Negative Interest Rate Policy and Aging Population

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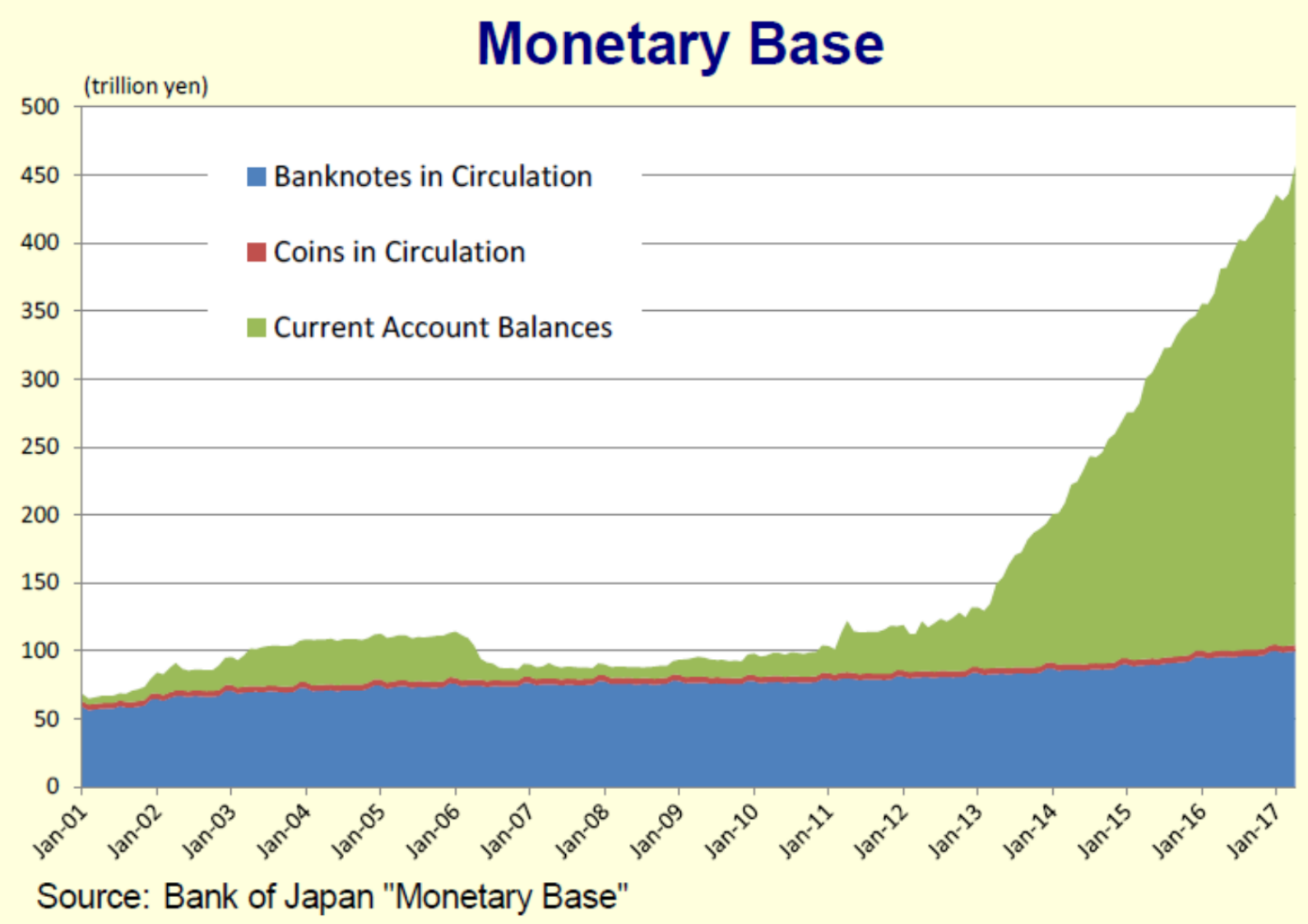
Inflation Target = 2%

The Effectiveness of the Negative Interest Rate Policy in Japan

Naoyuki Yoshino, Farhad Taghizadeh-Hesary and Hiroaki Miyamoto*



$$M = m \times MB$$

$$m = \frac{(CUR/D)+1}{(CUR/D)+R}$$

$$R=(RR+ER)/D$$

$$CUR/D=c$$

m declines

Monetary Base / Gross Domestic Product Ratio for Japan, United States, and Eurozone (%)

	Dec 2000	*Dec 2012*		*July 2016*	
	Monetary Base / GDP	*Monthly QE Volume / GDP*	*Monetary Base / GDP*	*Monthly QE Volume / GDP*	*Monetary Base / GDP*
Japan	15	0.2	29	1.3	80
US	6	0.5	16	–	21
Eurozone	7	–	17	0.8	20

GDP = gross domestic product, QE = quantitative easing, US = United States.

Source: International Monetary Fund, International Financial Statistics (2016).

Bank of Japan

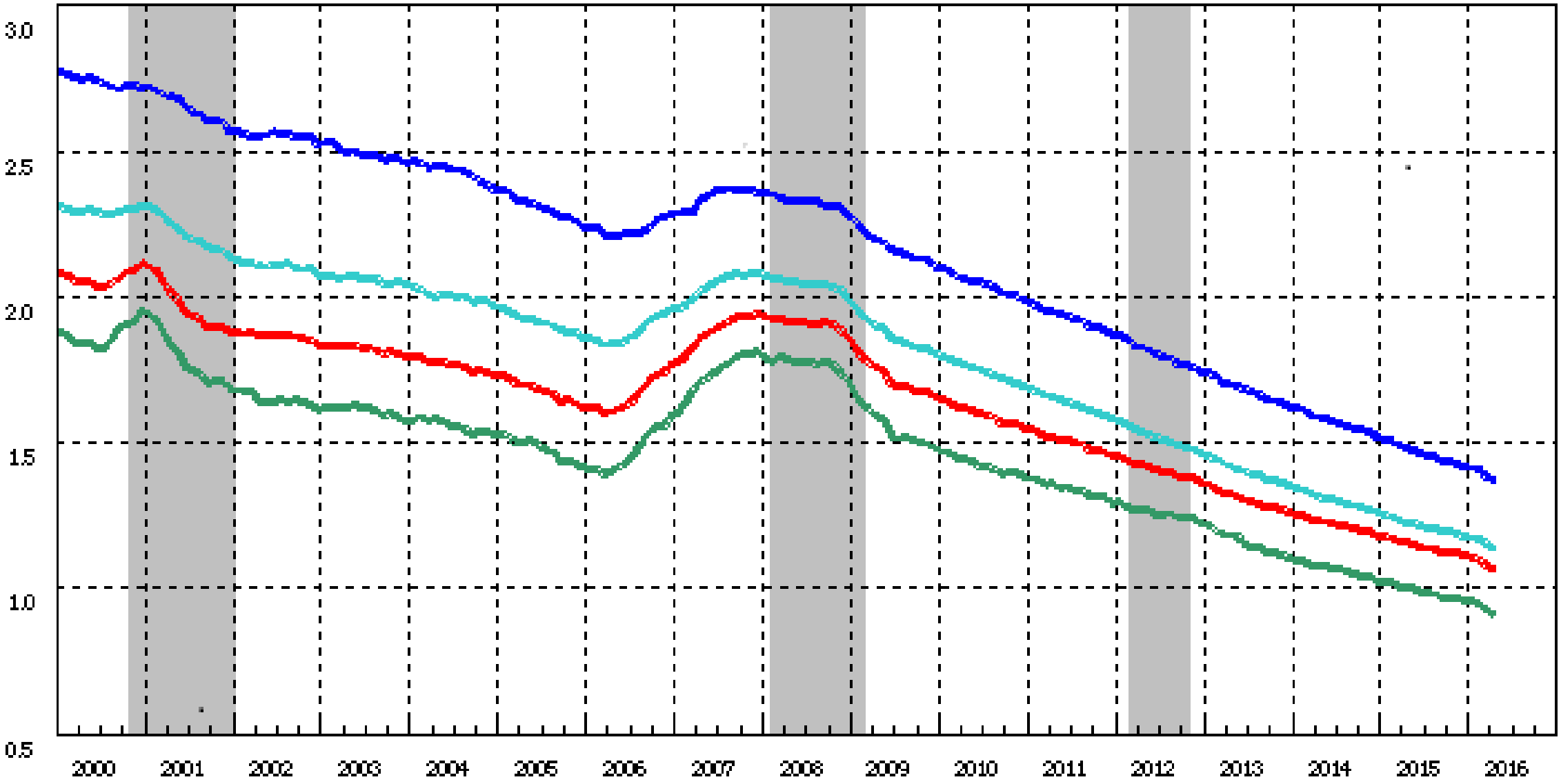
Foreign Deposits	RR
Reserves	*ER* ①
Government Bonds	Money
Capital (JGB)	

Banking Behavior

RR	
ER ①	
② Loans	
③ Bonds	

Negative Interest rate on Excess Reserves

Declining Bank Loans

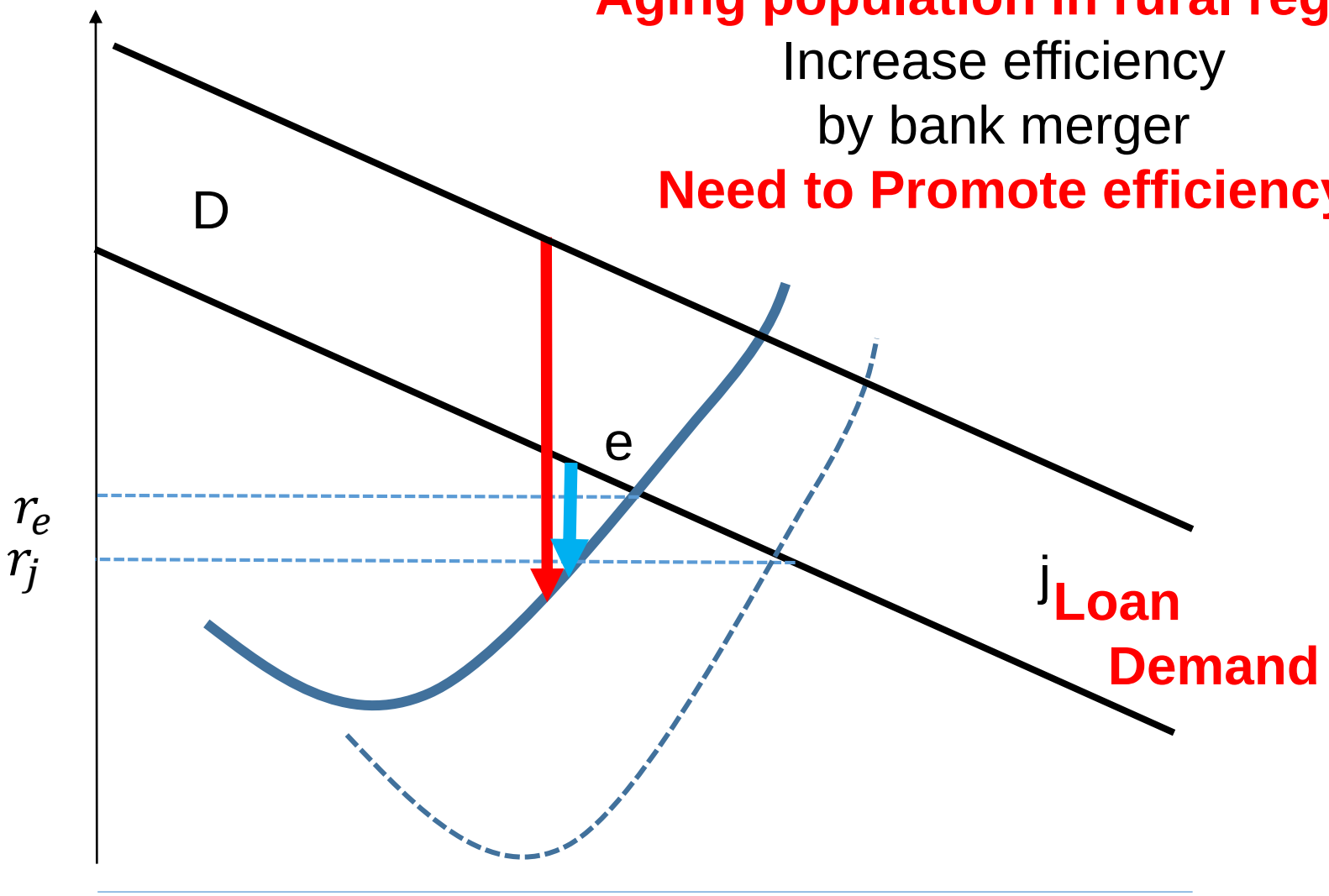


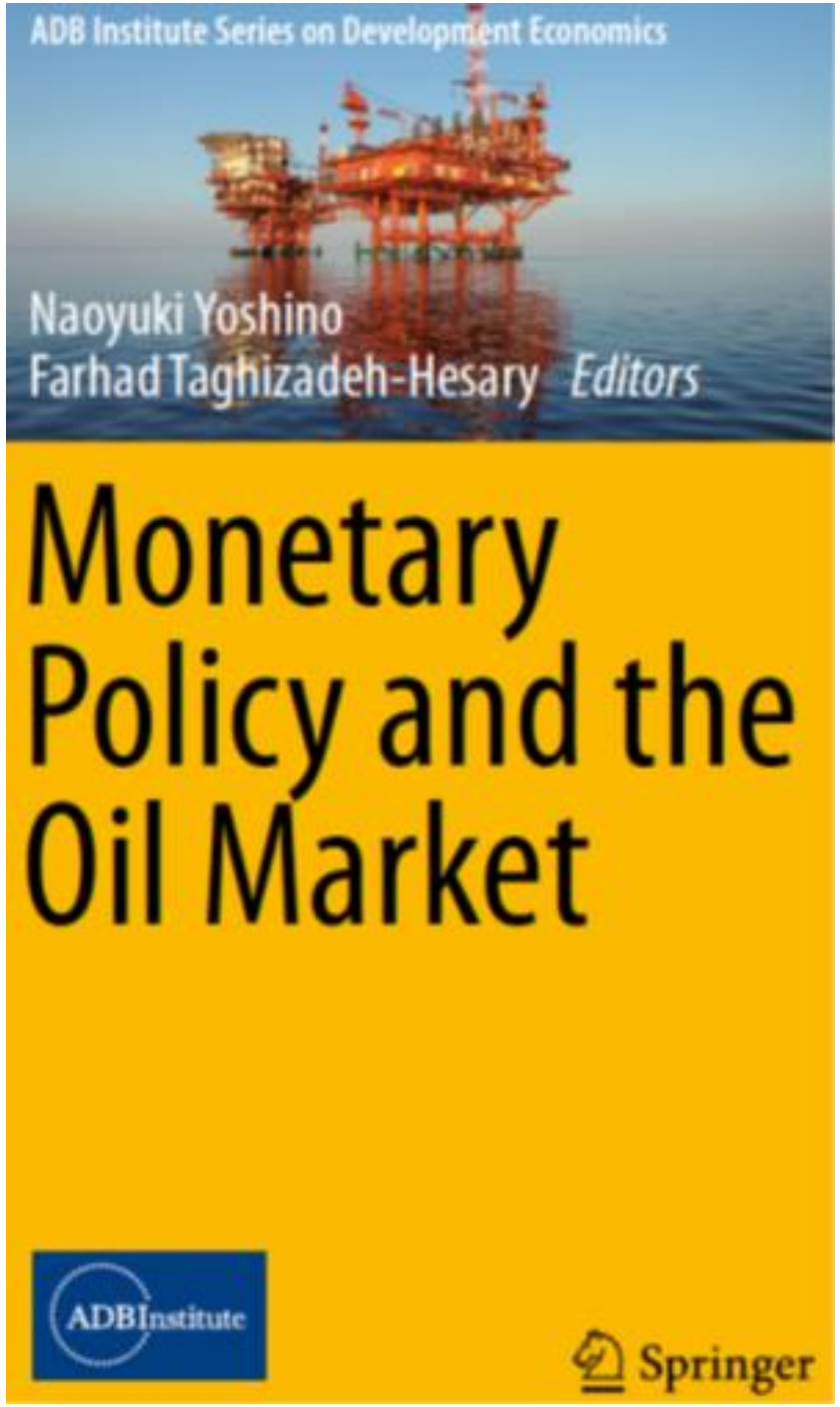
Declining Demand for Bank Loans

Aging population in rural region

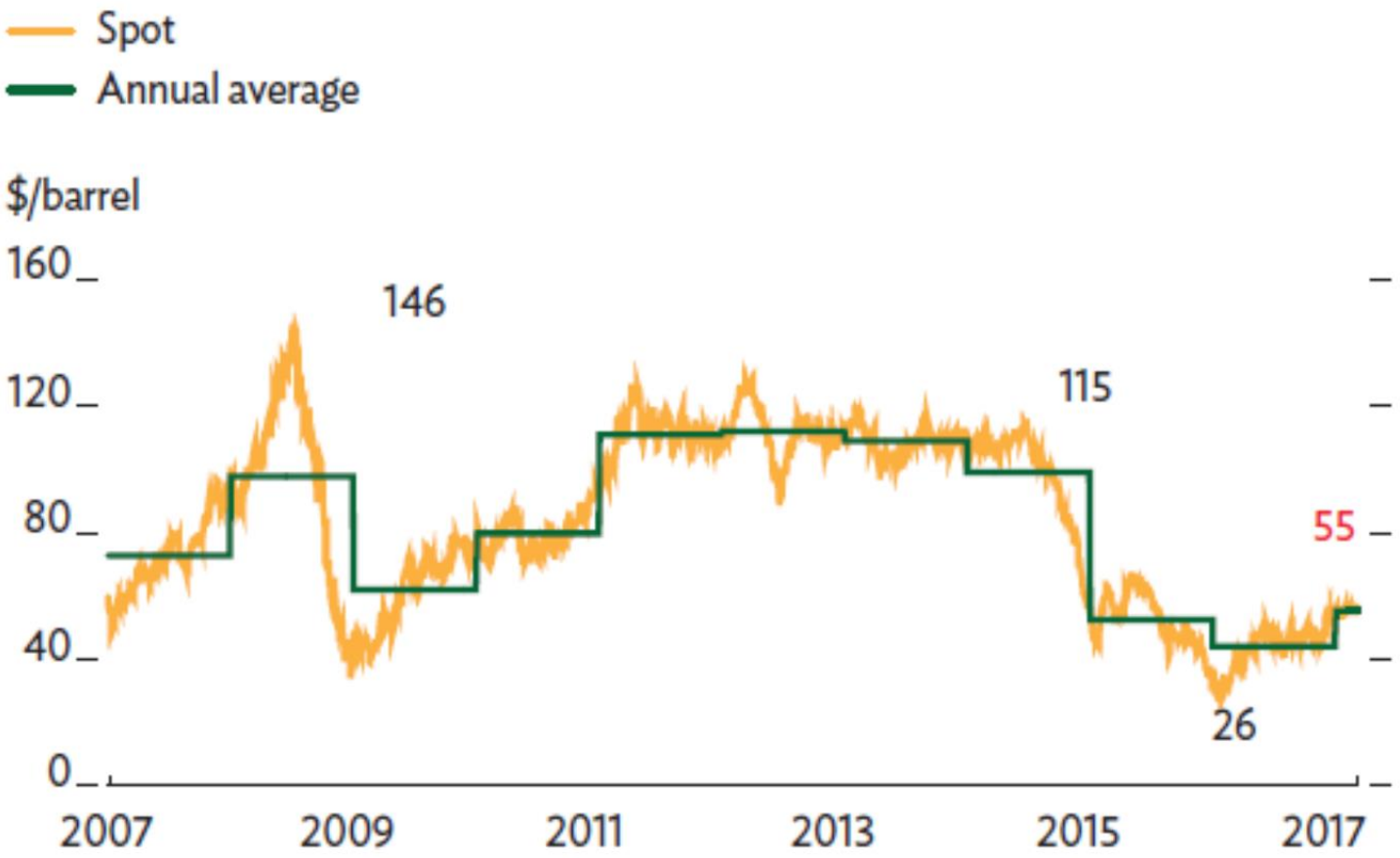
Increase efficiency
by bank merger

Need to Promote efficiency



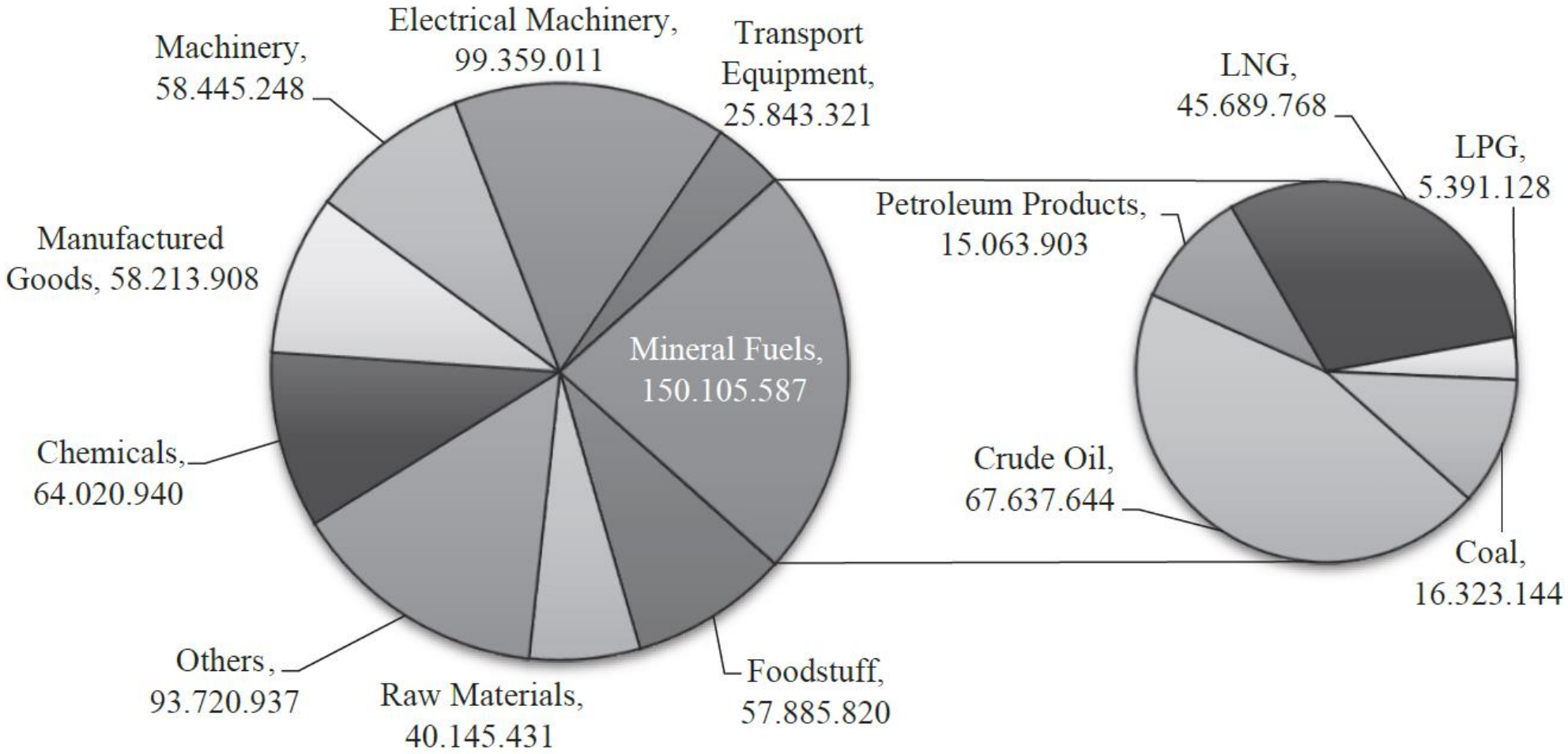


A1.13 Price of Brent crude



Sources: Bloomberg; World Bank. Commodity Price Data (Pink Sheet). http://www.worldbank.org (both accessed 9 March 2017).

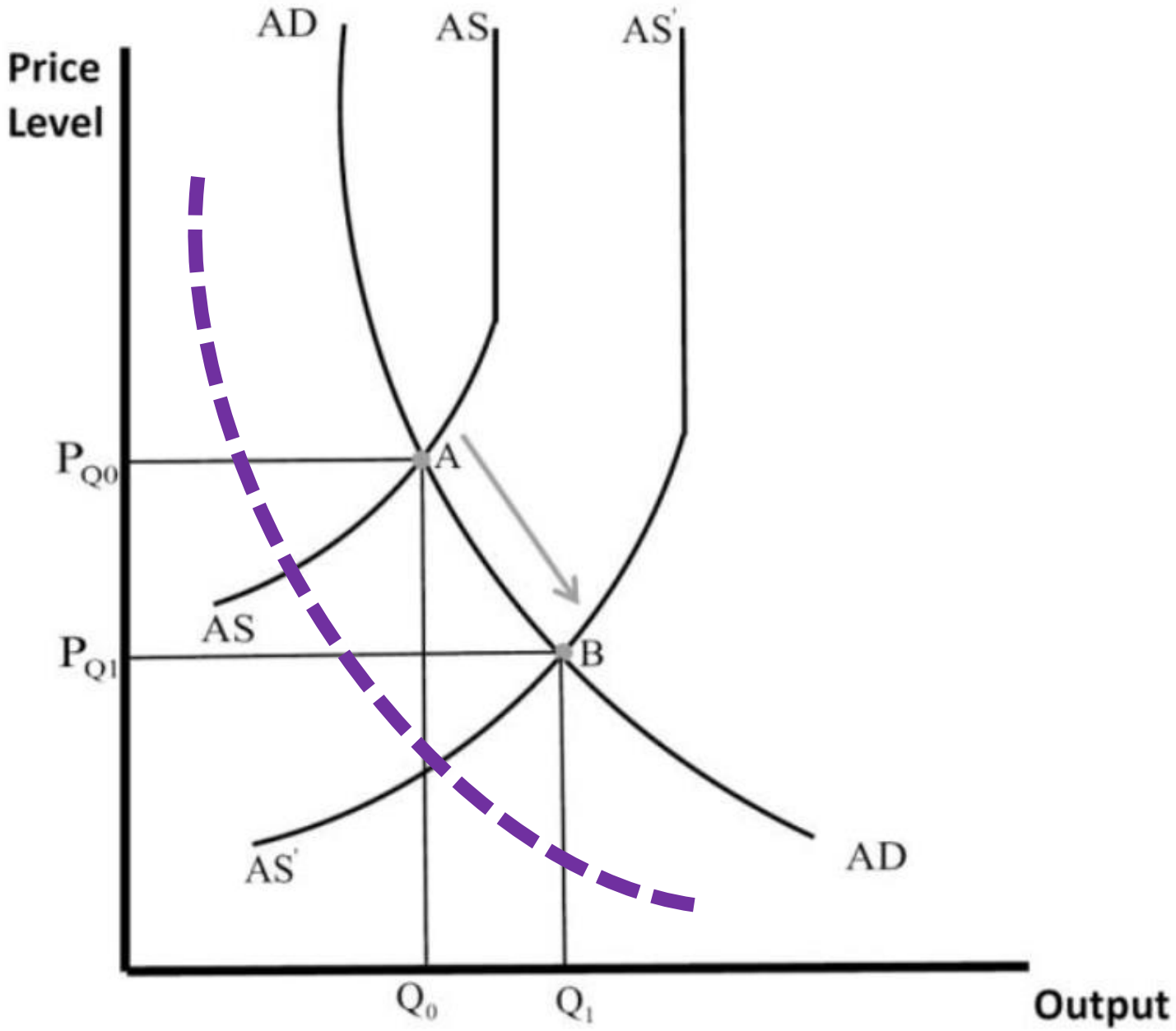
Impact of Oil Price Decline to Exporting Countries



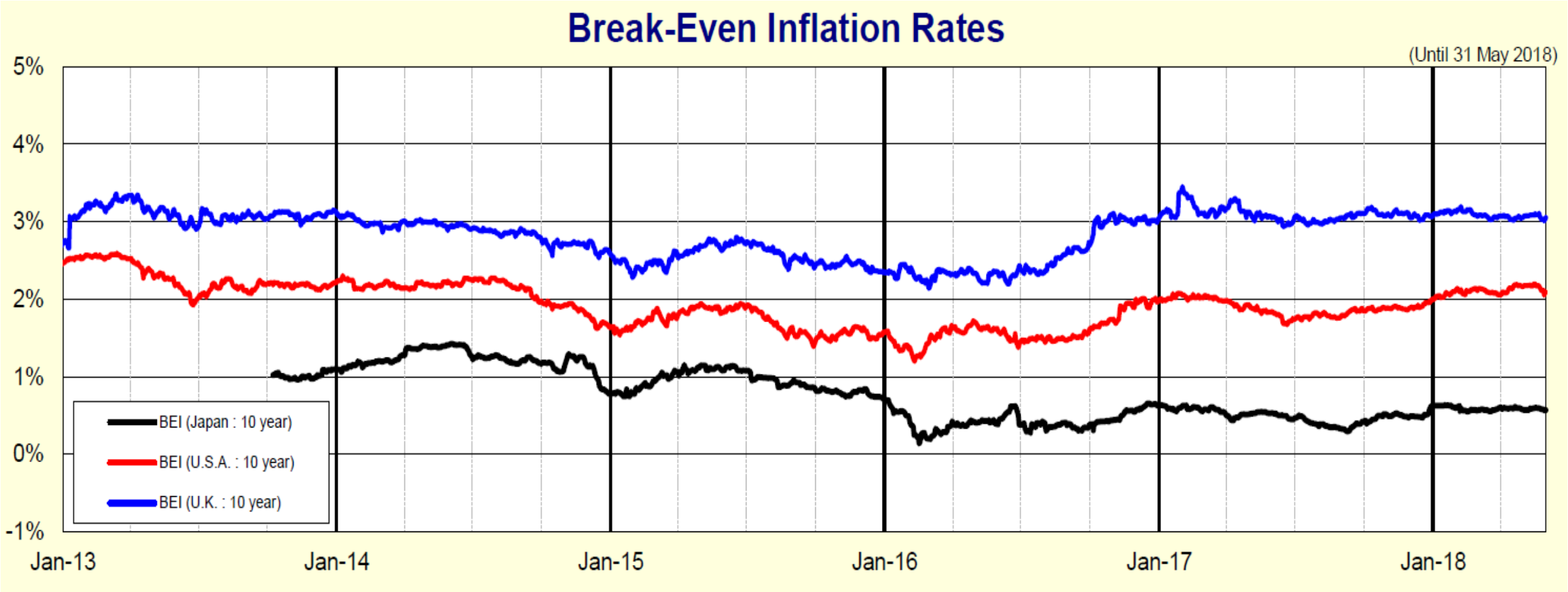
LNG = liquefied natural gas, LPG = liquefied petroleum gas.

Source: Japan External Trade Organization (2016).

Figure 2: Japan's Imports by Principal Commodity, 2015 (thousands of $)



AD = aggregate demand, AS = aggregate supply.


Break-Even Inflation Rates
(Until 31 May 2018)
5%
4%
3%
2%
1%
0%
-1%
Jan-13
Jan-14
Jan-15
Jan-16
Jan-17
Jan-18
BEI (Japan : 10 year)
BEI (U.S.A. : 10 year)
BEI (U.K. : 10 year)

Empirical Analysis of AS-AD equations of Japan

	Q2 1994–Q4 2001	Q1 2002–Q2 2014
Phillips curve (Inflation rate)		
Lagged inflation rate	0.89(4.08)**	–0.36(–1.12)
GDP gap	0.69(2.18)*	–0.24(–0.45)
Crude oil price	0.06(3.27)**	0.07(2.59)**
Gas price	0.03 (0.45)	0.05(1.17)
Aggregate Demand (GDP gap)		
Long-term real interest rate	–0.02(–4.71)**	–0.02(–1.09)
Lagged GDP gap	–0.33(–1.66)	0.42(1.52)
Exchange rate	0.09(2.18)*	0.07(1.17)
Taylor Rule (Short-term interest rate)		
Inflation rate	1.21(0.67)	1.94(2.16)*
GDP gap	4.76(2.72)**	3.89(3.01)**

GDP = gross domestic product.
Notes: T-statistics are in parentheses. * indicates significance at 5%. ** indicates significance at 1%.
Source: Yoshino and Taghizadeh-Hesary (2015a).

Vertical IS Curve

Table 3.

(Sample:

$$y_t = -0.16 - 0.0002(i - E\Delta p_{+1}) + 1.01 y_{t-1}$$

(–1.98)* (–0.53) (147.63)**

$R^2 = 0.99$ adjusted $R^2 = 0.99$ Durbin-Watson Statistic=1.70 S

$$y_t = -0.15 + 0.0002(i - E\Delta p_{+1}) + 1.01 y_{t-1}$$

(–2.36)* (1.17) (188.23)**

$R^2 = 0.99$ adjusted $R^2 = 0.99$ Durbin-Watson Statistic =1.62 S

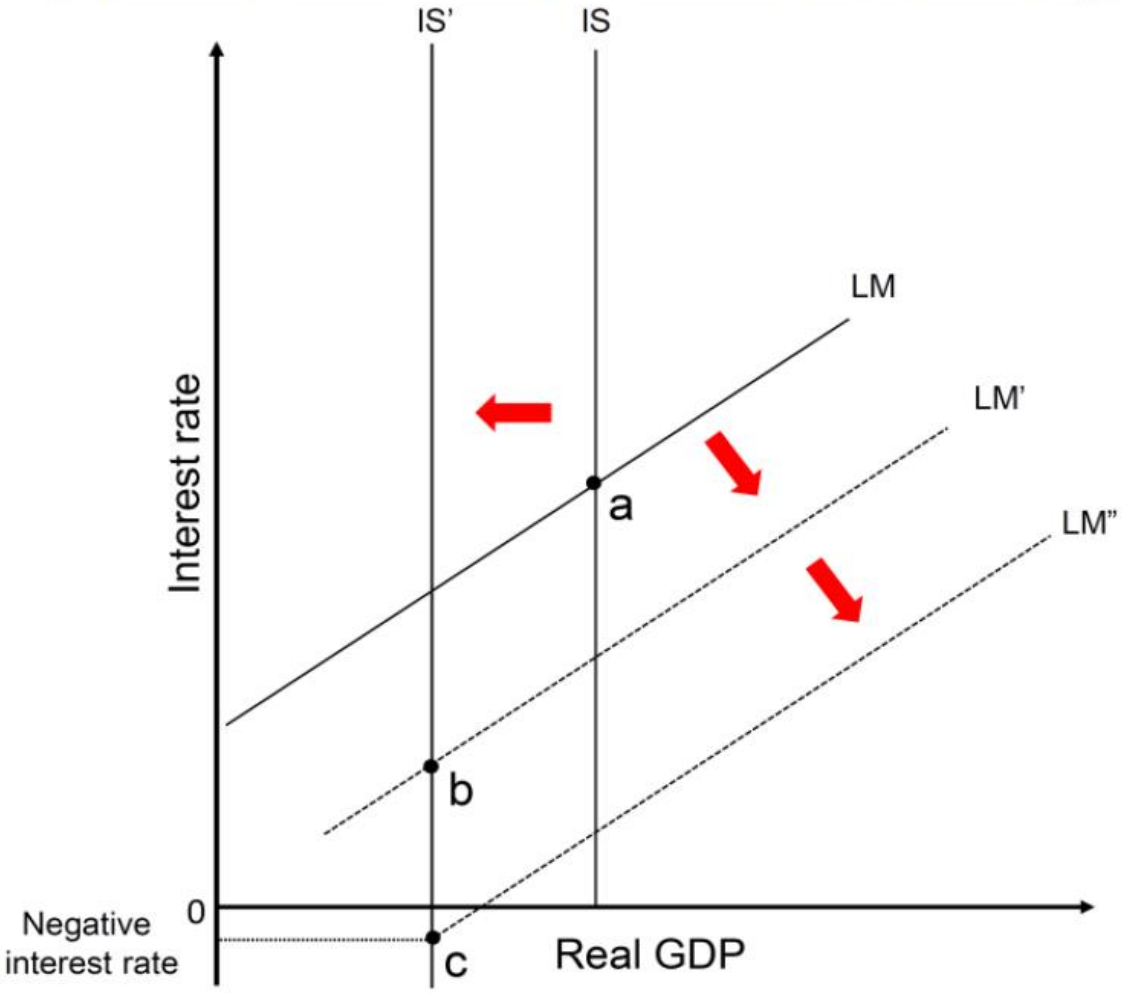
$$(m-p)_t = 0.02 + 0.70 y_t - 0.025 i_t + 0.99(m-p)_{t-1}$$

(0.11) (2.67)** (–2.72)** (171.06)**

$R^2 = 0.99$ adjusted $R^2 = 0.99$ Durbin-Watson Statistic =1.93

Source: Authors' compilation.

Figure 12: The Ineffectiveness of Monetary Policy in Japan

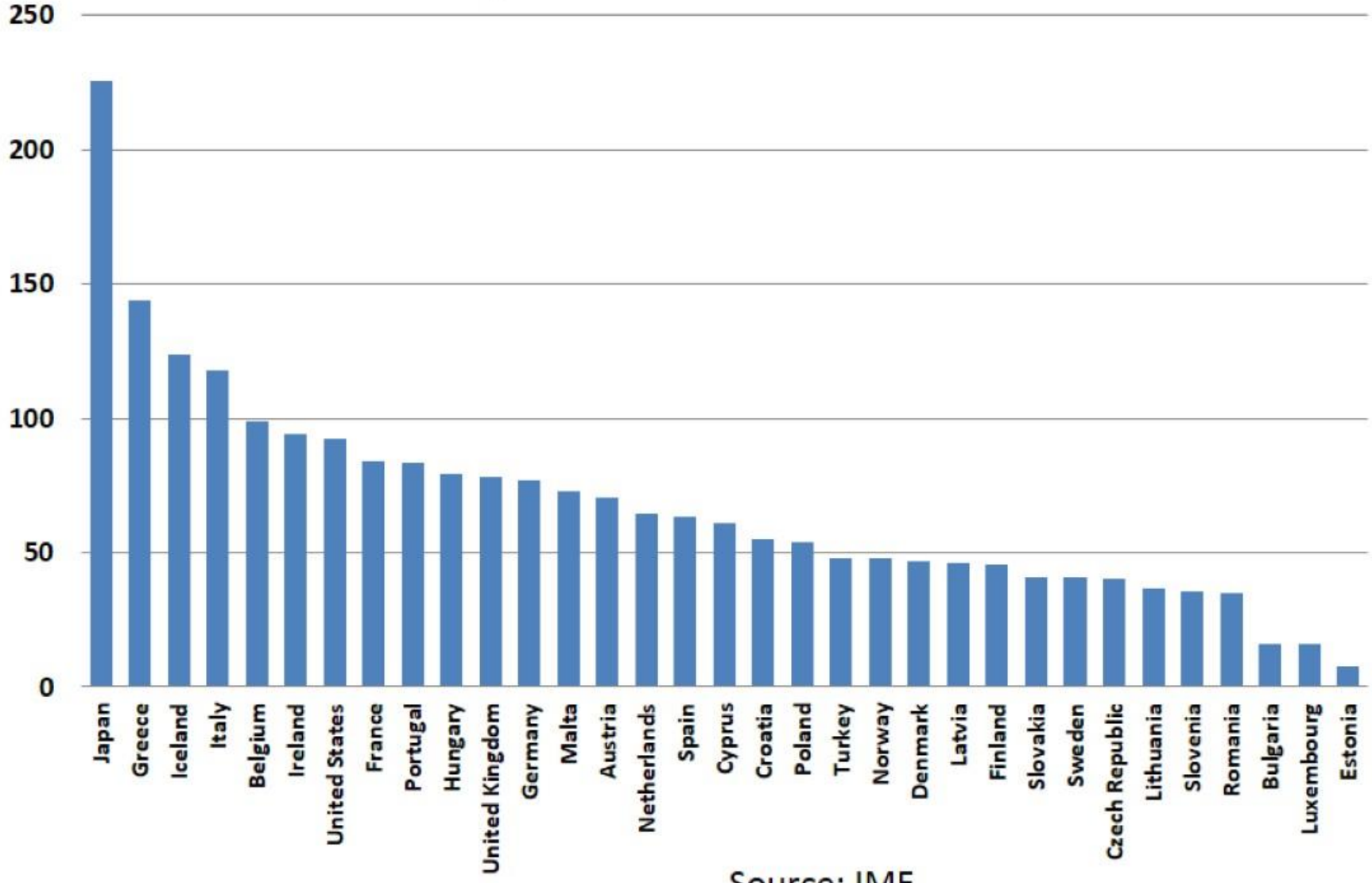


Year (0)	Producers (1)	CPI (2)	BM (3)'	Money (4)	Exchange (8)	Stock (9)	Land (10)	Oil (11)	Year
1984	0.30	2.11	5.40	7.80	251	11,061	86.5	:	1984
1985	-1.70	1.95	4.08	8.40	201	12,935	92.9	:	1985
1986	-5.20	0.00	6.12	8.70	160	18,032	106.2	:	1986
1987	-1.70	0.46	7.40	10.40	122	24,195	133.7	:	1987
1988	-0.60	0.79	10.31	11.20	126	28,865	171	:	1988
1989	2.70	2.81	10.77	9.90	143	34,968	212.8	:	1989
1990	1.30	3.17	11.09	11.70	136	26,872	276.8	:	1990
1991	0.40	2.90	1.94	3.60	125	23,350	285.3	:	1991
1992	-1.00	1.50	-2.29	0.60	125	17,189	241	:	1992
1993	-1.80	1.20	3.40	1.10	112	19,641	197.7	:	1993
1994	-1.40	0.50	4.60	2.10	99	19,509	174.9	:	1994
1995	-1.00	-0.30	5.20	3.20	103	19,868	151.4	:	1995
1996	-1.50	0.40	9.00	3.30	116	19,361	134.5	:	1996
2008	3.10	1.10	0.80	2.10	90.28	8,830	82.4	:	2008
2009	-5.20	-1.70	0.50	2.70	92.13	10,540	73.5	:	2009
2010	0.70	-0.40	0.90	2.80	81.51	10,210	69.6	116.94	2010
2011	1.40	-0.10	2.80	2.70	77.57	8,440	68.2	123.41	2011
2012	-1.10	-0.30	2.10	2.50	86.32	10,430		108.46	2012
2013	1.90	0.90	3.30	3.60	105.4	16,320		105.95	2013
2014	2.70	2.90	3.60	3.40	119.8	17,360		53.69	2014
2015	-3.20	0.20	4.90	3.70	120.4	19,000		36.75	
2016	-4.30	-0.40	6.80	3.40	103.63	16,610		40.76	

Monetary Base and Japanese Government Bond Purchase Data
(Comparison of April 2013 with May 2016)
(¥ Trillion)

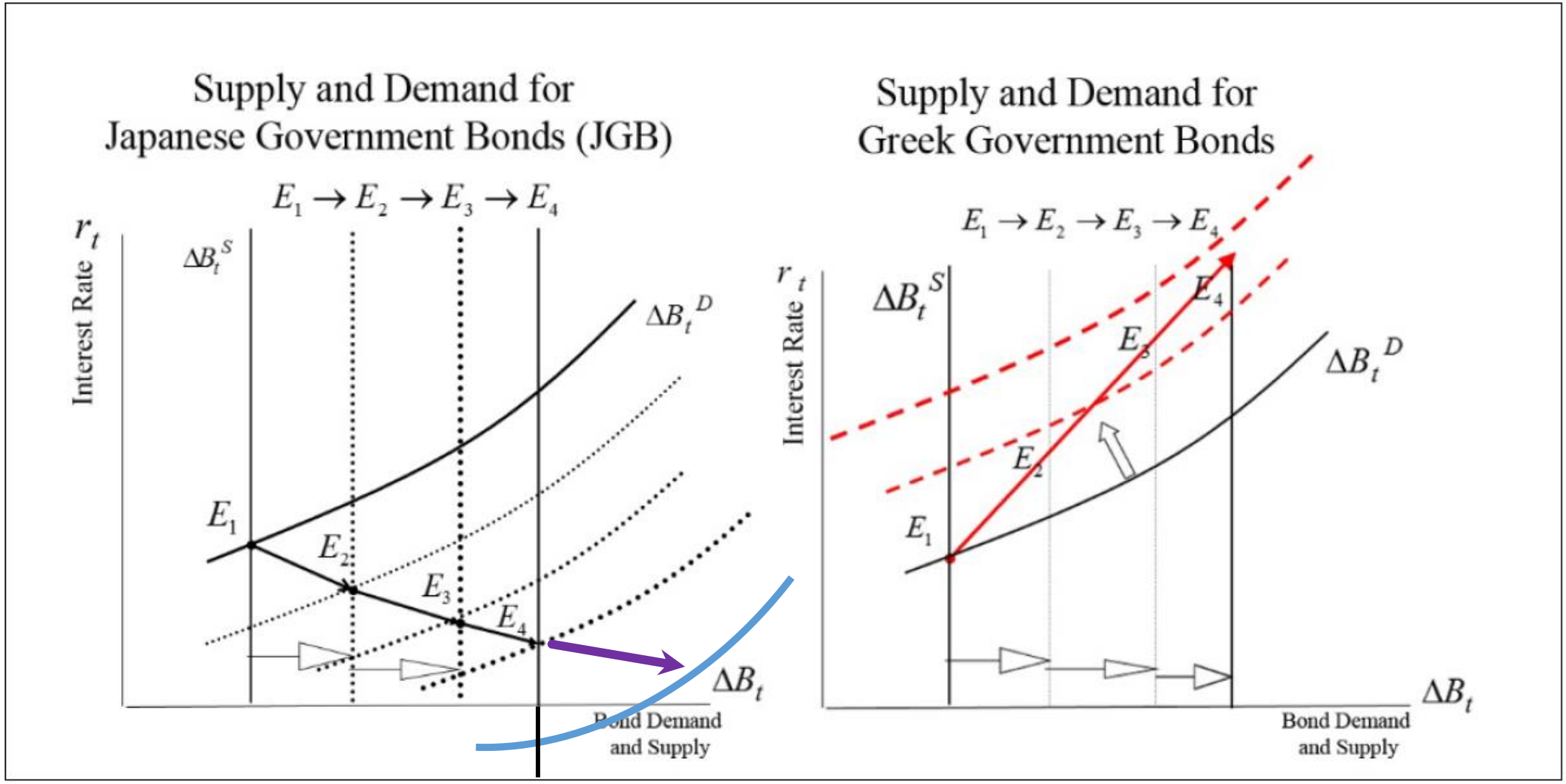
	April 2013 (actual)	*May 2016* (actual)	*Average Annual Increase*
Monetary Base	155	387	About 80 trillion
JGB	98	319	About 80 trillion
CP	1.4	2.3	Outstanding balance maintained
Corporate Bonds	2.9	3.2	Outstanding balance maintained
ETFs	1.7	8.0	About 3 trillion
J-REITs	0.13	0.31	About 90 billion
Total Assets of the BOJ	175	426	–

Gross Debt/GDP ratio, Japan, USA, EU



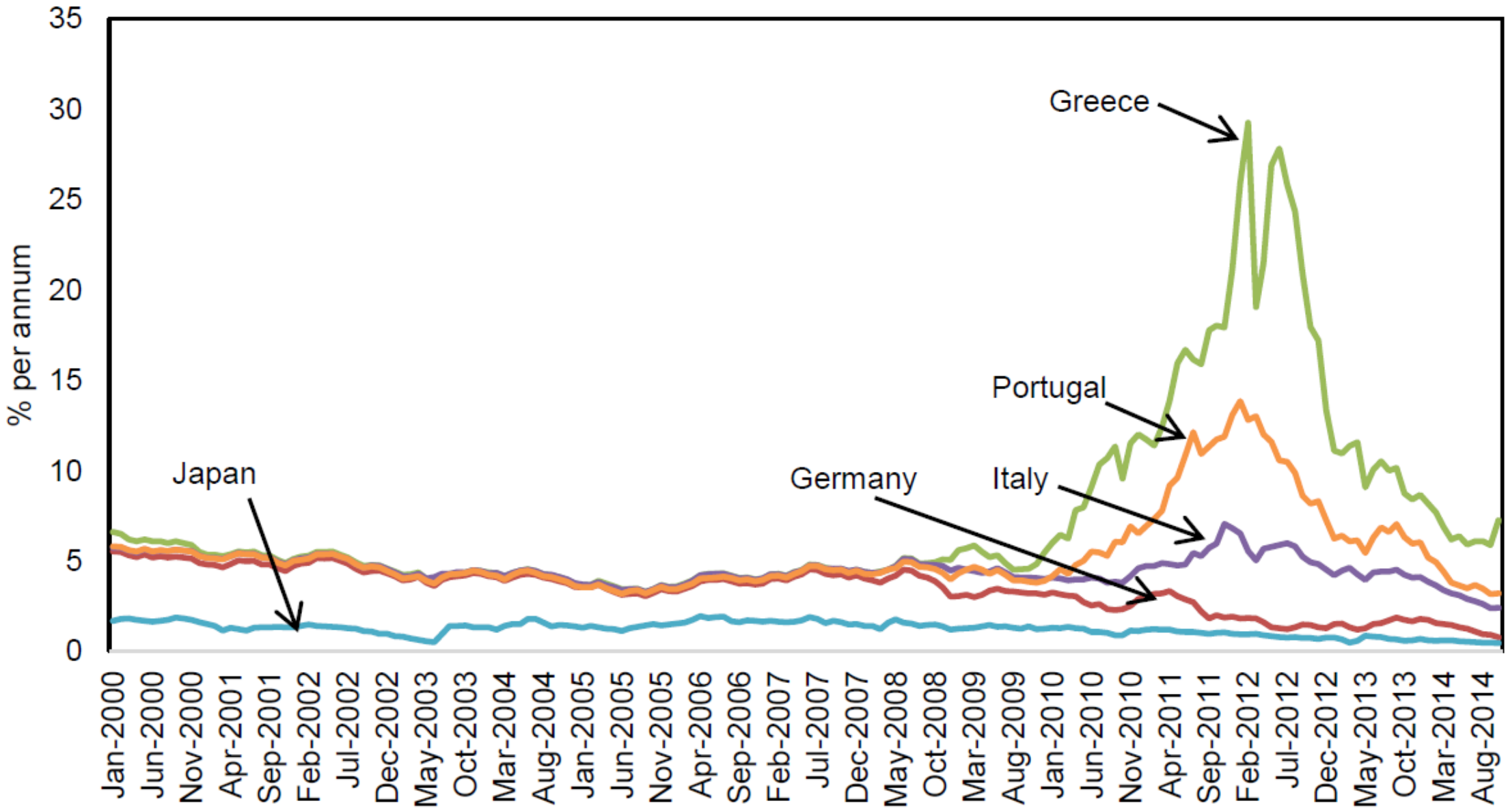
Source: IMF

Figure 2: Government Bond Markets of Japan and Greece

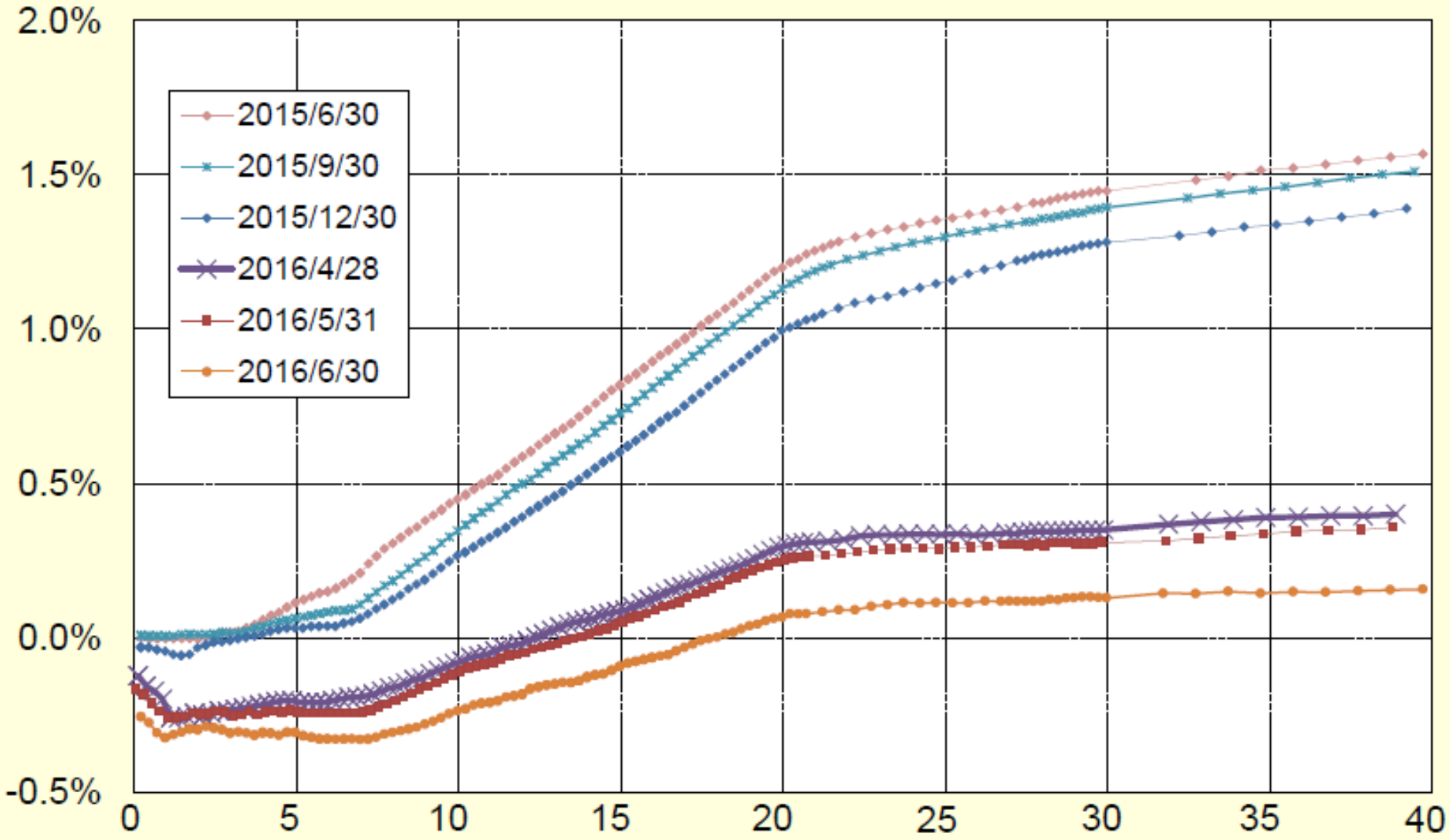


Source: Yoshino and Taghizadeh-Hesary (2014a).

Figure 2: Interest Rates in Selected OECD Countries

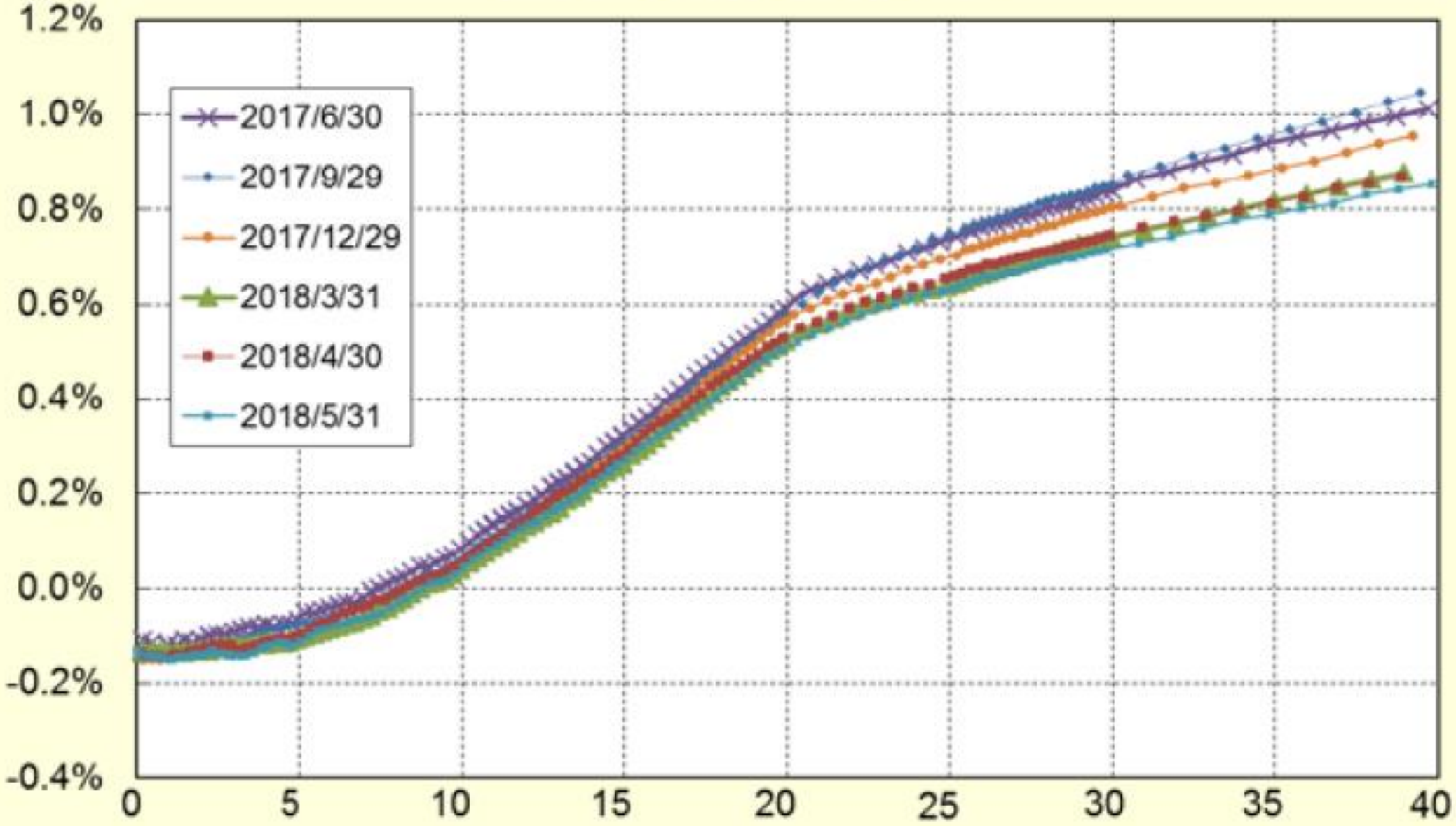


JGB Yield Curves



Source: Japan Bond Trading Co.,Ltd.

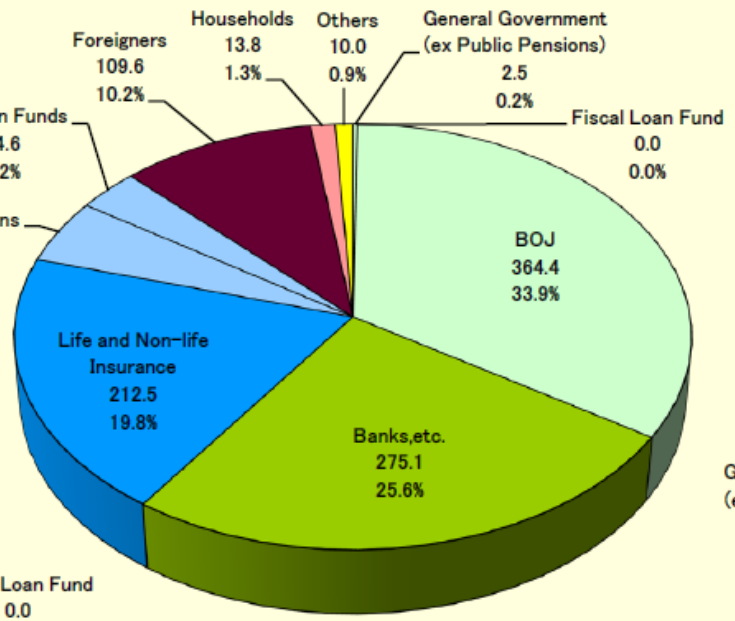
JGB Yield Curves



Breakdown by JGB and T-Bill Holders (Mar. 2016)

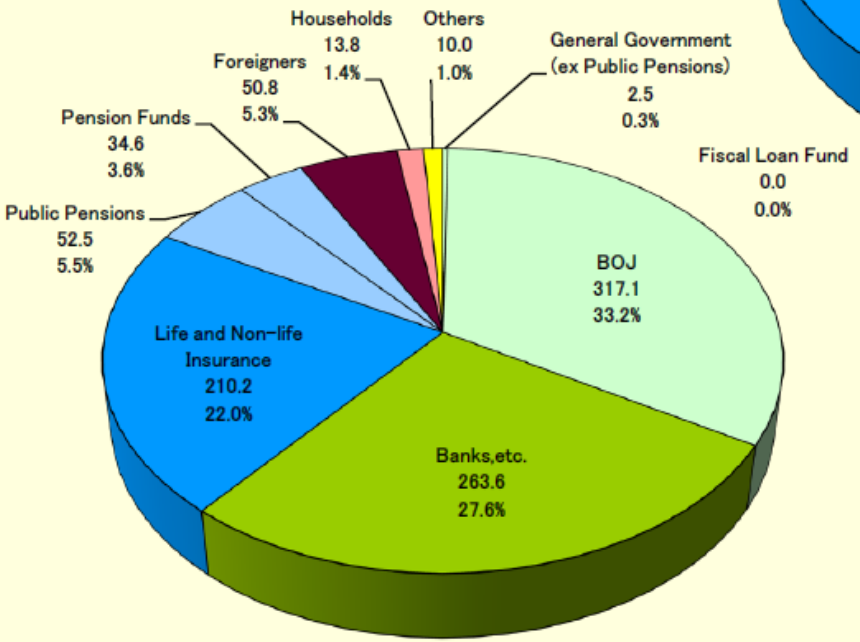
JGB and T-Bill Holders

(trillion yen)



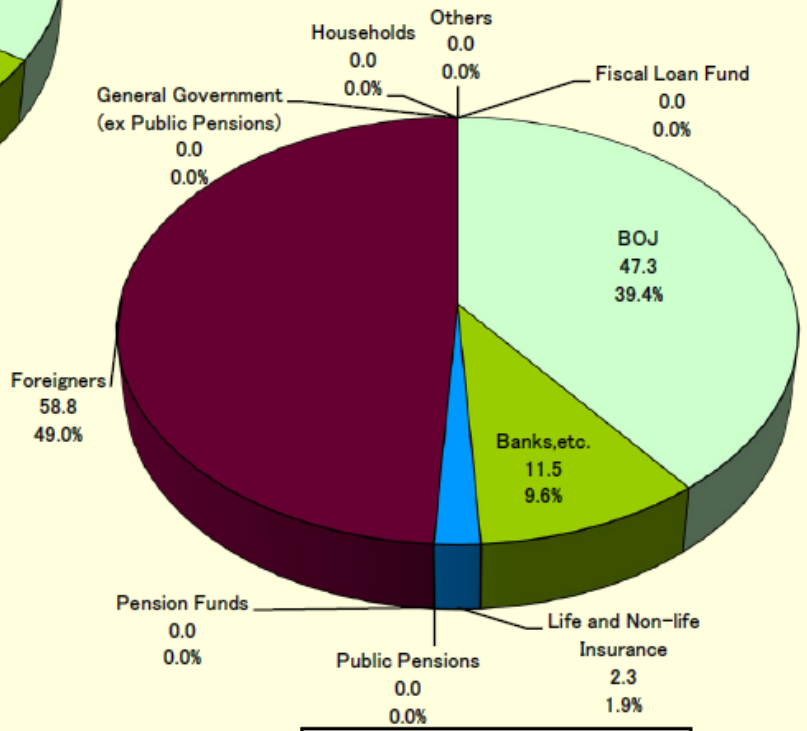
Total 1,075.0 trillion yen

JGB Holders



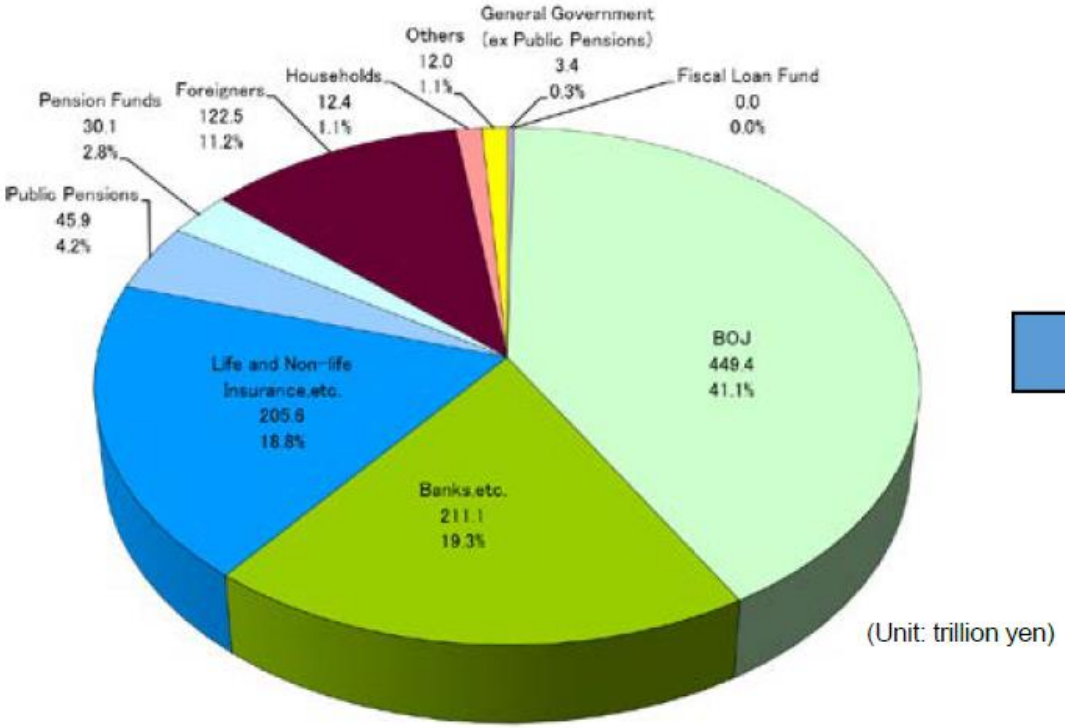
Total 955.0 trillion yen

T-Bill Holders



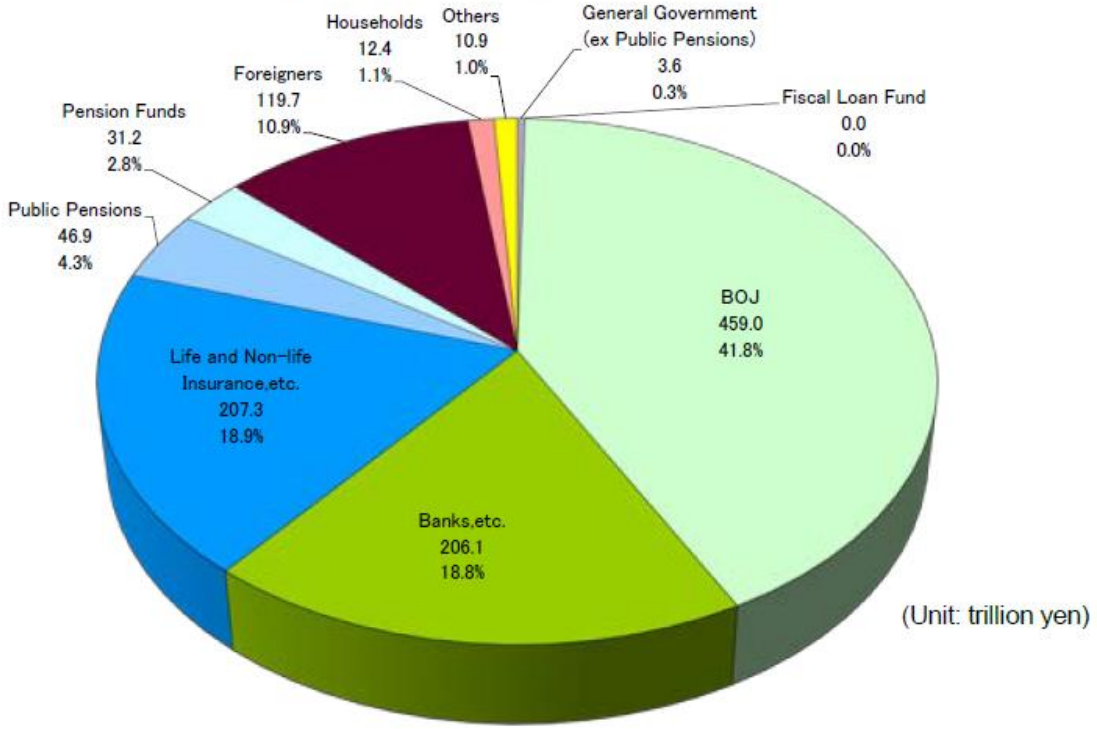
Total 119.9 trillion yen

The end of Dec. 2017



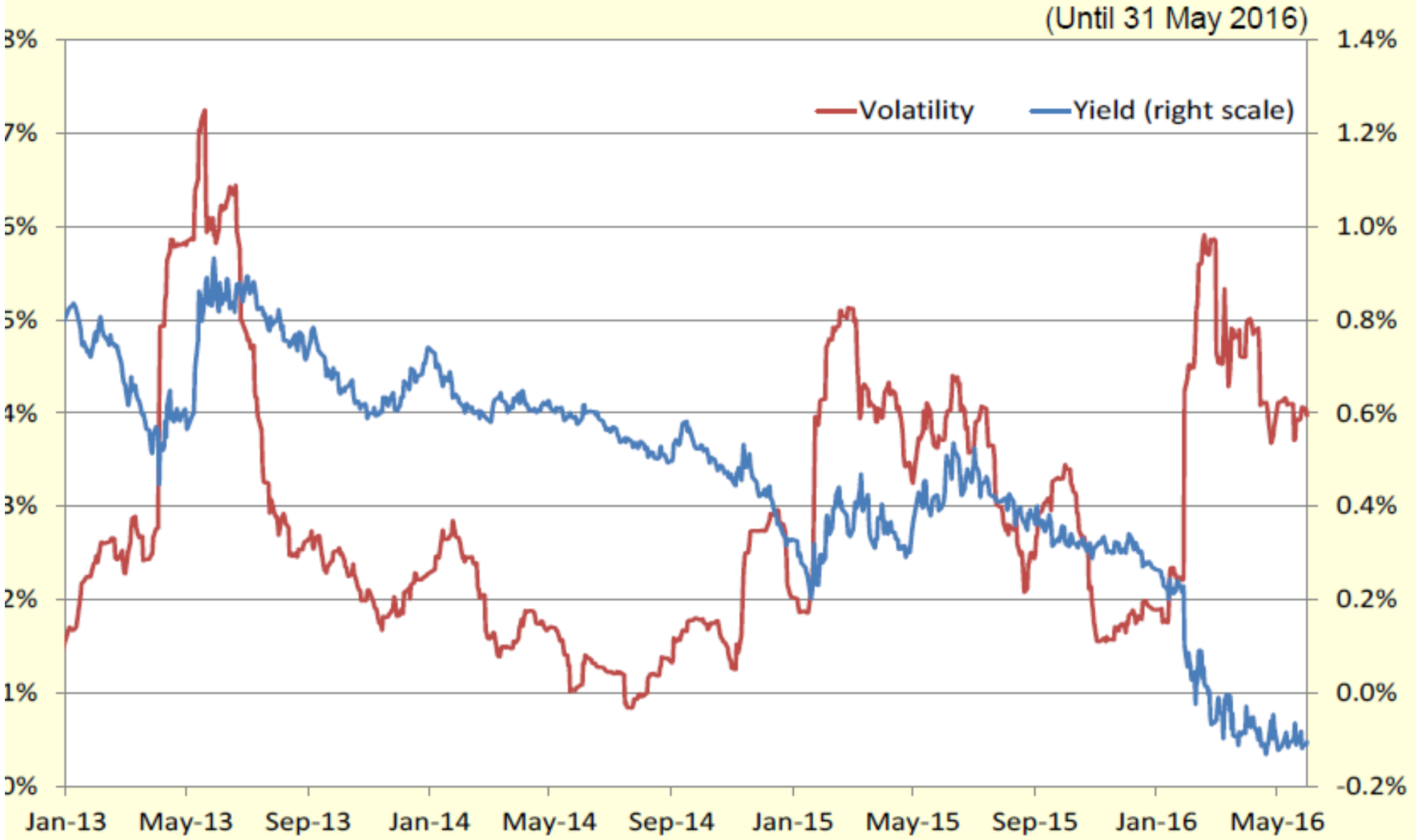
Total ¥1,092.4 trillion

The end of Mar. 2018



Total ¥1,097.1 trillion

Yield and Volatility (10Yr)



Source: Bloomberg, Calculation by the Ministry of Finance

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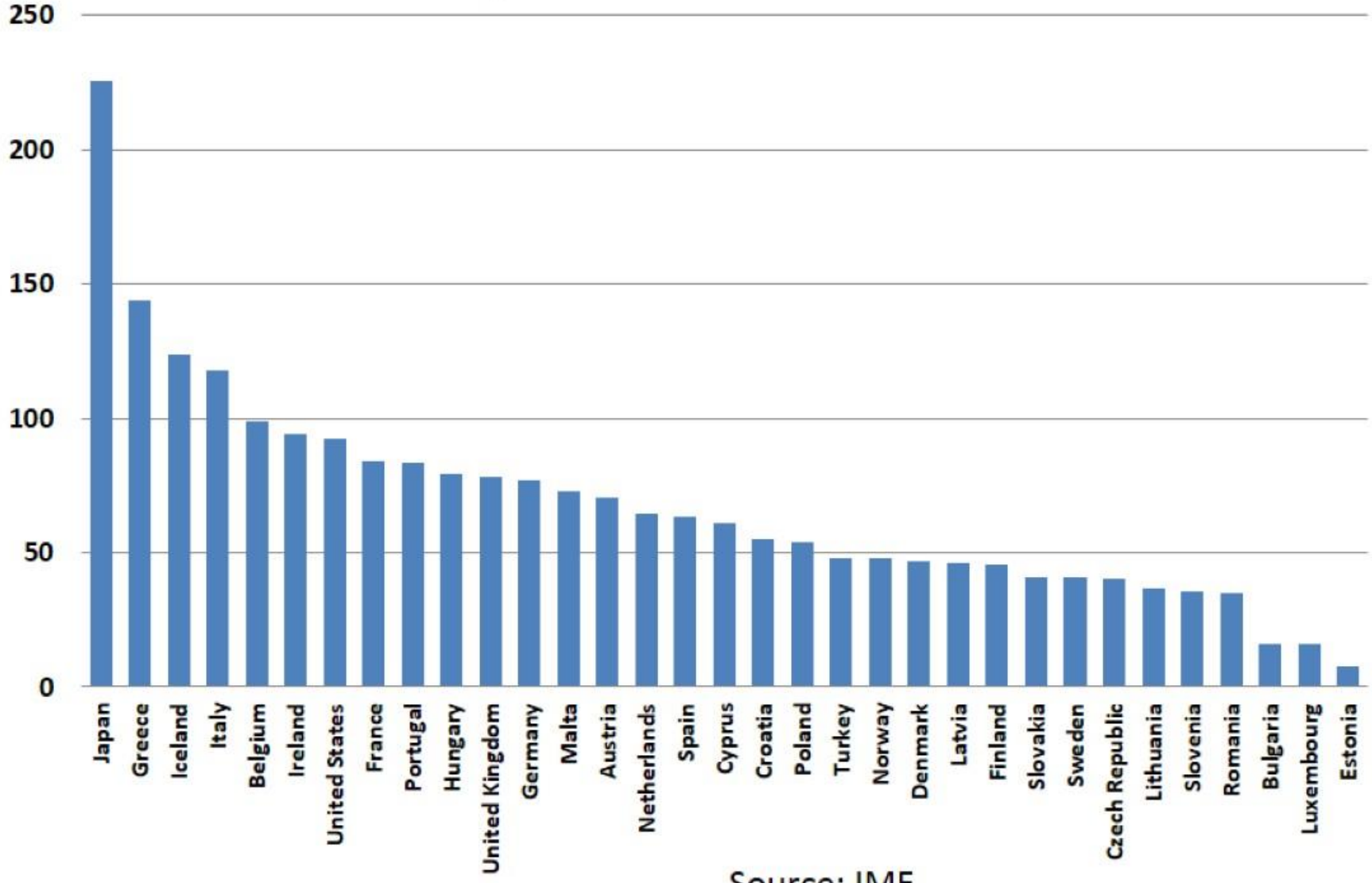
Declined effectiveness of fiscal and monetary policies faced with aging population in Japan☆

Naoyuki Yoshino[a], Hiroaki Miyamoto[b,*]

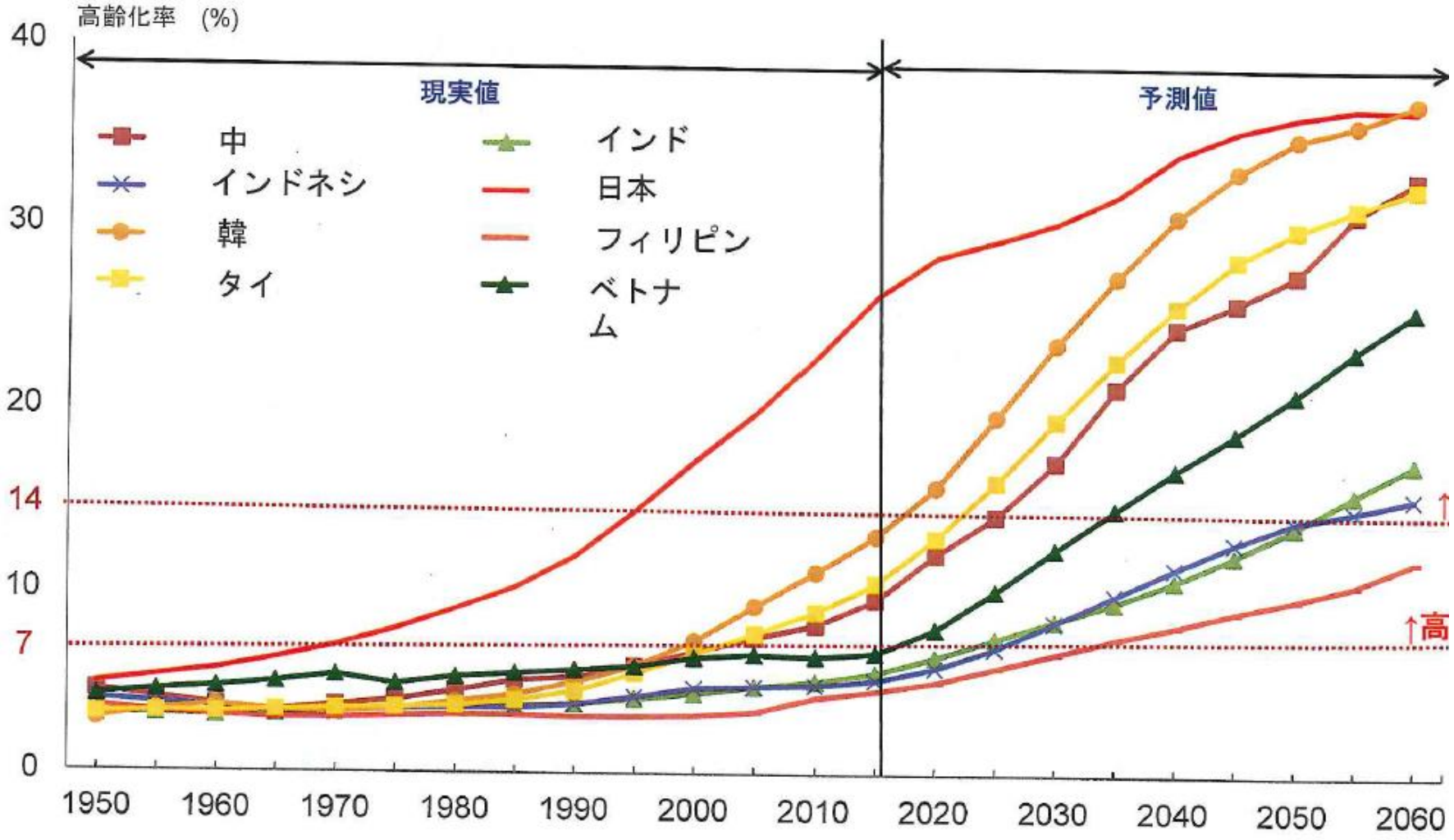
[a] Asian Development Bank Institute, Japan
[b] International Monetary Fund, United States

Gross Debt/GDP ratio, Japan, USA, EU



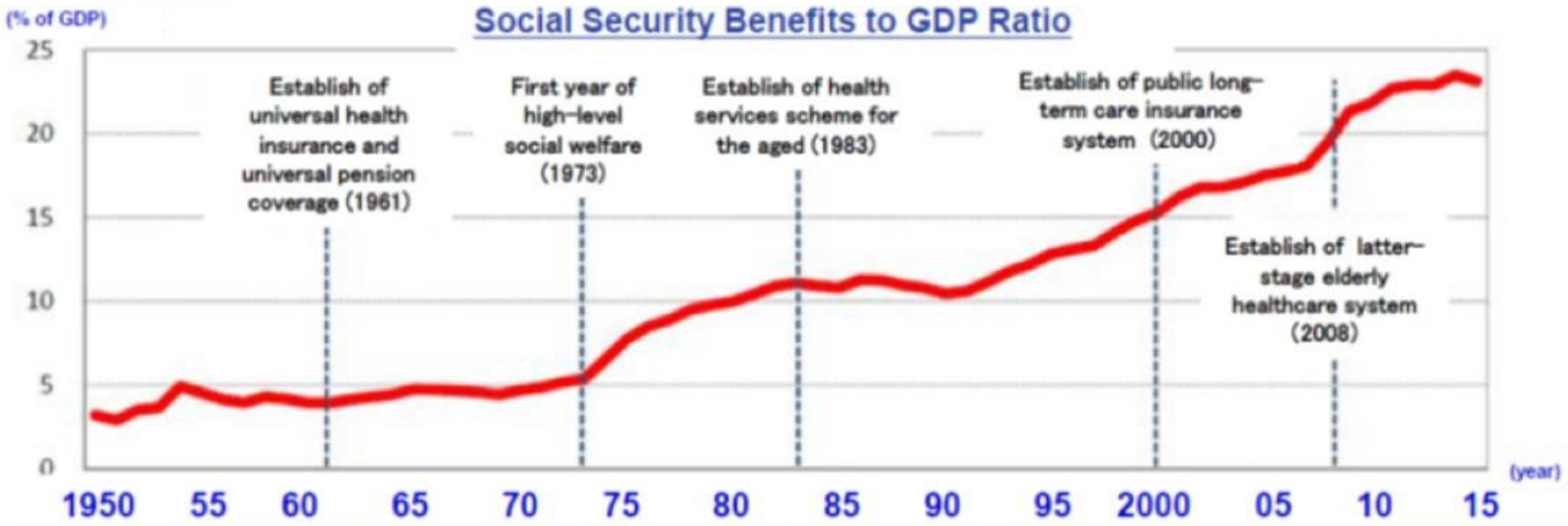
Source: IMF

Population Aging in Asian Countries



Increase in Social Security Benefits and the demographic transition in Japan

- ✓ **With the rapid progress of aging population, social security benefits have been increased.**



Year	1960	1970	1980	1990	2000	2010	2015
Topics, etc.	Establish of universal health insurance and universal pension coverage	First year of high-level social welfare	Establish of health services scheme for the aged	The bubble economy period	Establish of public long-term care insurance system	Establish of latter-stage elderly healthcare system	Last year
Life expectancy (Men)	65.3	69.3	73.4	75.9	77.7	79.6	80.8
Life expectancy (Women)	70.2	74.7	78.8	81.9	84.6	86.3	87.1
Aging rate	5.7	7.1	9.1	12.1	17.4	23.0	26.7
Total fertility rate	2.0	2.13	1.75	1.54	1.36	1.39	1.46

The model

1. A New Keynesian DSGE model with heterogeneous households.
   - Young (worker): supply labor services, earn wages, and pay taxes
   - Old (retiree): don't work, receive social security benefits

2. Workers maximize their intertemporal utility subject to a budget constraint.

3. Retirees consume only social security benefits in each period of time.

4. The proportion of working population is denoted by ϕ.

Household's problem (2.1)

- Worker's problem:

$$\max \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left\{ \frac{1}{1-\sigma} \left[\left\{ \omega c_{w,t}^{\frac{\zeta-1}{\zeta}} + (1-\omega)\, g_t^{\frac{\zeta-1}{\zeta}} \right\}^{\frac{\zeta}{\zeta-1}} \right]^{1-\sigma} + \frac{m_{w,t}^{1-\gamma}}{1-\gamma} - \frac{h_{w,t}^{1+\mu}}{1+\mu} \right\}$$

$$\begin{aligned} \text{s.t. } c_{w,t} + k_{w,t} + m_{w,t} + b_{w,t} &= w_t h_{w,t} + r_{k,t} k_{w,t-1} + (1-\delta) k_{w,t-1} \\ &\quad + R_{t-1} \frac{b_{w,t-1}}{\pi_t} + \frac{m_{w,t-1}}{\pi_t} + d_{w,t} - \tau_{w,t} \end{aligned}$$

- Retiree's problem:

$$c_{r,t} = s.$$

Final good producer's problem (2.2.1)

- Perfect competition
- Final good producer's problem:

$$\max_{y_{j,t}} P_t Y_t - \int_0^1 P_{j,t} y_{j,t} dj$$

  - Production function is given by

$$Y_t = \left(\int_0^1 y_{j,t}^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

  - Y: final goods
  - y_j: intermediate good j

Intermediate goods firm's problem (2.2.2)

- Monopolistic competitive market
- Production function of firm *j* is

$$y_{j,t} = \left(k_{j,t}^{d}\right)^{\alpha} \left(h_{j,t}^{d}\right)^{1-\alpha} k_{g,t}^{\alpha_g}$$

- An intermediate good firm is subject to price setting friction a la Calvo (1983)

$$\max_{P_t^*} \mathbb{E}_t \sum_{i=0}^{\infty} (\beta\xi)^i \lambda_{t+i} \left\{P_t^* - P_{t+i} mc_{t+i}\right\} y_{t+i}$$

  - ξ: Calvo parameter

Fiscal policies

- Government budget constraint:

$$b_t + \tau_t + \left(m_t - \frac{m_{t-1}}{\pi_t}\right) = g_t + i_{g,t} + R_{t-1}\frac{b_{t-1}}{\pi_t} + s\,(1-\phi)$$

- Fiscal policy rules:

$$\log(g_t) = (1-\rho_g)\log(g) + \rho_g \log(g_{t-1}) + \varepsilon_{g,t},\ \varepsilon_{g,t} \sim N(0,\sigma_g^2)$$

$$\log(i_{g,t}) = (1-\rho_i)\log(i_g) + \rho_i \log(i_{g,t-1}) + \varepsilon_{i,t},\ \varepsilon_{i,t} \sim N(0,\sigma_i^2)$$

$$\frac{\tau_t}{\tau} = \left(\frac{b_{t-1}}{b_t}\right)^{\psi}$$

- Future research: debt/GDP and deficit/GDP are incorporated.

Monetary policy

- Monetary policy rule:

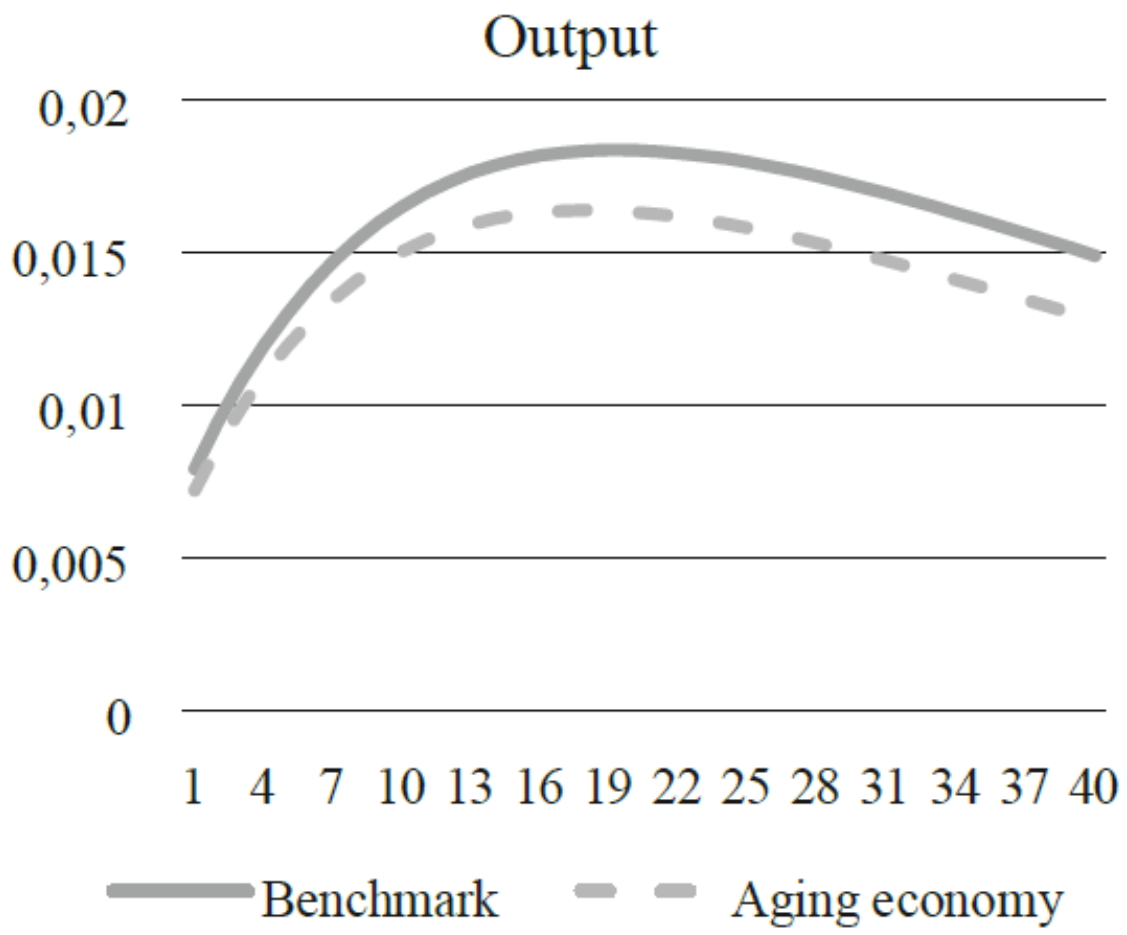
$$\frac{R_t}{R} = \left(\frac{\pi_t}{\pi}\right)^{\varphi_\pi} \left(\frac{Y_t}{Y}\right)^{\varphi_Y} \exp(\nu_t).$$

which can be linearized as

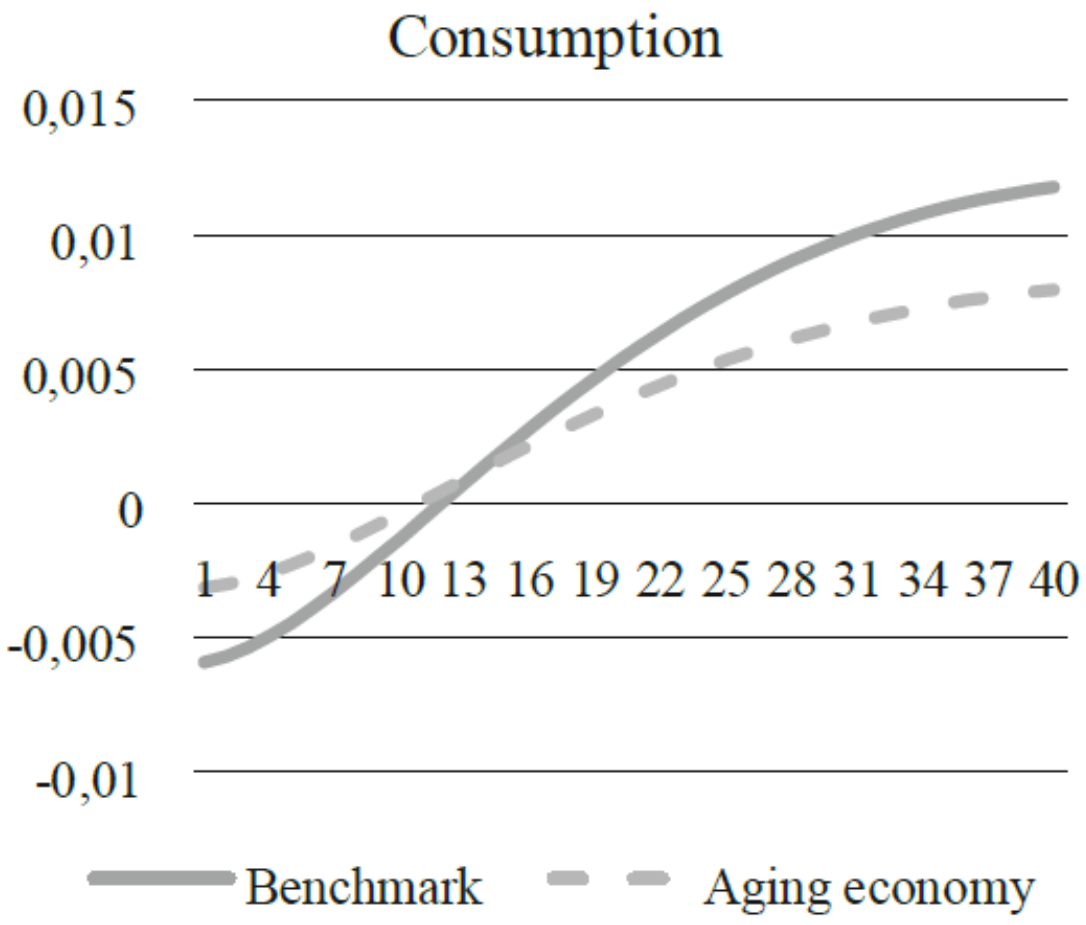
$$\hat{R}_t = \varphi_\pi \hat{\pi}_t + \varphi_Y \hat{y}_t + \nu_t$$

where

$$\nu_t = \rho_\nu \nu_{t-1} + \varepsilon_{\nu,t}, \varepsilon_{\nu,t} \sim N(0, \sigma_\nu^2)$$



(a) Effects of an expansionary monetary policy



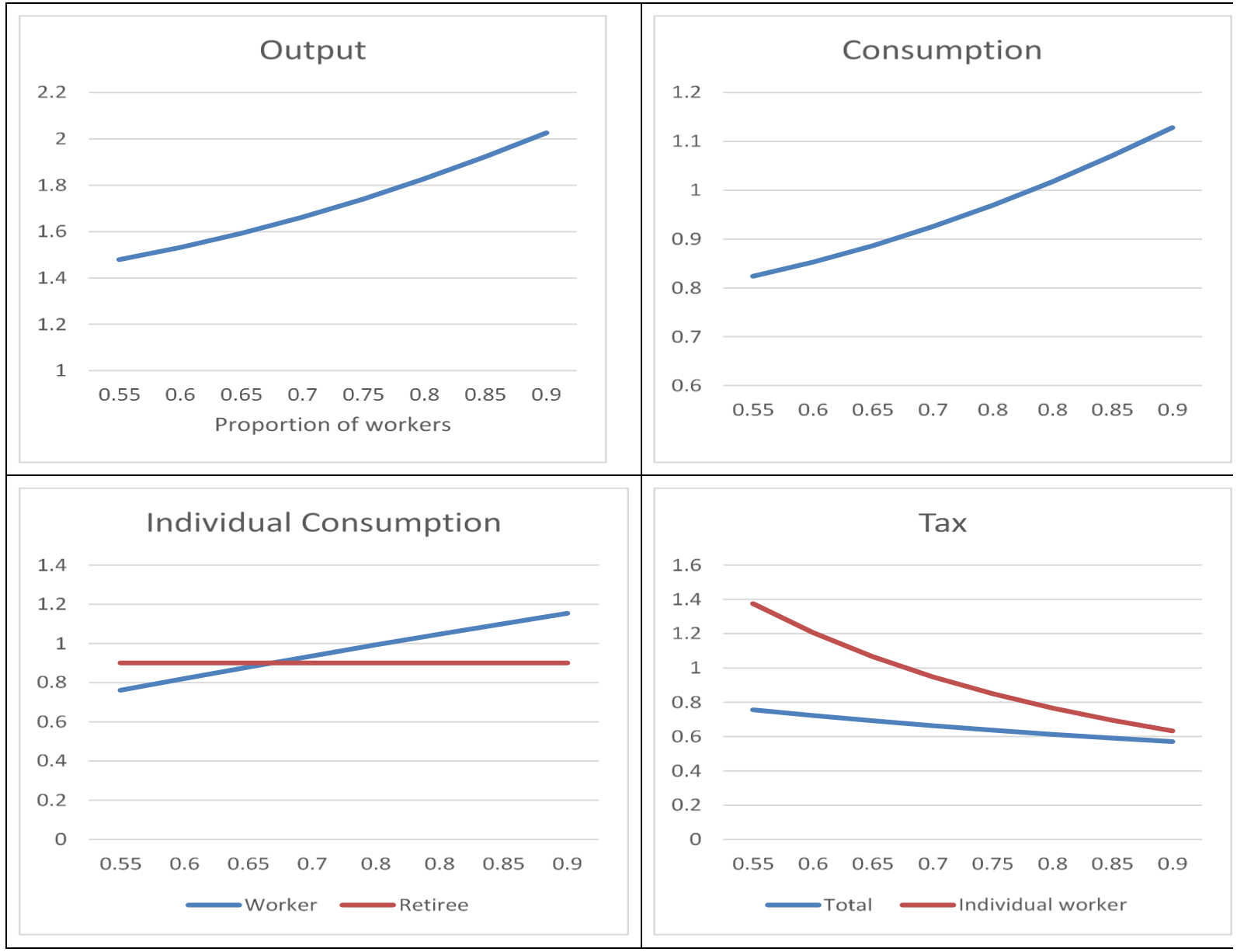
(b) Effects of a positive government investment shock

Aging Population

Productivity based wage rate and postpone retirement age

Yoshino-Miyamoto (2017) Japan and the World Economy

Yoshino-Farhad-Miyamoto (2017) Credit and Capital Markets



Source: Yoshino and Miyamoto (2016).

Declined Effectiveness of Fiscal Policy

Table 1: Spillover Effect Estimated from a Macroeconomic Translog Production Function

	1956-60	1961-65	1966-70	1971-75	1976-80	1981-85
Direct effect	0.696	0.737	0.638	0.508	0.359	0.275
Indirect effect(Kp)	0.452	0.557	0.493	0.389	0.270	0.203
Indirect effect(L)	1.071	0.973	0.814	0.639	0.448	0.350
20% returned	0.305	0.306	0.261	0.206	0.144	0.111
increment	0.438	0.415	0.410	0.404	0.400	0.402

	1986-90	1991-95	1996-00	2001-05	2006-10
Direct effect	0.215	0.181	0.135	0.114	0.108
Indirect effect(Kp)	0.174	0.146	0.110	0.091	0.085
Indirect effect(L)	0.247	0.208	0.154	0.132	0.125
20% returned	0.084	0.071	0.053	0.045	0.042
increment	0.392	0.392	0.390	0.390	0.391

Domar condition and Bohn's condition

The Domar condition is obtained from the government budget constraint as follows.

$$G_t + r_t B_{t-1} = \Delta B_t + T_t \qquad \text{Government Budget Constraint (1)}$$

Equation (1) states that government spending (G_t) + interest payments $(r_t B_{t-1})$ = new issue of government bonds (ΔB_t) + tax revenue (T_t).

Dividing Equation (1) by GDP (Y_t) and rewriting Equation (1), we get

$$b_t - b_{t-1} = \frac{(r_t - \eta_t)}{1+\eta_t} b_{t-1} + g_t - t_t \qquad \text{Domar Condition (2)}$$

where $b_t = B_t/Y_t$, $\eta_t = \Delta Y_t/Y_t$, $g_t = G_t/Y_t$, and $t_t = T_t/Y_t$

- $PB_t = g_t - t_t$ Primary Balance (PB)
- $PB_t = PB_1 + \mu(b_{t-1} - b_0)$ Bohn's Rule: Primary Balance improvement Rule at t

$$\sum_{t=1}^{\infty} \frac{PB_t}{(\lambda)^t} = b_0$$

- Bohn's Rule satisfied with "transvesarity condition".

We minimize the loss from the government's objective function by means of government spending (G_t) and the smooth change of taxation (T_t).

$$\min_{G_t,T_t} L(B_t, Y_t, G_t, T_t, \Delta B_t)$$
$$= \frac{1}{2}w_1(B_t - B_t^*)^2 + \frac{1}{2}w_2(Y_t - Y_t^f)^2 + \frac{1}{2}w_3(G_t - G_{t-1})^2 + \frac{1}{2}w_4(T_t - T_{t-1})^2$$
$$+ \frac{1}{2}w_5(\Delta B_t - \Delta B_t^*)^2$$

From Equation (15), we obtain our government spending rule.

$$G_t - G_{t-1} = \alpha_1(B_t - B_t^*) + \alpha_2(\Delta B_t - \Delta B_t^*) + \alpha_3(Y_t - Y_t^f)$$

Government Spending Rule (17)

where $\alpha_1 = \frac{w_1}{w_3}\left(\frac{B_{t-1}}{b_1 - B_{t-1}} + 1\right)$, $\alpha_2 = \frac{w_5}{w_3}\left(\frac{B_{t-1}}{b_1 - B_{t-1}} + 1\right)$, $\alpha_3 = -\frac{w_2}{w_3}\left(\frac{(d_1+i_1)+d_1 i_1}{\Delta}\right)$

$$T_t - T_{t-1} = \beta_1(B_t - B_t^*) + \beta_2(\Delta B_t - \Delta B_t^*) + \beta_3(Y_t - Y_t^f)$$

Taxation Rule (18)

where $\beta_1 = -\frac{w_1}{w_4}\left(\frac{B_{t-1}}{b_1 - B_{t-1}} + 1\right)$, $\beta_2 = -\frac{w_5}{w_4}\left(\frac{B_{t-1}}{b_1 - B_{t-1}} + 1\right)$, $\beta_3 = \frac{w_2}{w_4}\left(\frac{(d_1+i_1)c_1+d_1 i_1}{\Delta}\right)$.

From these two first-order conditions, we can find the relationship between $G_t, T_t, (B_t - B_t^*)$, $(\Delta B_t - \Delta B_t^*)$ and the primary balance.

$$PB_t - PB_{t-1} = (\alpha_1 - \beta_1)(B_t - B_t^*) + (\alpha_2 - \beta_2)(\Delta B_t - \Delta B_t^*) + (\alpha_3 - \beta_3)(Y_t - Y_t^f) \quad (19)$$

Figure 10: Government Expenditure and Tax Revenue