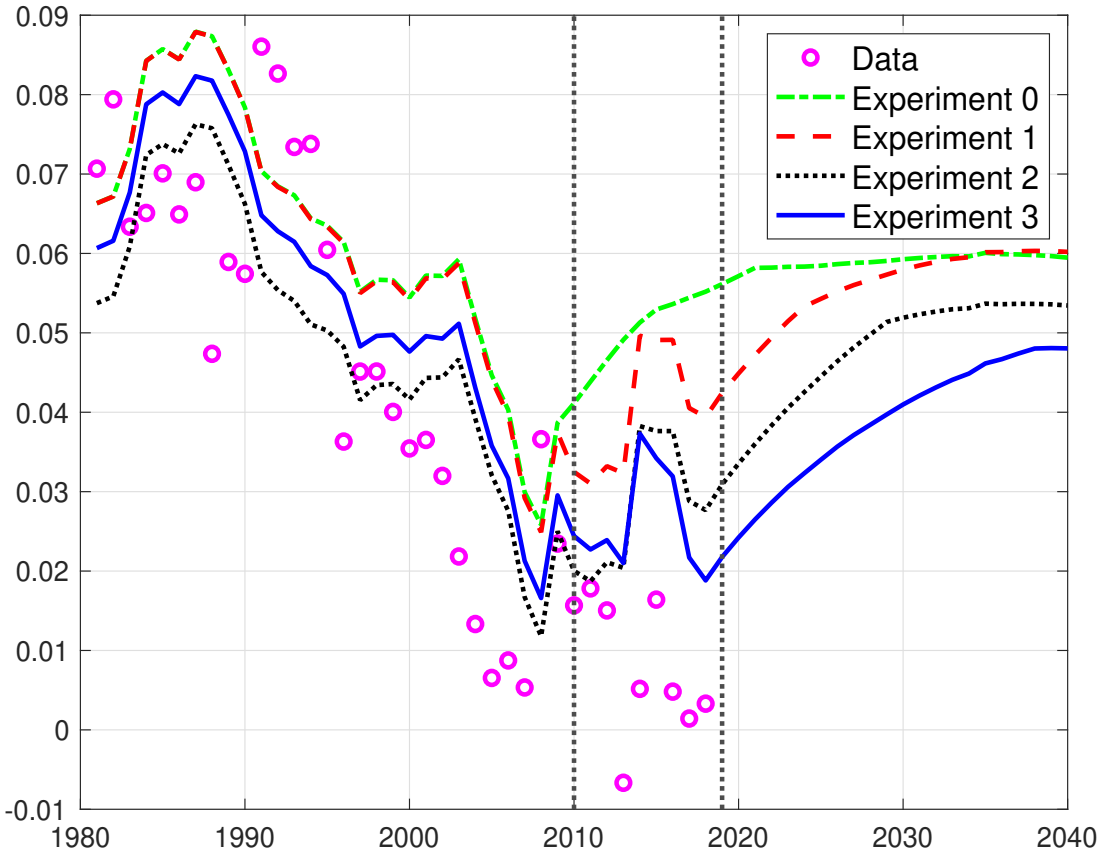


Figure: Debt to GNP Ratios: 1981-2060

B/Y reaches 250% in 2039.

Interest Rates on JGB's



Interest Payments on Debt

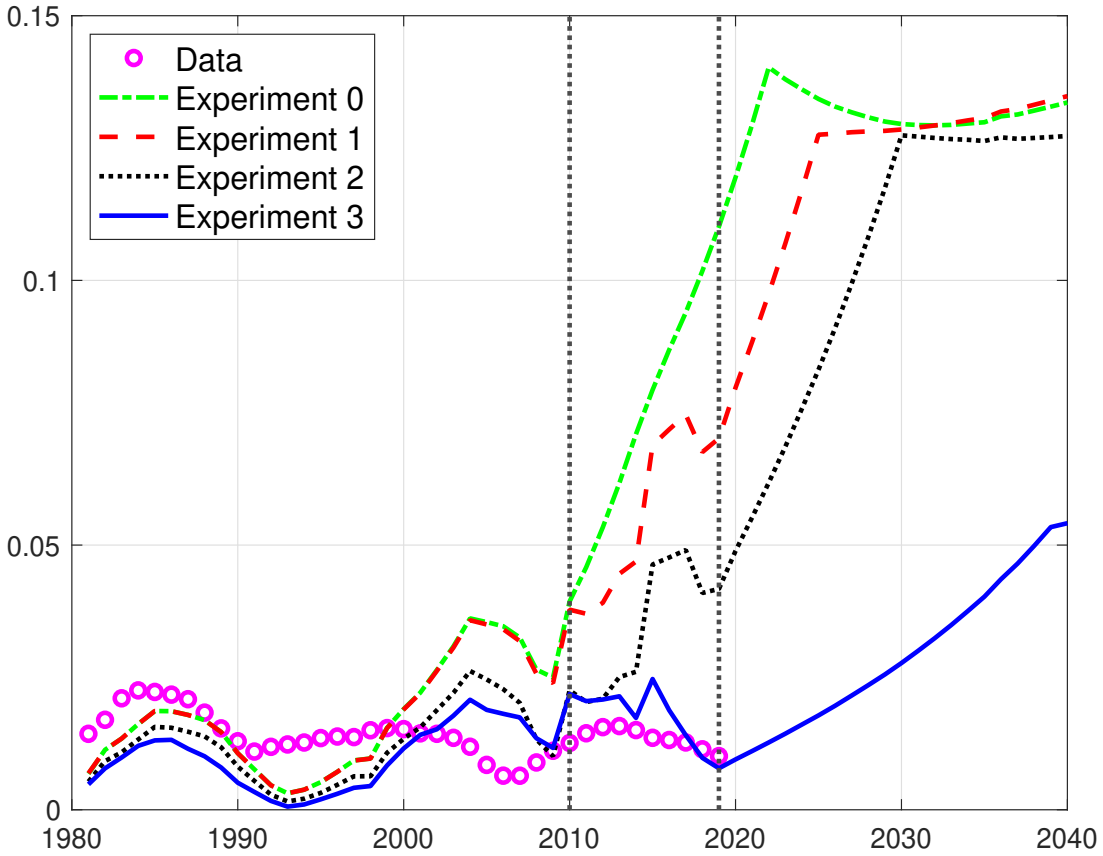
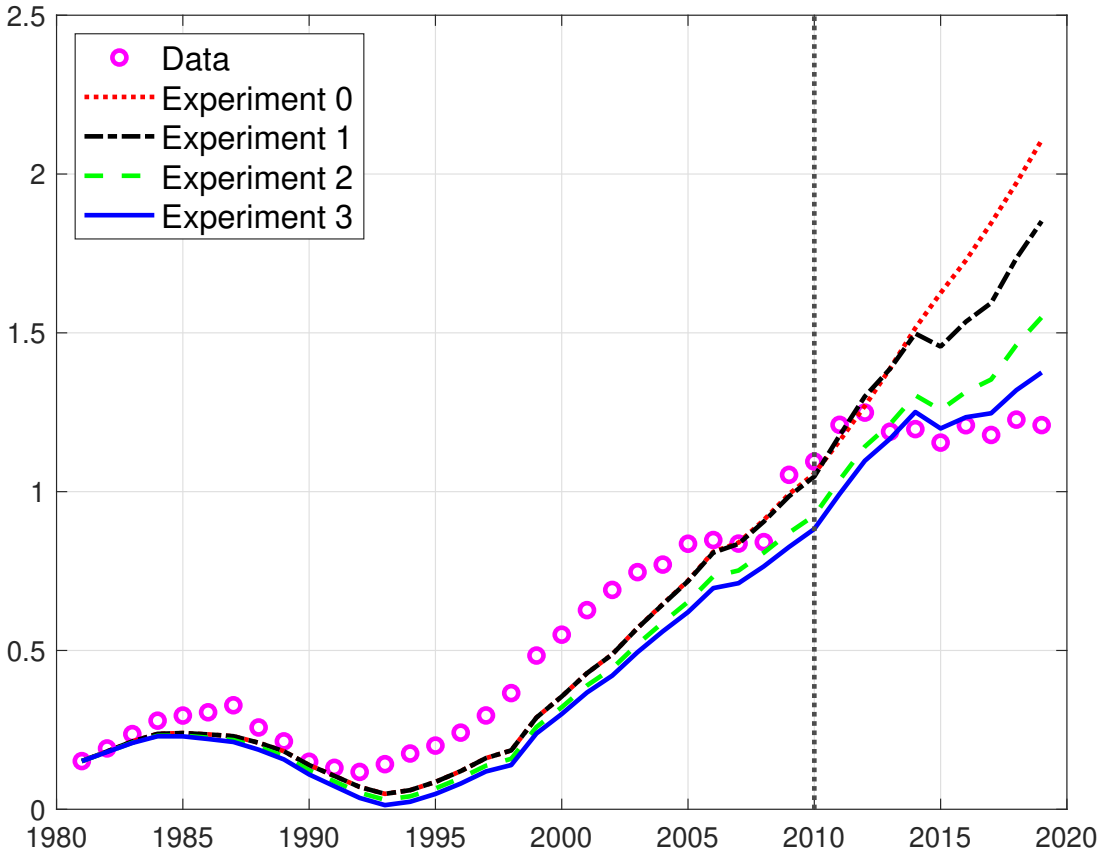


Figure: Interest Payments to GNP Ratios: 1981-2040

Debt to GNP: 1981-2019



Concluding Comments

- Hansen and Imrohoroglu (2016) (and other papers) found that government debt to output would reach unprecedented levels in the early 2020's without significant spending reductions and/or tax increases.
- Japan has been successful in stabilizing debt due to lower spending, low interest rates and a cooperative Bank of Japan.
- We find that this stabilization (without further fiscal policy changes) can only be temporary.
- Puzzle: Japanese debt was stable beginning in 2012. In our simulations, debt is stable beginning in 2014.