

On long-run mild deflations under fiscal unsustainability in Japan

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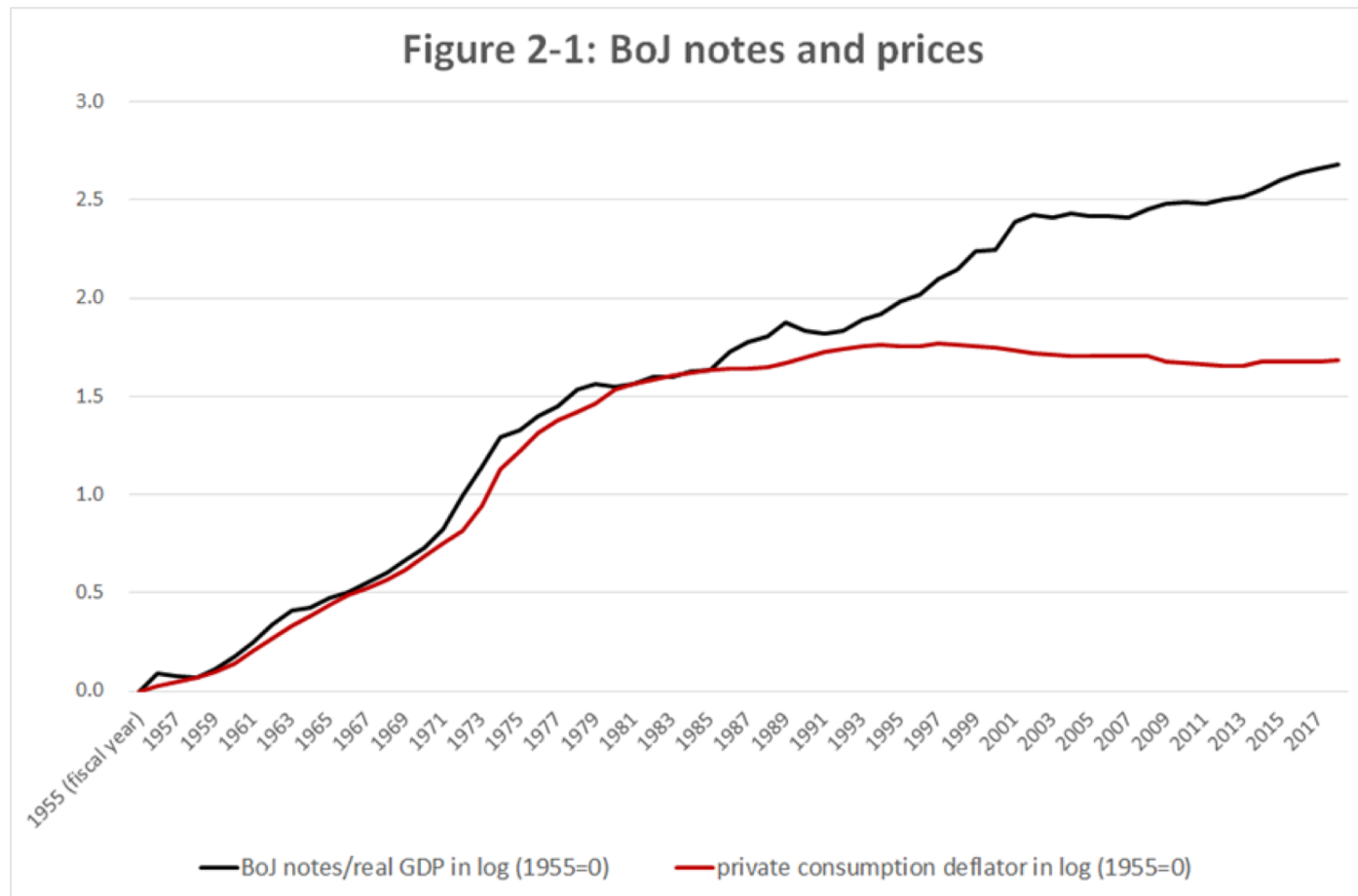
Fiscal reformers vs demand siders in the two-decade-long policy debates

- Given clear evidences for fiscal unsustainability, **fiscal reformers** propose drastic spending cuts and tax increases to avoid hyperinflations and sovereign defaults.
- Interpreting mild deflations as weak aggregate demand, **demand siders** recommend maintaining fiscal and monetary expansions to escape from a liquidity trap, and continuing them even after leaving a liquidity trap to keep low interest.
- However, either side fails to explain why mild deflations with near-zero rates of interest continued for such a long time, despite continuing primary budget deficits and unprecedented monetary expansion.
 - Even more ironically, given such a lukewarm macroeconomic environment, each side pursues their favorable prescription **without fear of its side effect** (severe deflations for fiscal reformers, and sharp interest-rate hikes for demand siders)

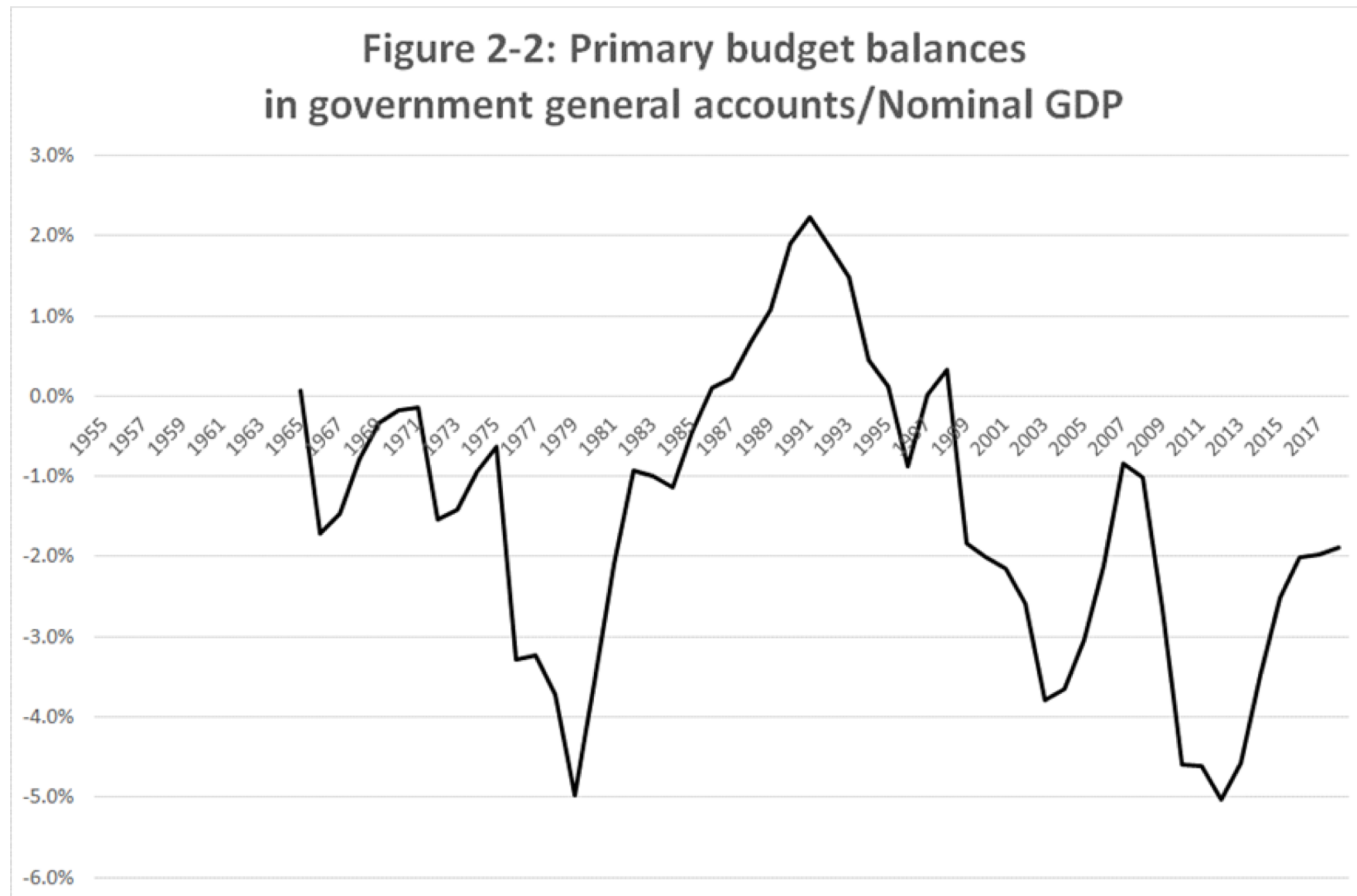
Puzzling phenomena...

- **Even before** the nominal rate of interest reached near-zero in the mid-1990s,
 - The price level was stable relative to growing money stocks, and
 - The primary budget deficits continued.
- **Even after** near-zero rates in the mid-1990s,
 - Long-term yields and ultra long-term yields remained relatively high, and
 - Upward-sloping yield curves emerged.

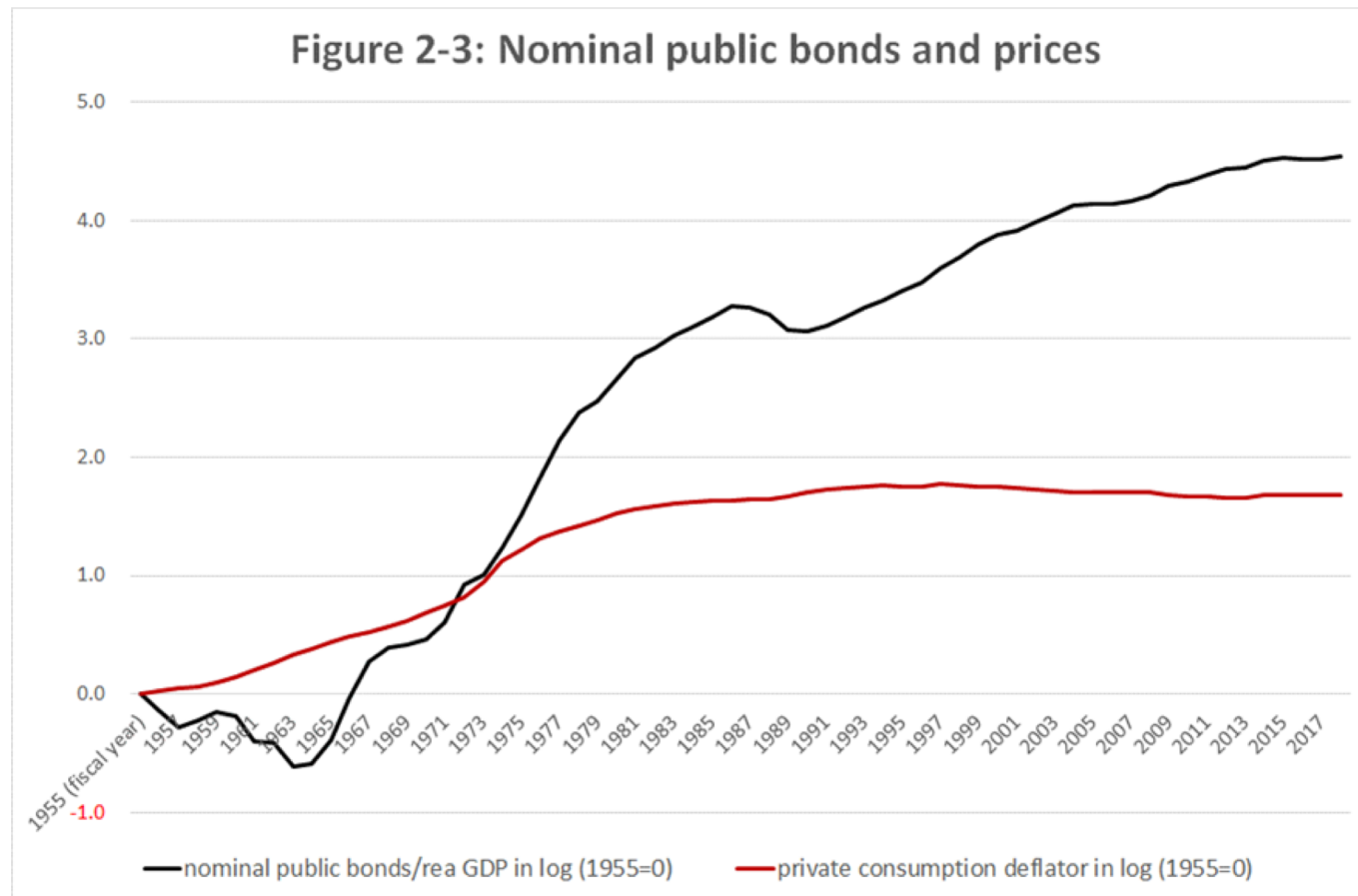
BoJ notes per unit of output, and consumption deflators



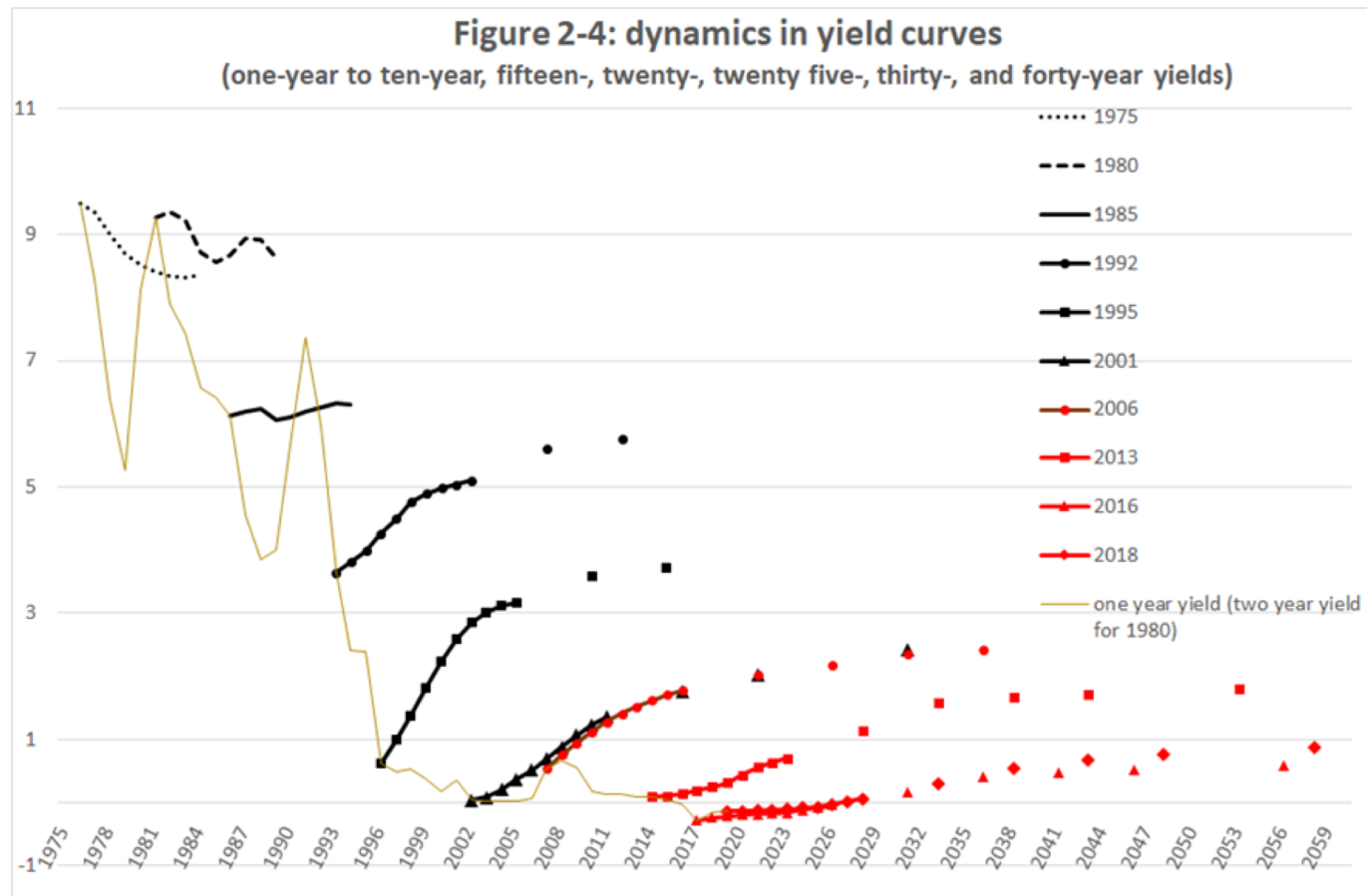
Continuing primary budget deficits



Nominal public bonds per unit of output, and consumption deflators



Steep yield curves



Presenting an alternative story for Japan's long-run mild deflation

- Two ingredients
 - Fiscal unsustainability is admitted temporarily or even persistently unlike in standard monetary models.
 - In contradiction to fiscal reformers or demand siders, fiscal sustainability will be restored at some point in the future *not* by either drastic fiscal reforms, hyperinflations, or continuous mild inflations with low interest rates, *but* through a one-off price surge.
 - A one-off price surge is by itself a rare and catastrophic event.
- This paper applies this framework to consistently explain the puzzling phenomena observed during the past decades in Japan.

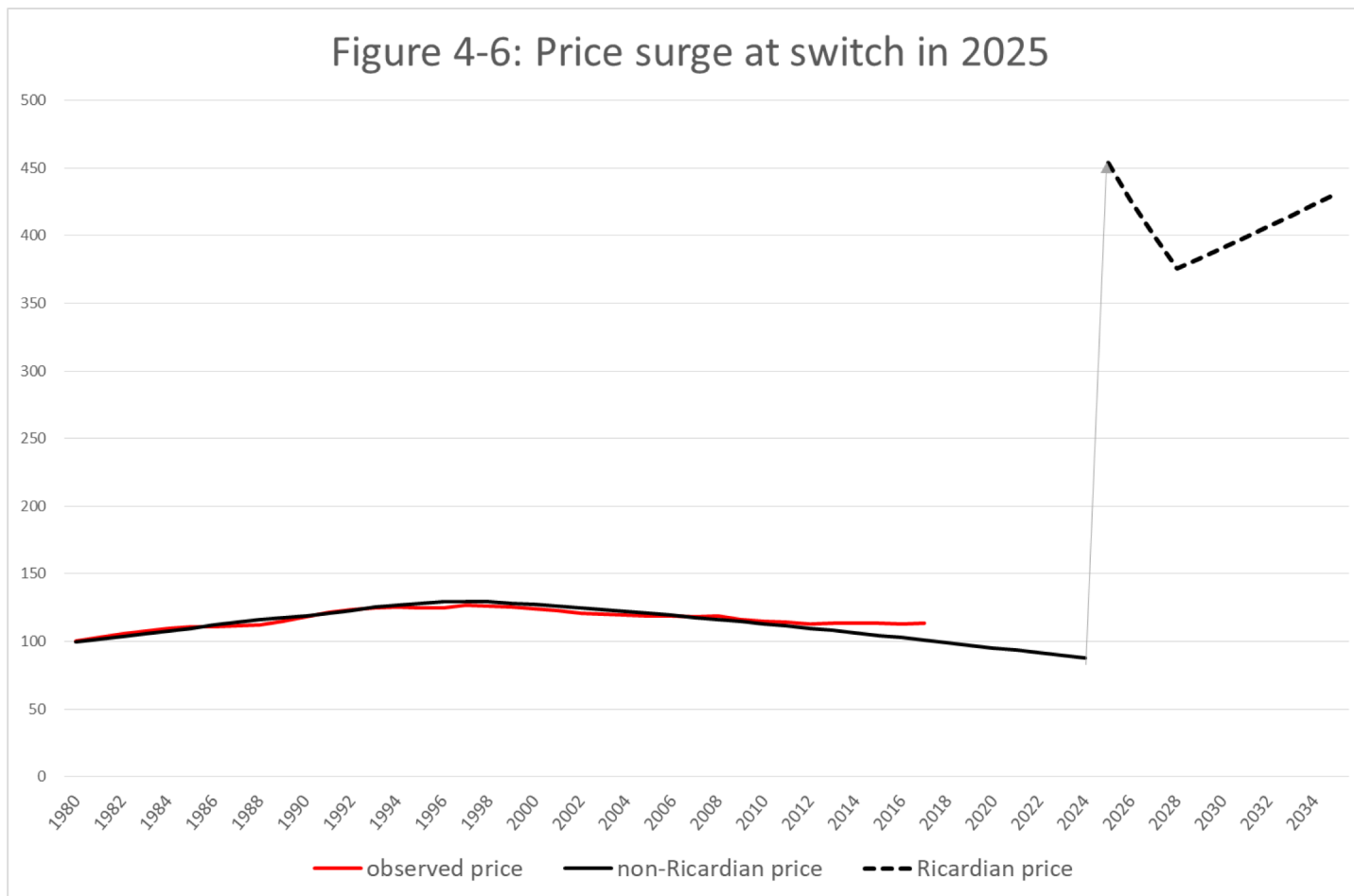
A sequence of fiscal policies

- The fiscally unsustainable regime (**FU** regime)
 - **Fiscal unsustainability** results from undisciplined fiscal policies
- The fiscally sustainable regime (**FS** regime)
 - **A price surge** is a **rare** and **catastrophic** event, and serves as a **trigger** for a regime switch.
 - Taking place with probability less than 5%,
 - Yielding catastrophic endowment shocks for the following years.
 - Upon a sharp price surge (several times as high as before), the regime switches from FU to FS.
 - **Fiscally sustainability** is restored by both
 - Mostly through **a heavy bond devaluation** by a price surge, and
 - **A moderate fiscal reform** implemented only after catastrophic shocks disappear.

A sketch (1): Long-run mild deflations with a one-off price surge

- Two regimes, and a switch from one to the other
 - Mildly deflationary equilibria in the fiscally unsustainable regime (**FU** regime)
 - The terminal condition never converges to zero, and the unfunded component emerges.
 - Quantity theory of money equilibrium in the fiscally sustainable regime (**FS** regime)
 - The price level is proportional to existing money stocks.
- Regime switch upon a rare price surge (less than 5% per year),
 - One-off price surge: The price level immediately surges from the deflationary path to the QTM level.
 - Several times as high as before.
 - Mild deflations may continue for a long time.
 - Price surges are hardly likely in the next year, and not very likely in the next decade, but most likely in the next century.

A one-off price surge: An example



A sketch (2): Fiscal unsustainability and downward pressures on the price level

- Government's intertemporal budget constraint with fiscal unsustainability

$$\frac{B_t}{P_t} = \text{PV of future fiscal surpluses} + \text{Terminal value}$$

- Non-zero terminal condition, or the unfunded component emerges in the GIBC.

$$0 < \text{Terminal value} < \infty$$

- The presence of the unfunded component yields
 - Downward pressures on the price level,
 - Feasible roll-over of public debt, and
 - A continuum of deflationary equilibria.

A sketch (3): A bare possibility of one-off price surges and the deflationary process

- From the Euler equation,

Real rate of interest \approx Expected deflations

$$\text{Real rate of interest} \approx \left[-(1 - \pi) \frac{\Delta P_{t+1}^{FU}}{P_t^{FU}} - \pi \frac{\Delta P_{t+1}^{FS}}{P_t^{FU}} \right]$$

- Several implications:

- A bare possibility of the price surge upon a catastrophe ($\frac{\Delta P_{t+1}^{FS}}{P_t^{FU}} \gg 0$) in the next period yields more deflationary pressures.
 - Realized deflations ($-\frac{\Delta P_{t+1}^{FU}}{P_t^{FU}}$) \gg Real rate of interest
- **Monetary expansion \rightarrow Sharper price surge in the future \rightarrow More deflationary pressures in the current**
- Stronger risk aversion to catastrophic risks \rightarrow Lower real rate of interest \rightarrow Less deflationary pressures

A sketch (4): A far-future possibility of one-off price surges and upward-sloping yield curves

- The price level will eventually surge to higher levels.
 - A sharp contrast in likelihood between near and far futures
- Long-term yields and ultra long-term yields remain relatively high by a far-future possibility of one-off price surges.
 - Yield curves up to forty years are upward sloping.

Related literature on the FTPL

- Fiscal unsustainability and the FTPL
 - LeRoy (2004), Bloise (2005), and Bloise and Reichlin (2008)
 - Basseto and Cui (2018)
 - Kobayashi (2019), and Sakuragawa (2019)
- Fiscal limit and regime switching
 - Davig et al. (2011)
 - Hitting the fiscal limit, fiscal sustainability may be achieved by not drastic cuts in welfare payments, but unprecedented inflations.
 - Benhabib et al. (2002) as a related literature
 - A liquidity trap is *ex ante* eliminated by a potential possibility of fiscal unsustainability.

Preference

- $$\sum_{t=0}^{\infty} \beta^t E_0 \left[u(c_t) + v \left(\frac{M_t}{P_t} \right) \right], \quad (1)$$

- $$u(c) = \ln(c), \quad (2)$$

- $$v \left(\frac{M}{P} \right) = \frac{\lambda}{1 - \frac{1}{\sigma}} \left(\chi + \frac{M}{P} \right)^{1 - \frac{1}{\sigma}}, \quad (3)$$

where χ represent an alternative means of exchange.

Two fiscal policies

- **Undisciplined fiscal policy** (constant real fiscal surplus, maybe zero or negative, before price surges)

- $$P_t^{FU}(\tau_t^{FU} - g_t) = P_t^{FU}\varepsilon - (M_t - M_{t-1}),$$

- **Disciplined fiscal policy** (debt-sensitive fiscal surplus after price surges)

- If $\gamma B_{t-1} > \underline{B}$ with $0 < \gamma < 1$, then

$$P_t^{FS}(\tau_t^{FS} - g_t) = (R_{1,t-1} - \gamma)B_{t-1} - (M_t - M_{t-1}),$$

- otherwise,

$$P_t^{FS}(\tau_t^{FS} - g_t) = (R_{1,t-1}B_{t-1} - \underline{B}) - (M_t - M_{t-1}).$$

Endowment process

- Before a price surge (a catastrophic event),

- $c_t = c = y - g$ (7)

- A price surge reduces endowment substantially, and shifts more resources to public expenditures.

- Just after a price surge,

- $c_s = c(1 - d)^L$, (8)

- In the catastrophic periods,

- $c_{s+l} = c(1 - d)^{L-l}$ (8')

The price process in the fiscally sustainable regime (FS regime)

- FOCs

- $\beta R_{1,t} \left[\frac{P_t^{FS}}{P_{t+1}^{FS}} (1 - d_0) \right] = 1,$ (9)

- $\lambda \left(\chi + \frac{M_t}{P_t} \right)^{-\frac{1}{\sigma}} = \frac{1}{c_t} \left(1 - \frac{1}{R_{1,t}} \right).$ (10)

- The price process

- $\frac{P_t^{FS}}{P_{t+1}^{FS}} = \frac{1}{\beta R_{1,t}(1-d_0)} = \frac{1}{\beta(1-d_0)} \left[1 - \lambda \left(\chi + \frac{M_t}{P_t^R} \right)^{-\frac{1}{\sigma}} c_t \right]$ (11)

Three potential cases with $d = 0$ (1)

- **Case 1: The quantity theory of money**

- $$P_t^{QT(d=0)} = \frac{1}{\left(\frac{\lambda(1+\mu)}{1+\mu-\beta} c^{1-\frac{1}{\sigma}}\right)^\sigma} \frac{M_t}{c} \quad (15)$$

- $$\lim_{T \rightarrow \infty} \left[\beta^{T-s} \frac{B}{(1+\mu)^{T-s} P_s^{QT}} \right] = \lim_{T \rightarrow \infty} \left[\left(\frac{\beta}{1+\mu}\right)^{T-s} \frac{B}{P_s^{QT}} \right] = 0$$

- The below choice of λ is consistent with constant Marshallian k ($\kappa = \frac{M}{P^{QT}c}$), around 8% for the current Japanese economy.

$$\lambda = \left(\frac{\chi}{c} + \kappa\right)^{\frac{1}{\sigma}} \frac{1+\mu-\beta}{1+\mu} c^{\frac{1}{\sigma}-1} > 0 \quad (16)$$

Three possible cases with $d = 0$ (2)

- Case 2: **A continuum of deflationary equilibria** starting from $P_s^{FS} < P_s^{QT(d=0)}$ is *not* feasible, because the real money balance goes to infinity, and

$$0 < \lim_{T \rightarrow \infty} \left[\beta^{T-s} \frac{B}{\beta^{T-s} P_s^{FS}} \right] = \frac{B}{P_s^{FS}} < \infty$$

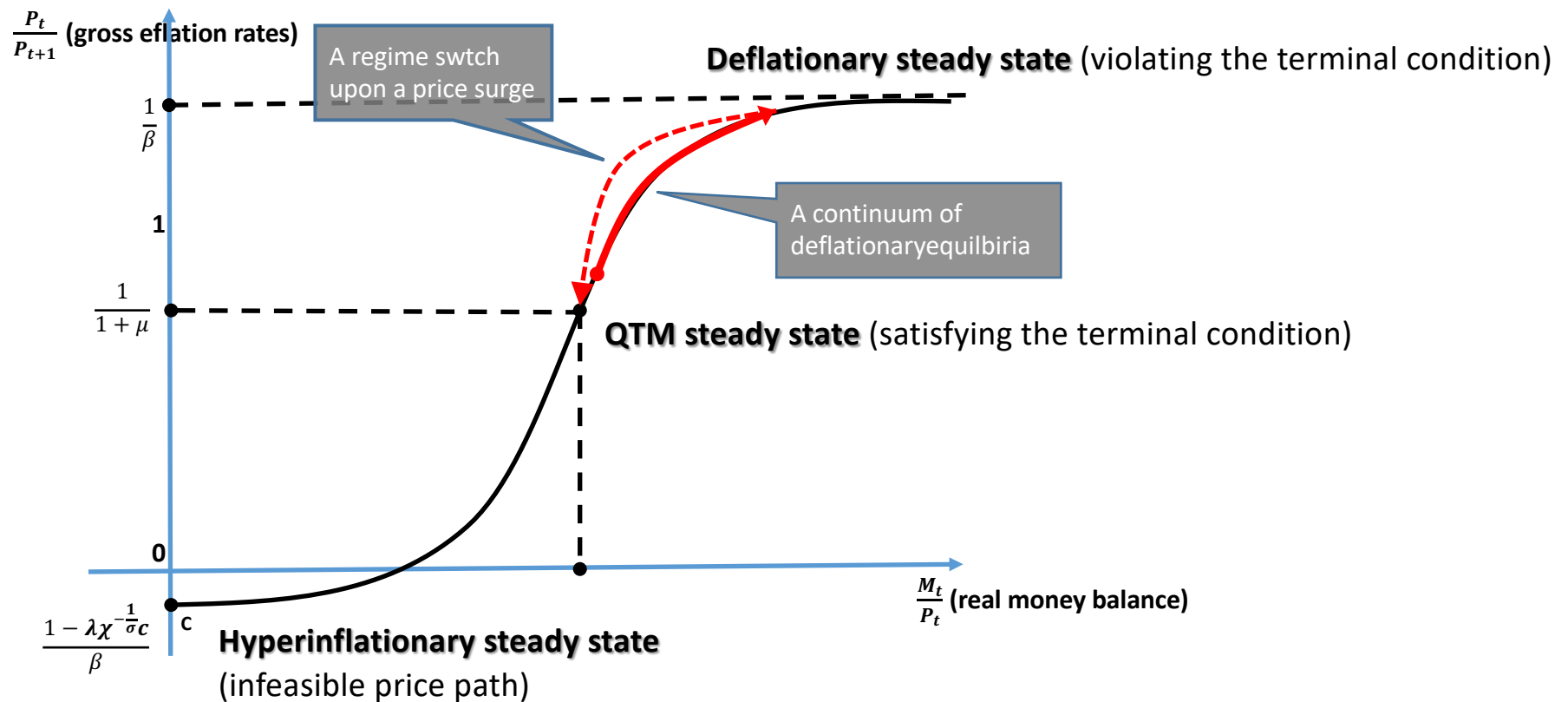
Three possible cases with $d = 0$ (3)

- Case 3: **A continuum of inflationary equilibria** starting from $P_s^{FS} > P_s^{QT(d=0)}$ is possible if $0 < \lambda \chi^{-\frac{1}{\sigma} c} < 1$, because the real money balance degenerates to zero, and

$$\lim_{T \rightarrow \infty} \frac{\beta^{T-s} \underline{B}}{\left(\frac{\beta}{1 - \lambda \chi^{-\frac{1}{\sigma} c}} \right)^{T-s} P_s^{FS}} = \lim_{T \rightarrow \infty} \left[\left(1 - \lambda \chi^{-\frac{1}{\sigma} c} \right)^{T-s} \underline{B} \right] = 0$$

- But, if $1 < \lambda \chi^{-\frac{1}{\sigma} c}$, then a continuum of inflationary equilibria is not feasible, because a positive price is not supported at a steady state.

Three possible steady states, and a regime switch from the deflationary trend up to the QTM price



An examination of the government's intertemporal budget constraint (GIBC) in **FU regime** (a deflationary regime) with $d = 0$

- GIBC

$$\begin{aligned} \frac{B_0}{P_0^{FU}} &= \sum_{t=0}^{\infty} \left\{ \beta^t (1 - \pi)^t \left[\beta(1 - \pi)\varepsilon + \beta\pi \frac{R_{1,t}B_t}{P_{t+1}^{QT(d=0)}} \right] \right\} + \lim_{T \rightarrow \infty} \left[\beta^T (1 - \pi)^T \frac{B_T}{P_T^{FU}} \right] \\ &= \frac{\beta(1 - \pi)\varepsilon}{1 - \beta(1 - \pi)} + \sum_{t=0}^{\infty} \left(\beta^t (1 - \pi)^t \beta\pi \frac{R_{1,t}B_t}{P_{t+1}^{QT(d=0)}} \right) + \lim_{T \rightarrow \infty} \left[\beta^T (1 - \pi)^T \frac{B_T}{P_T^{FU}} \right] \end{aligned}$$

- Terminal condition under a deflationary process

$$0 \leq \lim_{T \rightarrow \infty} \left[\beta^T (1 - \pi)^T \frac{B_T}{P_T^{FU}} \right] < \infty$$

Three sources of public debt repayment

- **Black**: backed by non-Ricardian fiscal surpluses (maybe negative)
- **Blue**: backed by a heavy devaluation
- **Red**: unfunded component

$$\frac{B_0}{P_0^{FU}} = \frac{\beta(1-\pi)\varepsilon}{1-\beta(1-\pi)} + \sum_{t=0}^{\infty} \left(\beta^t(1-\pi)^t \beta \pi \frac{R_{1,t}B_t}{P_{t+1}^{QT(d=0)}} \right) + \lim_{T \rightarrow \infty} \left[\beta^T(1-\pi)^T \frac{B_T}{P_T^{FU}} \right]$$

- Important feature: Only the unfunded component is dependent on the path of P_t^{FU} .
 - Note that P_t^{FS} is determined according to existing money stocks.

The nature of the unfunded component

- $\lim_{T \rightarrow \infty} \beta^T (1 - \pi)^T \frac{B_T}{P_T^{FU}} > 0$

$$B_T \rightarrow \underline{B}$$

$$\frac{P_t^{FU}}{P_t^{FU}} \rightarrow \frac{1}{\beta(1 - \pi)}$$

- In the limit, the public bonds are appreciated by the rate of deflation ($\frac{1}{\beta(1-\pi)}$), which is the same as the rate of stochastic discounting ($\beta(1 - \pi)$).
- Thus, the unbacked component converges to a certain positive as long as it is present.

Ricardian equivalence in the fiscally unsustainable regime!

- The initial price P_0^{FU} is independent of non-Ricardian fiscal policy or ε .

$$\begin{aligned}
 \frac{B_0}{P_0^{NR}} &= \frac{\beta(1-\pi)\varepsilon}{1-\beta(1-\pi)} \\
 &+ \left\{ \left(\sum_{t=0}^{\infty} \left[\beta^t (1-\pi)^t \beta \pi \frac{R_{1,t} \prod_{i=0}^{t-1} R_{1,i} B_0}{P_{t+1}^{QT(d=0)}} \right] + \lim_{T \rightarrow \infty} \left[\beta^T (1-\pi)^T \frac{\prod_{i=0}^{T-1} R_{1,i} B_0}{P_T^{FU}} \right] \right\} - \frac{\beta(1-\pi)\varepsilon}{1-\beta(1-\pi)} \\
 &= \sum_{t=0}^{\infty} \left[\beta^t (1-\pi)^t \beta \pi \frac{R_{1,t} \prod_{i=0}^{t-1} R_{1,i} B_0}{P_{t+1}^{QT(d=0)}} \right] + \lim_{T \rightarrow \infty} \left[\beta^T (1-\pi)^T \frac{\prod_{i=0}^{T-1} R_{1,i} B_0}{P_T^{FU}} \right] \quad (22')
 \end{aligned}$$

Calibration

- A large-scale Tokyo inland earthquake as a rare, but catastrophic event.
 - $\pi = 0.04$ ($\pi = 0.02$ is also considered.)
 - $d = 0.072$
 - $L = 3$
 - The catastrophic possibility is introduced from 1986 on.
- Preference parameters
 - Detrended consumption: $\mathbf{c} = \mathbf{1}$
 - Growth-adjusted monetary expansion: μ_t set at the observed level for the years 1980 to 2017, and at 2% from 2018 on.
 - Discount factor: $\beta = 0.98$ or 0.99 .
 - A set of parameters associated with money demand is chosen consistently with the 1955-1970 average of $\frac{M}{Py}$ ($\kappa = 0.078$).

- $\sigma = 0.01$ consistent with empirical findings of Japan's money demand.

$$\frac{\Delta(M_t/P_t)}{M_{t-1}/P_{t-1}} = -\sigma \frac{\chi + M_{t-1}/P_{t-1}}{M_{t-1}/P_{t-1}} \frac{\Delta R_t}{R_{1,t-1}-1} + \sigma \frac{\chi + M_{t-1}/P_{t-1}}{M_{t-1}/P_{t-1}} \frac{\Delta c_t}{c_{t-1}} \quad (27)$$

- $\lambda \chi^{-\frac{1}{\sigma} c} > 1$ excludes a continuum of inflationary equilibria in either regime.
- $\Delta = (\gamma - \eta)d = 2 \times 0.072 = 0.144$, or $\Delta = 3 \times 0.072 = 0.216$, where η ranges between 0.8 and 0.9.
- The economy starts in 1980 with the initial price slightly less than the QTM price, initiating the deflationary process.

Figure 4-3: Predicted price path

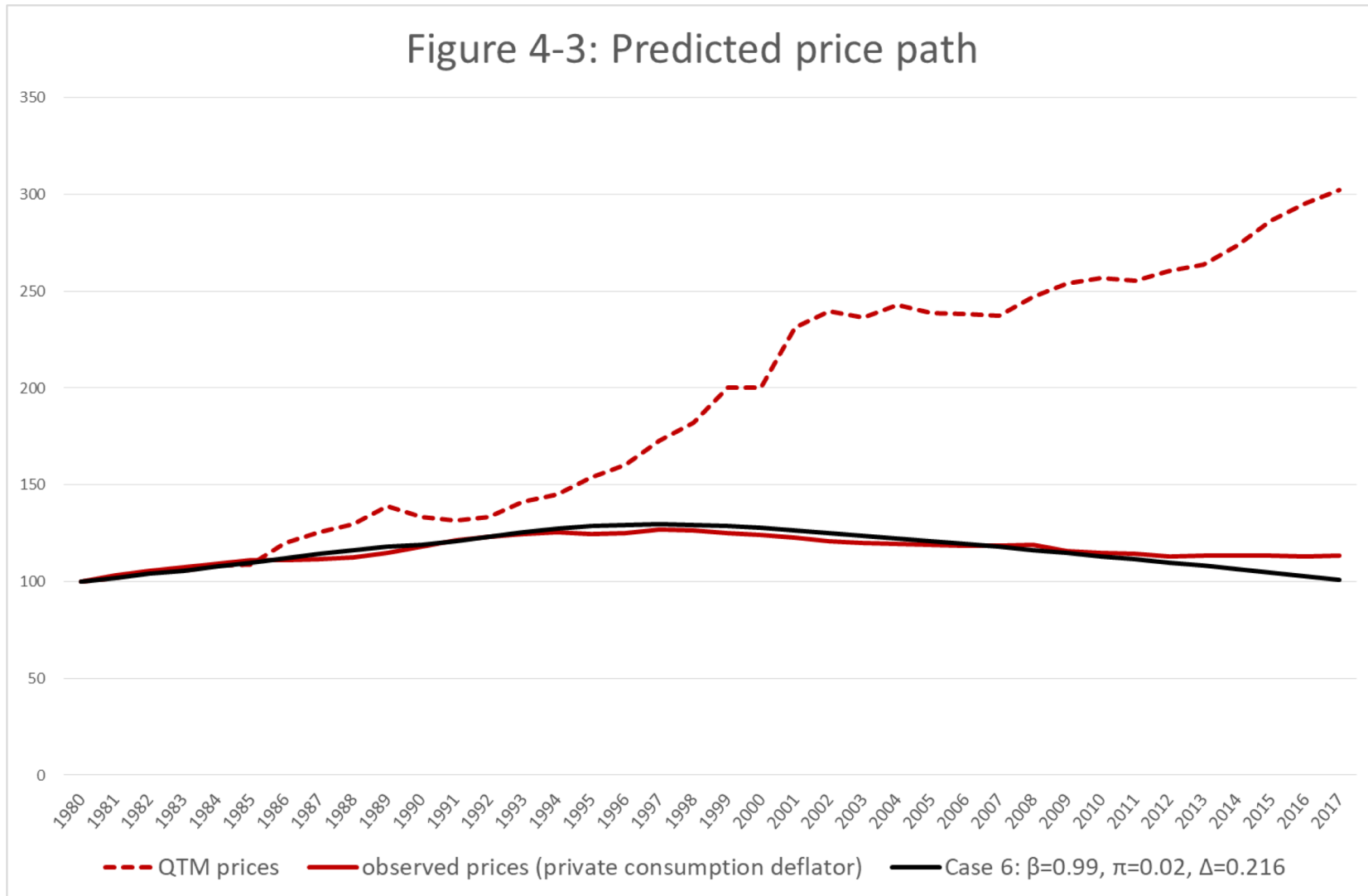
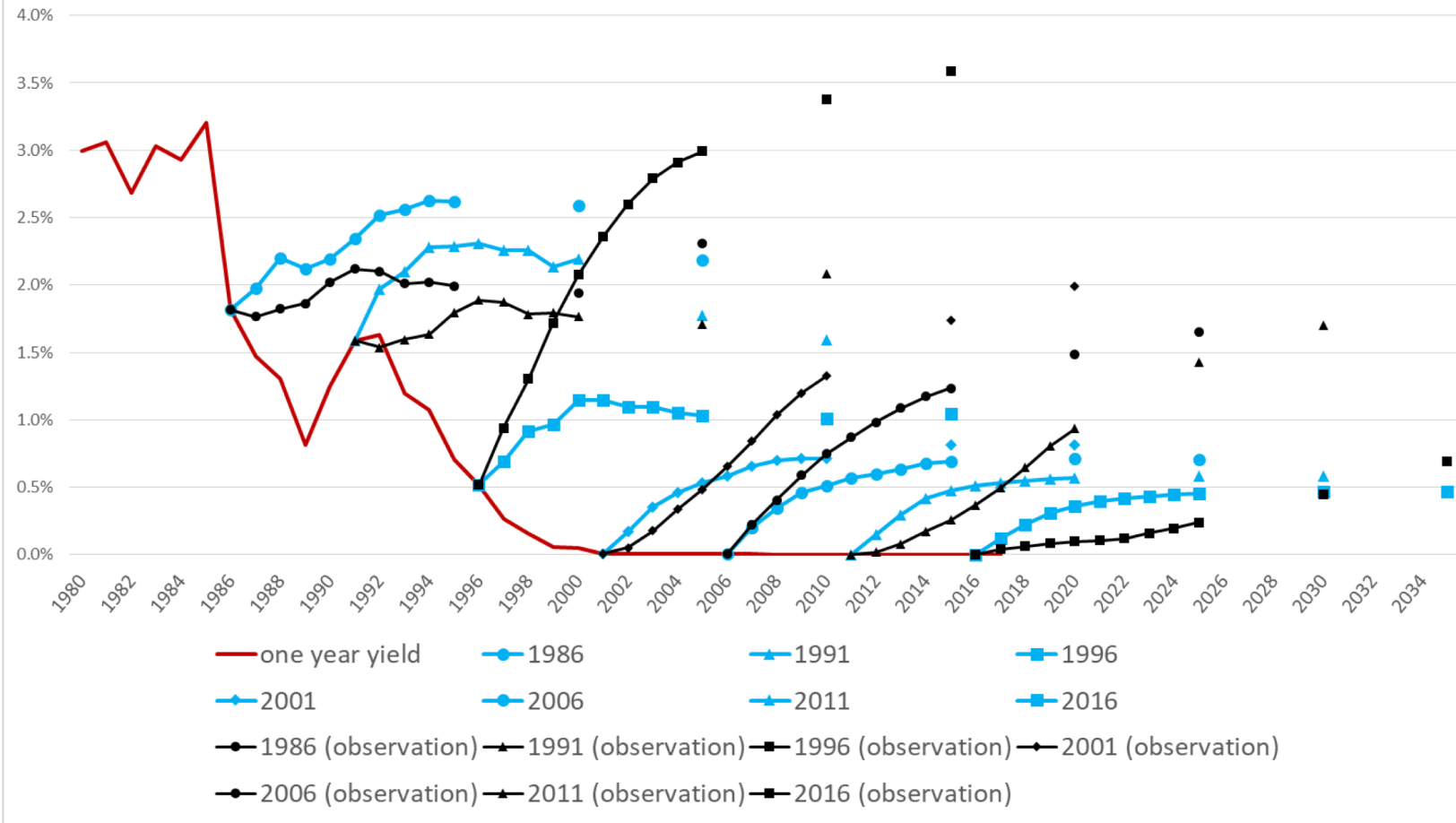


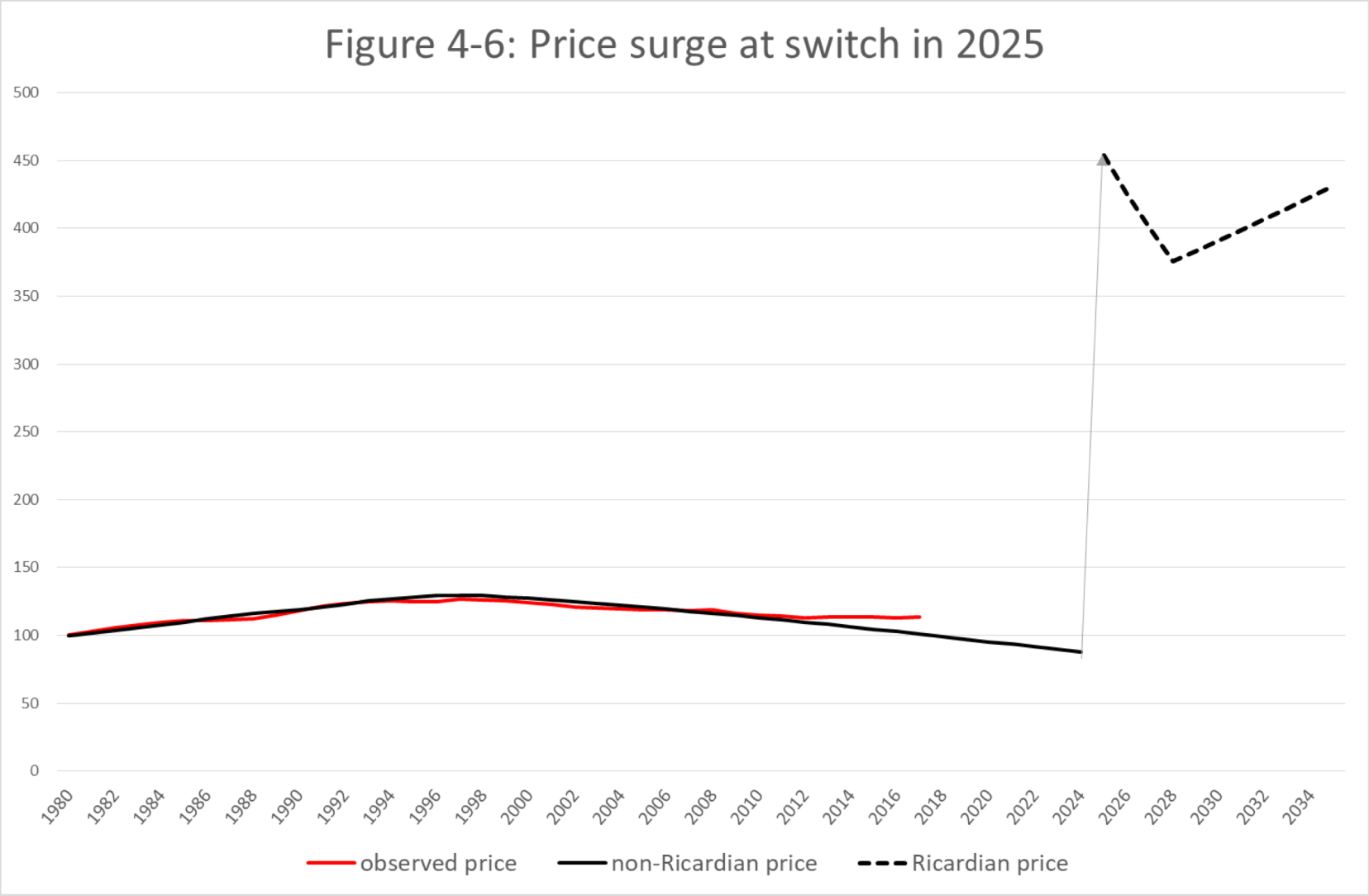
Figure 4-5-3: Predicted yield curves
 (Case 6: $\beta=0.99$, $\pi=0.02$, $\Delta=0.216$)



Immense nominal adjustment upon switching

- Upon a regime switching
 - The price level surges sharply, as several times as high as before.
 - The nominal rate of interest leaves the zero level, and overshoots even the long-run rate (monetary growth + discount rate, a few percents).

Figure 4-6: Price surge at switch in 2025



The share of the unfunded component relative to the real valuation of the public bonds

- Case 6 ($\beta = 0.99$, $\pi = 0.02$, $\Delta = 0.216$)
- As time goes, the unfunded component grows as a consequence of sharper price surges.

	1980	2000	2010	2017
The share	34.2%	58.4%	69.9%	77.2%

Conclusion (1): Implications inconsistent with demand siders' or fiscal reformers'.

- **The current mild deflations are tightly linked with the (far) future price surge.**
 - The present mild deflation with near-zero rates of interest cannot be controlled completely independently of such a long-run equilibrium context.
 - In contradiction to the demand siders, mild deflations cannot be fixed by monetary or fiscal expansion. Mild inflations will come only after a one-off price surges, but they accompany not low, but high interest rates.
 - In contradiction to the fiscal reformers, fiscal sustainability will be restored not by fiscal reforms or hyperinflations, but through one-off price surges.
 - One caveat is that the current representative agent framework ignores possible intergenerational impacts on the price level.

Conclusion (2): Is there any historical episode for the one-off price surge?

- Is the current model out of any historical context, or a mere theoretical abstraction?
- One-off price surges differ from hyperinflations.
 - The real money balance degenerates to zero in hyperinflations, but reverts to a long-run level in one-off price surges.
- The 1945-1950 experience as a one-off price surge:
 - The BoJ notes multiplied **6.6** times.
 - The GNE deflator multiplied **32.4** times.
 - Thus, the money-stock-adjusted price level multiplied only **4.9** times, much far from hyperinflationary phenomena.
- Given the 1945-1950 experience, the prediction demonstrated in the calibration may be not only theoretically consistent, but also empirically plausible.
 - The relative BoJ notes now exceed 20%, but at some point in the future, they would revert to the long-run level (around 8%) by a one-off price surge, several times as high as before.

Long-run trend in the relative money stocks

