Bubble Cycles

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Motivation

- Very often bubbles go hand in hand with investment. Emerging bubbles are followed by the economic boom, but the crash of bubbles, often followed by financial turmoil, leads to severe and prolonged recession.
- Observe the positive correlation between bubbles and investment in Japan and United States, and the current China.

Purpose

1. Construct a simple model that explains the complementarity between bubbles and investment in both the short and long runs.

2. Answer the question if bubbles crowd investment in or out

3. Characterize conditions under which crowding in arises ?

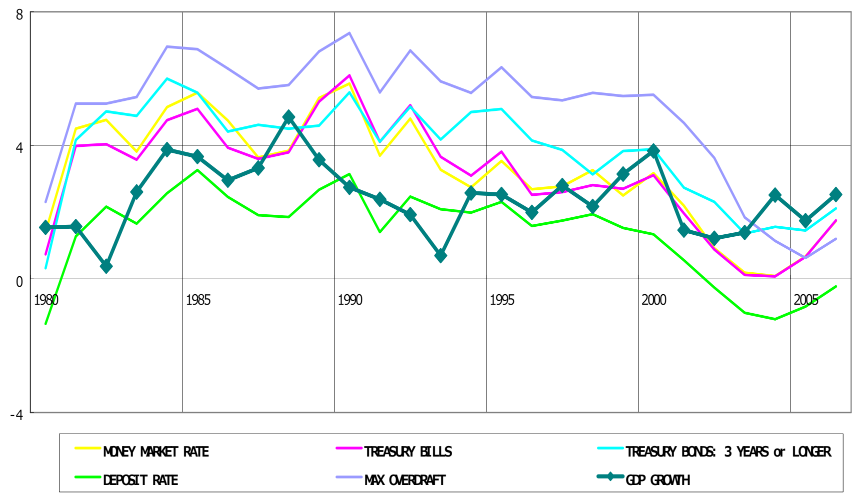
Unrealistic findings in Tirole(1985)

"Interest Rate(r) =Growth Rate (g)" holds when bubbles arise.

But his model contradicts with facts on bubbles….

1. Bubbles arise when there is **over investment** in the bubbleless economy , with **r <g**
   → ***under investment ?***
2. Bubbles **crowds out** investment
   → ***crowding in ?***

Figure X　Interest Rates and Growth Rate



Common features on bubbles

1. Bubbles are related to ***financial technology development*** or ***stock market boom***
   (Tulipmania, Holland 1637)
   (South See Company, England 1720)
   (The Great Depression, US, 1929)
   (Subprime loan US, 2007)
2. Bubbles are related to ***high saving, leading to real estate appreciations***.
   (Japan, 1986-1992) (China, 2000-?)

Financial Frictions View

- Financial frictions leads to a decline in the real interest rate and the emergence og bubbles.
- Bubbles are used as collateral for financing investment.

- Kiyotaki and Moore 1997, Venture, 2003, Caballero and Krishnamurthy, 2001

Saving Boost View

- Saving boost leads to a decline in the real interest rate and the emergence of bubbles.
- Saving boost generate bubbles.
- ････“Saving Glut” argument

Related works

- Caballero et al (2006) develop a model that explains the correlation between investment and bubbles in the transition, not at the steady state, using their saving-boost-view approach.

- Farhi and Tirole (2009) develops a three- asset model of financial friction, consisting of capital, bubbles, and real bond , and demonstrate more investment in the bubbly steady state.

Overlapping Generations Economy with *3-period-lived agents.*

- Agents born at t are endowed with E_t *units of the final good and save all* ***in the young age****,*

- *Supply one unit of labor, and* depending on types of agents, *save/consume* ***in the middle age***,

- *Consume* ***in the old age***.

Production and Endowment

1. The final good is produced according to the CRTS technology, $Y_t = F(K_t, A_t N_t)$.
2. *The technology* A_t grows at rate *g.*
3. The output per effective worker is described
4. as $y_t = f(k_t)$ *, with* $k_t \equiv K_t/A_t$ *, and* $N_t=1$*.*
5. The rate of return on capital is $R_t = f'(k_t)$ *and the wage rate is* $w_t = f(k_t) - k_t f'(k_t)$
6. Endowment E_t *grows at rate g to meet* $E_t = A_t e$*.*
7. *The final good is transformed into capital that is used as an input for the final good.*

"Type 1" agents

- "Type 1" agents with a fraction α ($0 < \alpha < 1$) are all *"**entrepreneurs**",* who have access ***in the middle age*** to a linear technology that transforms *one* unit of the final good into *one* unit of capital after one period.
- They maximize <u>their old age consumption.</u>

“Type 2” agents (1)

- “Type 2” agents with a fraction 1-α are ***“entrepreneurs”*** with prob. a half , and “***investors”*** with prob. a half, who have no access to that production.
- Know if they have access to entrepreneurs at the timing after receiving wage and before deciding consumption/saving behavior in the middle age.

“Type 2” agents (2)

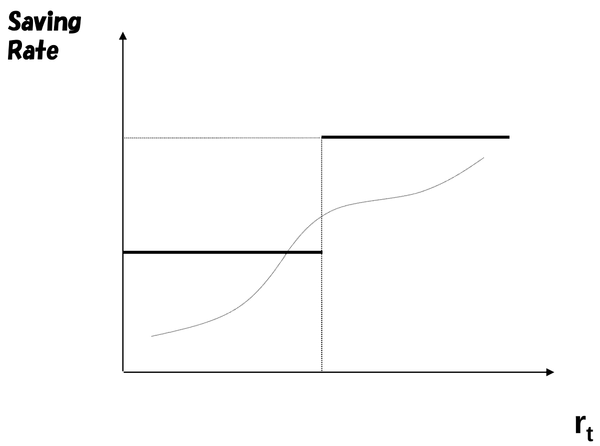
- Maximize the linear utility $C_{m,t} + \beta C_{o,t+1}$.
- ***Save all*** *if the expected rate of return on saving is greater than 1/*β, and ***consume all*** if otherwise.
- *The aggregate saving rate depends on the expected rate of return and thus on* r_{t+1}*!*

Expected rate of return of "Type 2" agents

- = 0.5 × rate of return as an entrepreneur +
- 0.5 × rate of return as an investor,

- *which will be positively linked to* r_{t+1}

Aggregate savings increase ***rapidly*** as interest rate rises for some region



Low saving or high saving ?

- Saving rate (middle-aged) ･･･ s_t
- Measure of entrepreneurs ･･･α_t

1. Low saving economy (s_t = α,α_t = α)Type I agents only save and implement projects.
2. High saving economy (s_t = 1, α_t = α+0.5(1-α) ≡ α_H) All agents save.

Financial Friction

- When a debtors breaches the contract and refuses to make repayment, a portion λ (0 < λ <1) of his earnings are seized by the creditors.
- Pledgeability parameter λ, expresses the creditor's ability to supply financial assets, and thus the degree of development of financial markets.

Behavior of Entrepreneurs

- ***At the young age***
- Endowed with E_{t-1}
- Invest in investment of the generation 't-1' and bubbles

- ***At the middle age***
- *Earn interest income* $(1+r_t) E_{t-1}$ *and labor income* $A_t w_{t..}$
- $(1+r_t) E_{t-1} + A_t w_{t.}$ *becomes net worth* X_t *for financing investment*

Bubbles

- Bubbles are stores of value, has no real values, public debt, fiat money, land, gold etc….. . *Liability is owed by the next generation….**Outside Money ！？***

- The saving of the middle $s_t\{A_t w_t+(1+r_t) E_{t-1}\}$ *and the saving of the young* E_t *consist of the supply of funds to finance* investment, $\alpha_t I_t$, *and* bubbles $p_t B_t$.

Asset Market Clearing

(3) $\alpha I_t + p_t B_t = s_t \{ A_t W(k_t) + (1 + r_t) E_{t-1} \} + E_t$

Letting $b_t \equiv p_t B_t / A_t$, $k_t \equiv \alpha_t I_t / A_t (1+g)$,

(5) $(1+g) k_{t+1} + b_t = s_t \{ W(k_t) + e \frac{1+r_t}{1+g} \} + e$

.

As e→0, the standard expression:

$$(1+g) k_{t+1} + b_t = s_t W(k_t)$$

Bubble Evolution

No-arbitrage condition between capital and bubbles generates

(6) $(1+g) b_{t+1} = (1 + r_{t+1}) b_t$

Endogenous Borrowing Constraint(1)

Entrepreneurs borrow ($I_t - X_t$) and earn

($) $$f'(k_{t+1})I_t - (1+r_{t+1})(I_t - X_t)$$

*if r*epaying debt *honestly,* while

(#) $$(1-\lambda) f'(k_{t+1})I_t$$

if breaching contract.

Incentive compatibility implies ($)>(#), or

(2) $$(1+r_{t+1})(I_t - X_t) \le \lambda f'(k_{t+1})I_t$$

Endogenous Borrowing Constraint(2)

Binding incentive compatibility

→ Binding borrowing constraint

$$1+r_{t+1} = \frac{(1+g)\lambda f'(k_{t+1})k_{t+1}}{(1+g)k_{t+1} - \alpha\{W(k_t) + \frac{1+r_t}{1+g}e\}}$$

$\lambda f'(k_{t+1})$ ･･･pledgeable rate of return on capital

$\frac{(1+g)k_{t+1}}{(1+g)k_{t+1} - \alpha\{W(k_t) + \frac{1+r_t}{1+g}e\}}$ ･･･ measure of leverage

Endogenous Borrowing Constraint(3)

$$1+r_{t+1} = \frac{(1+g)\lambda f'(k_{t+1})k_{t+1}}{(1+g)k_{t+1} - \alpha_t\{W(k_t) + \frac{1+r_t}{1+g}e\}}\}$$

- λ･･･a measure of creditor's ability of supplying financial assets
- α_t･･･ a measure of balance sheet
- e ･･･ a measure of balance sheet

◆ A rise in λ, α_t, e ⇒ a rise in r_{t+1}

A competitive bubbly economy is defined as a sequence , $\{k_t, b_t, s_t, \alpha_t, r_t\}_{t=0}^{\infty}$ with an initial capital level k_0, that satisfies

(5) $(1+g)k_{t+1} + b_t = s_t\{W(k_t) + e\frac{1+r_t}{1+g}\} + e$

(6) $(1+g)b_{t+1} = (1+r_{t+1})b_t$

(7) $1+r_{t+1} = \min\{f'(k_{t+1}), \frac{(1+g)\lambda f'(k_{t+1})k_{t+1}}{(1+g)k_{t+1} - \alpha_t\{W(k_t) + \frac{1+r_t}{1+g}e\}}\}$

and $s_t = \alpha_t = \alpha$ if $r_{t+1} < 1/\beta - 1$,

or $s_t = 1$ and $\alpha_t = \alpha_H$ if otherwise.

When the borrowing constraint is not binding, a competitive bubbly economy is defined as a sequence, $\{k_t, b_t, s_t, \alpha_t, r_t\}_{t=0}^{\infty}$ that satisfies

(5) $(1+g)k_{t+1} + b_t = s_t\{W(k_t) + e\frac{1+r_t}{1+g}\} + e$

(6) $(1+g)b_{t+1} = (1+r_{t+1})b_t$

(7) $1+r_{t+1} = f'(k_{t+1})$,

and $s_t = \alpha_t = \alpha$ if $r_{t+1} < 1/\beta - 1$,
or $s_t = 1$ and $\alpha_t = \alpha_H$ if otherwise.

Bubbly economy with borrowing constraint(1)

The wedge of financial friction generates

$f'(k_{t+1}) > 1 + r_{t+1}$.

At the bubbly steady state with r=g,

$f'(k_{t+1}) > 1 + g$.

Under-investment arises…..Golden rule is not realized…..

What will happen if

$f'(k_{t+1}) > 1 + g > 1 + r_{t+1}$?

Bubbly economy with borrowing constraint(2)

Proposition 1

If the borrowing constraint binds, the bubbly steady state features ***less investment*** than the Golden Rule.

- Capital under-accumulation is ***compatible with*** bubbles to emerge.
- Capital over-accumulation is ***not necessary*** for bubbles to emerge.

>0)

Steady State Analysis (1)

- Bubbles are increasing (decreasing) in the capital stock if $\tilde{s} > (<) \tilde{\alpha} + \lambda\phi(\tilde{k}_B)$.

(14) $$\tilde{b} = \frac{(1+g)\{\tilde{s} - \tilde{\alpha} - \lambda\phi(\tilde{k}_B)\}}{\lambda\phi(\tilde{k}_B) + \tilde{\alpha}} \tilde{k}_B + \frac{(1+\tilde{s})\lambda\phi(\tilde{k}_B) + \tilde{\alpha}}{\lambda\phi(\tilde{k}_B) + \tilde{\alpha}} e$$

- As the saving rate is high, the bubbly equilibrium is more sustainable.

(15) $$\tilde{b} > 0 \quad \Leftrightarrow \quad W(\tilde{k}_B) < \frac{1 + \tilde{s} - \tilde{\alpha}}{\lambda\phi(\tilde{k}_B) - (\tilde{s} - \tilde{\alpha})} e$$

Steady State Analysis (2)

Capital stock in the bubbly steady state with high saving is simply expressed as

(16) $(1+g)\tilde{k}_B = \{\lambda\phi(\tilde{k}_B) + \alpha_H\}W(\tilde{k}_B) + \alpha_H e$

where $\phi(k) \equiv f'(k)k/W(k)$

Capital stock in the bubbleless steady state with low saving is simply expressed as

(17) $(1+g)\tilde{k} = \{\alpha\lambda\phi(\tilde{k}) + \alpha\}W(\tilde{k}) + e$

Steady State Analysis (3)

Proposition 2

(A) Crowding out ($\tilde{k} > \tilde{k}_B$) arises *whenever* the saving rate is low.

(B) Crowding in ($\tilde{k}_B > \tilde{k}$) arises if (i) the saving rate is high, and (ii) balance sheet parameters, α and/or λ, are high (but not too high)

(C) bubbles/capital is high if saving rate is high, but α and/o λ are low (low credit availability).

Dynamics (1)

The system is governed by three equations,

(6) $(1+g)b_{t+1} = (1+r_{t+1})b_t$

(9) $1+r_{t+1} = \dfrac{\lambda(1+g)f'(k_{t+1})k_{t+1}}{(1+g)(1-\frac{\alpha_t}{s_t})k_{t+1} + \frac{\alpha_t}{s_t}(e-b_t)}$

(19) $(1+g)k_{t+1} + b_t =$

$$s_t\{W(k_t) + \frac{s_{t-1}f'(k_t)k_t e}{(s_{t-1}-\alpha_{t-1})(1+g)k_t + \alpha_{t-1}e} + \frac{\alpha_{t-1}eb_t}{(s_{t-1}-\alpha_{t-1})(1+g)k_t + \alpha_{t-1}e}\} + e$$

given s_t and α_t .

Dynamics (2)

(19) Asset market clearing

$$(1+g)k_{t+1} + b_t = s_t\{W(k_t) + \frac{es_{t-1}f'(k_t)k_t}{(s_{t-1}-\alpha_{t-1})(1+g)k_t + \alpha_{t-1}e}$$

$$+\frac{\alpha_{t-1}eb_t}{(s_{t-1}-\alpha_{t-1})(1+g)k_t + \alpha_{t-1}e}\} + e$$

↑

Portfolio Effect ①

Collateral Effect ② ↑

Portfolio Effect ① ＞ Collateral Effect ②

◆Saving boost is necessary to have crowding in

Link between Inside Money and Outside Money

"portfolio effect" ･･･ bubbles compete with investment in the portfolio, and crowds investment out

Imperfect capital markets ⇒ Scarce inside money ⇒ outside money (bubbles)

"collateral effect" ･･･bubbles increase net worth of borrowers and promote investment

Outside money used as collateral ⇒supply greater inside money

Dynamics (3)

- **Proposition 3 (Local saddle-path stability)**
- Given the saving rate, there exists a locally unique saddle-path converging to the bubbly steady state

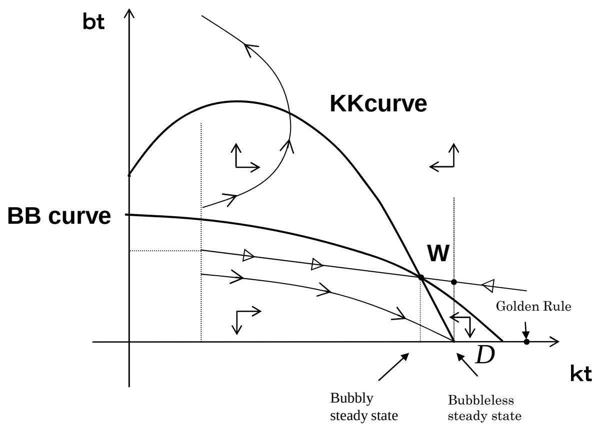
Global Dynamics (Low Saving)

$k_{t+1} = k_t$ (KK curve) is

(20) $$(1-\alpha)b_t = \alpha W(k_t) - (1+g)k_t + \alpha\lambda f'(k_t)k_t + e$$

$b_{t+1} = b_t$ (BB curve) is

(21) $$b_t = e - \lambda f'(k_t)k_t$$



Global Dynamics(high saving)

$k_{t+1} = k_t$ (KK curve) is

(23)

$$[1-\frac{\alpha_H e}{(1-\alpha_H)(1+g)k_t+\alpha_H e}]b_t = W(k_t)-(1+g)k_t+e\frac{\lambda f'(k_t)k_t}{(1-\alpha_H)(1+g)k_t+\alpha_H e}+e$$

$b_{t+1} = b_t$ {BB curve) is

(24)

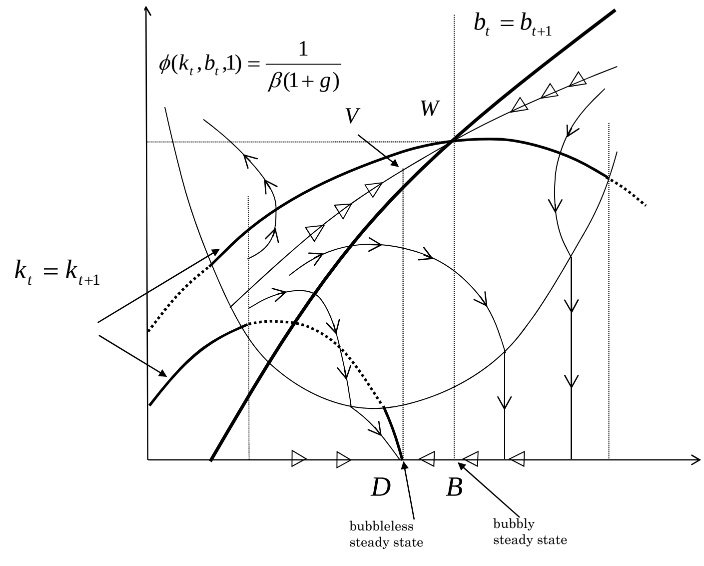
$$1=\frac{\lambda f'(k_{t+1})k_{t+1}}{(1+g)(1-\alpha_H)k_{t+1}+\alpha_H(e-b_t)}$$

and the high saving rate condition

(22)

$$b_t \ge \frac{k_t}{\alpha_H}\{\frac{1-\alpha_H}{\beta}-\lambda f'(k_t)\}+\frac{e}{\beta(1+g)}$$

• *Crowding In*



*Bubbles crowd investment **in**!*

- The rise in the interest rate will ***increase savings***, which generate the positive feedback between bubbles and investment (V → W).

Bubbles ↑⇒net worth ↑⇒borrowing ⇒ Investment↑⇒wage ↑⇒ savings↑ ⇒bubbles↑….

◆***Positive feedback is strong when collateral effect works well.***

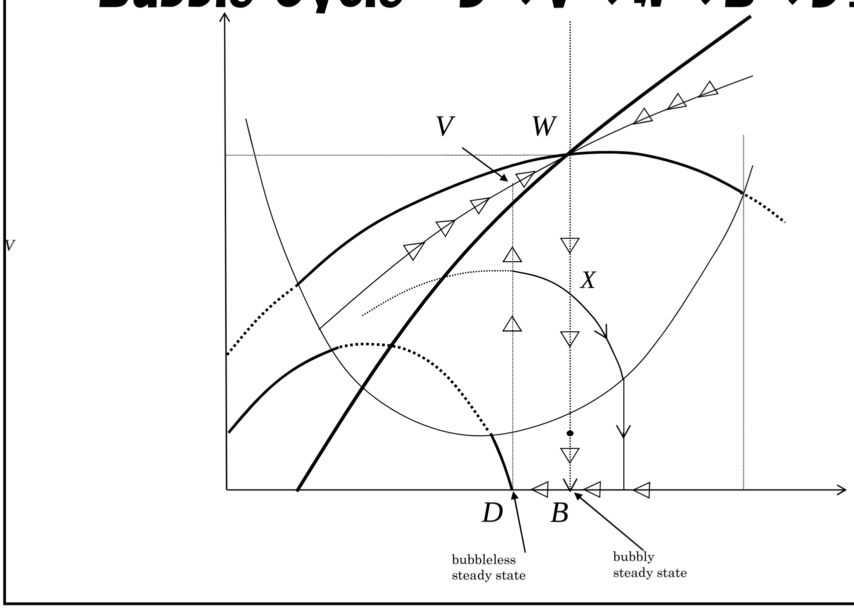
Bubble and Savings

- When people anticipate bubbles, all people save, and thus bubbles are ***self-fulfilling***.
- We provide a story of business cycles that are driven by the boost and burst of bubbles, that arise from ***sunspots.***

Stochastic Bubbles

- The sunspot variable is a Markov chain with two states, *{b, c}.*
- *When the state* is *b , all agents coordinate their expectations on the bubbly path.*
- *When the state is c , they do* on the path toward the low capital steady state *D.*
- *The probability when the same state occurs between periods is δ.*
- *Assuming δ→ 1*

- **Bubble Cycle D→V→W→B→D…**



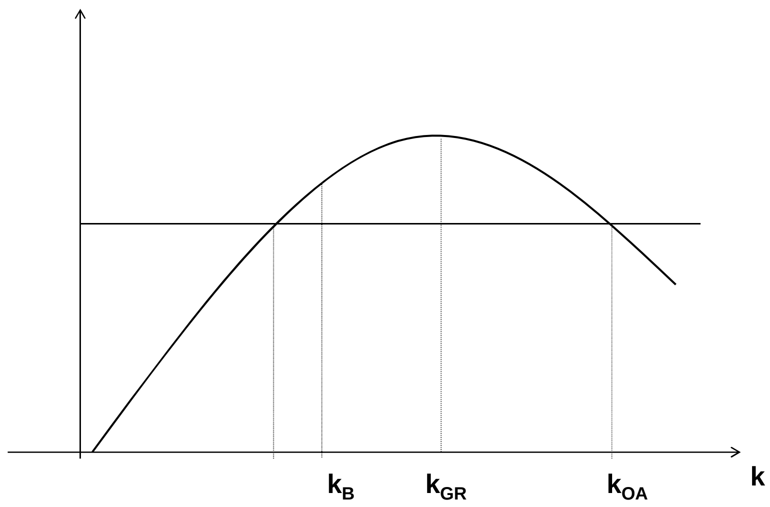
Inside money versus outside money

- Bubbles/capital is positively linked to Outside money/ inside money
- Might be interpreted as "money multiplier"
- high
- Bubbly economy with high financial tech. and low saving → ***high multiplier***
- Bubbly economy with low financial tech. and high saving → ***low multiplier***

Dynamic Efficiency and Bubbles

- *Conditions on dynamic efficiency and rational bubbles break down!*
- When crowding out arises, the bubbleless economy is dynamically efficient.
- When crowding in arises, the bubbleless economy is dynamically inefficient.

$f(k)-(1+g)k$ Dynamic Efficiency



- *f '(k) >1+g* is ***neither*** a necessary ***nor*** sufficient condition for *dynamic efficiency*
- *･･･contradicts with Abel criterion*

- Bubbles arise when *f '(k) >1+g >1+r,* and improve efficiency when bubbles crowd investment in.

- Even when *f '(k) <1+g , and capital over-accumulation holds in the bubbleless economy, dynamically efficiency holds*

Interpreting Saving behavior in times of bubbles(1)

- CRRA utility function:
- u(c)+βu(c)
- u(c)=c・exp(1-σ)/(1-σ), with σ<1
- Saving rate s（r）＝s(Φ(k, b)) is increasing in r and bubbles!

- Steady state analysis is tractable, but dynamics is difficult to analyze

Interpreting Saving behavior in times of bubbles(2)

1. As Thaler (1990) suggested, “mental accounting” explain the differential MPC from various sources of wealth.
2. Sinai and Souleles (2005) suggested that the aggregate wealth effect from house price fluctuations is small, taking into account the risk hedge of homeownership.
3. Buiter (2008) shows that wealth effect is small because housing value increase results is offset by higher costs of housing.

Interpreting Saving behavior in times of bubbles(3)

- Horioka (1996) reports that given that the capital gain of land is included in income, the household's saving rate rose about 30 percent in times of bubbles!

- Evidence on small and negligible wealth effects on consumption; Case et al. (2006) and Calomiris et al. (2009) in the US, and Ogawa et al. (1996) and Horioka (1996) in Japan.

Different forms of bubbles!?

- Specificity of real estate (land and housing) as wealth

1. We have to buy too expensive real estate.
2. We can not sell too expensive real estate.
3. Real estate is illiquid, but can be liquid by issuing real-estate backed security
4. Real estate is indivisible.

Other models on rational bubbles

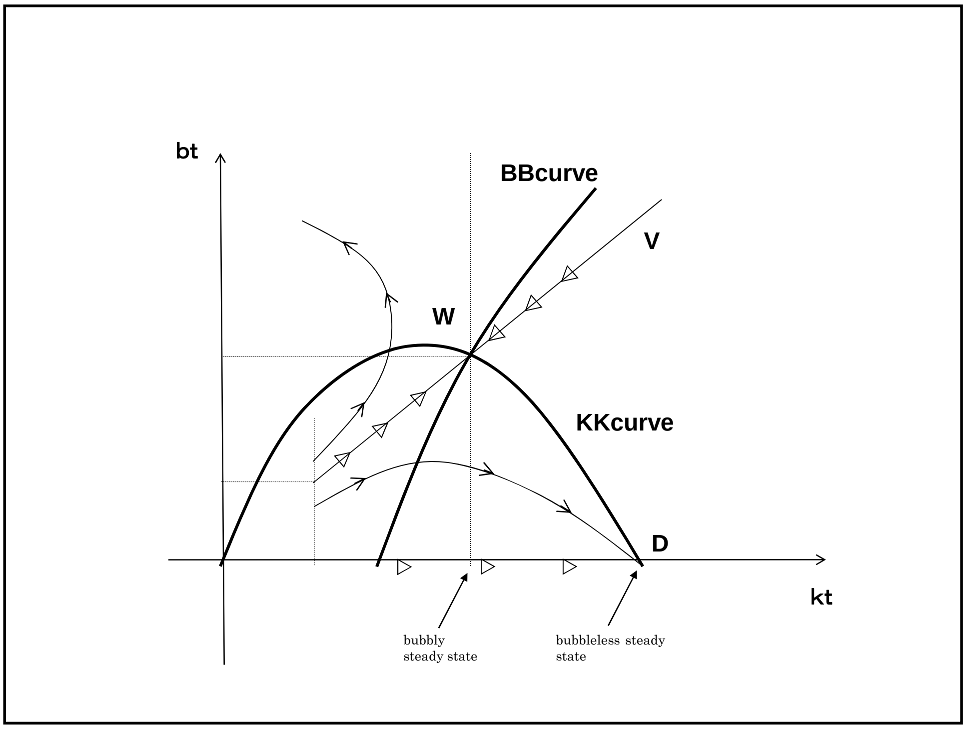
- Woodford (1990), Bohn (1999), Kiyotaki and Moore (2008), Hellwig and Lorenzoni (2009), Kocherlakota (2009), and Sakuragawa and Hosono (2009).

- Combining financial frictions with the heterogeneity in the access to production among agents to have implications on the lower interest rate than the growth rate.

Further Research

- Describe bubble cycle as a coordination failure
- Is $r<g$ necessary to have a bubbly economy?
- Extend to a dynamic model with one period being one year.

- Comparing bubbles between Japan, US, China
- Discuss “bubble substitution”
- Explore micro-foundation behind saving boost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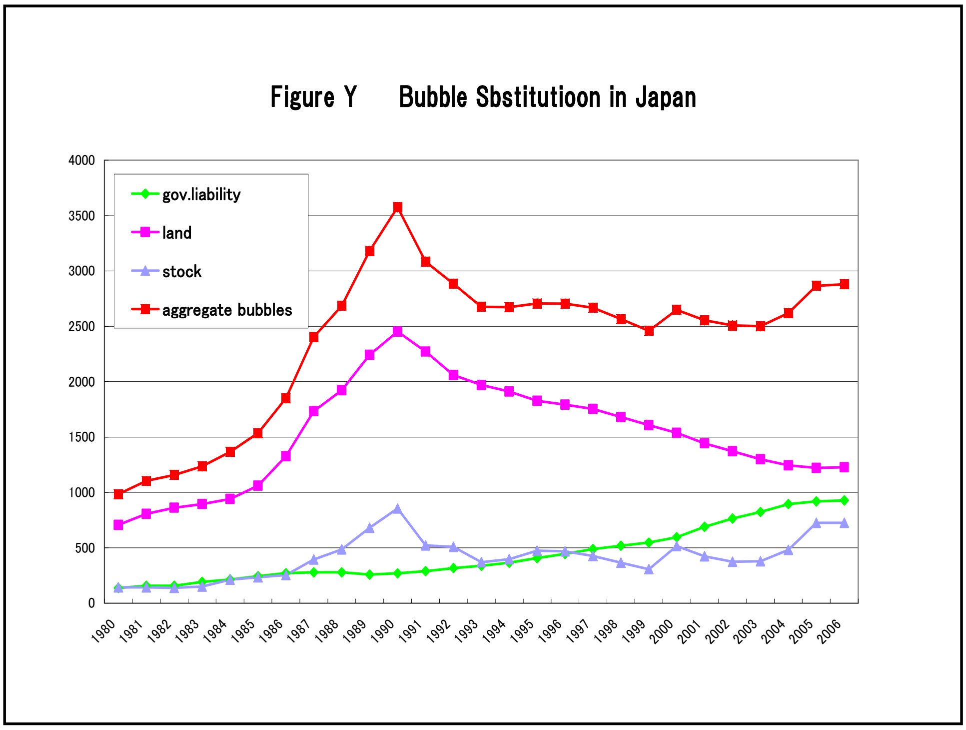
Figure Y Bubble Sbstitutioon in Japan
gov.liability
land
stock
aggregate bubbles
4000
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