Low interest rates, financial technologies outside banks, and financial stability

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Views expressed in this paper are those of the authors and do not necessarily reflect the official views of the Bank of Japan.

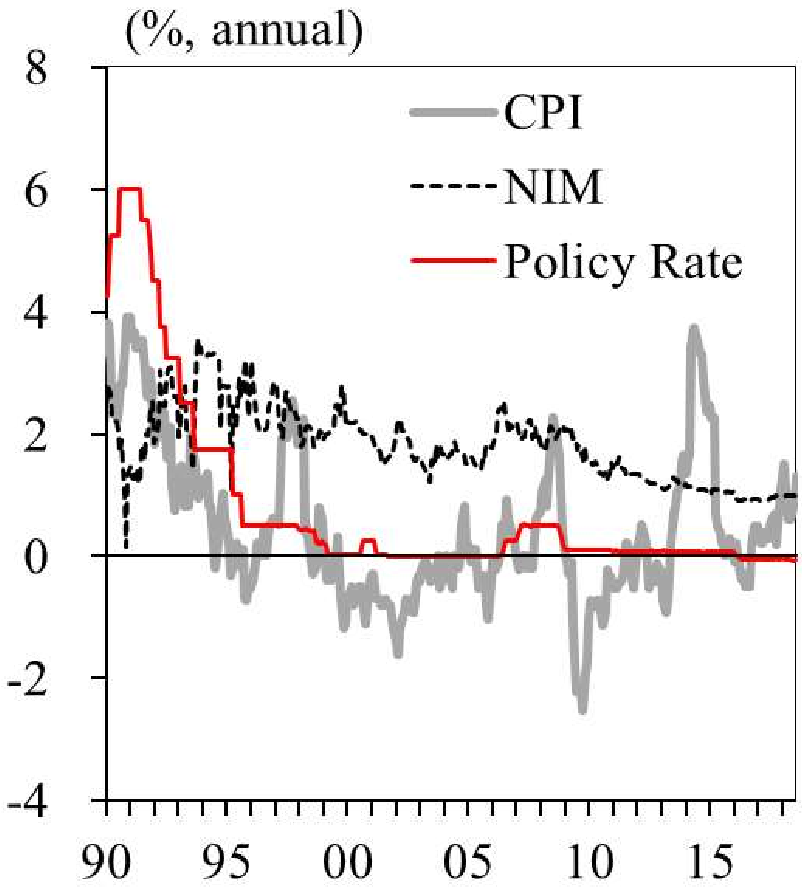
Motivation

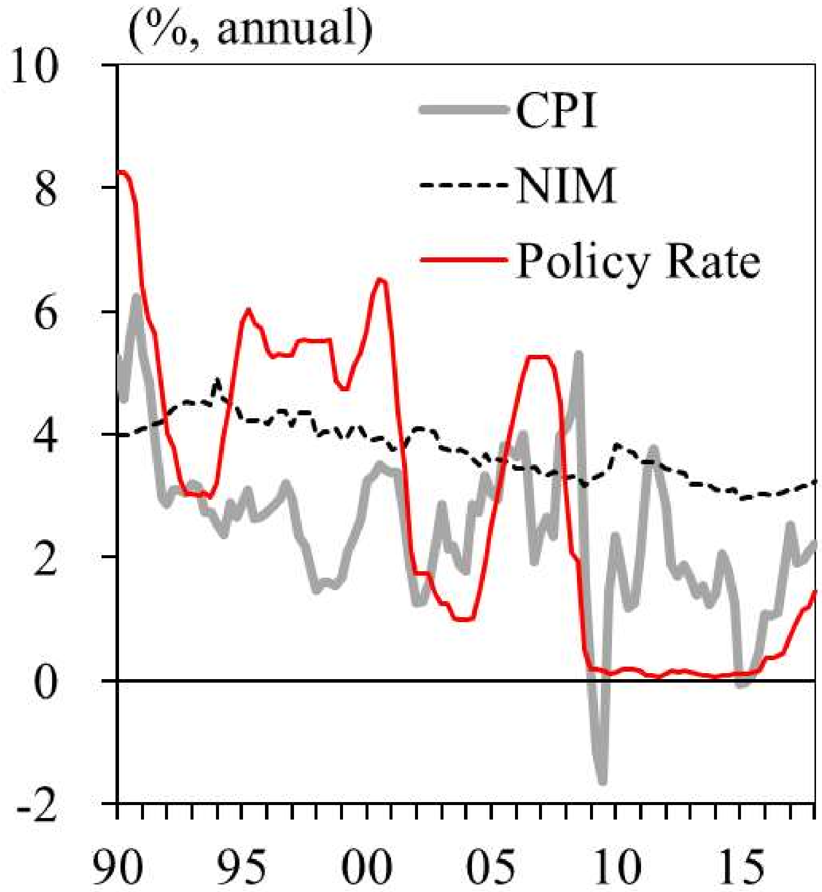
- Banks in advanced countries are facing two big threats to their business environments.

1. Prolonged low interest rates due to prolonged deflation.
2. Emergence of Fintech, in particular that takes place outside banking industry.

Low Interest Rates

- In some countries, such as Japan (left) and U.S. (right), low interest rate and net interest margin (NIM) have gone hand-in-hand.





Financial Technologies (1)

- New technologies are on the rise. Some inside banks and others outside banks.

Area of financial transaction	Technology
Lending, investment, and asset management	▪Peer-to-peer lending ▪Market place lending ▪Crowd funding platforms ▪Robo-advice ▪Credit-scoring
Payment, Clearing, and Settlement	▪Financial applications of distributed ledger technology or other form of digitalized (both state-issued and private-issued) currencies ▪Peer-to-peer transfers ▪Mobile payment or wallets
Deposit and Storage of Assets	▪Mobile banks ▪Robo-advice ▪Cryptocurrencies

Note 1. BCBS, Consultative Document (2017) "Sound Practices: Implications of fintech developments for banks and bank supervisors," Graph 1, combined with Rysman and Schuh (2016).

Note 2. According to FSB, 'FinTech' is technologically enabled financial innovation that could result in new business models, applications, processes, products, or services with an associated material effect on financial markets and institutions and the provision of financial services.

Financial Technologies (2)

- For banks, both risks and opportunities emanate from such technological changes.

	Risks	Opportunities
Impact on Consumer Sector	▪Data privacy ▪Data security ▪Discontinuity of banking services ▪Inappropriate marketing practices	▪Financial inclusion ▪Better and more tailored banking services ▪Lower transaction costs and faster banking services
Impact on banks and banking system	▪Strategic and profitability risks ▪Increased interconnectedness between financial parties ▪High operational risk – systemic ▪High operational risk – idiosyncratic ▪Third-party/vendor management risk ▪Compliance risk including failure to protect consumers and data protection regulation ▪Money laundering – terrorism financing risk ▪Liquidity risk and volatility of bank funding sources	▪Improved and more efficient banking processes ▪Innovative use of data for marketing and risk management purposes ▪Potential positive impact on financial stability due to increased competition ▪Regtech

BCBS, Consultative Document (2017) "Sound Practices: Implications of fintech developments for banks and bank supervisors," Graph 6.

Voices of Concern

- Some concern that such threats may dampen banks' profits and undermine stability of financial system as a whole.

''…analyzes the potential long-term impact of a scenario of sustained low growth and low real and nominal rates for the business models of banks, insurers, and pension funds.. and finds that yield curves would likely flatten, lowering bank earnings—particularly of smaller, deposit-funded, and less diversified institutions."(GFSR, 2017)

''the rapid adoption of new technologies along with their effect in lowering barriers to entry in the financial services market has fostered the emergence of new business models and many new fintech entrants. These factors may prove to be more disruptive than previous changes in the banking industry, although as with any forecast, this is in no way certain.'' (BCBS, 2017)

Questions

- How does low interest rate affect banks’ profits and financial stability?

- How do advances of financial technology outside banks affect banks’ profits and financial stability?

- What are the net effects of low interest rates and advances of financial technology outside banks?

What We Do

- We extend the model of bank run by Gertler and Kiyotaki (2015, AER).

  Roughly speaking, our model is

  Gertler and Kiyotaki (2015) + Liquidity services (money & deposit)

  + Time-varying financial technologies

Our Findings

- Result 1: Deflation, the key reason why interest rates are low, dampens banks' profits and undermines financial stability.
- Result 2: Improved lending technologies of non-banks reduce banks' profits but counter adverse effects of deflation on financial stability.
- Result 3: Improved non-deposit transaction technologies can improve or undermine financial stability depending on precise nature of the technology.

- Regarding financial stability, net effect may not be rosy, but not necessarily gloomy as well.

Contribution

- We provide an explanation why interest rates, banks' interest margin, and banks' profits move together.

- We provide a theoretical framework in which implications of level of interest rates and financial technologies outside banks to financial stability are addressed.

✓ Deflation (= low interest rate) may undermine financial stability by impairing banks' earnings from liquidity premium.

✓ Financial services by non-bank institutions may attenuate the adverse effects, since they are in nature less susceptible to deflation.

Model

Economy

• 6 sectors: households, banks, firms, non-bank financial intermediators (NBFI), non-bank liquidity service provider (NBLP), and the government (including the central bank).

• Banks provide 2 services: lending services and liquidity services.

-- Banks can default.

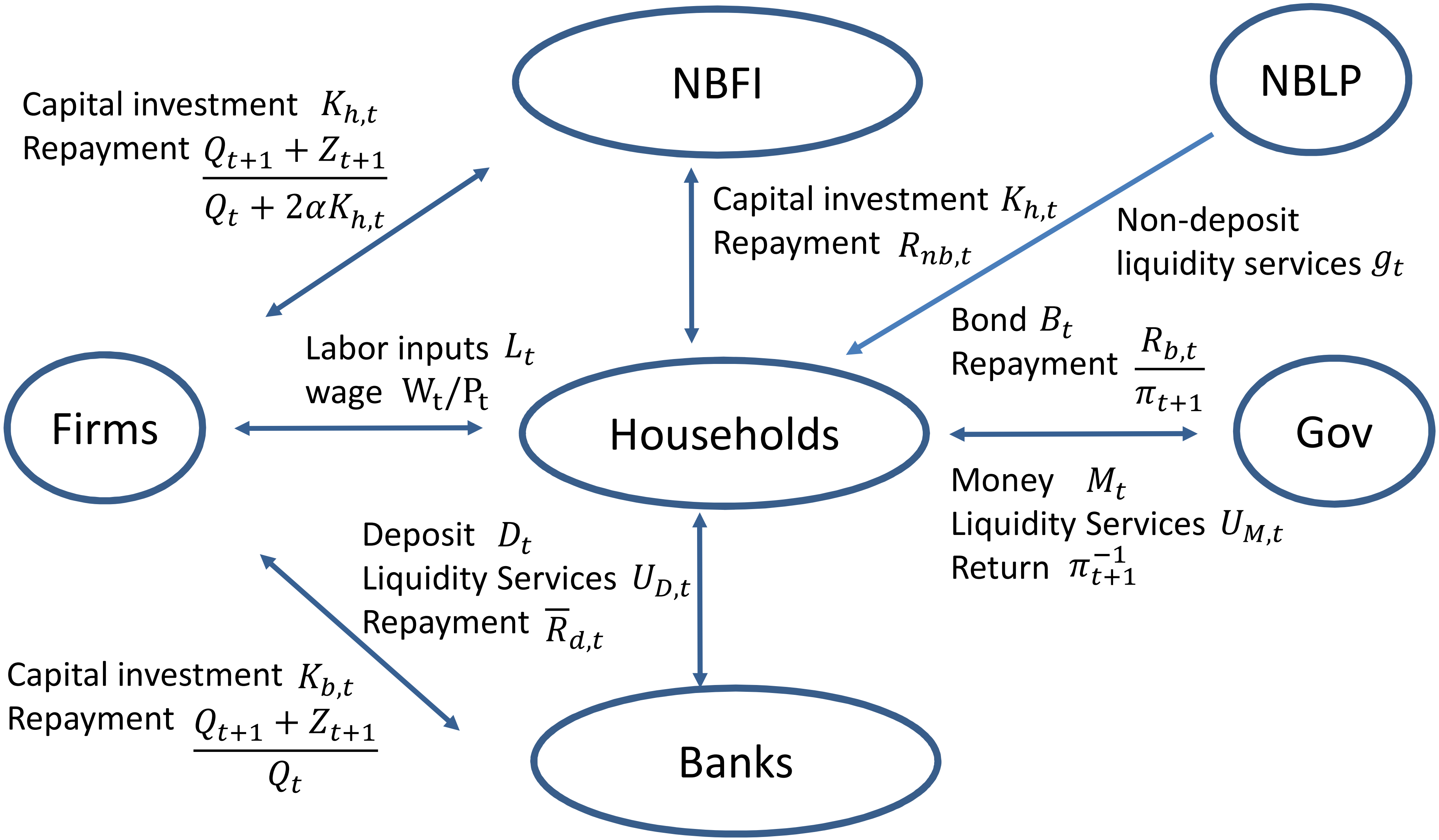
-- Banks' default probability p_t is a function of banks' solvency.

• NBFI provides lending services but not liquidity services.

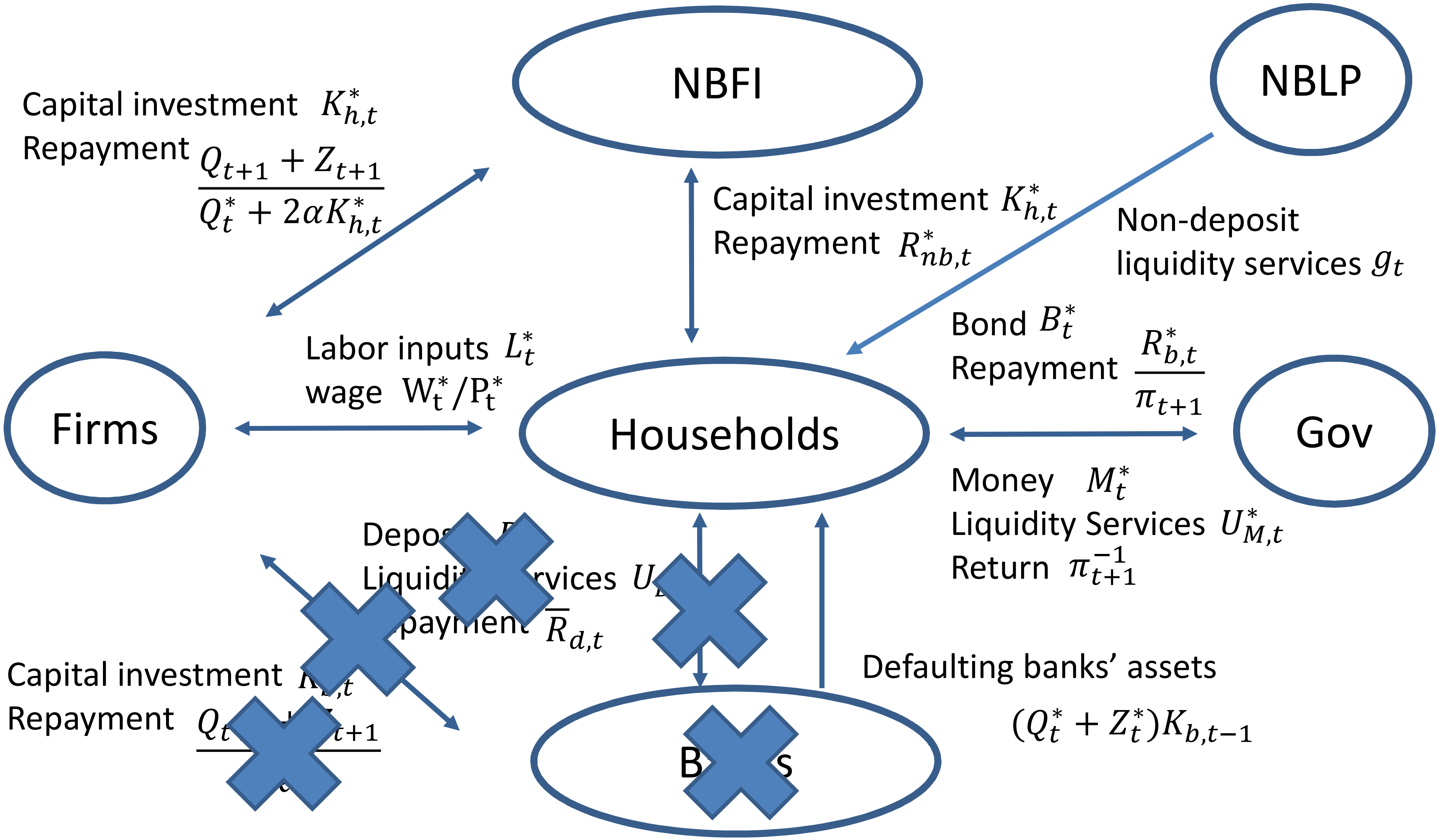
• NBLP provides liquidity services but not lending services.

-- i.e., there are three means of transaction, with deposit, money, and non-deposit liquidity services.

Model Outline: Normal times



Model Outline: Bank Run



Banks

- Banks use net worth N_t and deposits D_t to conduct capital investment $K_{b,t}$ under regulatory capital requirement (fixed leverage).
- Banks' investment size and profits increase with NIM $\frac{Q_{t+1}+Z_{t+1}}{Q_t} - \frac{\bar{R}_{d,t}}{\pi_{t+1}}$.

$$\phi \geq \frac{Q_t K_{b,t}}{N_t}$$

$$+$$

$$N_t = \sigma[(Q_t + Z_t)K_{b,t-1} - \frac{D_{t-1}\overline{R}_{d,t-1}}{P_{t-1}\pi_t}] + AW_b$$

$$Q_t K_{b,t} = \sigma\phi[(Q_t + Z_t)K_{b,t-1} - \frac{D_{t-1}\overline{R}_{d,t-1}}{P_{t-1}\pi_t}] + \phi AW_b$$

- Banks are likely to default when banks' asset value when run occurs becomes smaller than banks' debt obligation.
- Run probability p_t is a function of recovery rate and is given as

$$p_t \equiv 1 - \min\left[1, \frac{(Z_{t+1}^* + Q_{t+1}^*)K_{b,t}}{\left(\frac{\overline{R}_{d,t}}{\pi_{t+1}^*}\right)\left(\frac{D_t}{P_t}\right)}\right]$$

recovery rate

NBFI

- When investing, NBFI pays monitoring cost worth of $\alpha_t K_{h,t}^2$ and receives $(Q_{t+1} + Z_{t+1})K_{h,t}$ in return.

  -- Under perfect competition, it implies that $R_{nb,t} = \dfrac{Q_{t+1} + Z_{t+1}}{Q_t + 2\alpha_t K_{h,t}}$

- NBFI does not provide liquidity services.

- We capture technological advancements in NBFI's lending by a decline in monitoring cost parameter α_t.

  ▪ Peer-to-peer lending ▪ Robo-advice

  ▪ Market place lending ▪ Crowd funding platforms

NBLP

- NBLP supplies non-deposit liquidity services to households g_t.
  -- Households gain utility from composite of liquidity services described as Ω_t and technological advancement is captured by an increase in g_t (type I change).

$$\Omega_t = \omega \ln \left[\left(\frac{\mu_t D_t}{P_t} \right)^{\zeta} + \left(\frac{M_t}{P_t} \right)^{\zeta} + (g_t)^{\zeta} \right]^{1/\zeta}$$

▪Digitalized privately-issued currency

- In addition, we consider an increase in μ_t (type II change) so as to capture changes in technology that rely on deposits.

▪Digitalized state-issued currency (Mobile banks)

Model Mechanism

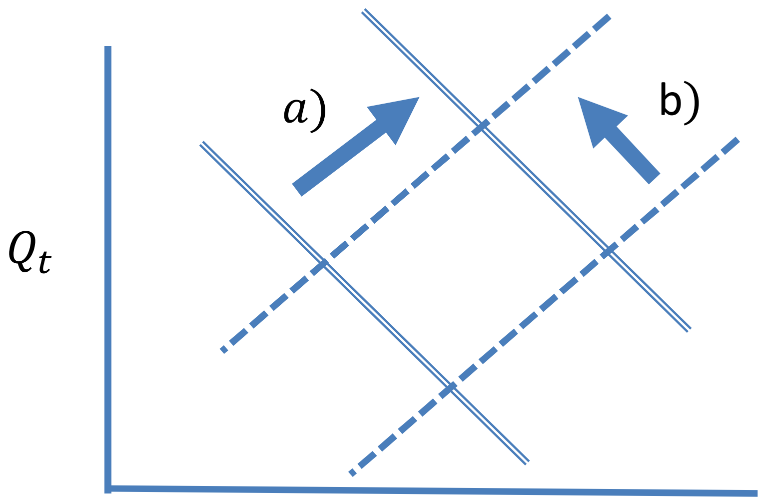
Capital and deposit market

a) A rise in productivity of goods sector

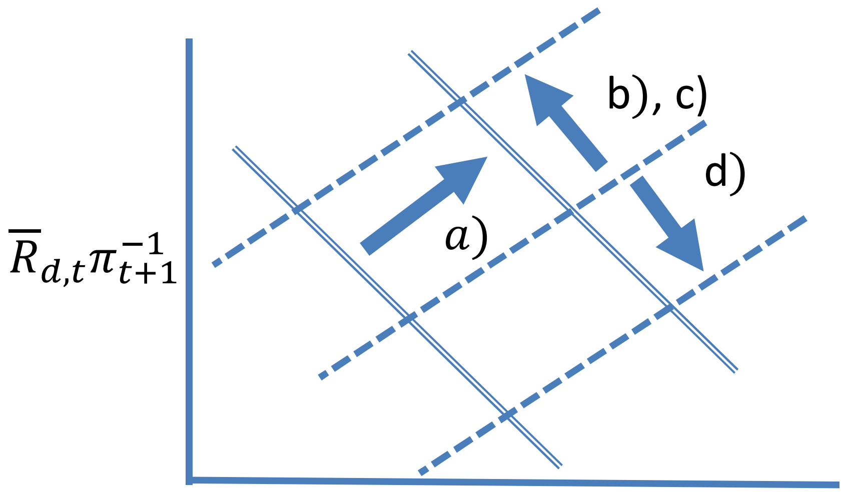
b) A rise in NBFI lending technology

c) Changes that make deposit less attractive
(deflation, type I change of liquidity services)

d) Changes that make deposit more attractive (type II change)



Banks' demand and NBFI's supply of capital $K_{b,t}$



Households' supply and Banks' demand towards $\frac{D_t}{P_t}$

Simulations

Direction

- We conduct steady-state analyses.
- We ask how deposit and money holding, banks' centrality (assets held by banks vs assets held by NBFI), NIM, and financial stability change to the following changes.

(1) Steady-state inflation rate.

(2) Lending technologies of NBFI

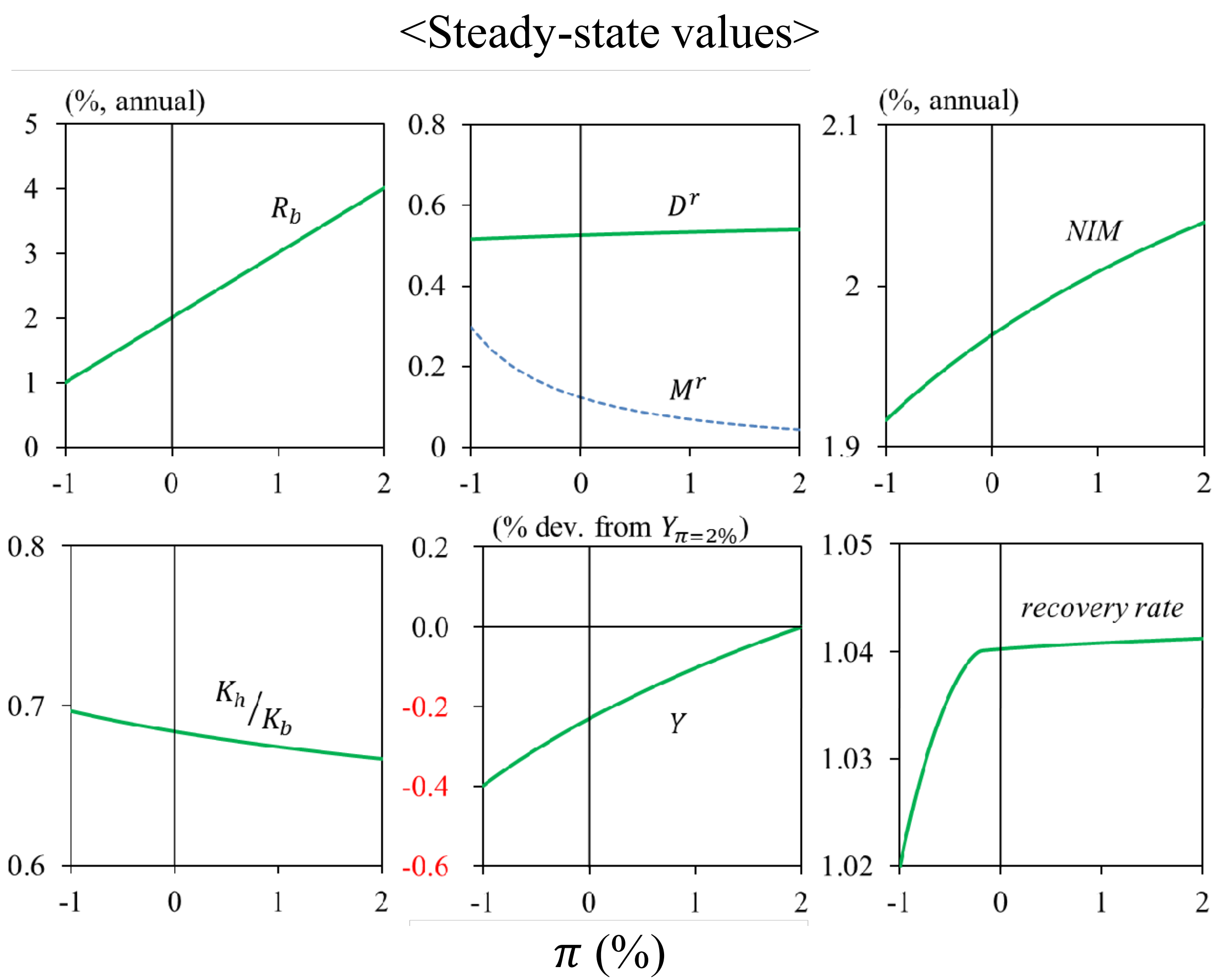
(3) Type I liquidity services

(4) Type II liquidity services

- We use recovery rate $\frac{(Z^*_{t+1}+Q^*_{t+1})K_{b,t}}{\left(\frac{\bar{R}_{d,t}}{\pi^*_{t+1}}\right)\left(\frac{D_t}{P_t}\right)}$ as the measure of financial stability.

Deflation (1)

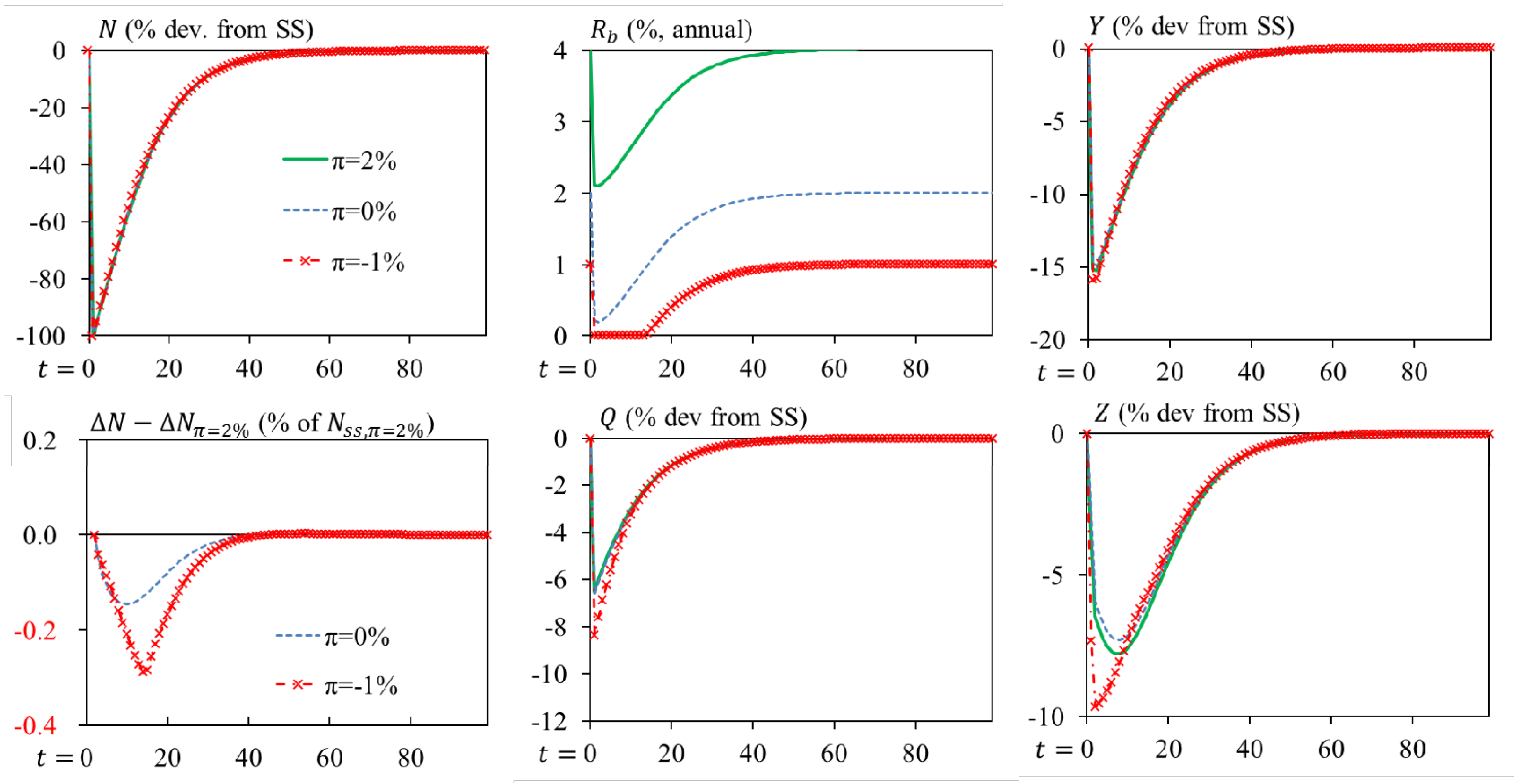
- Deflation reduces NIM, and undermines financial stability.



Deflation (2)

- Deflation undermines financial stability in two channels: Lower NIM and zero lower bound when a run occurs.

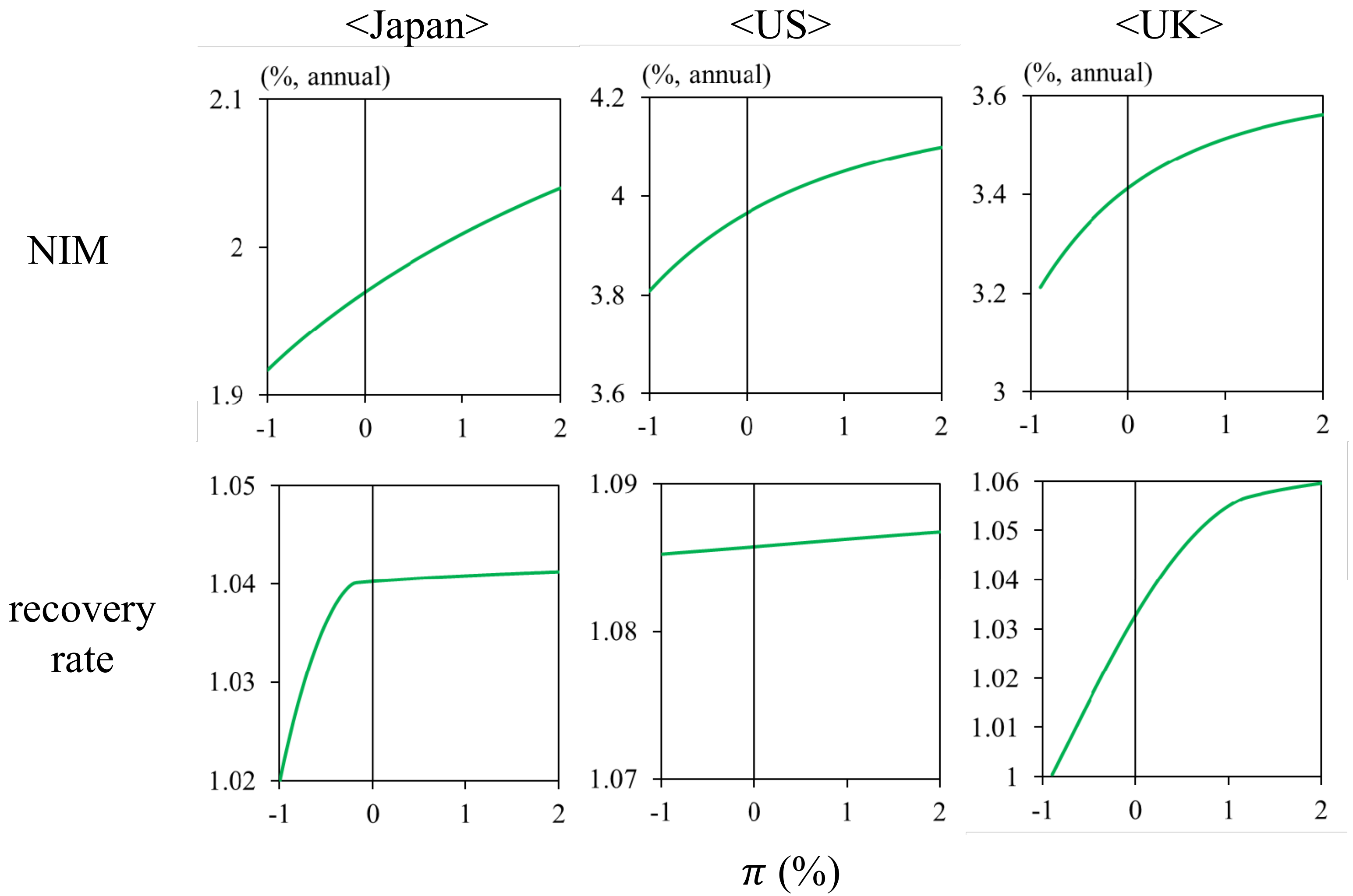
<Dynamics after a run at $t = 1$>



Note: $\Delta N_t \equiv N_t - N_{t-1}$

Deflation (3)

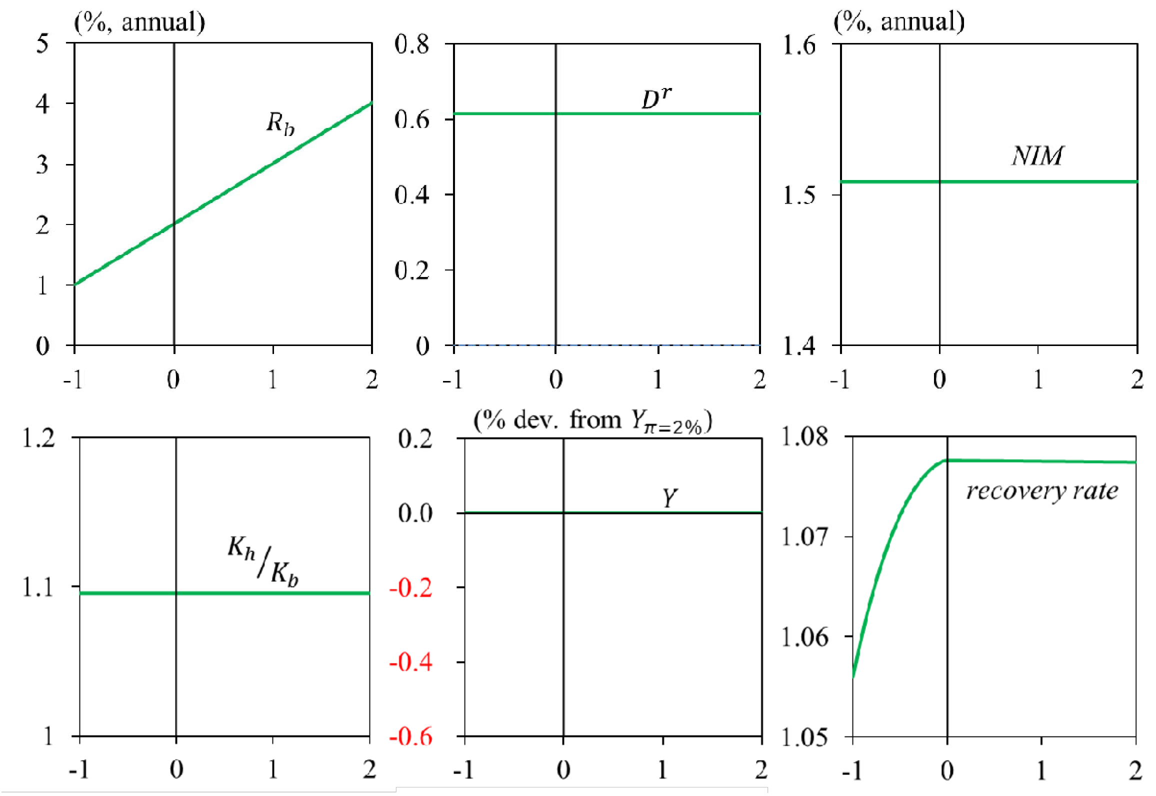
- Implications are qualitatively robust when a model is calibrated to other countries.



Deflation (4)

- Comovement between deflation and NIM disappears when liquidity services are absent.
- Due to zero lower bound, recovery rate falls when inflation falls.

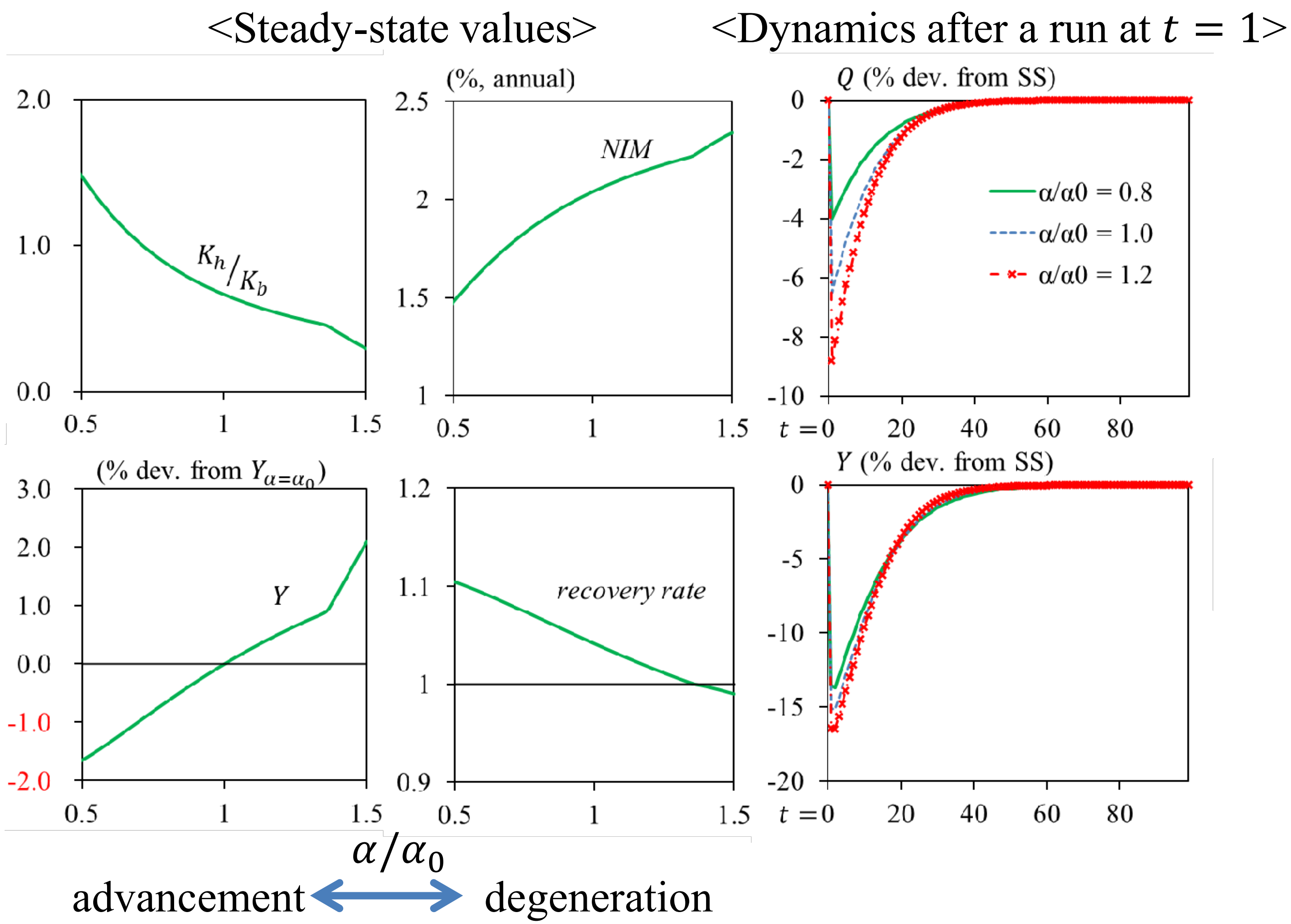
<Steady-state values, when $\omega = 0$>



π (%)

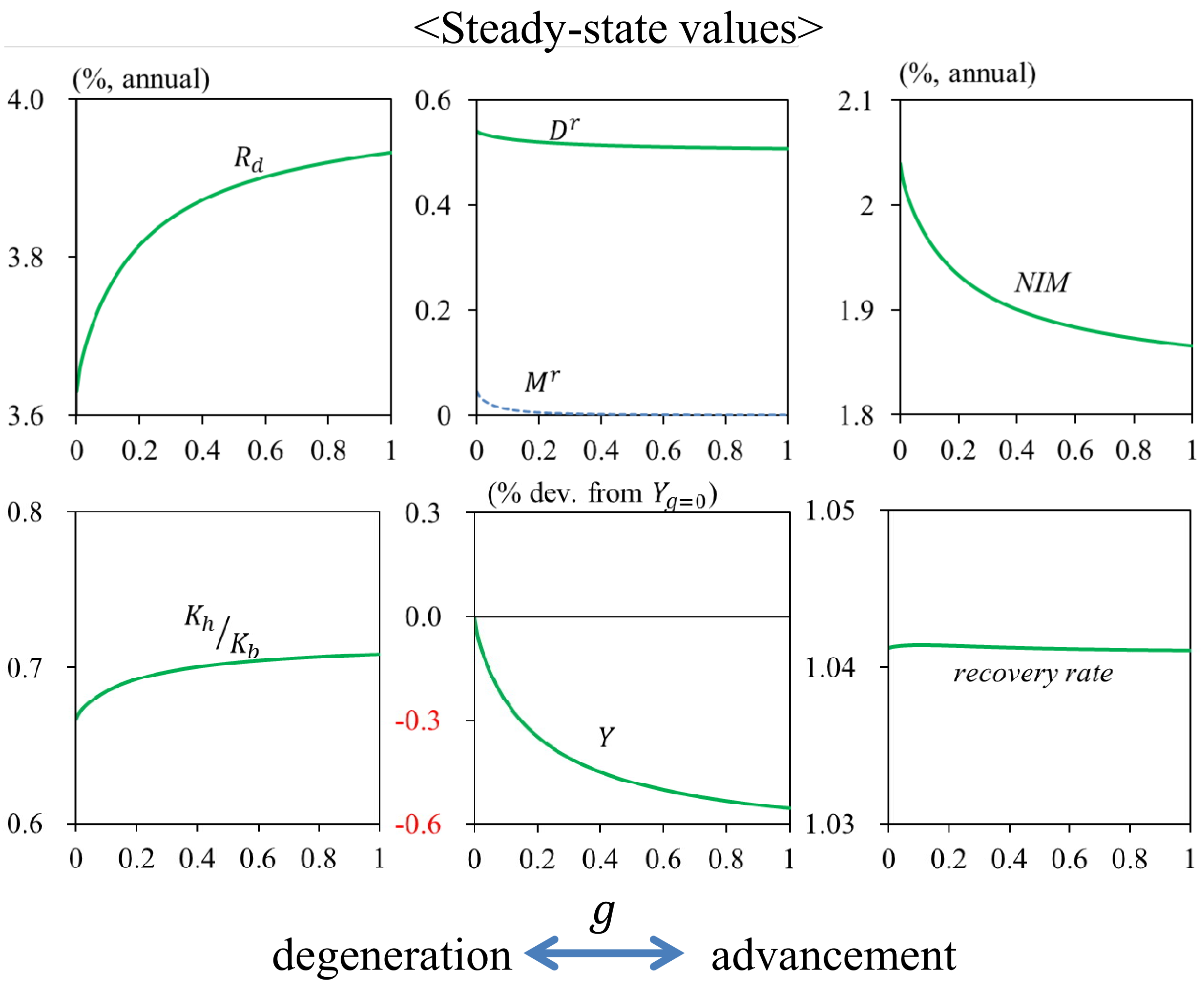
Improved NBFI's Lending Technology

- It reduces NIM, but improves financial stability.



Improved Type I Technology

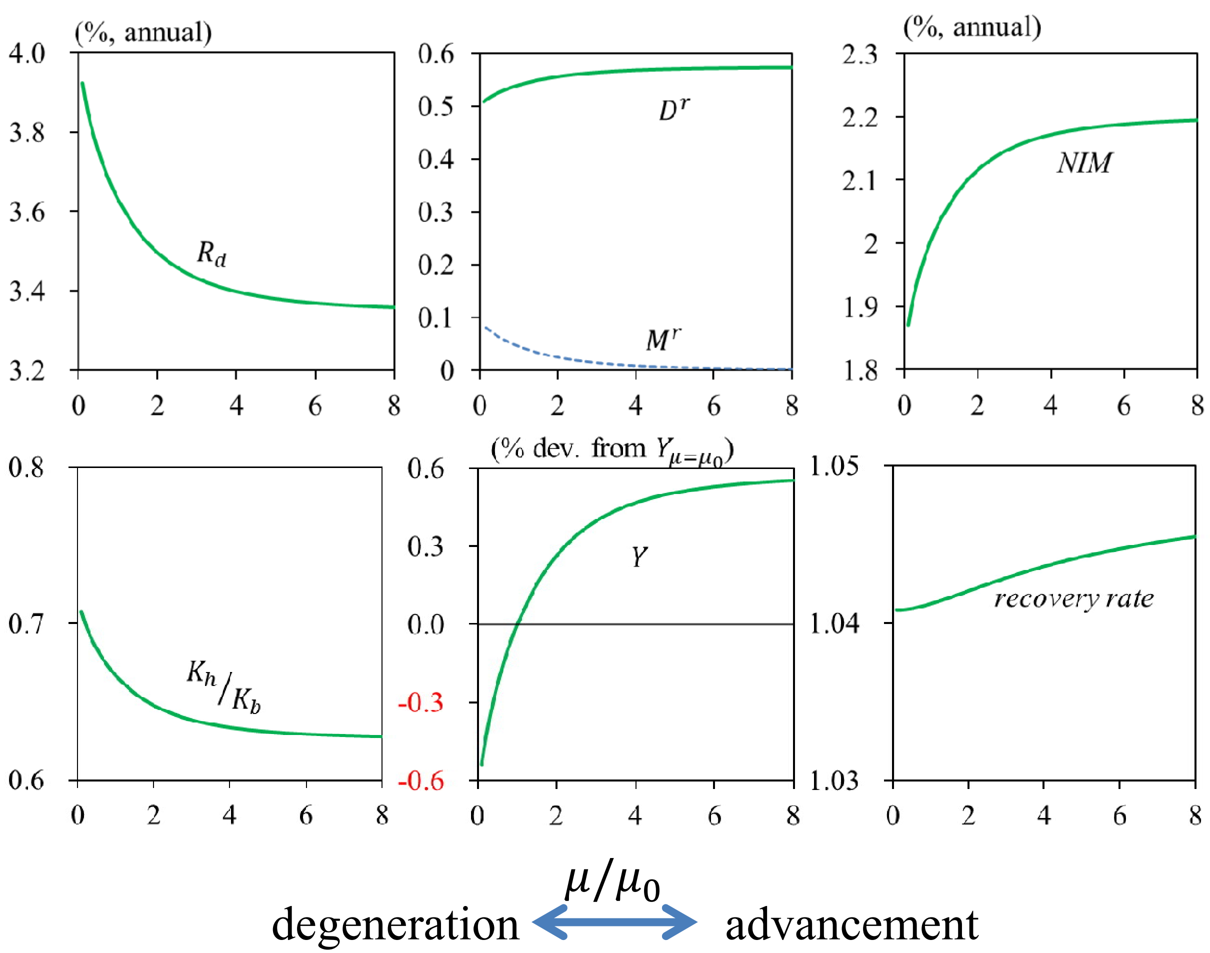
- It reduces NIM and slightly undermines financial stability.



Improved Type II Technology

- In contrast to type I technology, it widens NIM and improves financial stability.

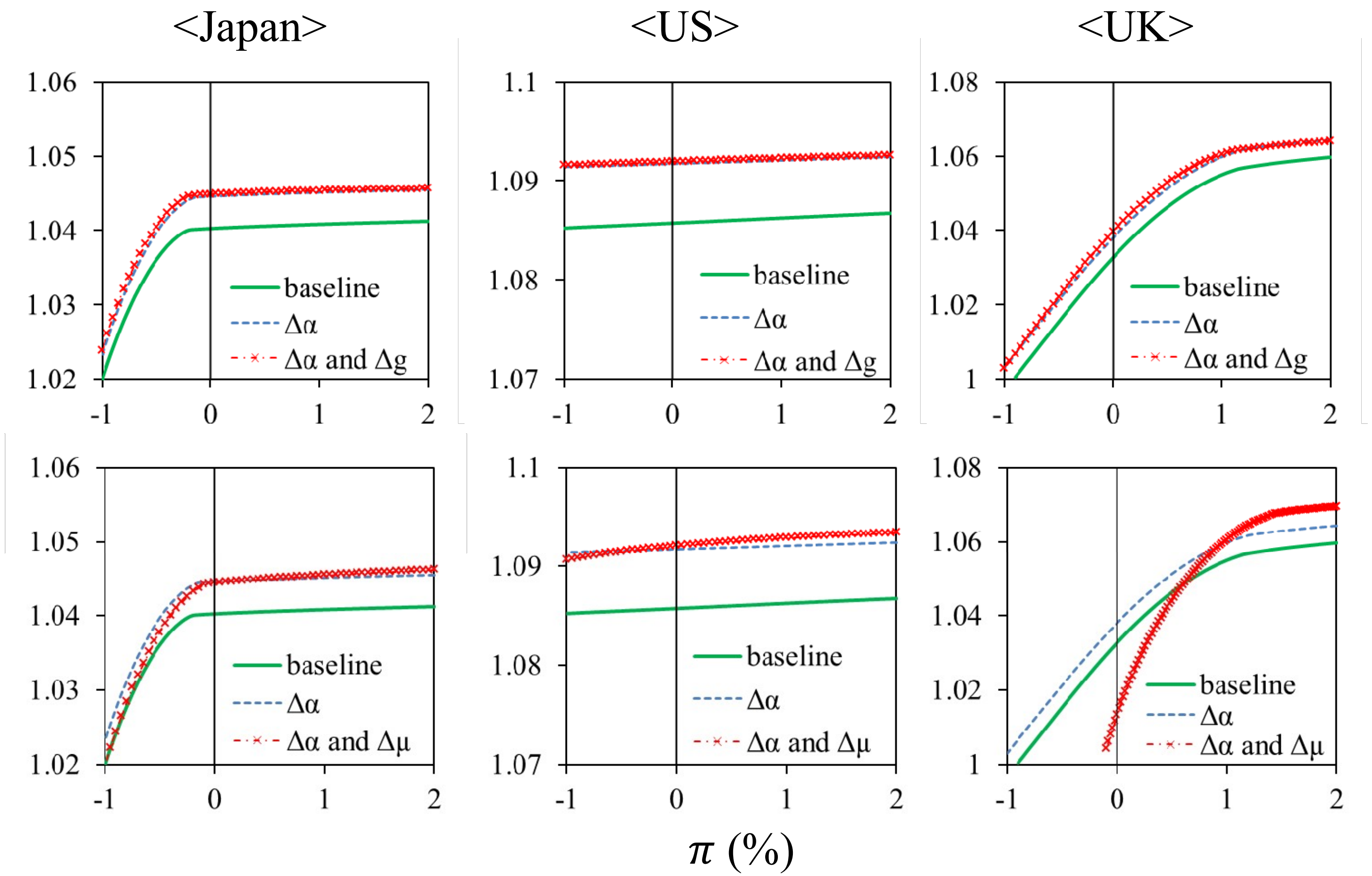
<Steady-state values>



Net Effect

Deflation + technological progress by 2.5%

- Improvements in lending technologies of NBFI counter adverse effects of deflation on financial stability.
- Implications of improvements in NBLP are not clear cut.



Conclusion

Conclusion

- Result 1: Deflation reduces interest rate, dampens banks' profits, and undermines financial stability, by making deposit less attractive.
- Result 2: Improved lending technologies of non-banks can counter adverse effects of deflation on financial stability, since non-banks are less susceptible to impacts of deflation.
- Result 3: Improved non-deposit transaction technologies can improve or undermine financial stability depending on precise nature of the technology.

- Net effect may not be rosy, but not necessarily gloomy as well.

Going Forward

- Theoretically explore implications to monetary policy implementation.

(1) How are monetary policy implementation and safeguarding financial stability interacted?

(2) How is the lower bound of short-term interest rate determined by financial technologies?

- Empirically examine effects of financial innovations on financial stability in the past and going forward.

Thank You!

Literature Review

1. Low Interest Rates and Banks

- It is generally agreed that low interest rates come together with low banks' profits, but why it does so is not much explored theoretically.
- Some existing (and growing) studies argue that a cut in policy rate below zero damages banks' profits and undermines expansionary effects of monetary easing.

Question	Views expressed in existing works
Does low interest rate lower NIM or banks' profit?	▪Yes: Deutsche Bank (2013), Borio et al. (2015), Claessens et al. (2017) -- Claessens et al. (2017), based on a sample of 3,385 banks from 47 countries from 2005 to 2013, document that a 1% decline in interest rate implies an 8 bps lower net interest margin. ▪Not so clear: Ennis et al. (2016)
Can negative interest rate harm banks' profits and undermine effects of monetary policy?	▪Yes: -- Theoretically, reversal rate or qualitatively similar situation may arise (Brunnermeier and Koby, 2018, Eggerton et al., 2018). -- Empirically, banks with different reliance on deposit funding experience a different pass-through of negative policy rates (Heider et al, 2018). ▪No: "all channels in the transmission mechanism can be expected to be active (the Riksbank, 2015)."

2. Effects of Financial Technologies

• Impacts of financial technologies have already been studied from a wide range of aspects, but implications to financial stability have rarely been studied.

Author(s)	What technological advance in financial intermediation does
Greenwood et al.(2010)	▪It fosters economic growth.
Buera et al. (2011)	▪It increases output.
Gerardi et al. (2007)	▪It helps consumption smoothing.
Jermann and Quadrini. (2006)	▪It decreases output volatility but increases volatility of financial variables.
Gai et al. (2008)	▪It makes financial crises less likely but potentially more severe.
Chen et al. (2012)	▪It fosters economic growth but leads to higher growth volatility among industries that are dependent on external financing.

3. Studies/Documents about Fintech

• Related empirical works grow rapidly, in particular P2P lending, but none addresses the macroeconomic implications, perhaps due to lack of theoretical framework and data limitations.

• Reactions from authorities to the emergence of Fintech

BCBS (2017): Identifies 10 key observations and recommendations for considerations by banks and bank supervisors about Fintech.

FSB (2017): defines the scope of Fintech activities and identifies potential benefits and risks to financial stability.

•Other works about Fintech

Author(s)	Views expressed in the analysis
Rysman and Schuh(2016)	・Prospects and impediments to adoption regarding mobile payments, faster payments, and digital currencies are discussed.
Buchak et al. (2018)	・Regulation accounts for roughly 60% of shadow bank growth, while technology accounts for roughly 30%, in doubling of shadow bank market share in residential mortgage origination from 2007 to 2015.
de Roure et al.(2018)	・Based on German data, (i) P2P lending grows when banks are faced with higher regulatory costs; (ii) P2P loans are riskier than bank loans; and (iii) the risk-adjusted interest rates on P2P loans are lower than those on bank loans.

4. Substitutability of Banks' Services

• Banks have never attained absolute centrality in lending and provision of liquidity services. There have always been substitutes.

A type of financial services studied	Works
Banks' lending vs merchantile credit (or trade credit)	▪They are substitutes: Meltzer (1960), Ono (2001) ▪They are complements: Uesugi (2005) ▪They can be both: Ogawa (2003)
Banks' lending vs commercial paper issuance	▪They are Imperfect substitutes: Kashyap, Stein, and Wilcox (1993)
Banks' lending vs P2P lending	▪They are substitutes: Buchak et al. (2018) ▪They can be both: Tang (2018), de Roure et al.(2018)
Banks' deposits vs money and/or electronic money	▪BIS (1997)
Banks' deposit vs central bank's digital currency (CBDC)	▪Barrdear and Kumhof (2016)
Banks' deposit vs equity (from households' point of view)	▪Brunnermeier and Nagel (2008), Aoki et al. (2016), Ito et al. (2018)

Model Settings

Households (1)

• Households supply labor inputs to firms and receive labor income.

• Households store their assets in four forms, claims to non-bank financial intermediaries ($K_{h,t}$), government bonds (B_t), deposit (D_t), and money (M_t).

•Deposit is risky assets since banks may default.

• In contrast to Gertler and Kiyotaki (2015), households receive utility from liquidity services provided by deposits and money holding.

• Note also that NBFI' capital investment is less efficient than banks.

Households (2)

- Households' problem is formulated as follows.

$$\max \quad E_t\left[\sum_{j=0}^{\infty} u(C_{t+j}) - \frac{\chi}{1+v} L_{t+j}^{1+v} + \Omega\left(\frac{D_{t+j}}{P_{t+j}}, \frac{M_{t+j}}{P_{t+j}}\right)\right]$$

$$\Omega \equiv \omega \ln\left(\left[\left(\frac{\mu_t D_t}{P_t}\right)^{\zeta} + \left(\frac{M_t}{P_t}\right)^{\zeta} + (g_t)^{\zeta}\right]^{1/\zeta}\right)$$

$$C_t + \frac{D_t + M_t + B_t}{P_t} + Q_t K_{h,t} + \alpha_t {K_{h,t}}^2 \le L_t w_t + Z_t K_{h,t-1} + \frac{R_{d,t} D_{t-1} + M_{t-1} + R_{b,t-1} B_{t-1}}{P_t}$$
$$+ Q_t K_{h,t-1} + \Pi_t - T_t$$

- Return to deposit $\frac{R_{d,t} D_{t-1}}{P_{t-1}}$ equals to $\frac{\bar{R}_{d,t-1} D_{t-1}}{P_{t-1}}$ if banks do not default, and $\pi_t^*(Z_t^* + Q_t^*) K_{b,t-1}$ if they do.

Households (3)

- Euler equations for four assets ($K_{h,t}$, B_t, D_t, and M_t) are given as follows.

$$\beta \frac{(1-p_t)(Z_{t+1}+Q_{t+1})u_c(C_{t+1})}{(Q_t+2\alpha_t K_{h,t})u_c(C_t)} + \beta \frac{p_t(Z^*_{t+1}+Q^*_{t+1})u_c(C^*_{t+1})}{(Q_t+2\alpha_t K_{h,t})u_c(C_t)} = 1$$

$$\frac{\beta(1-p_t)R_{b,t}u_c(C_{t+1})}{\pi_{t+1}u_c(C_t)} + \beta \frac{p_t R_{b,t} u_c(C^*_{t+1})}{\pi^*_{t+1}u_c(C_t)} = 1$$

$$\frac{\beta(1-p_t)\overline{R}_{d,t}u_c(C_{t+1})}{\pi_{t+1}u_c(C_t)} + \beta \frac{p_t(Z^*_{t+1}+Q^*_{t+1})\,K_{b,t}u_c(C^*_{t+1})}{D^r_t u_c(C_t)} + \frac{\omega\Omega_D}{u_c(C_t)} = 1$$

$$\frac{\beta(1-p_t)u_c(C_{t+1})}{\pi_{t+1}u_c(C_t)} + \beta \frac{p_t u_c(C^*_{t+1})}{\pi^*_{t+1}u_c(C_t)} + \frac{\omega\Omega_M}{u_c(C_t)} = 1$$

Households (4)

- Order of the size of expected returns of four asset runs as follows.

  (1) Claim to NBFI ($K_{h,t}$) for $R_{nb,t}$.

  (2) Government bonds (B_t) for $R_{b,t}\pi_{t+1}^{-1}$.

  (3) Deposit (D_t) for $\overline{R}_{d,t}\pi_{t+1}^{-1}$ and $U_{D,t}$.

  (4) Money (M_t) for π_{t+1}^{-1} and $U_{M,t}$.

- The spread between the assets capture….

  (1) – (2) → risk of bank runs

  (2) – (3) → premium for liquidity service provided by deposits

  (3) – (4) → substitutability of deposits and money holdings

Firms

- Firms are standard. Intermediate goods firms produce intermediate goods x_t from labor inputs L_t and capital inputs K_t and sell with price $p_{x,t}$.

$$\max \quad p_{x,t}x_t - w_t L_t - Z_t\left(K_{b,t-1} + K_{h,t-1}\right)$$

$$x_t = A_t L_t^{\eta}\left(K_{b,t-1} + K_{h,t-1}\right)^{1-\eta}$$

- Final goods firms produce final goods Y_t from intermediate inputs. They are monopolistically competitive and subject to nominal rigidity.

$$(\epsilon - 1) - \epsilon p_{x,t} + \kappa\pi_t(\pi_t - \pi_{ss}) - \frac{\epsilon\kappa}{2}(\pi_t - \pi_{ss})^2 = \frac{\beta(1-p_t)u_c(C_{t+1})}{u_c(C_t)}\kappa\pi_{t+1}(\pi_{t+1} - \pi_{ss})\frac{x_{t+1}}{x_t} + \frac{\beta p_t u_c(C_{t+1}^*)}{u_c(C_t\ )}\kappa\pi_{t+1}^*(\pi_{t+1}^* - \pi_{ss})\frac{x_{t+1}^*}{x_t}$$

Other equations

- Resource constraint

$$1 = K_{b,t} + K_{h,t}$$

$$x_t \left[1 - \frac{\kappa}{2}(\pi_t - \pi_{ss})^2\right] = C_t + C_{b,t} + \alpha K_{h,t}^2$$

Note: exiting bankers' consumption

$$C_{b,t} = (1-\sigma)[(Q_t + Z_t)K_{b,t-1} - \frac{D_{t-1}\overline{R}_{d,t-1}}{P_{t-1}\pi_t}]$$

- Central Bank

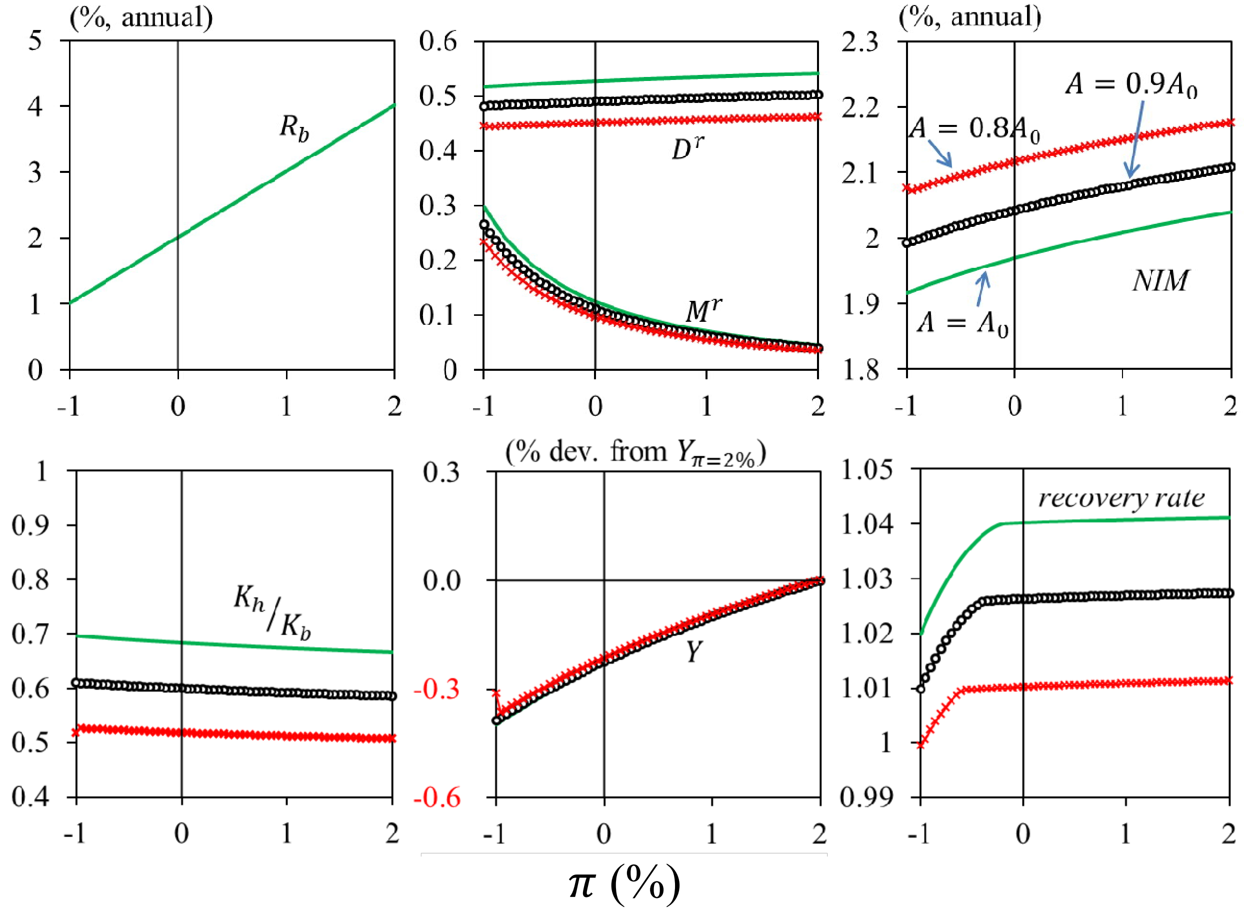
$$R_{b,t} = \min\left[1, r_{ss}\pi_{ss}\left(\frac{\pi_t}{\pi_{ss}}\right)^{\psi}\right]$$

Simulations when a bank run probability is above zero

Deflation + adverse shock

- When low productivity of the economy and deflation both occur, a probability of a bank run easily surfaces above zero.

<Steady-state values when $A/A_0 = 1$, 0.9, and 0.8>



Simulations based on a model calibrated to other countries

Calibration (1)

- Key parameters are set so as to meet the following conditions at the steady state.

	NIM	$R_b\pi^{-1} - R_d\pi^{-1}$	$(Q+Z)/Q - R_b\pi^{-1}$	$\frac{M}{D}$	K_h	**Calibration period**
Japan	2.05	0.39	1.66	0.083	0.40	2007
US	4.12	1.12	3.00	0.049	0.75	2002-2007
UK	3.58	1.92	1.66	0.045	0.43	2002-2007

- Calibrated parameter values:

	A	α	ω	μ	σ
Japan	0.041	0.0051	0.033	0.10	0.90
US	0.057	0.0050	0.017	0.59	0.86
UK	0.040	0.0048	0.096	1.31	0.87

Calibration (2)

- Other conventional parameters are set following Gertler and Kiyotaki (2015) or existing studies.

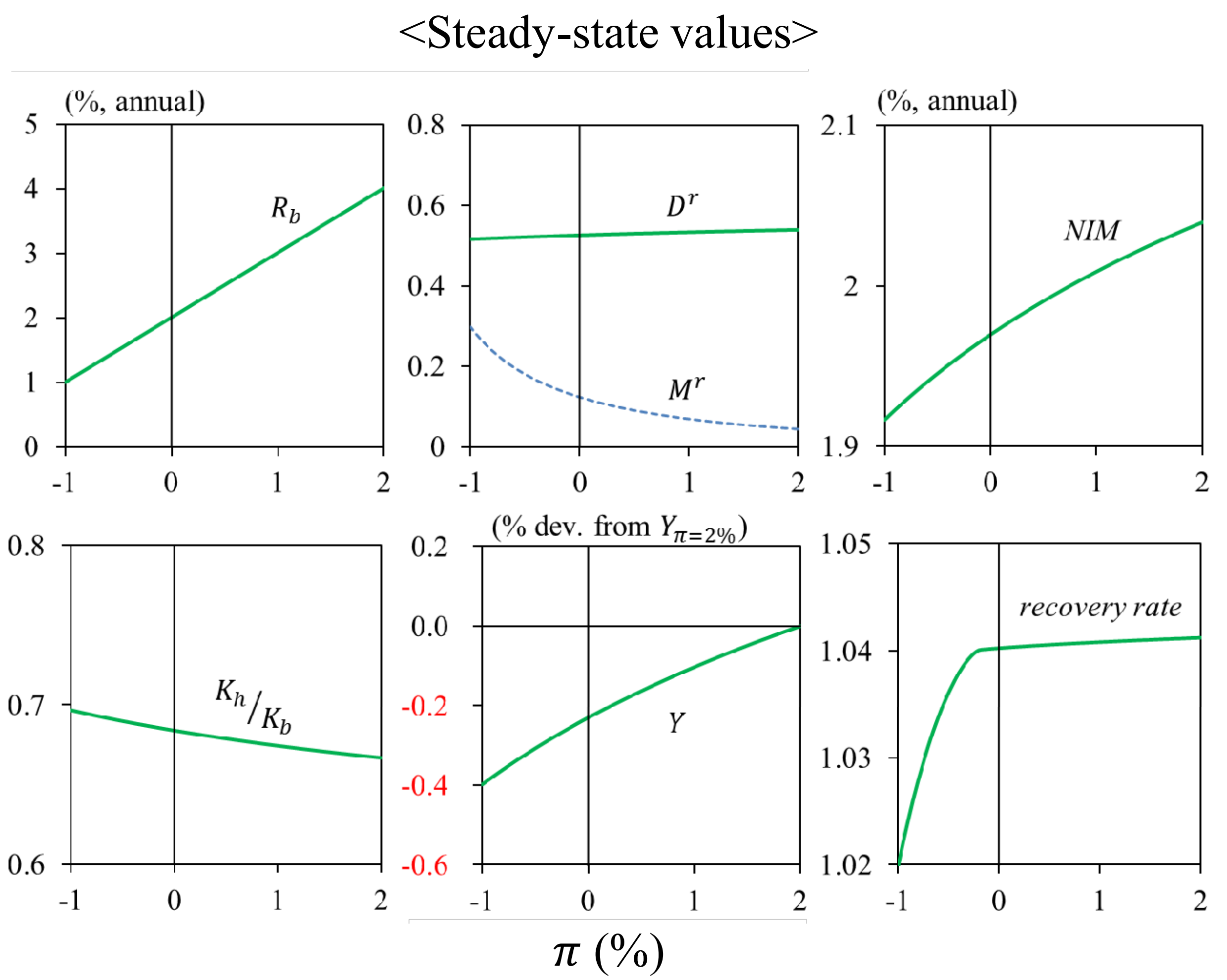
Discount factor $\beta = 0.995$,
Inverse Frisch elasticity $v = 1$
Coefficient for the labor disutility χ =1,
Elasticity of substitution for intermediate goods $\varepsilon = 6$,
Price adjustment cost (Rotemberg) $\kappa = 1400$,
Taylor rule coefficient $\psi = 1.5$,
Labor share $\eta = 0.7$.

- Other key parameters are arbitrarily fixed:

Degree of substitution between money and deposit $\zeta = 0.7$,
Transfer from households to new bankers $AW_b = 0.05N$,
Leverage for the banks $\phi = 10$.
NBLP's liquidity service at initial steady state $g = 0$.

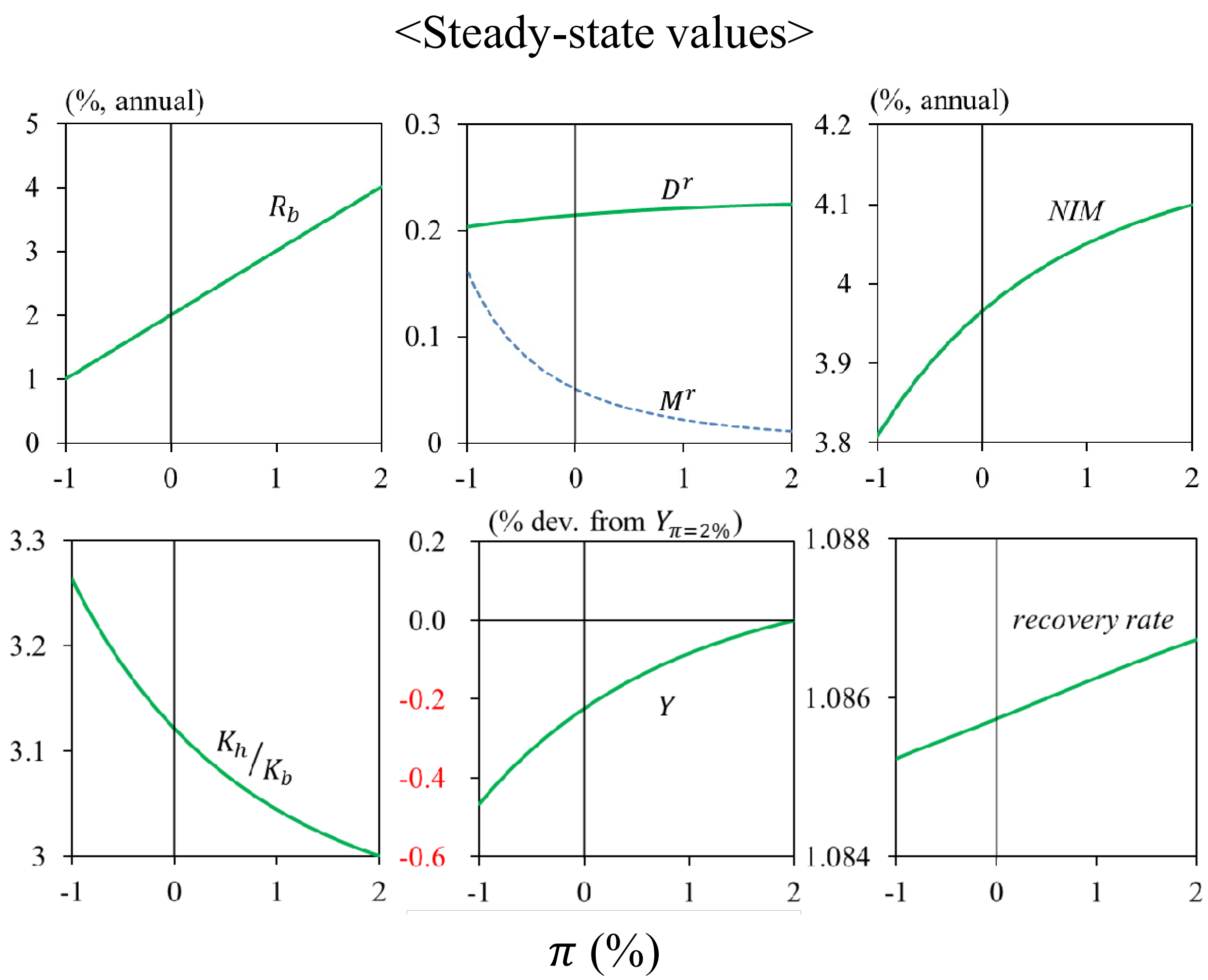
Deflation (Japan)

- Deflation shrinks NIM and undermines financial stability.



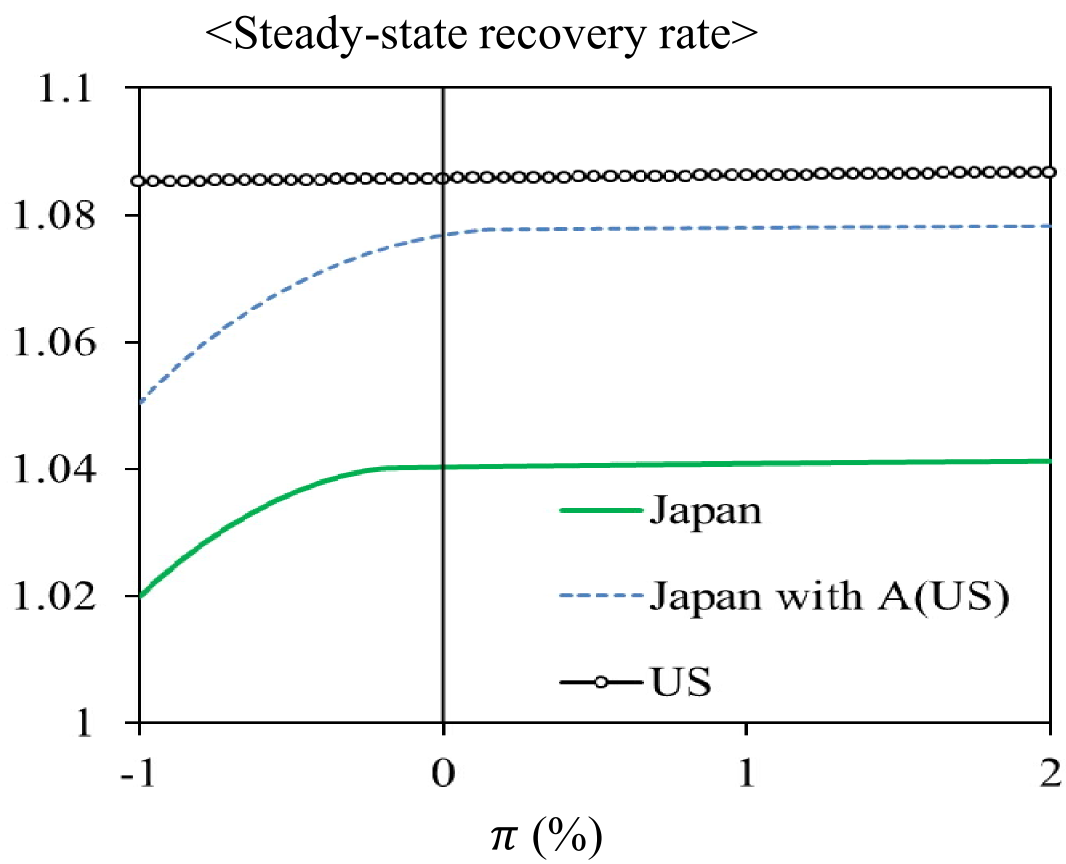
Deflation (US)

- US system is less susceptible to deflation.



Japan-and-US Comparison

- With A as high as US, Japanese system becomes as resilient as that of the U.S. when inflation is positive.
- With low inflation rates, two depart drastically.



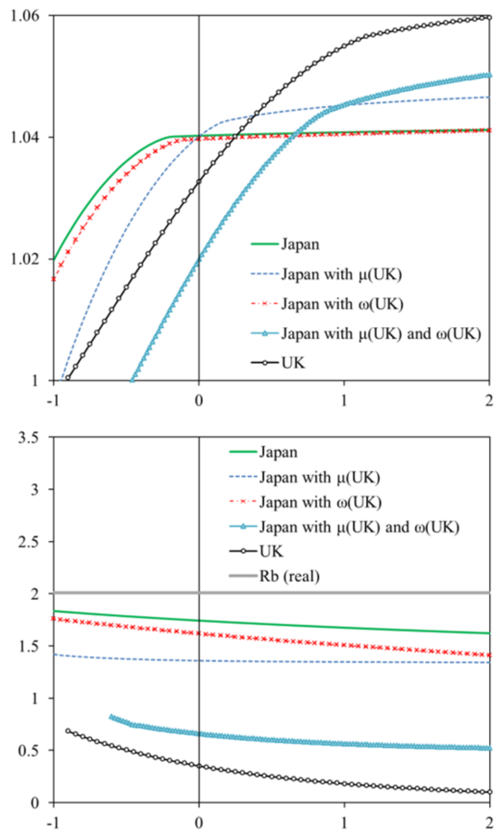
Japan-and-UK Comparison

- With μ and ω as high as UK, Japanese system becomes as susceptible as that of UK.

<Steady-state values>

recovery rate

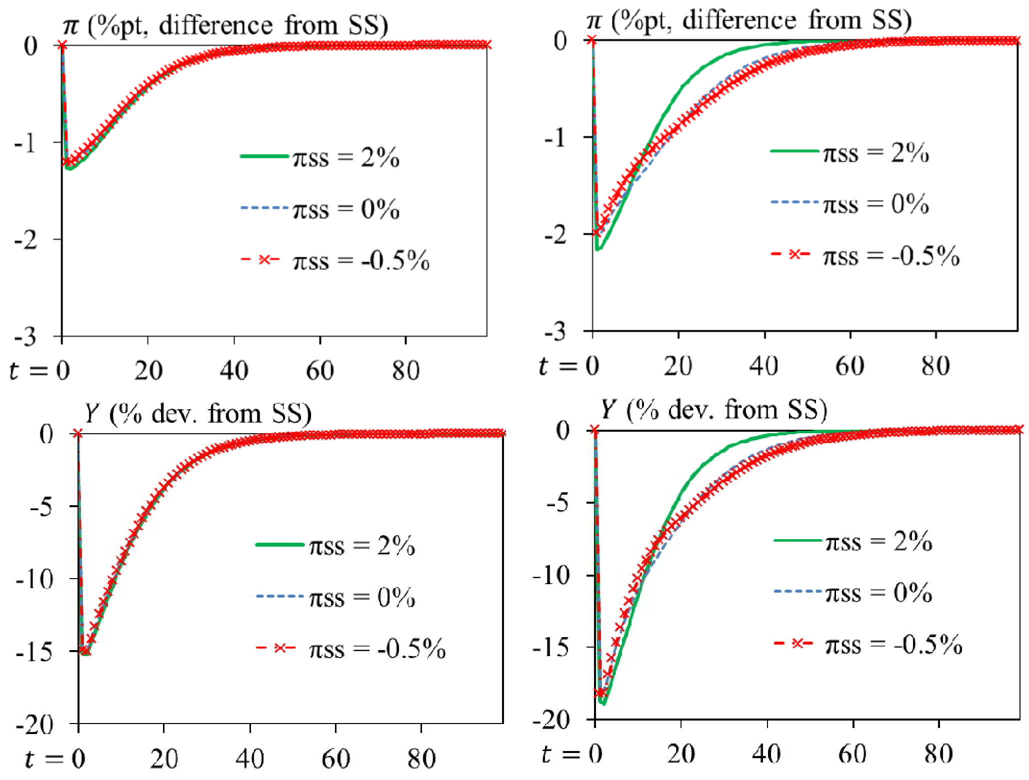
$\frac{r_{d,t}}{\pi_t}$



π (%)

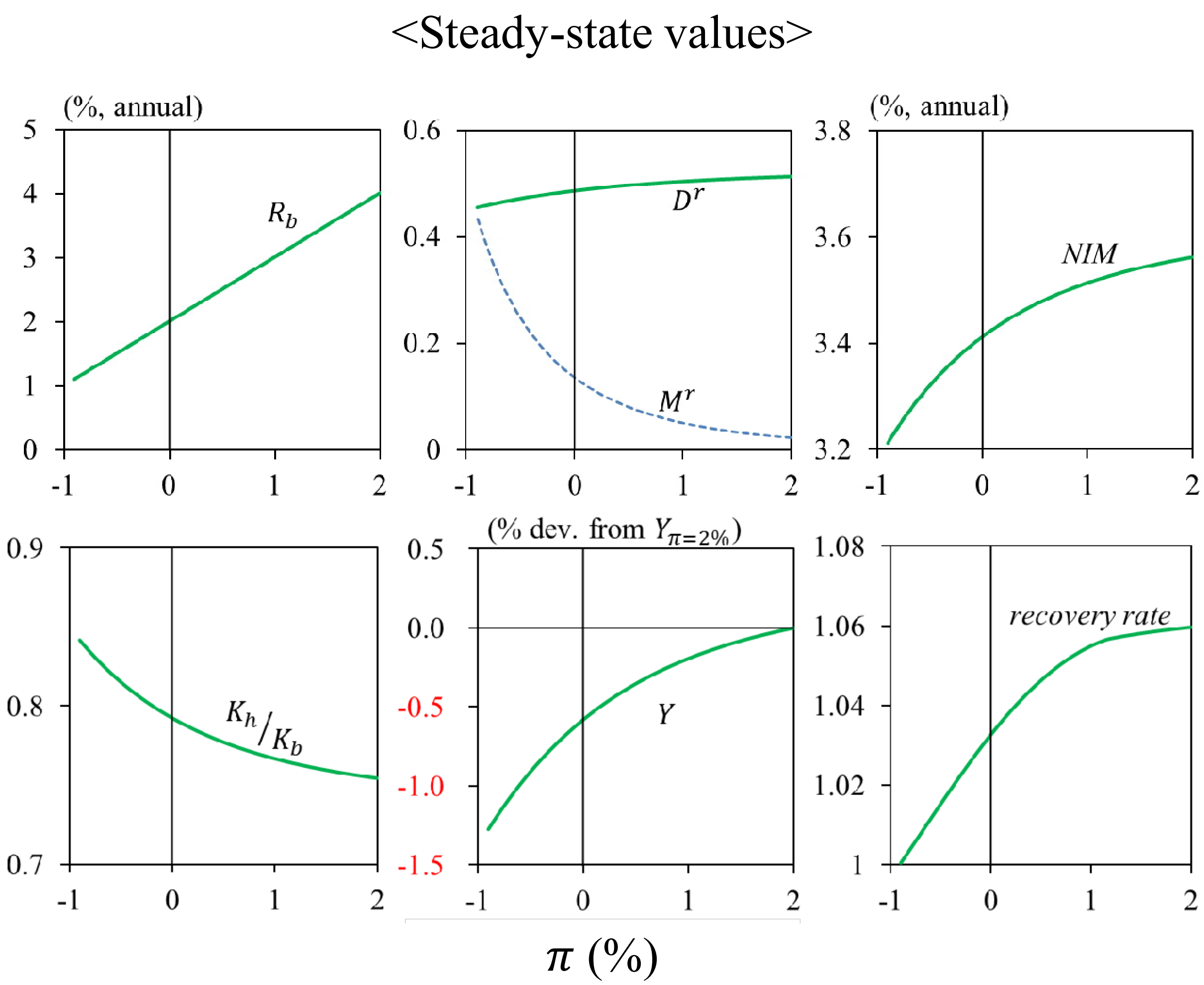
< Dynamics after a run at $t = 1$ >

<Japan> <UK>



Deflation (UK), (1)

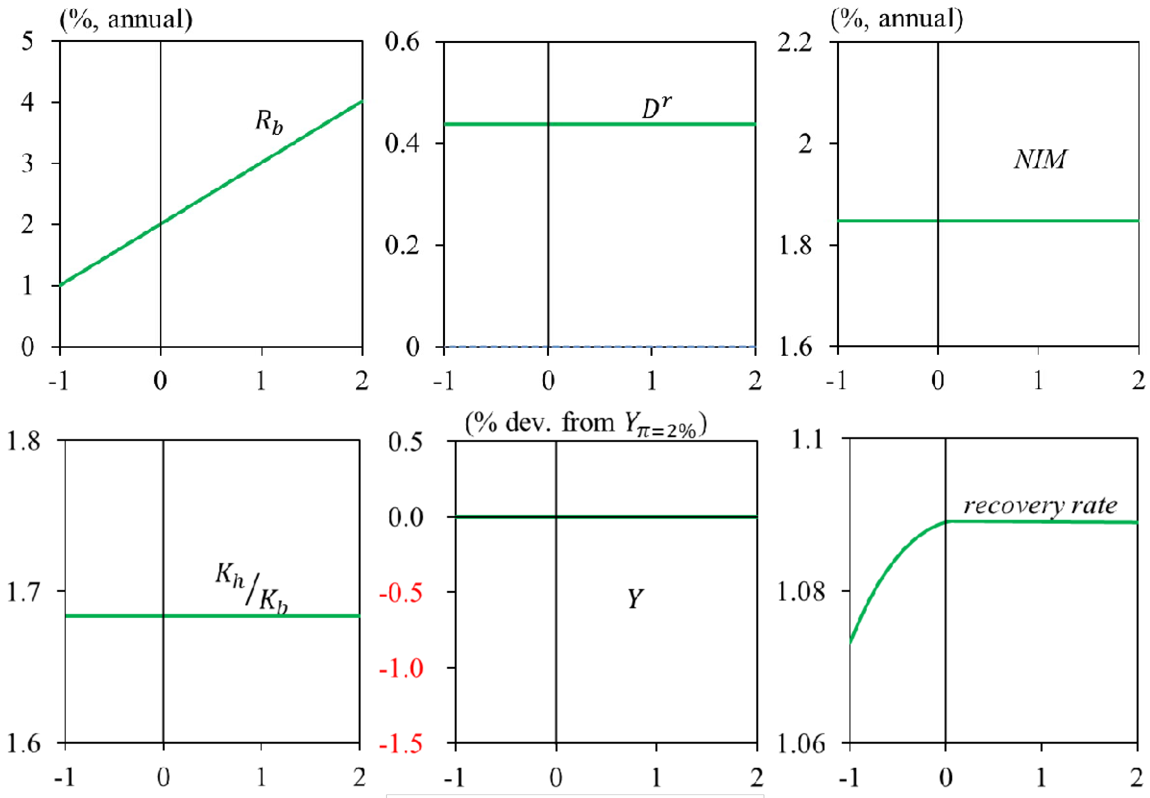
- UK system reacts greater to deflation.



Deflation (UK), (2)

- When liquidity services are absent, NIM does not react to deflation but recovery rates react due to zero lower bound.

<Steady-state values, when $\omega = 0$>



π (%)