

# 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.

# 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).

# Liquidity Constraint

- ▶ Investors and savers in the economy.
- ▶ Investors borrow money using capital as collateral.
- ▶ Can't finance the total costs due to liquidity constraints.
- ▶ Intrinsically useless (liquid) assets may have a positive value.
- ▶ Fiat money in Kiyotaki and Moore.
- ▶ Bubbles in our model.

# Capacity Utilization

- ▶ Capital can be intensively used.
- ▶ More capital service.
- ▶ Faster depreciation.
- ▶ Example: road trip in Hokkaido (recommend!).
  - ▶ pros: fun!
  - ▶ cons: added mileages lower the used-car value

# Learning-By-Doing

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

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

- ▶  $A_t$  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  $f \rightarrow b$ .
- ▶ Sudden disappearance when  $b \rightarrow f$ .
- ▶ Markov switching.

# Regimes

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

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).

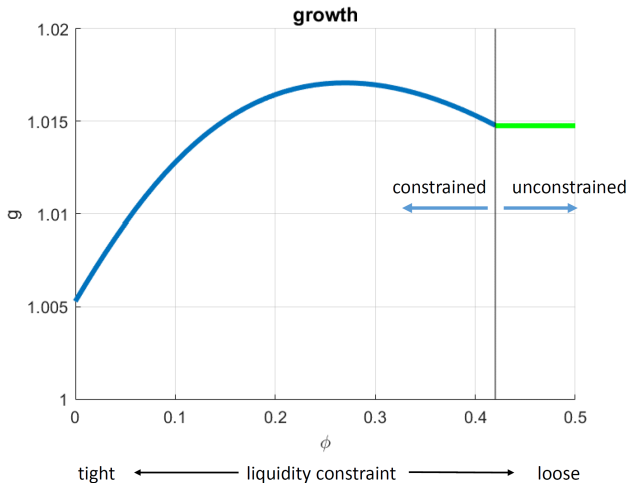
# Comparative Statics

# Permanent Fundamental

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

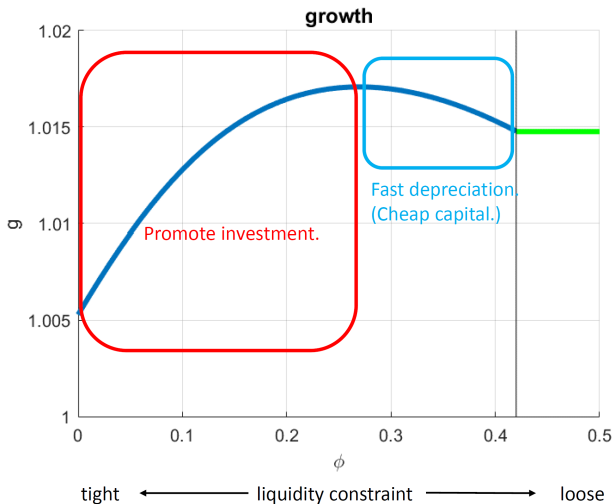
# Fundamental Equilibrium

Non-linear relation when liquidity constraint binds.



# Fundamental Equilibrium

Competing effects of a marginal change in liquidity constraint.

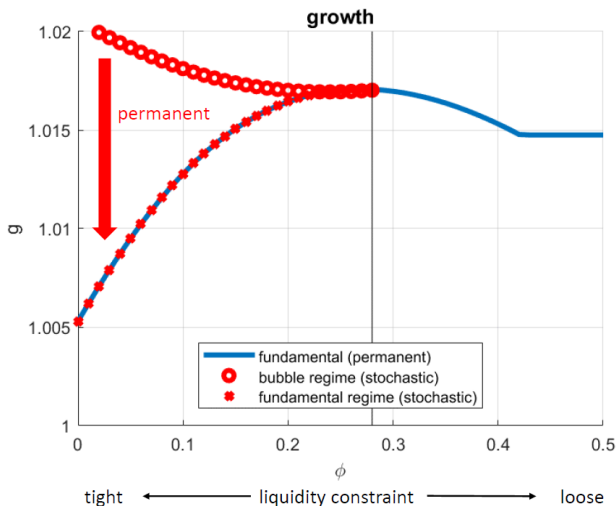


# Stochastic Bubble

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

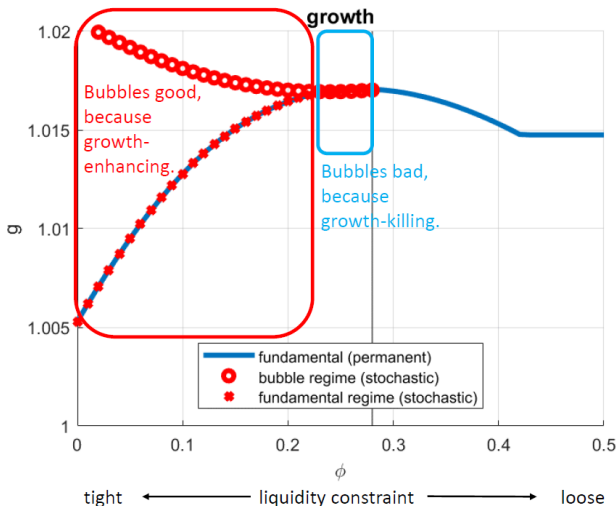
# Bubble Equilibrium (Stochastic)

Start from “special.” Back to “normal.”



# Bubble Equilibrium (Stochastic)

High growth with bubble? Lucky you!

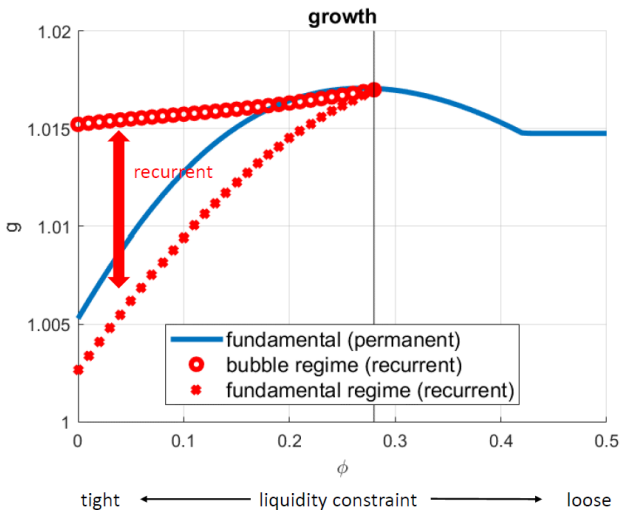


# Recurrent Bubble

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

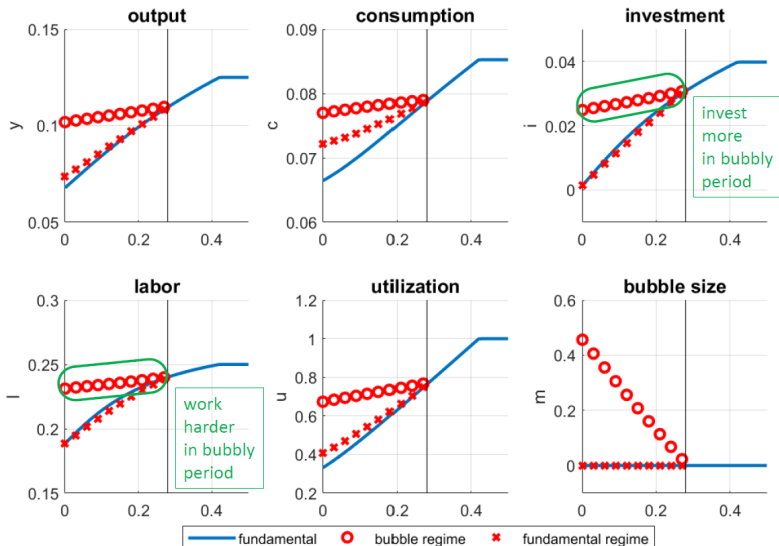
# Bubble Equilibrium (Recurrent)

High growth in bubble; low in the other.



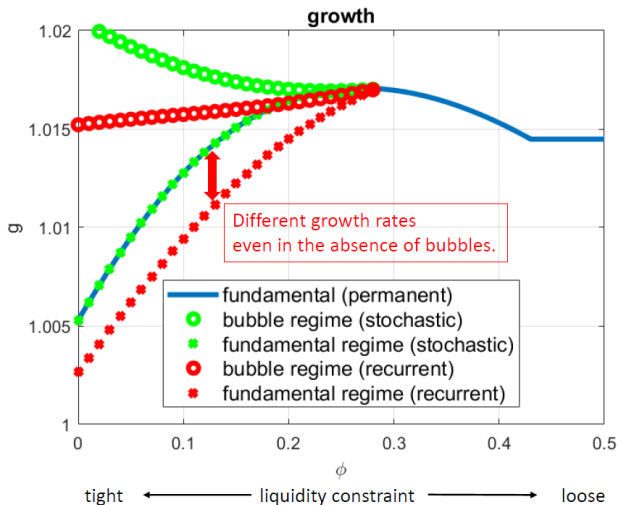
# Bubble Equilibrium (Recurrent)

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



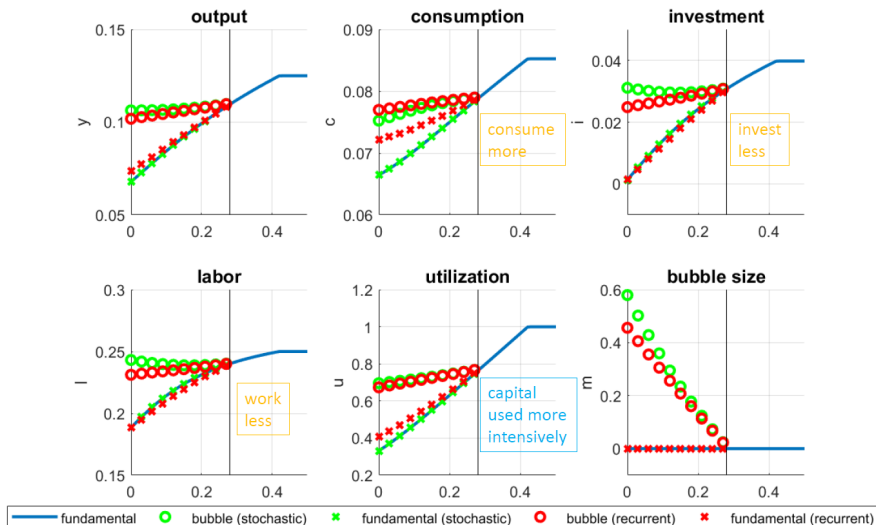
# Recurrent v.s. Stochastic

Discrepancy in fundamental too.



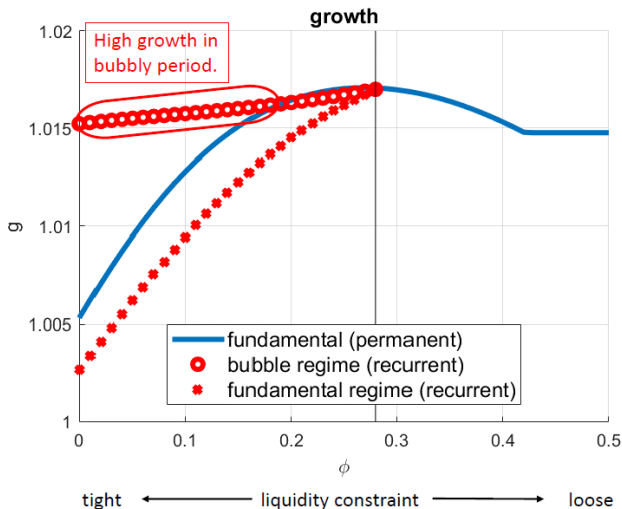
# Recurrent v.s. Stochastic

Both **wealth effect** and **price effect** at work.



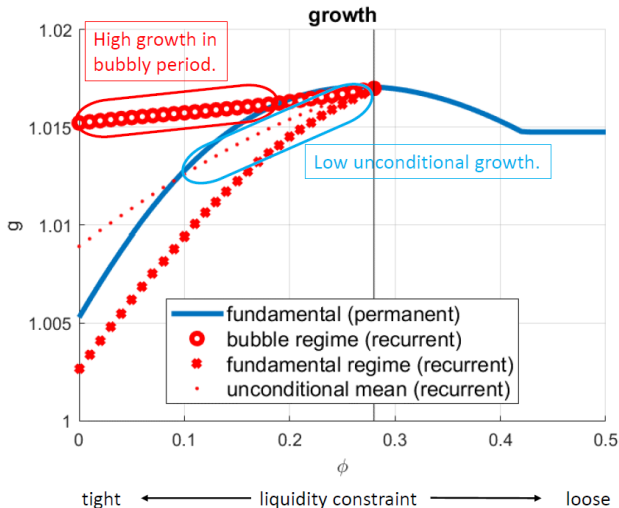
# Takeaways (Growth)

The economy may grow fast in the presence of bubble.



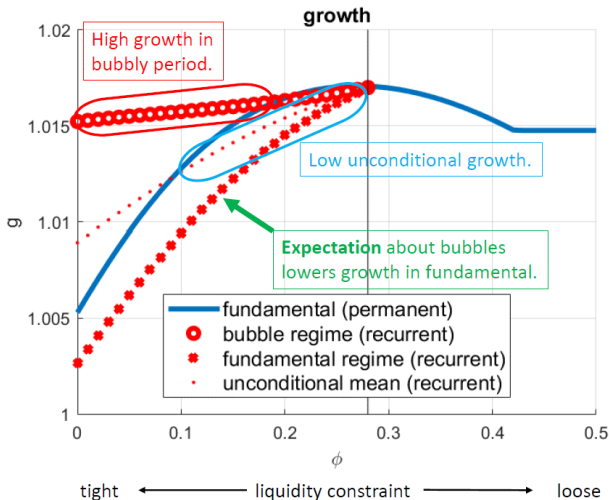
# Takeaways (Growth)

Not necessarily means unconditionally high growth.



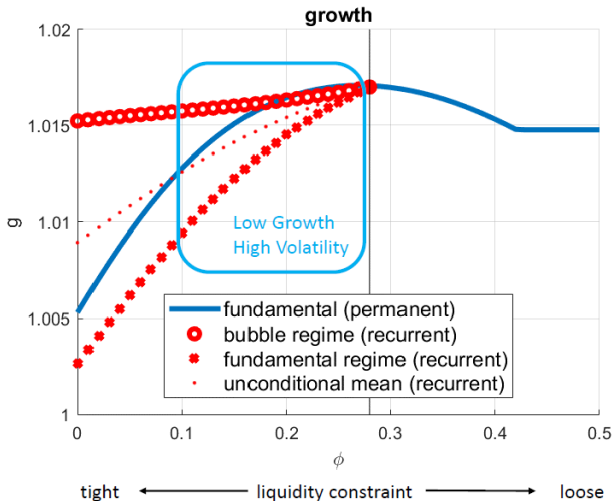
# Takeaways (Growth)

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



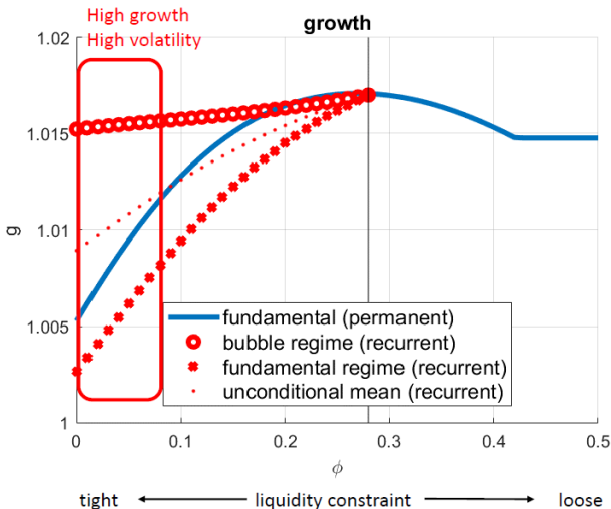
# Takeaways (Growth and Volatility)

Bubbles likely to be undesirable if financial system is dependable.



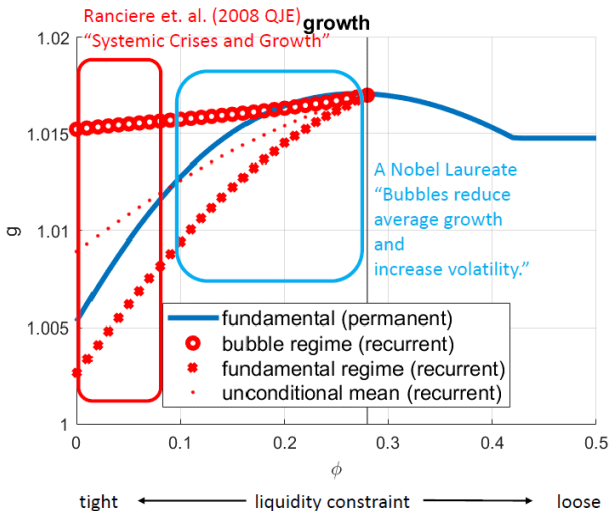
# Takeaways (Growth and Volatility)

Bubbles can be desirable if financial system is weak.



# Takeaways (Growth and Volatility)

Seemingly puzzling views not a puzzle in our model.



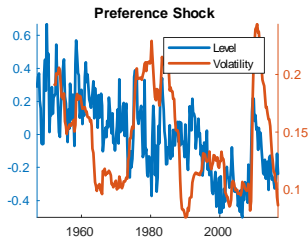
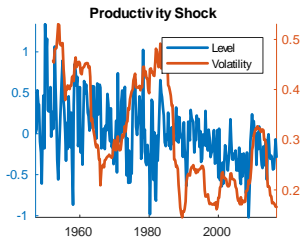
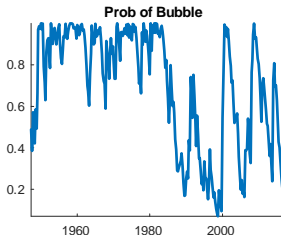
# Estimation

# 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.

# 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

# Literature

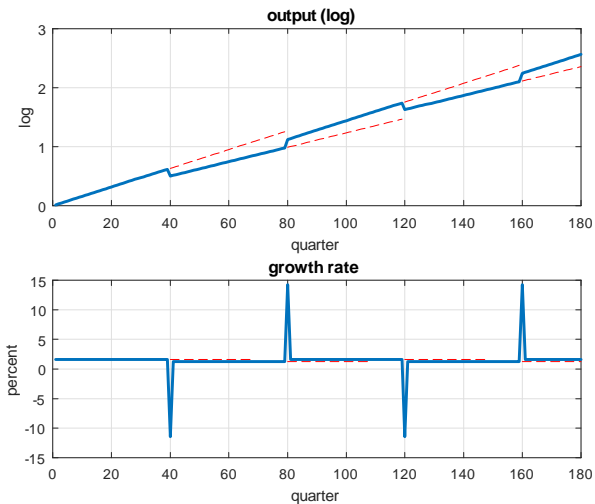
- ▶ **Bubbles:** Tirole (1982), Kocherlakota (1992), Martin and Ventura (2011), Gali (2015, 2017), Hirano and Yanagawa (2017), Dong, Miao, and Wang (2017)
- ▶ **Financial Frictions:** Jermann and Quadrini (2012), Kiyotaki and Moore (2012), Shi (2015)
- ▶ **Endogenous Productivity:** Romer (1990), Comin 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)

# Parameter Values

Parameter	Value	Calibration Target
$\beta$	0.99	Exogenously Chosen
$\alpha$	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
$\eta$	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%
<b>bubble size</b>	<b>2.29%</b>	<b>0%</b>

- 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%
<b>bubble size</b>	<b>-0.87%</b>	<b>0%</b>

- Preference shock reduces bubbles by making people impatient.