RIETI International Workshop

Long-term Growth and Secular Stagnation

Handout

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Recurrent Bubbles, Economic Fluctuations, and Growth

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Motivation

- Hysteresis and super hysteresis.
- Renewed attention;
  - Great Stagnation hypothesis (Hansen, Summers),
  - Blanchard, Cerutti, and Summers (2015).
- Bubbles may be important.
  - Japan's lost decades.
  - Jorda, Schularick, and Taylor (2015).
- Construct a model; bring it to the data.

Literature

- **Bubbles**: Tirole (1982), Kocherlakota (1992), Martin and Ventura (2011), Gali (2015, 2017), Hirano and Yanagawa (2017), Dong, Miao, and Wang (2017)
- **Financial Frictions:** Jermann and Quadrini (2012), Kiyotaki and Moore (2012), Shi (2015)
- **Endogenous Productivity:** Romer (1990), Comin and Gertler (2006), Guerron and Jinnai (2017)
- **Solution/Estimation Markov-Switching DSGE Models:** Farmer, Waggoner, and Zha (2009), Hamilton (2016), Bianchi (2014), Kim and Nelson (1999)

Plan

1. Model
2. Comparative Statics
3. Estimation
4. Conclusion

Model

Model

Otherwise standard model with

1. liquidity constraint (Kiyotaki and Moore 2012),
2. variable capacity utilization (Greenwood et. al. 1998),
3. learning-by-doing (Arrow 1962; Sheshinski 1967; Romer 1986).

Household's Structure

- A continuum of households with measure one.
- Each household has a unit measure of members.
- Some members become investors; others become savors.
- Member's role ex ante unknown; re-shuffled every period.
- Members return home every period.
- Wealth distribution reset (making aggregation easy).

Household's problem

- Representative household maximizes

$$E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\pi \log \left[c_t^i \right] + (1-\pi) \log \left[c_t^s \left(1 - l_t \right)^{\eta} \right] \right) \right]$$

- c_t^i is investor's consumption; c_t^s savor's.
- Choose consumption, investment, labor, and utilization.
- Make portfolio decision. go

Liquidity Constraints

- Investment projects financed by selling capital.
- But there is a limit (liquidity constraint).
- Investors face

$$\underbrace{n_{t+1}^{i}}_{\text{gross equity purchase}} \geq (1-\phi)\left(\underbrace{i_t}_{\text{investment}} + \underbrace{\left(1-\delta\left(u_t\right)\right)n_t}_{\text{undepreciated capital}}\right).$$

- Intrinsically useless (liquid) assets may have a positive value.
- Fiat money in KM; bubbles in our model.

Capacity Utilization

- Capital can be intensively used, which means
  - more capital service;

$$\underbrace{KS_t}_{\text{capital service}} = \underbrace{u_t}_{\text{utilization}} \underbrace{K_t}_{\text{capital stock}}$$

  - faster depreciation;

$$K_{t+1} = \underbrace{\pi i_t}_{\text{gross investment}} + \left(1 - \underbrace{\delta(u_t)}_{\text{depreciation rate}}\right) K_t$$

- Example: road trip in Hokkaido (recommend!).

Learning-By-Doing

- Competitive firms maximize profits.
- Cobb-Douglas production function

$$Y_t = \underbrace{A_t}_{\text{technology level}} (u_t K_t)^{\alpha} (L_t)^{1-\alpha}.$$

- A_t is endogenous;

$$A_t = \underbrace{\bar{A}}_{\text{scale parameter}} \underbrace{(K_t)^{1-\alpha}}_{\text{externality}}.$$

- Individual firms take A_t as exogenous ("Big K, little k" trick).
- Growth is sustained by externality.

Regimes

- Bubble and fundamental regimes.
- M units of bubble assets in bubble regime.
- No bubble assets in fundamental regime.
- Helicopter drop of bubble assets when $f \longrightarrow b$.
- Sudden disappearance when $b \longrightarrow f$.
- Markov switching.

Regimes

period	0	1	2	3	4	5	6	7	8	9	$\cdots$
regime	f	f	b	b	b	b	f	f	b	b	$\cdots$
bubble assets	0	0	M	M	M	M	0	0	M	M	$\cdots$

Table: example

If bubbles arise in the future, why not now?

- We exclude it by assumption.
- No bubble markets in the fundamental regime.
- Neither spot nor future.
- No way to purchase bubble assets (literally). go

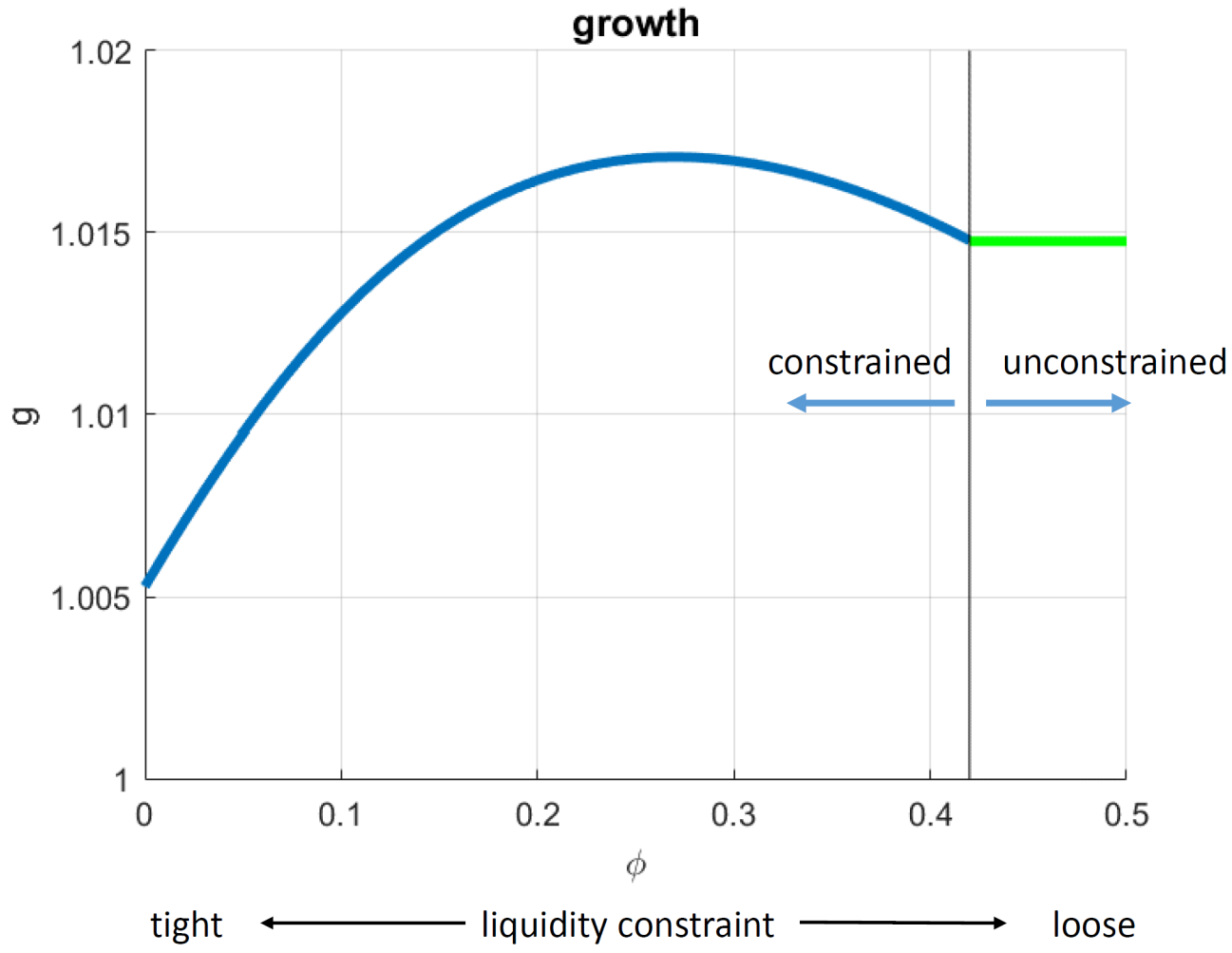
Comparative Statics

Permanent Fundamental

- Turn off the regime switch for a while.
- Always fundamental.

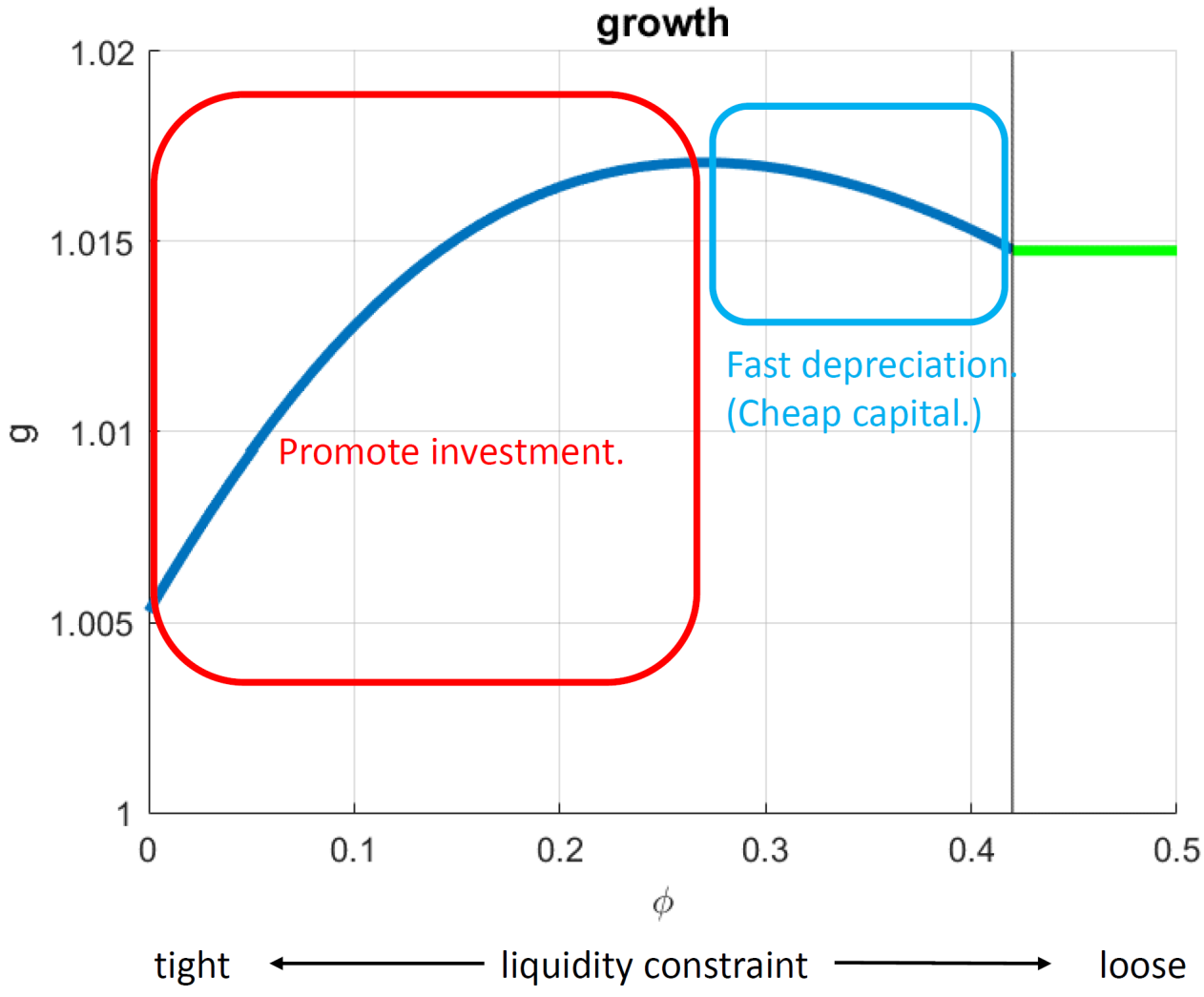
Fundamental Equilibrium

Non-linear relation when liquidity constraint binds.



Fundamental Equilibrium

Competing effects of a marginal change in liquidity constraint.

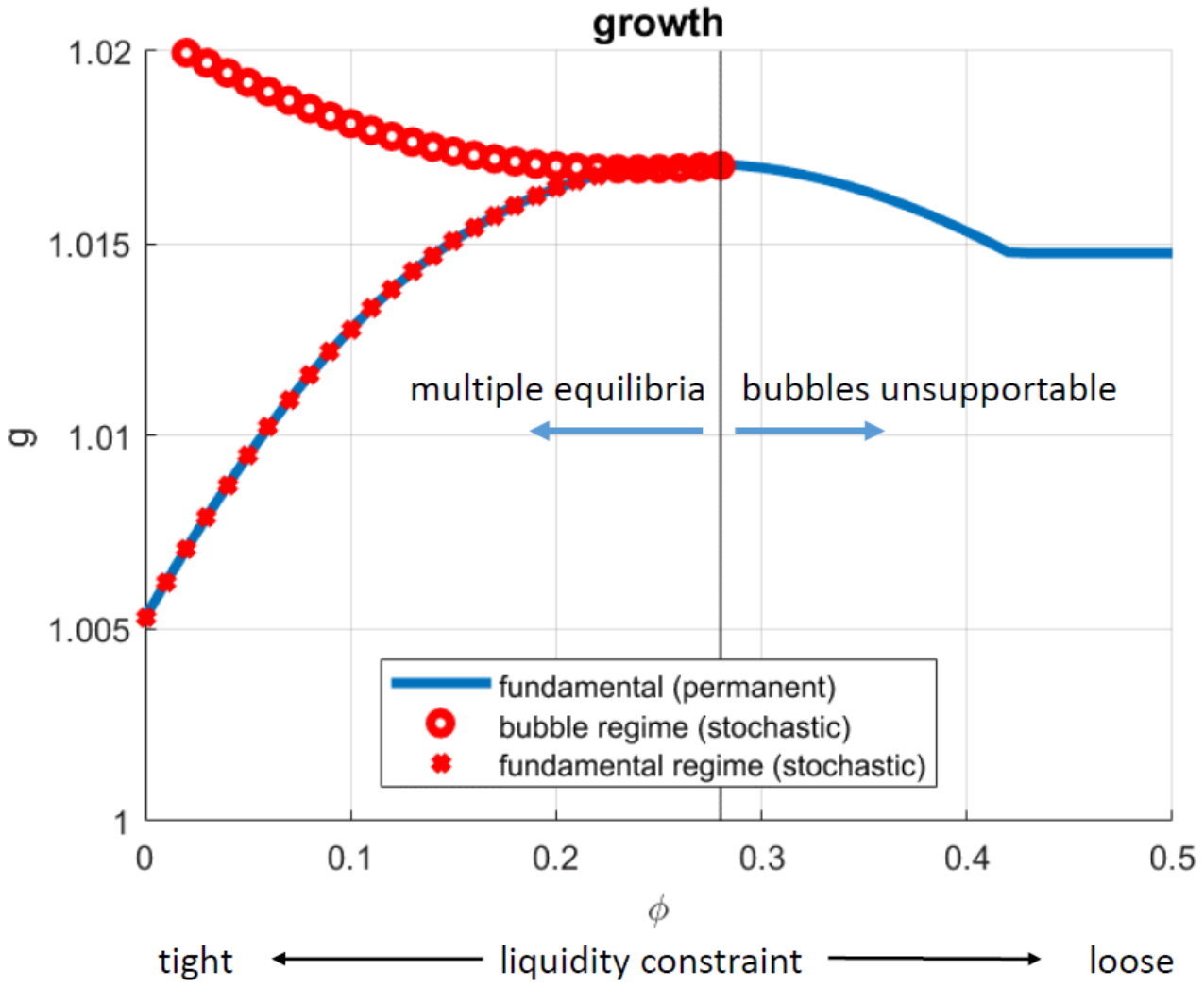


Stochastic Bubble

- The economy starts with b.
- Transitions to f with prob. 1% per quarter.
- Stays in f forever (Weil 1987).

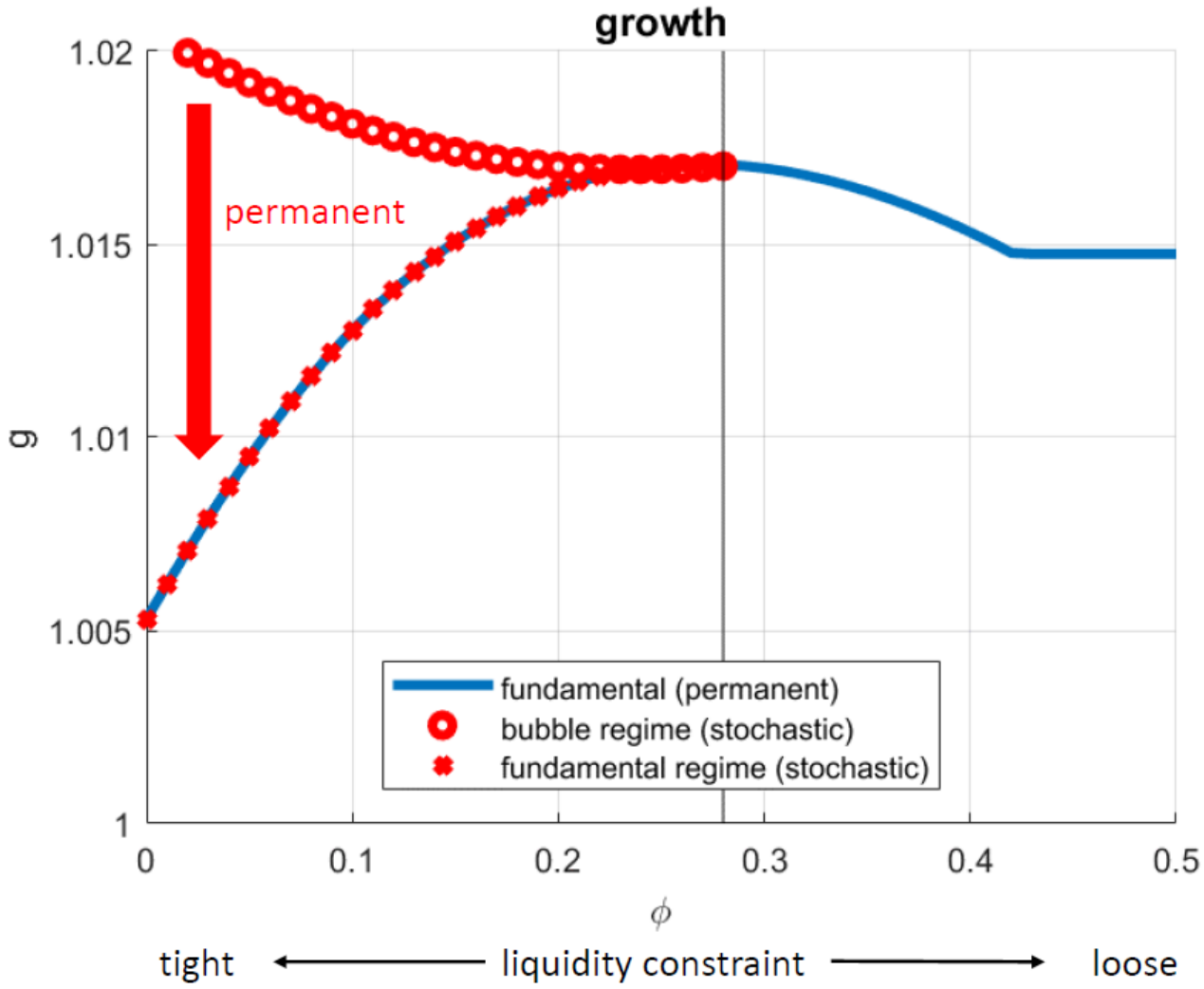
Bubble Equilibrium (Stochastic)

Multiple equilibria when liquidity constraint is tight.



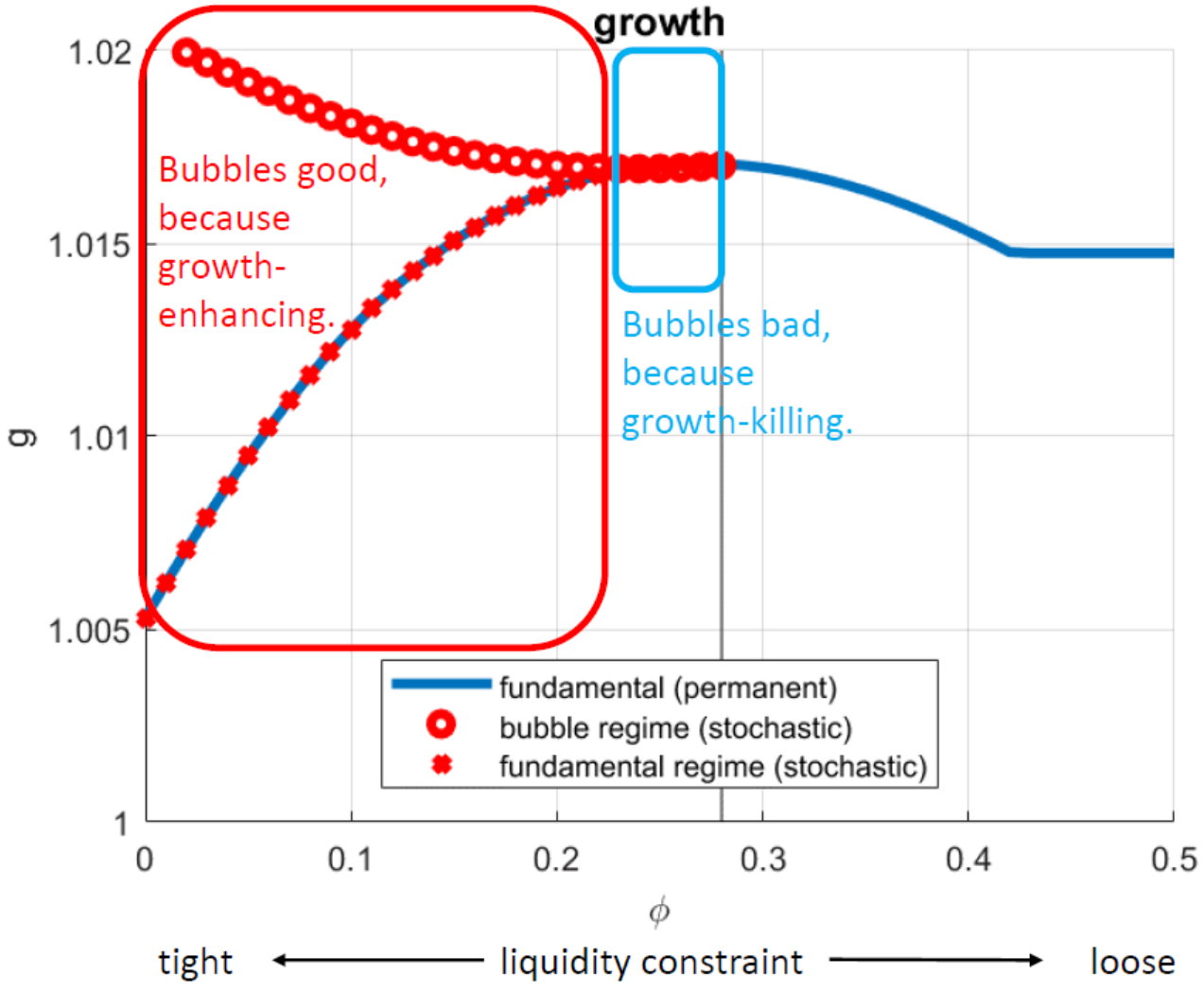
Bubble Equilibrium (Stochastic)

Start from "special." Back to "normal."



Bubble Equilibrium (Stochastic)

High growth with bubble? Lucky you!

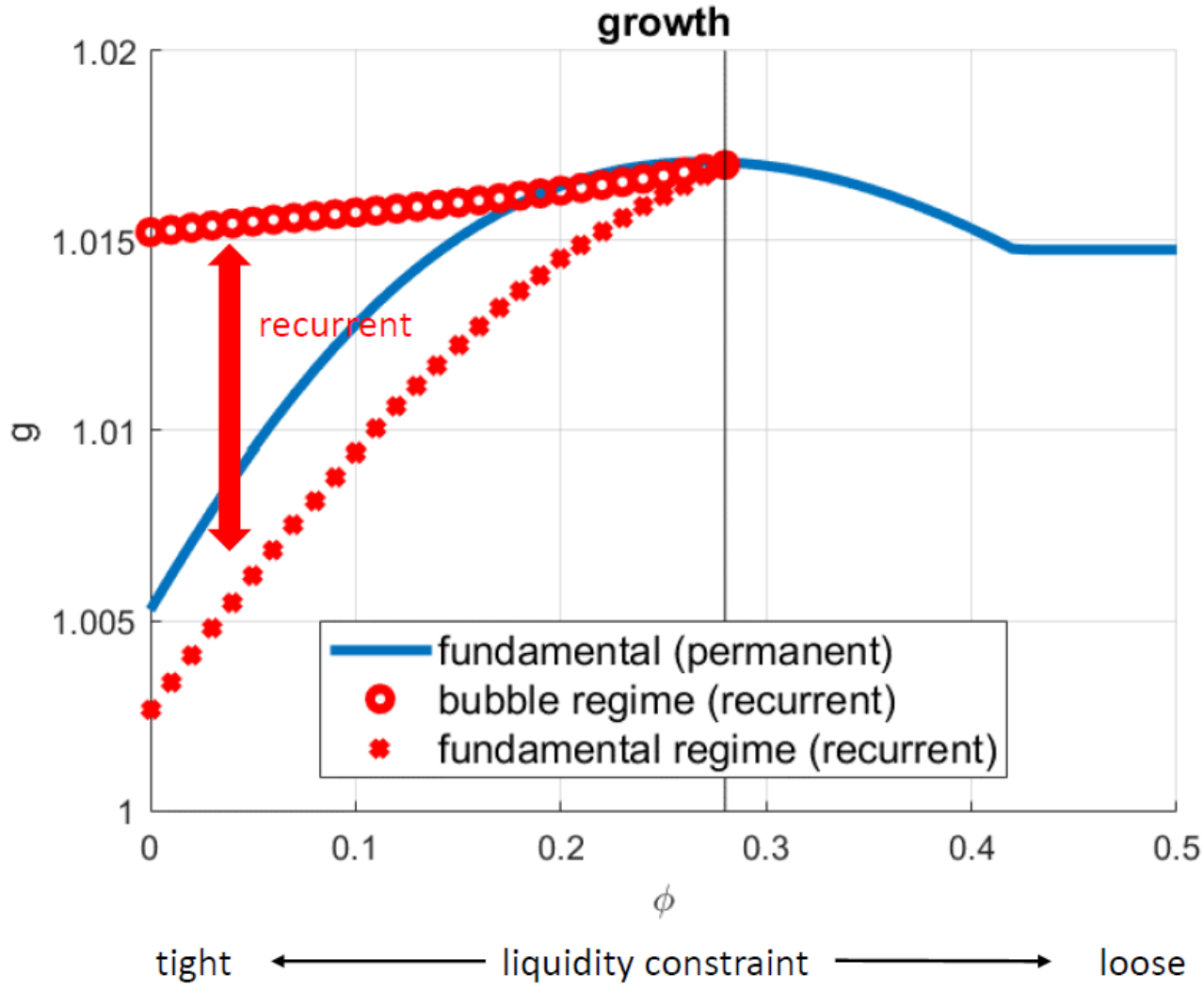


Recurrent Bubble

- Turn on two-way regime switch.
- Both $b \longrightarrow f$ and $f \longrightarrow b$ with prob. 1% quarterly.

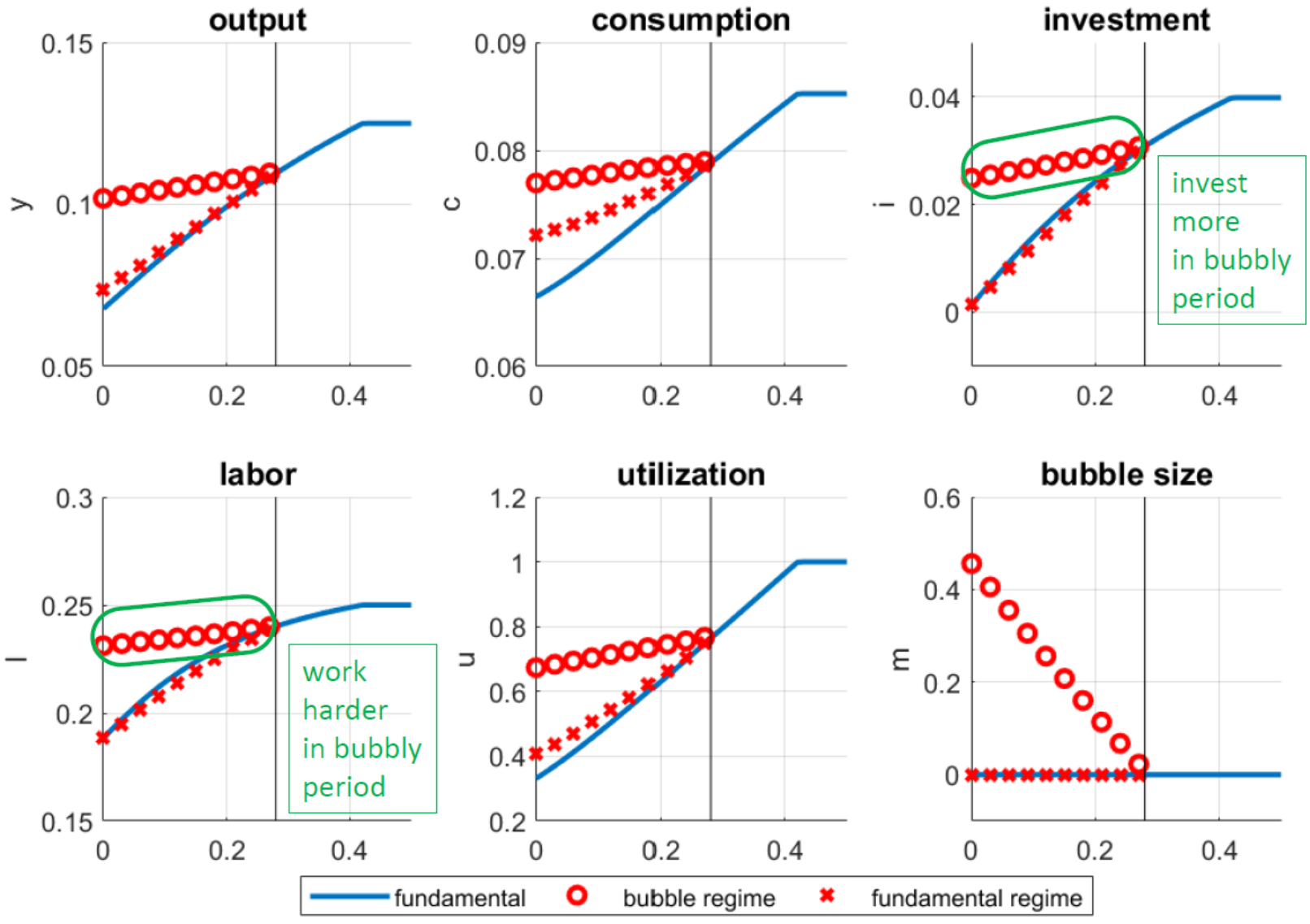
Bubble Equilibrium (Recurrent)

High growth in bubble; low in the other.



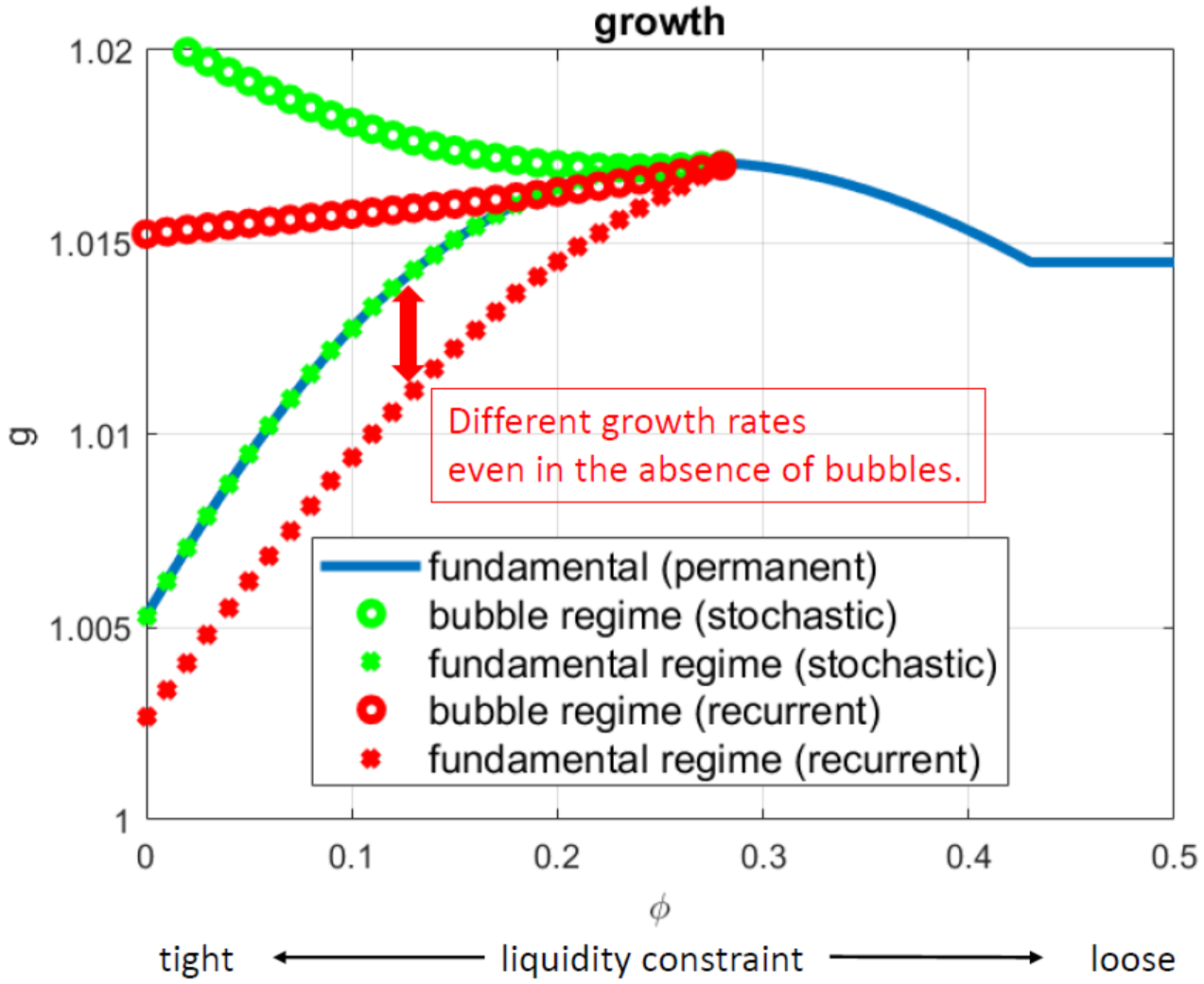
Bubble Equilibrium (Recurrent)

Inter-temporal (inter-regime) substitution at work.



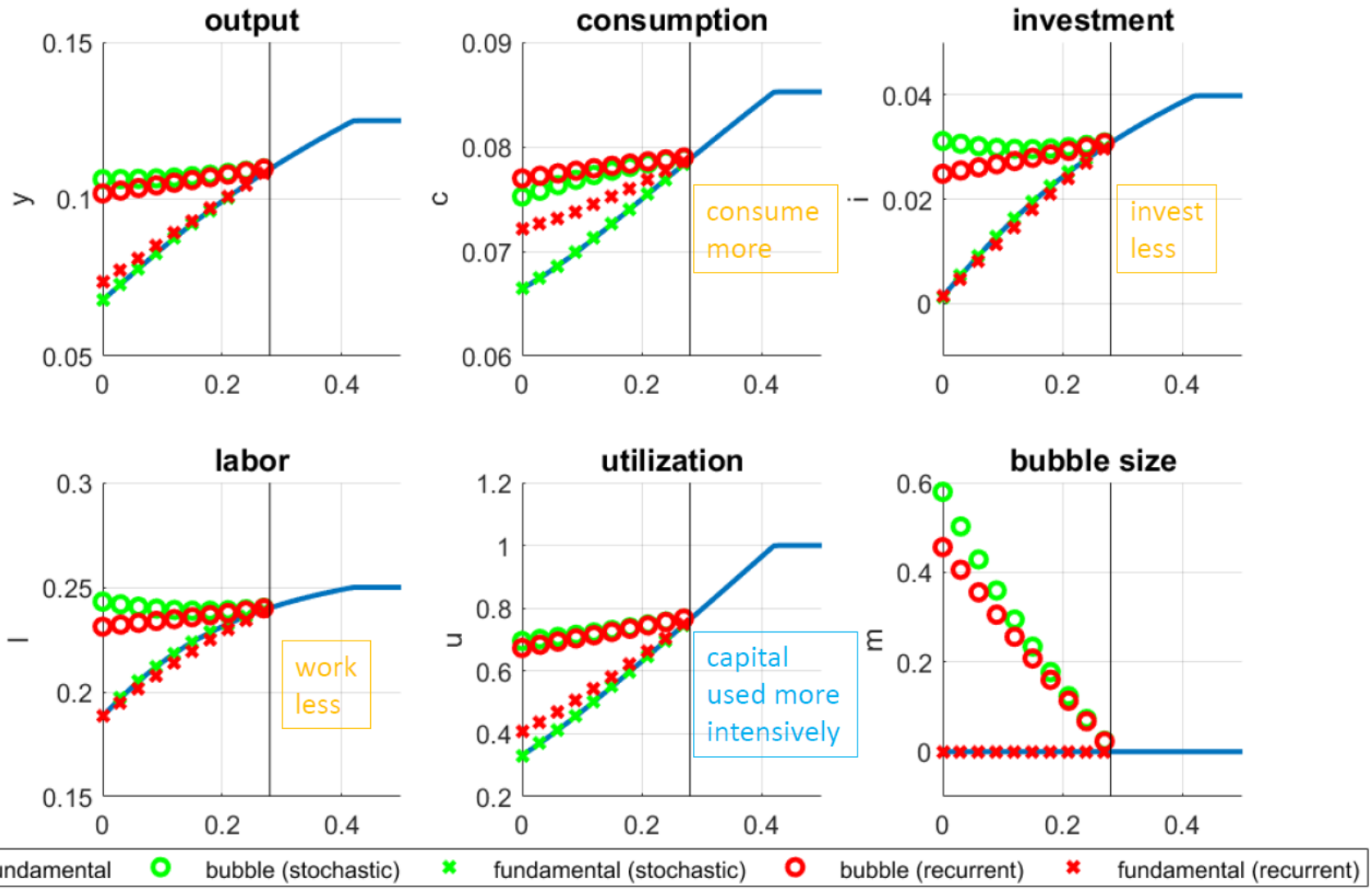
Recurrent v.s. Stochastic

Discrepancy in fundamental too.



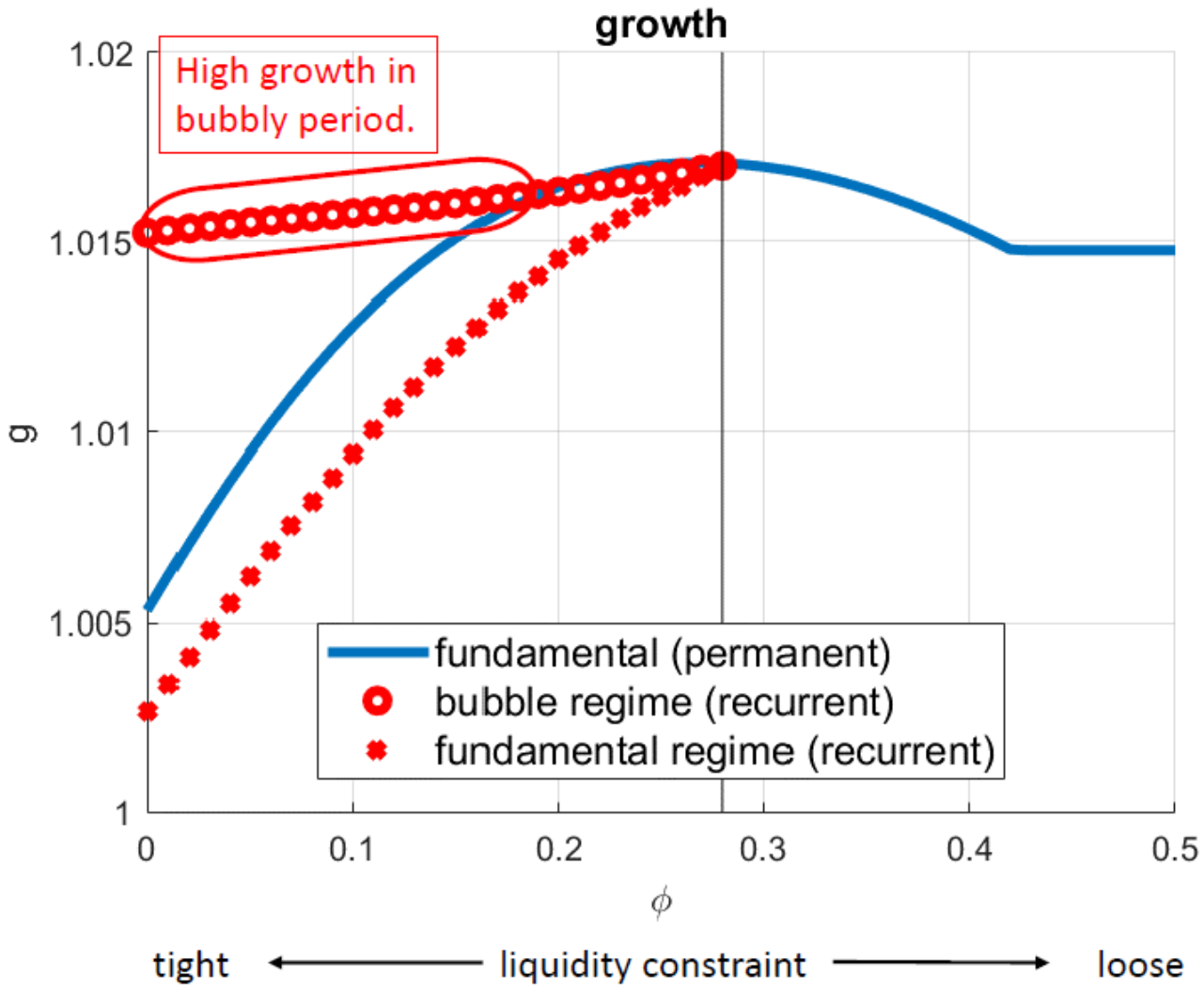
Recurrent v.s. Stochastic

Both wealth effect and price effect at work.



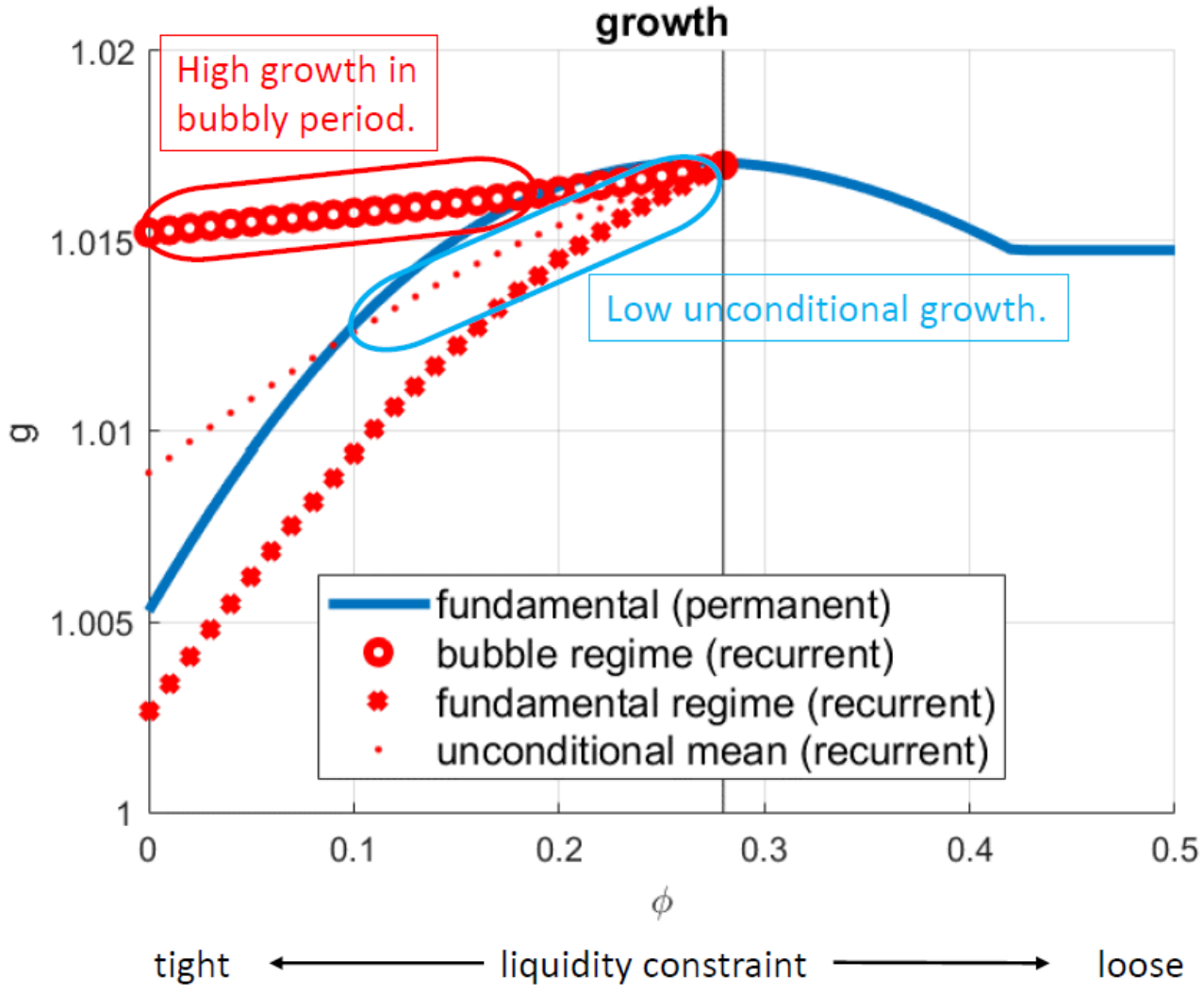
Takeaways (Growth)

The economy may grow fast in the presence of bubble.



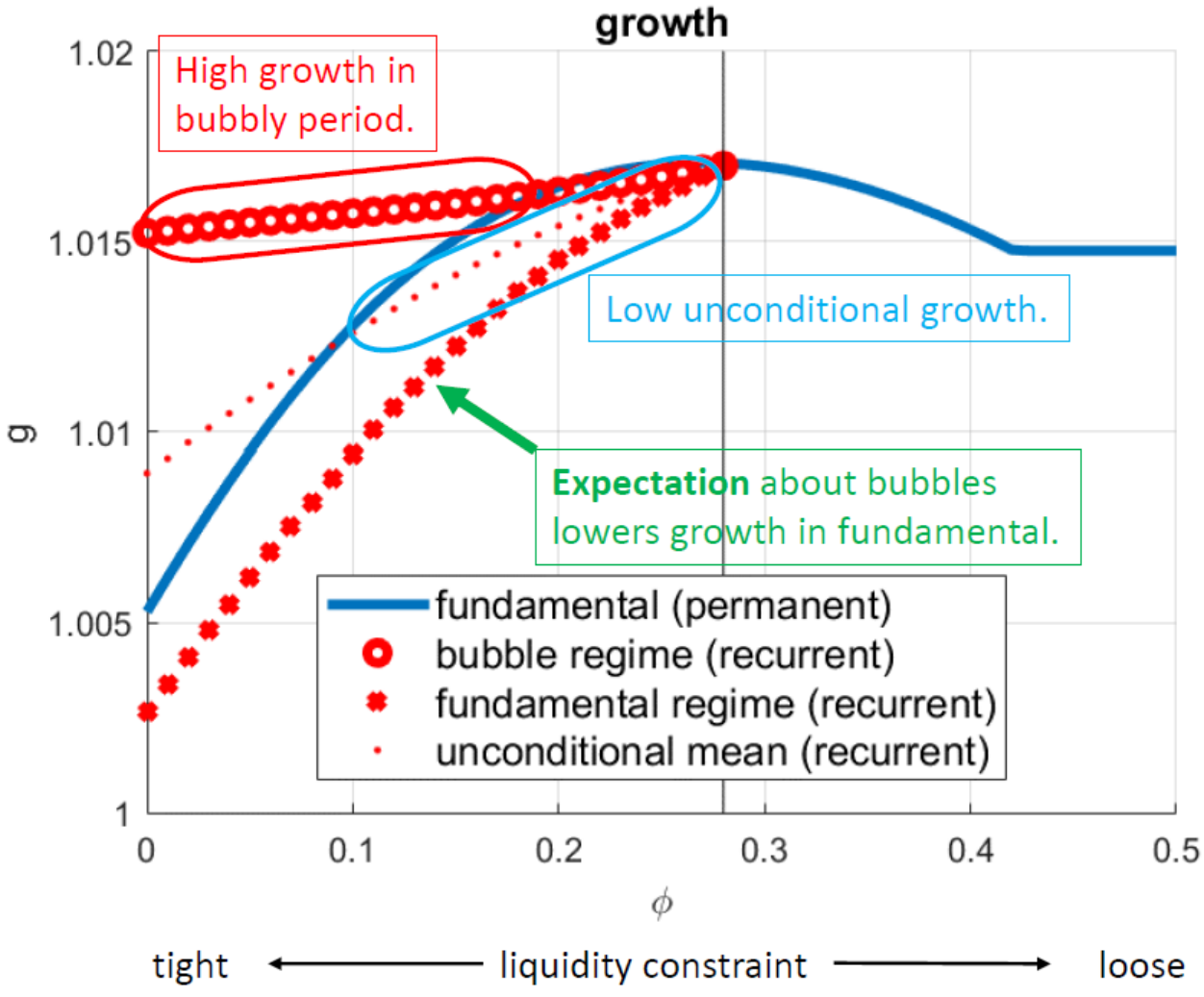
Takeaways (Growth)

Not necessarily means unconditionally high growth.



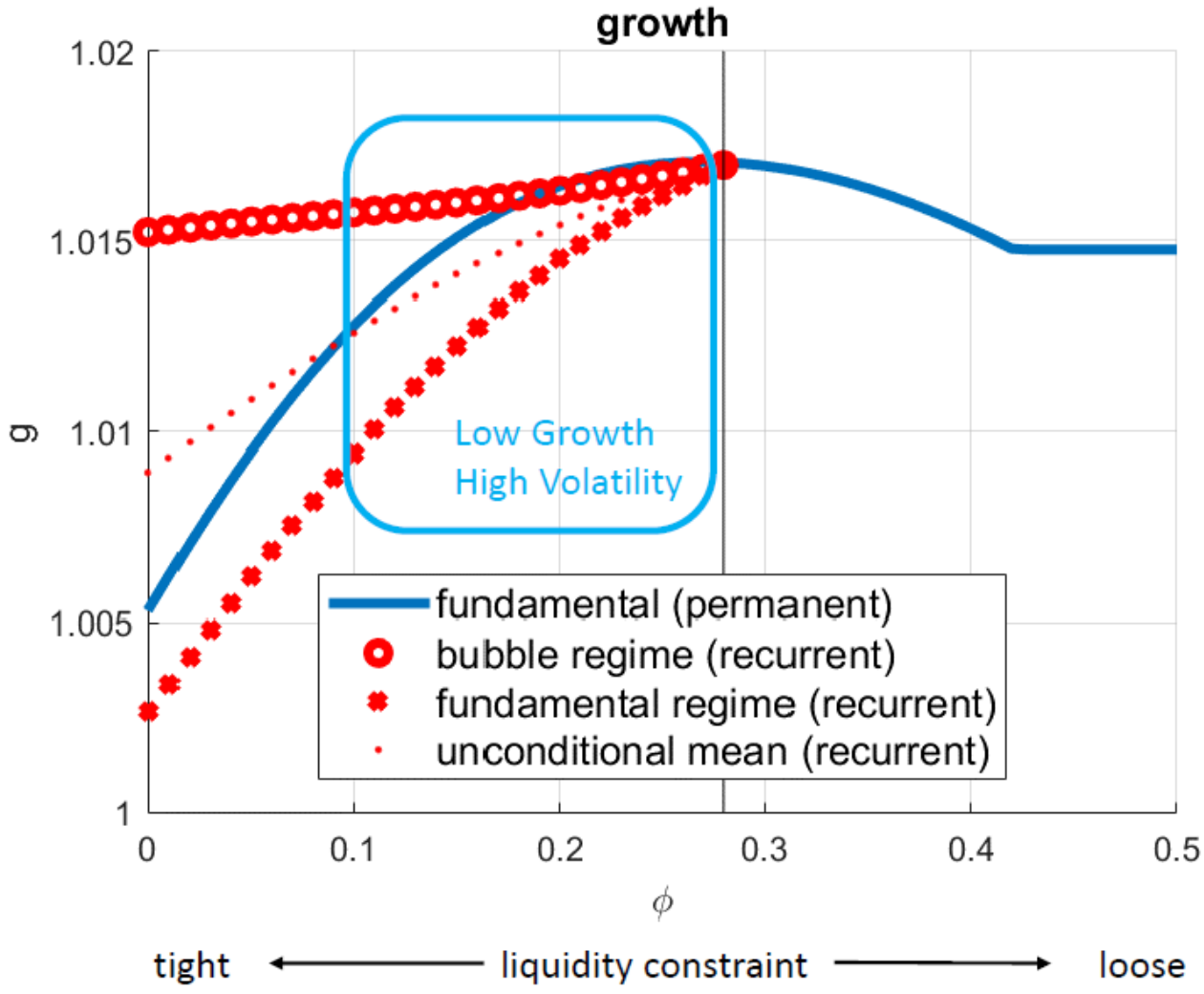
Takeaways (Growth)

Bubbleless growth is slow just because people **expect** bubbles.



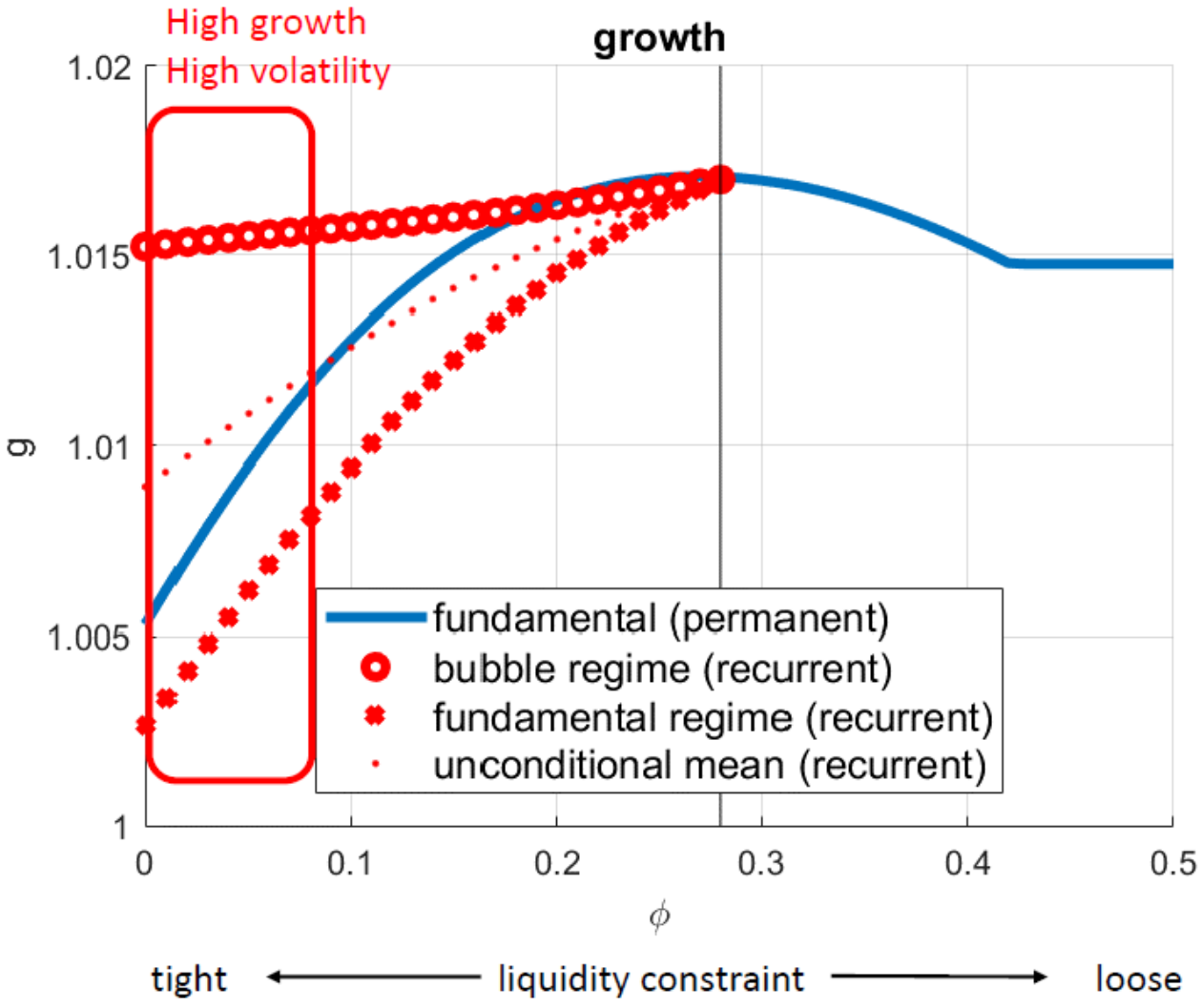
Takeaways (Growth and Volatility)

Bubbles likely to be undesirable if financial system is dependable.



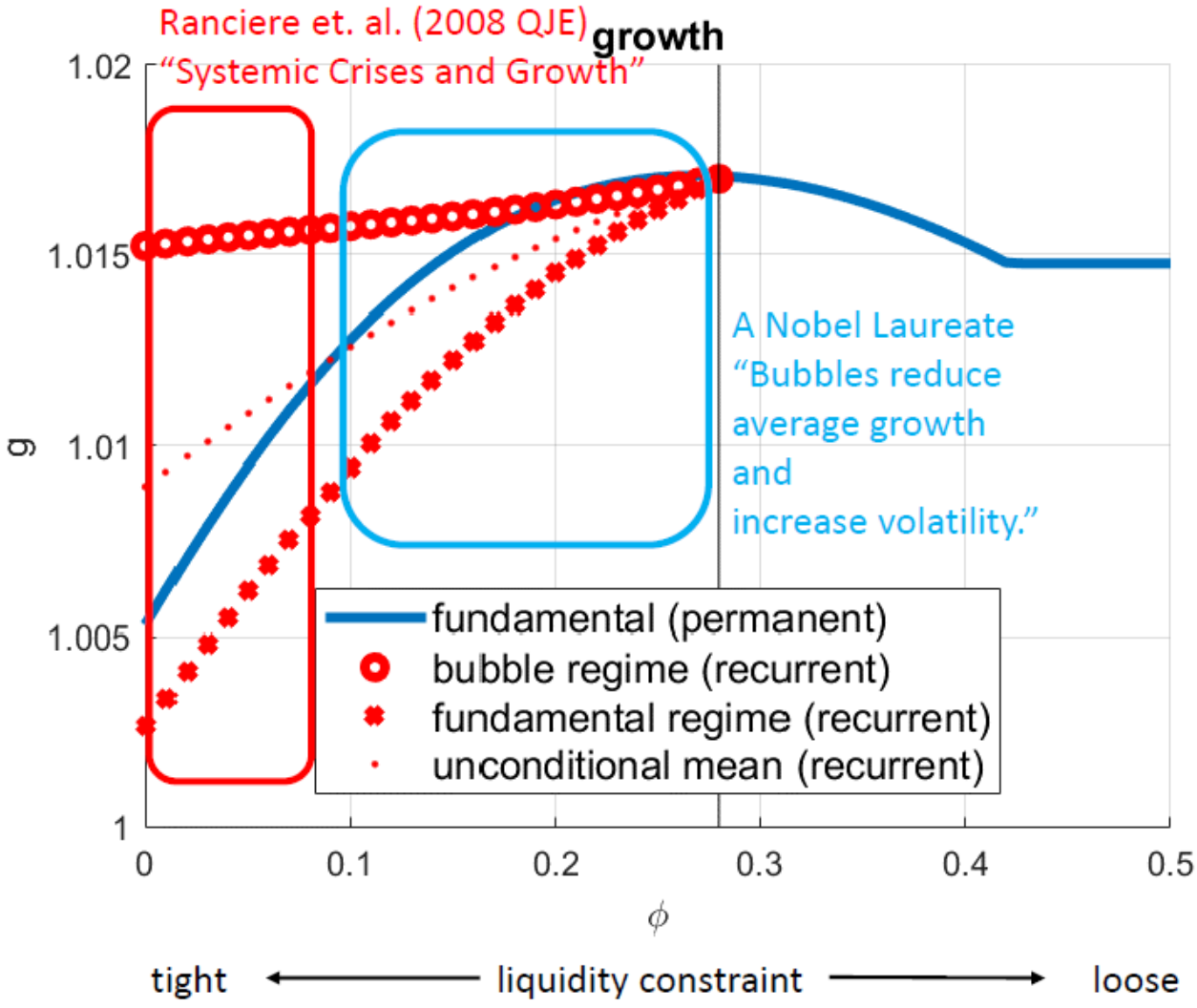
Takeaways (Growth and Volatility)

Bubbles can be desirable if financial system is weak.



Takeaways (Growth and Volatility)

Seemingly puzzling views not a puzzle in our model.



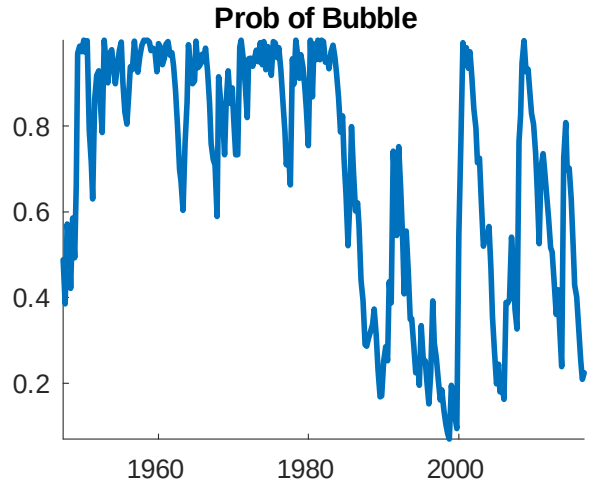
Estimation

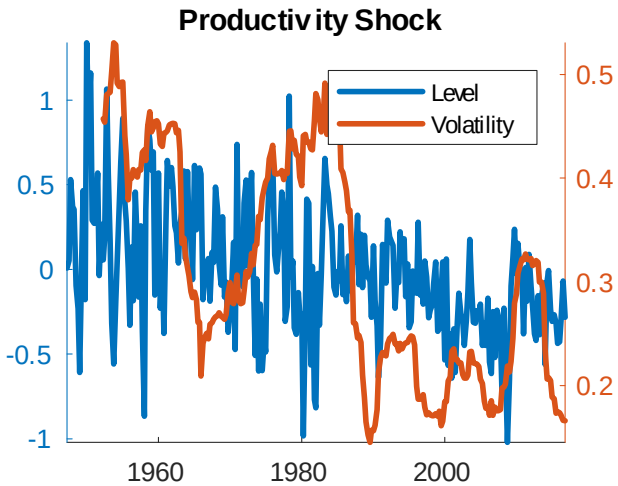
Estimation (Method)

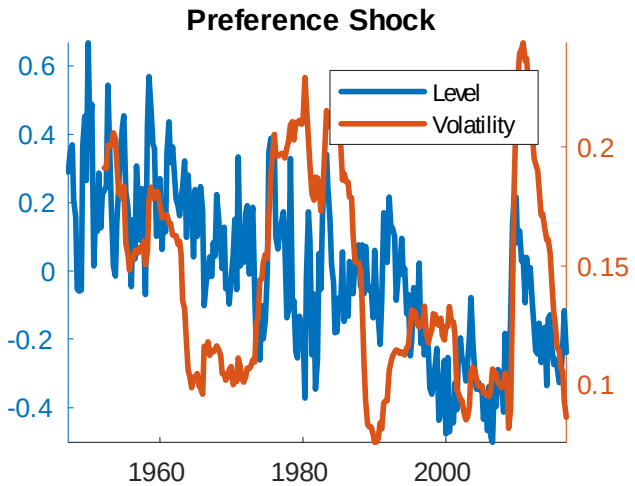
- Data: GDP growth and consumption-investment ratio.
- In a first pass;
  - estimate bubble and fundamental regimes,
  - estimate persistence and volatility of shocks (added),
  - retain rest of parameters.
- Identification: according to our model,
  - bubble: high growth and high volatility,
  - fundamental: low growth and low volatility.
- Absence of endogenous states facilitates estimation.

Estimation (U.S.)

Regime switches from bubble→fundamental→bubble.







Estimation (Japan)

Bubbles in the late 80s, the mid 90s, and very recent years.

Conclusion

- Recurrent bubbles.
- Two-way dynamic effects ($b \leftarrow f$ and $f \leftarrow b$).
- Super-hysteresis.
- Structural estimation.

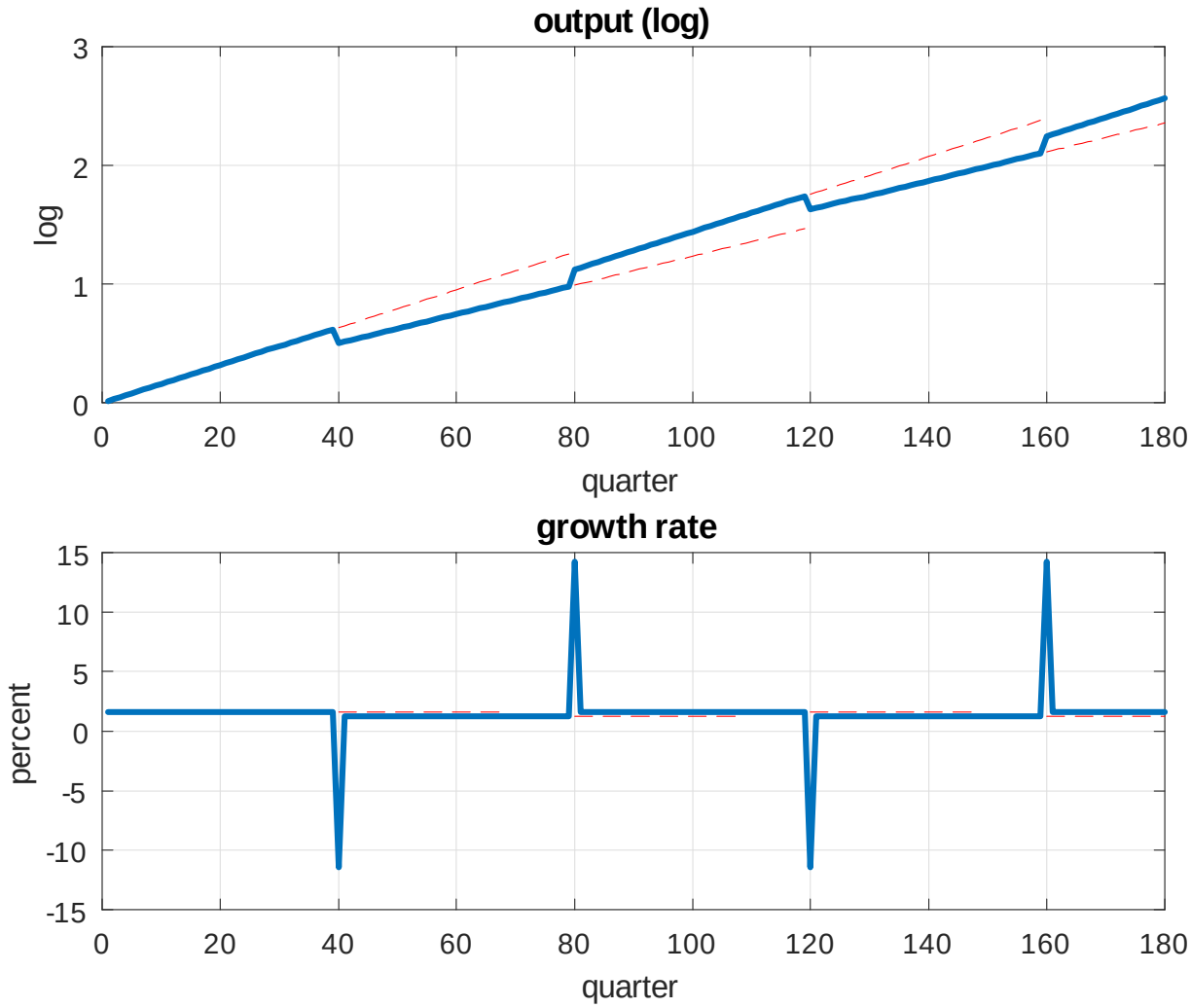
Appendix

Parameter Values

Parameter	Value	Calibration Target
β	0.99	Exogenously Chosen
α	0.4	Capital Share=0.4
fraction of investors	0.05	Exogenously Chosen
IES	1	Exogenously Chosen
elasticity of $\delta'(u_t)$	0.33	Exogenously Chosen
$\delta(1)$	0.025	Annual Depreciation=0.10
η	2.78	Labor Supply=0.25
$\bar{A}$	0.30	Rental Rate of Capital=0.05

Effects of Regime Switches

Super hysteresis after regime changes.



Impulse Responses (Productivity Shock)

- Effects amplified in the bubble regime.

Supply Shock ($\Delta a_t = 1\%$, $\text{Corr}(a_t, a_{t-1}) = 0.95$)

Change in Period t in	Bubble Regime	Fundamental Regime
capital growth	0.033%	0.019%
output	1.24%	1.09%
consumption	1.08%	1.04%
investment	1.69%	1.28%
labor	0.12%	0.04%
utilization	0.41%	0.16%
price of capital	0.74%	0.96%
bubble size	2.29%	0%

- Productivity shock increases bubbles for strong demand.

Impulse Responses (Preference Shock)

- Effects amplified in the bubble regime.

Demand Shock ($\Delta b_t = 1\%$, $\text{Corr}(b_t, b_{t-1}) = 0.8$)

Change in Period t in	Bubble Regime	Fundamental Regime
capital growth	-0.034%	-0.024%
output	0.03%	0.11%
consumption	0.31%	0.30%
investment	-0.78%	-0.71%
labor	-0.22%	-0.15%
utilization	0.39%	0.49%
price of capital	-0.53%	-0.60%
bubble size	-0.87%	0%

- Preference shock reduces bubbles by making people impatient.

Constraints

- Budget constraint

$$\begin{aligned} & \pi c_t^i + (1-\pi)\, c_t^s + q_t n_{t+1} + \mathbf{1}_{\{z_t=b\}} \tilde{p}_t\, (1-\pi)\, \tilde{m}_{t+1}^s \\ = \; & \left[u_t r_t + (1-\delta(u_t))\, q_t\right] n_t + \pi\lambda_t \left(u_t r_t + \phi q_t\, (1-\delta(u_t))\right) n_t \\ & + \mathbf{1}_{\{z_t=b\}} \tilde{p}_t\, (1+\pi\lambda_t)\, \tilde{m}_t + (1-\pi)\, w_t l_t. \end{aligned}$$

- Bubbly asset accumulation

$$\tilde{m}_{t+1} = (1-\pi)\, \tilde{m}_{t+1}^s + \mathbf{1}_{\{z_t=f, z_{t+1}=b\}} M.$$

- No markets for bubble in fundamental

$$\mathbf{1}_{\{z_t=f\}} \tilde{m}_{t+1}^s = 0.$$