Bubbly Collateral and Economic Activity

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Introduction

- Recent years: trillions of government dollars to financial institutions
  - Spain: €100 billion last week
  - Ireland: €85 billion in 2010
  - EFSF: €750 billion, partly to recapitalize banks
  - ECB: over a trillion € of cheap loans to banks between Dec. 2011 and Jan. 2012
  - in the US: TARP and Term Asset Backed Lending Facility
- What is the rationale for these bailout schemes, even by governments that are under stress?
  - do they correct underlying market failure?
  - do they boost activity in the short run at the expense of long run incentives?

This paper

- Start with simple observation: bailouts date back to 2007 crisis
  - crisis characterized by significant and rapid decline in asset prices
  - can be modeled as bursting of bubble, i.e. large shock to investor sentiment that destroys wealth (Martin-Ventura 2011)
  - absent financial frictions: decline in wealth leads to decline in consumption
  - in real-world financial markets: because of financial frictions, wealth used as collateral
  - collapse of investor sentiment destroys collateral
- To model this insight
  - macroeconomic model with financial frictions
  - key role of credit markets: savers $\leftrightarrow$ financial intermediaries $\leftrightarrow$ entrepreneurs
  - but lending must be collateralized, and collateral is scarce (weak enforcement institutions)
- In this setting
  - investor optimism leads to bubbles that raise value of firms or banks
  - bubbles expand stock of collateral, raising credit and investment
  - when bubbles burst, collateral falls and credit and investment contract

Main insights

- Firms and banks combine fundamental and bubbly collateral
  - bubbly collateral: pyramid schemes
    - valued today only because expected to be valued in the future
  - far fetched?
    - stocks traded at price above NPV of dividends
    - credit raised by firm/bank in excess of the cash flows it may generate
- Role for policy
  - in principle, preserve or complement bubbly collateral
  - is this feasible?
  - bailout policy that guarantees private promises
    - ex-ante: this policy creates collateral, boosts credit, investment and growth
    - ex-post: this policy needs to pay for bailout, taxation lowers credit, investment and growth
    - this policy might raise average growth, but exacerbate cycles
  - different from standard view: bailouts lower growth ex-ante, raise it ex-post
    - collateral vs. liquidity?

Related literature

- Rational bubbles
  - Samuelson (1958), Tirole (1985)
  - Samuelson (1958), Kiyotaki and Moore (2008): fiat money as a bubble
- Bubbles and economic growth
  - Saint-Paul (1992), Grossman and Yanagawa (1993), King and Ferguson (1993), Olivier (2000)
- Bubbles and financial frictions: macroconomic implications
  - Azariadis and Smith (1993): existence
  - Caballero and Krishnamurthy (2006), Farhi and Tirole (2010), Miao and Wang (2011), Aoki and Nikolov (2011): liquidity
  - Kocherlakota (2010), Martin and Ventura (2011): collateral
  - Ventura (2011): cost of capital
- Financial accelerator
  - Bernanke and Gertler (1989), Kiyotaki and Moore (1997)
- Bailouts (preliminaty)
  - Tornell and Schneider (2004), Ranciere, Tornell and Westermann (2008)

Roadmap

- Objective for the talk:

  1. Present model in which bubbles provide useful collateral (as in our previous research)
  2. Describe its implications for business cycles
  3. Explore the role of stabilization policy in the model
  4. Introduce financial intermediaries
  5. Conclusions

Model

- OLG: young and old
- Each generation: composed of $i \in \{S, E\}$, savers and entrepreneurs
- *Preferences*: all generations maximize expected consumption when old (i.e. they are patient and risk neutral!)

$$U_t^i = E_t^i \{c_{t+1}\}$$

- Savers (measure one) supply one unit of labor when young, $N_t = 1$; and receive wage W_t.
- Portfolio problem: inventories or credit?
  - Inventories (I_t): storage, gross return of one per unit invested
  - Credit ($W_t - I_t$): gross return of $E_t R_{t+1}$ per unit invested
  - Optimal portfolio: $I_t \begin{cases} = 0 & \text{if } E_t R_{t+1} > 1 \\ \in [0, W_t] & \text{if } E_t R_{t+1} = 1 \end{cases}$

Entrepreneurs

- Derive all income from managing firms
  - During youth, borrow L_t to purchase firms and/or invest
  - During old age, hire workers to produce: production technology

$$Y_t = K_t^{\alpha} \cdot (A_t \cdot N_t)^{1-\alpha} \quad \text{with} \quad A_{t+1} = \gamma^{t+1},\ \gamma > 1$$

    where K depreciates at rate δ and can be converted back into consumption goods.
  - After producing, sell firm at price V_{t+1}, pay debts $R_{t+1}L_t$, and consume

- Loans L_t need to be collateralized
  - Weak enforcement institutions: firm profits cannot be pledged
  - Borrowing constraint

$$R_{t+1}L_t \leq V_{t+1}$$

- Optimal borrowing: $L_t \begin{cases} = \dfrac{E_t V_{t+1}}{E_t R_{t+1}} & \text{if } E_t R_{t+1}^K > E_t R_{t+1} \\ \in \left[V_t, \dfrac{E_t V_{t+1}}{E_t R_{t+1}} \right] & \text{if } E_t R_{t+1}^K = E_t R_{t+1} \end{cases}$

$$\text{where} \quad R_{t+1}^K \equiv \alpha \cdot \left(\frac{1-\alpha}{W_{t+1}/A_{t+1}} \right)^{\frac{1-\alpha}{\alpha}} + \frac{\partial V_{t+1}}{\partial K_{t+1}}$$

Markets and prices

- Labor market competitive and frictionless:

$$W_t = (1-\alpha) \cdot A_t^{1-\alpha} \cdot K_t^{\alpha}$$

- Credit market: entrepreneurs sell credit contracts to savers at interest rate

$$E_t R_{t+1} = \begin{cases} 1 & \text{if } \dfrac{E_t V_{t+1}}{W_t} \leq 1 \\ \dfrac{E_t V_{t+1}}{W_t} & \text{if } 1 < \dfrac{E_t V_{t+1}}{W_t} < E_t R_{t+1}^K \\ E_t R_{t+1}^K & \text{if } E_t R_{t+1}^K \leq \dfrac{E_t V_{t+1}}{W_t} \end{cases}$$

  depending on whether collateral or resources limit credit

- Stock market: young entrepreneurs purchase firms

$$V_t = (1-\delta) \cdot K_t + B_t$$

  where B_t is bubble component of firm prices

  – young entrepreneur pays B_t for stock of old bubbles: also attaches new bubbles to firm

  – discounted value of new bubbles: $\dfrac{E_t B_{t+1}}{E_t R_{t+1}} - B_t$

- In equilibrium

$$\frac{E_t B_{t+1}}{E_t R_{t+1}} \geq B_t \geq 0$$

Competitive Equilibrium

- The economy in a nutshell:

$$K_{t+1} = L_t - B_t$$

$$L_t = \min\left\{\frac{E_t B_{t+1} - B_t}{\delta} + B_t, W_t\right\}$$

$$E_t R_{t+1} = \max\left\{1, \frac{E_t B_{t+1} - B_t}{\delta \cdot W_t} + \frac{B_t}{W_t}\right\}$$

$$W_t = (1-\alpha) \cdot A_t^{1-\alpha} \cdot K_t^{\alpha}$$

$$\frac{E_t B_{t+1}}{E_t R_{t+1}} \geq B_t \geq 0$$

- Note: there is a "multiplier" attached to new bubbles
  - increase in bubbly collateral $\longrightarrow$ raises credit $\longrightarrow$ boosts fundamental collateral
- Competitive equilibrium: stochastic proces for bubble shock

$$\left\{B_t\left(h^t\right), E_t B_{t+1}\left(h^t\right)\right\}_{t=0}^{\infty}$$

and sequences

$$\left\{K_t\left(h^t\right), L_t\left(h^t\right), E_t R_{t+1}\left(h^t\right), W_t\left(h^t\right)\right\}_{t=0}^{\infty}$$

satisfying previous equations for all periods t and histories h^t

What are bubbles doing?

- In equilibrium, it is possible for $b_t > 0$
- Bubbly economy: three assets to transfer consumption across periods: capital, bubbles, inventories
  - Insufficient fundamental collateral
  - Bubbly collateral used to sustain transfers
- Transfers supported by bubbles fluctuate randomly across periods and histories
- Transfers from young savers to young entrepreneurs and old savers:
  - transfer from young savers to young entrepreneurs: $\min\left\{\frac{E_t B_{t+1} - B_t}{\delta} + B_t, W_t\right\}$
  - kept by young entrepreneurs and used to finance capital: $\left\{\frac{E_t B^B_{t+1} - B_t}{\delta}, W_t - B_t\right\}$
  - transferred to old savers: B_t

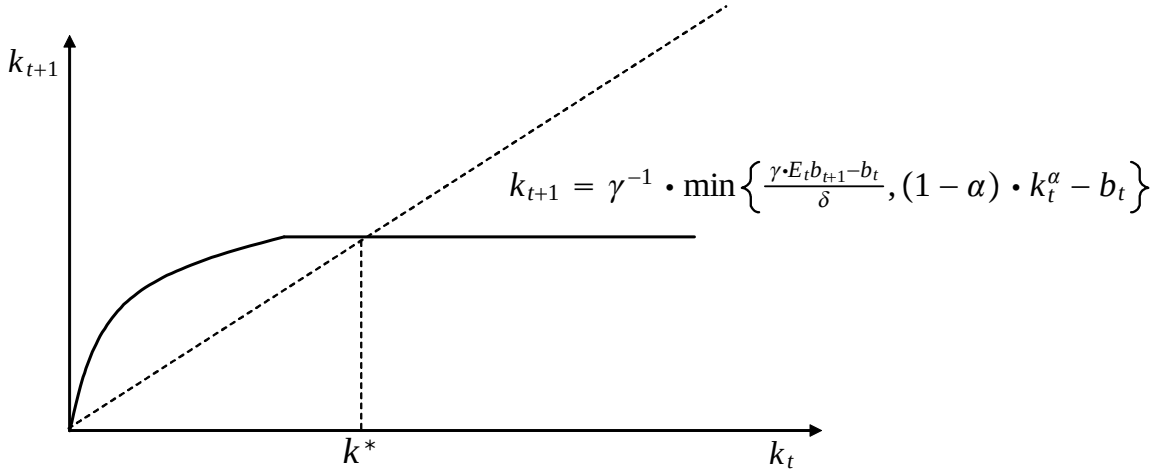
Bubbly Business Cycles

- Define all quantity variables in terms of efficient workers, i.e $k_t = \dfrac{K_t}{A_t L_t}$ and so on.
- Equilibrium dynamics of capital and bubbles:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{\gamma \cdot E_t b_{t+1} - b_t}{\delta}, (1-\alpha) \cdot k_t^{\alpha} - b_t \right\}$$

$$\frac{\gamma \cdot E_t b_{t+1}}{E_t R_{t+1}} \geq b_{t+1} \geq 0$$

- Macroeconomic implications:



- Economy subjecto to investor sentiment shocks that drive bubble
  - Bubble creates collateral and partially sustains missing credit
  - Bubbly episodes coincide with booms: high k, capital, output and consumption

Discussion on Pareto Optimality....

- PO equilibria: economy has enough collateral to intermediate all savings of young savers:

$$\frac{\gamma \cdot E_t b_{t+1} - b_t}{\delta} + b_t \geq (1-\alpha) \cdot k_t^{\alpha} \geq b_t \text{ for all } t \text{ and } h^t \in H_t$$

  i.e., inventories eliminated in all histories

- In any PO equilibrium

$$E_t R_{t+1} \in \left\{ 1, \gamma \cdot \left(\frac{k_{t+1}}{k_t} \right)^{\alpha} \right\}$$

- All savings intermediated. Where does intermediation go?
  - In PO equilibria with low interest rates: to young entrepreneurs
    - high capital stock and consumption
  - In PO equilibria with high interest rates: to old savers
    - low capital stock and consumption

Bailout policies

- Bubbly economy characterized by lack of collateral
  - can public policy be used to relieve this scarcity?
- It depends on what the government can do
  - consider it can use taxes and debt to back private promises
  - government provision of collateral
- Two extreme cases: unlimited and no taxation
- Without taxation: government cannot affect the set of equilibria of the model
  - all public transfers financed through public debt
  - but public debt without taxation is itself a bubble
- With unlimited and non-distortionary taxation: government can implement any allocation it desires
- We analyze intermediate case
  - public collateral limited to fraction $\tau_{t+1} < \overline{\tau}$ of next period's labor income

Economy with bailouts

- Introduce government that can provide bailout S_t to firms
  - formally: in each period t, government commits to providing subsidy S_{t+1}
  - could be contingent (e.g. on private collateral) or non contingent
- Government budget constraint,

$$S_t + B_t^G \leq \frac{T_t}{1+\eta} + \frac{E_t B_{t+1}^G}{E_t R_{t+1}},$$

  where $T_t \leq \overline{\tau} \cdot W_t$ is taxation, η is tax distortion, and $E_t B_{t+1}^G$ is government debt
  - note government debt valued at market interest rate
- What else changes?
  - Government debt / taxes crowd out inventories: $I_t \leq W_t - T_t - \frac{E_t B_{t+1}^G}{E_t R_{t+1}}$
  - Expected bailouts relax credit constraint of entrepreneurs:

$$R_{t+1} \cdot L_t \leq V_{t+1} + S_{t+1}$$

and optimal borrowing becomes

$$L_t \begin{cases} = \dfrac{E_t\{V_{t+1} + S_{t+1}\}}{E_t R_{t+1}} & \text{if } E_t R_{t+1}^K > E_t R_{t+1} \\ \in \left[V_t, \dfrac{E_t\{V_{t+1} + S_{t+1}\}}{E_t R_{t+1}}\right] & \text{if } E_t R_{t+1}^K = E_t R_{t+1} \end{cases}$$

Economy with bailouts: equilibrium

- In equilibrium, interest rate now satisfies:

$$E_t R_{t+1} = \begin{cases} 1 & \text{if } \dfrac{E_t\left\{V_{t+1} + S_{t+1} + B^G_{t+1}\right\}}{W_t - T_t} \leq 1 \\ \dfrac{E_t\left\{V_{t+1} + S_{t+1} + B^G_{t+1}\right\}}{W_t - T_t} & \text{if } 1 < \dfrac{E_t\left\{V_{t+1} + S_{t+1} + B^G_{t+1}\right\}}{W_t - T_t} < E_t R^K_{t+1} \\ E_t R^K_{t+1} & \text{if } E_t R^K_{t+1} \leq \dfrac{E_t\left\{V_{t+1} + S_{t+1} + B^G_{t+1}\right\}}{W_t - T_t} \end{cases}$$

- Equilibrium loans and interest rate:

$$L_t = \min\left\{\frac{E_t\left\{B_{t+1} + S_{t+1}\right\} - (1-\delta)\cdot B_t}{\delta}, W_t - T_t - \frac{E_t B^G_{t+1}}{E_t R_{t+1}}\right\}.$$

$$E_t R_{t+1} = \max\left\{1, \frac{E_t\left\{B_{t+1} + S_{t+1}\right\} - (1-\delta)\cdot B_t + \delta E_t B^G_{t+1}}{\delta\cdot(W_t - T_t)}\right\}$$

- In all equations: bailout policy
  - raises collateral and intermediation: raises demand for funds
  - raises debt and taxes: lowers supply of funds

- Competitive equilibrium: stochastic process for shock $\left\{B_t\left(h^t\right), E_t B_{t+1}\left(h^t\right)\right\}_{t=0}^{\infty}$ satisfying bubble restrictions, fiscal policy $\left\{S_t\left(h^t\right), T_t\left(h^t\right), B^G_t\left(h^t\right)\right\}_{t=0}^{\infty}$ satisfying government budget constraint and sequences $\left\{K_t\left(h^t\right), L_t\left(h^t\right), E_t R_{t+1}(h^t), W_t\left(h^t\right)\right\}_{t=0}^{\infty}$ satisfying previous conditions for all t and $h^t \in H_t$.

Bubbly Business Cycles with Bailouts

- Equilibrium dynamics of capital and bubbles:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{\gamma \cdot E_t \left\{ b_{t+1} + s_{t+1} \right\} - b_t}{\delta}, (1-\alpha) \cdot k_t^{\alpha} - b_t - s_t \cdot (1+\eta) \right\}$$

$$E_t R_{t+1} = \max \left\{ 1, \frac{\gamma \cdot E_t \left\{ b_{t+1} + s_{t+1} \right\} - (1-\delta) \cdot b_t}{\delta \cdot ((1-\alpha) \cdot k_t^{\alpha} - s_t \cdot (1+\eta))} \right\}$$

$$\frac{\gamma \cdot E_t b_{t+1}}{E_t R_{t+1}} \geq b_{t+1} \geq 0$$

$$s_t \leq \frac{\overline{\tau} \cdot (1-\alpha) \cdot k_t^{\alpha}}{1+\eta}$$

- Once again:
  - expected bailouts, i.e. $\gamma \cdot E_t s_{t+1}$: provide collateral and expand investment and the capital stock
  - realized bailouts, i.e. s_t; reduce the funds available for investment and contract investment and the capital stock

- Illustrate effects of these bailout policies through a series of examples

Example I: constant growth bubble

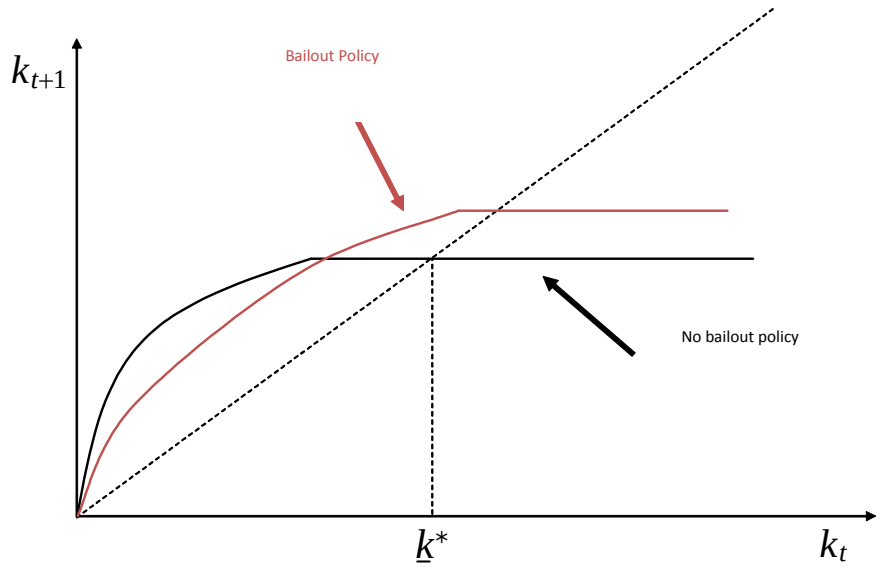
- Deterministic bubble that grows at rate γ: $b_t = b$ in all periods and histories
- Both expected and realized bubble are constant
- Law of motion of the system is

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{(\gamma - 1) \cdot b + \gamma \cdot E_t s_{t+1}}{\delta}, (1 - \alpha) \cdot k_t^{\alpha} - b - s_t \cdot (1 + \eta) \right\}$$

- Consider $s_t = s \cdot b_t$, then economy converges monotonically to

$$k^* = \gamma^{-1} \cdot \min \left\{ \frac{(\gamma \cdot (1 + s) - 1) \cdot b}{\delta}, (1 - \alpha) \cdot (k^*)^{\alpha} - b \cdot (1 + s \cdot (1 + \eta)) \right\}$$

- Graphically: effect of bailout policy



Example II: fluctuations in realized bubble

- Expected bubble is deterministic and grows at rate γ: $E_t b_{t+1} = b$ in all periods and histories
- Realized bubble can fluctuate

$$b_t = \begin{cases} b_H & \text{with prob. } \pi \\ b_L & \text{with prob. } 1-\pi \end{cases}$$

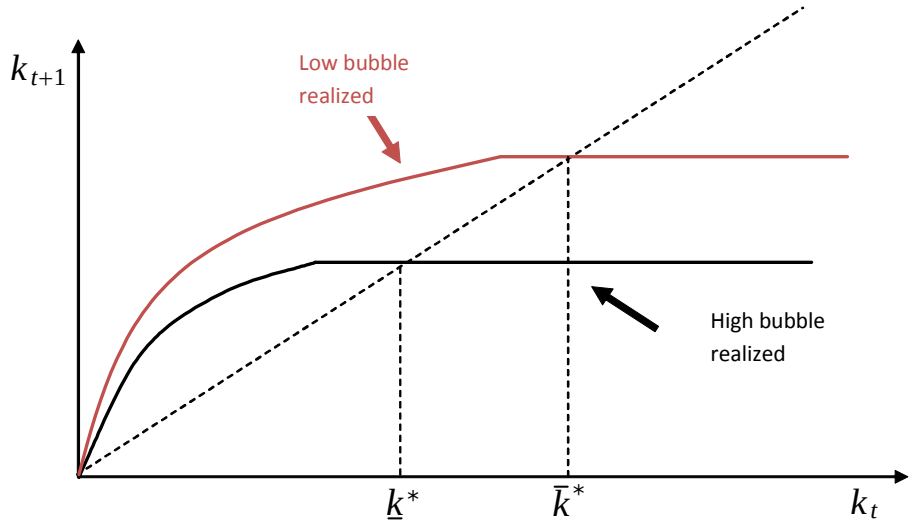
  where $b_H > b_L$; and $b = \pi \cdot b_H + (1-\pi) \cdot b_L$.

- With this bubble, law of motion is:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{\gamma \cdot b - b_t}{\delta}, (1-\alpha) \cdot k_t^{\alpha} - b_t \right\}$$

- The economy fluctuates between two steady states:

$$\bar{k}^* = \frac{\gamma \cdot b - b_L}{\delta} \quad \text{and} \quad \underline{k}^* = \frac{\gamma \cdot b - b_H}{\delta}$$



Example II: fluctuations in realized bubble

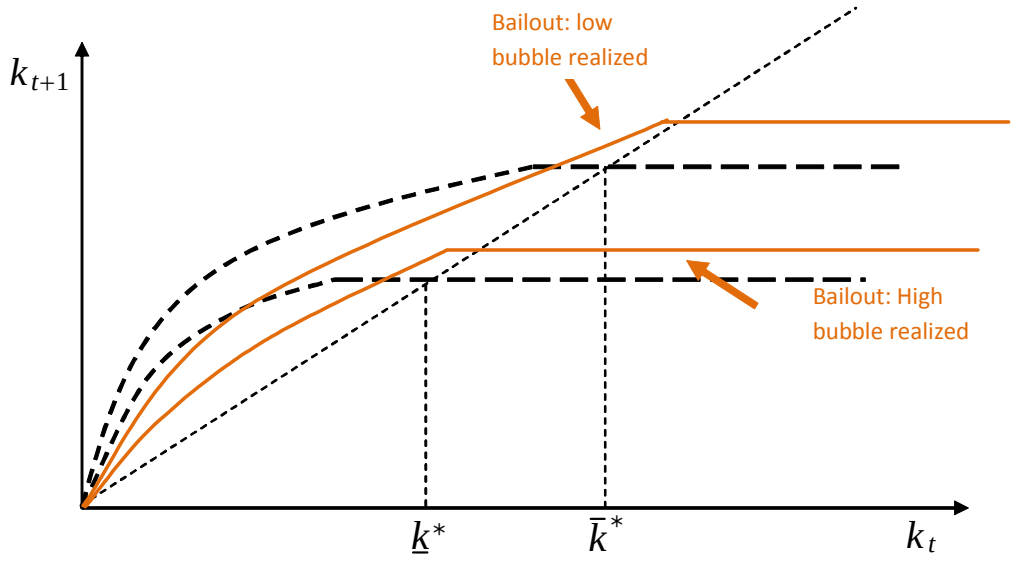
- With government policy, law of motion becomes:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{\gamma \cdot b - b_t + \gamma \cdot E_t s_{t+1}}{\delta}, (1-\alpha) \cdot k_t^{\alpha} - b_t - s_t \cdot (1+\eta) \right\}$$

- Assume the government sets again $s_t = s \cdot b_t$. Then, the two steady-states become:

$$\bar{k}^* = \frac{\gamma \cdot (1+s) \cdot b - b_L}{\delta} \quad \text{and} \quad \underline{k}^* = \frac{\gamma \cdot (1+s) \cdot b - b_H}{\delta}$$

- Graphically,

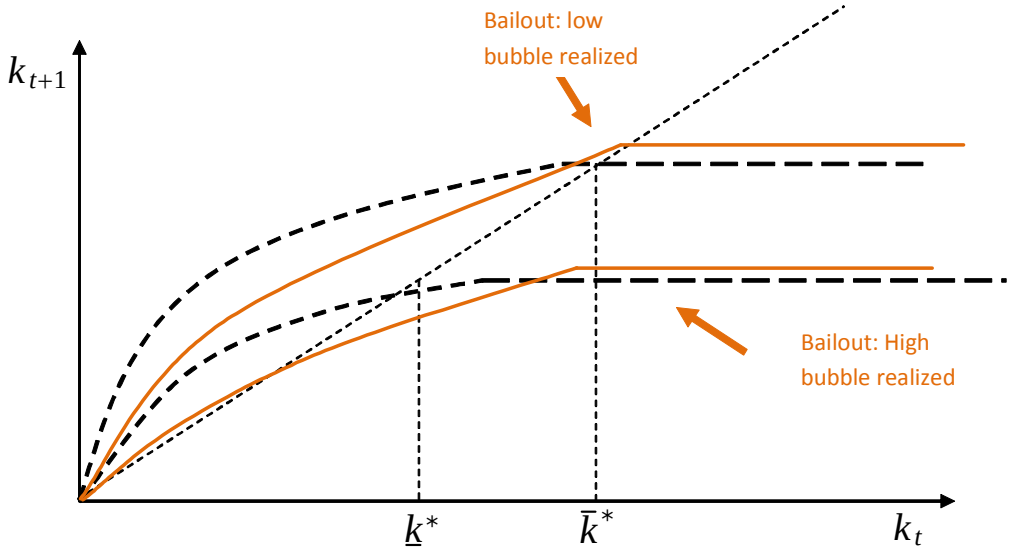


Example II: fluctuations in realized bubble

- Same as before, but steady states without intervention are

$$\bar{k}^* = \frac{\gamma \cdot (1+s) \cdot b - b_L}{\delta} \quad \text{and} \quad \underline{k}^* = (1-\alpha) \cdot (\underline{k}^*)^{\alpha} - b_H$$

- In this case, same policy as before can exacerbate volatility
  - expand economic activity during boom
  - contract it during the recession
- Graphically,



Example III: fluctuations in expected bubble

- Expected bubble fluctuates, i.e. $E_t b_{t+1} = b_t$ in all periods and histories
- But realized bubble can fluctuate. In particular:

$$E_t b_{t+1} = b_t = \begin{cases} b_H & \text{with prob. } \pi \\ b_L & \text{with prob. } 1-\pi \end{cases}$$

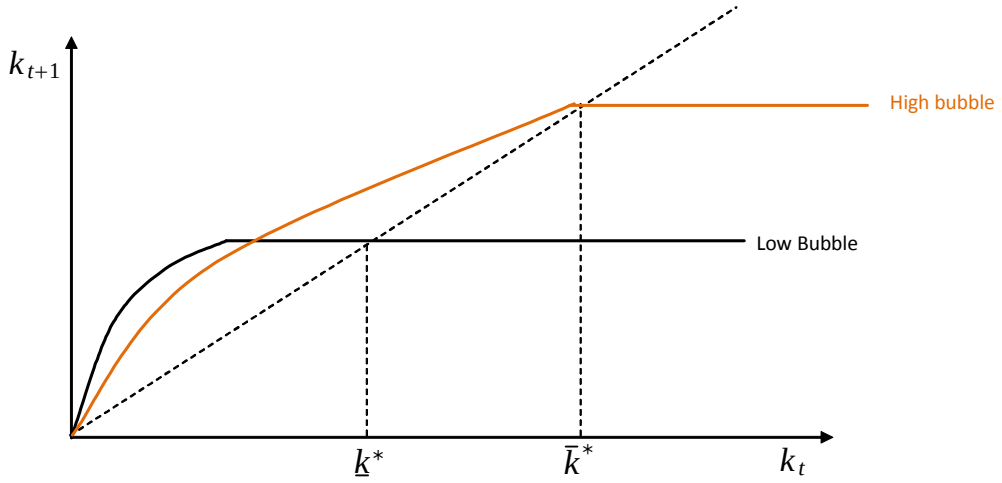
  where $b_H > b_L$

- With this bubble, the law of motion is:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{(\gamma - 1) \cdot b_t}{\delta}, (1-\alpha) \cdot k_t^{\alpha} - b_t \right\}$$

- Economy fluctuates between two steady states:

$$\bar{k}^* = \frac{(\gamma - 1) \cdot b_H}{\delta} \quad \text{and} \quad \underline{k}^* = (1-\alpha) \cdot k_t^{\alpha} - b_t \frac{(\gamma - 1) \cdot b_L}{\delta}$$



Example III: fluctuations in expected bubble

- With government policy, law of motion becomes:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{(\gamma - 1) \cdot b_t + \gamma \cdot E_t s_{t+1}}{\delta}, (1 - \alpha) \cdot k_t^{\alpha} - b_t - s_t \cdot (1 + \eta) \right\}$$

- We could have similar discussion as before
  - By raising the collateral of firms, government policy can boost growth by dimishing inventories
  - But it might also make downturns worse because taxation diverts resources away from credit and investment

Financial intermediaries

- Introduce financial intermediaries: bankers (B_t)
  - same preferences as savers or entrepreneurs
- Derive all income from managing banks
  - During youth, borrow deposits D_t to make loans L_t
  - During old age, collect payment $R^L_{t+1}L_t$ from entrepreneurs
  - After producing, sell bank at price V^B_{t+1}, pay debts $R^D_{t+1}D_t$, and consume
- Deposits need to be collateralized
  - Weak enforcement institutions: only fraction $\phi \in [0,1]$ of loan repayments can be pledged
  - Borrowing constraint

$$R^D_{t+1} \cdot D_t \leq V^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}$$

- Note: banks contain no real assets and their price consists only of the bubble component: $V^B_t = B^B_t$
- Optimal demand for deposits

$$D_t \begin{cases} = \dfrac{E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}}{E_t R^D_{t+1}} & \text{if } E_t R^L_{t+1} > E_t R^D_{t+1} \\ \in \left[B^B_t, \dfrac{E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}}{E_t R^D_{t+1}} \right] & \text{if } E_t R^L_{t+1} = E_t R^D_{t+1} \end{cases}$$

Markets and prices

- Credit market affected:
  - rate on deposits must satisfy

$$E_t R^D_{t+1} = \begin{cases} 1 & \text{if } E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1} \leq W_t \\ \dfrac{E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}}{W_t} & \text{if } 1 < \dfrac{E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}}{W_t} < E_t R^L_{t+1} \\ E_t R^L_{t+1} & \text{if } E_t R^L_{t+1} \leq \dfrac{E_t B^B_{t+1} + \phi \cdot E_t R^L_{t+1} \cdot L_{t+1}}{W_t} \end{cases}$$

    reflecting ratio of demand to supply of deposits
  - rate on loans must satisfy

$$E_t R^L_{t+1} = \begin{cases} E_t R^D_{t+1} & \text{if } \dfrac{E_t V^E_{t+1}}{D_t - B^B_t} \leq E_t R^D_{t+1} \\ \dfrac{E_t V^E_{t+1}}{D_t - B^B_t} & \text{if } E_t R^D_{t+1} < \dfrac{E_t V^E_{t+1}}{D_t - B^B_t} < E_t R^K_{t+1} \\ E_t R^K_{t+1} & \text{if } E_t R^K_{t+1} \leq \dfrac{E_t V^E_{t+1}}{D_t - B^B_t} \end{cases}$$

    reflecting ration of demand to supply of loans

- Here, once again, bubbly collateral sustains intermediation:
  - bubble in financial intermediaries helps sustain deposits
  - bubble in firms helps sustain loans

Competitive Equilibrium

- The economy in a nutshell:

$$K_{t+1} = L_t - B_t^E$$

$$L_t = D_t - B_t^B$$

$$D_t = \min \left\{ \frac{EB_{t+1}^B + \phi \cdot \left(E_t B_{t+1}^E - (1-\delta) \cdot \left(B_t^E + B_t^B \right) \right)}{1 - \phi \cdot (1-\delta)}, \frac{E_t B_{t+1}^E - (1-\delta) \cdot B_t^E}{\delta} + B_t^B, W_t \right\}$$

$$W_t = (1-\alpha) \cdot A_t^{1-\alpha} \cdot K_t^{\alpha}$$

$$D_t - B_t^B \geq B_t^E \geq 0 \text{ and } B_t^B \geq 0$$

- Competitive equilibrium: stochastic proces for bubble shock

$$\left\{ B_t^B \left(h^t \right), B_t^E \left(h^t \right), E_t B_{t+1}^B \left(h^t \right), E_t B_{t+1}^E \left(h^t \right) \right\}_{t=0}^{\infty}$$

and non-negative sequence for the capital stock and its price, loans, deposits and savings:

$$\left\{ K_t \left(h^t \right), L_t \left(h^t \right), D_t \left(h^t \right), W_t \left(h^t \right), \right\}_{t=0}^{\infty}$$

satisfying previous restrictions

Bubbly Business Cycles

- Bubbles now implement transfers
  - from young savers to young bankers and old savers
  - from young bankers to young entrepreneurs and old entrepreneurs
- Equilibrium dynamics of capital and bubbles:

$$k_{t+1} = \gamma^{-1} \cdot \min \left\{ \frac{\left(\gamma \cdot E_t b_{t+1} - b_t^B\right) + \left(\phi \cdot \gamma \cdot E_t b_{t+1}^E - b_t^E\right)}{1 - \phi \cdot (1 - \delta)}, \frac{\gamma \cdot E_t b_{t+1}^E - b_t^E}{\delta}, (1 - \alpha) \cdot k_t^\alpha - b_t^E - b_t^B \right\}$$

- Main insights
  - dynamics affected not only by amount of collateral, but also by its distribution
  - hence, dynamics affected both by size and distribution of bubbly collateral

Discussion and final thoughts

- Simple, theoretical model of bubbly business cycles
- Bubbly episodes: growth in stock prices, collateral, credit and productive investment
  - investment and output rise
  - interaction of different types of private collateral: productive and financial sectors
- Connection with models of the financial accelerator (Martin Ventura 2011)
  - like them: higher asset prices raise credit, efficiency and growth
  - unlike them: asset prices decoupled from fundamentals
- Policy implications:
  - in economy with scarce collateral, government can use taxation power to provide public collateral
    - this provision might seam inexpensive (or profitable!) when bubble boosts growth
    - costly in recession, making downturn worse
  - government can also intervene to avoid wasteful investment and excessive bubble
- At the end of the day revisit old and fascinating question
  - should the authority target asset prices? (Bernanke and Gertler (1999))
  - but do so in a theoretically consistent model in which prices are endogenous

Where do we go from here?

- Can these mechanisms really be quantitatively important?
  - let's see
  - embed investor sentiment shock into quantitative model
    - sophisticated model with rich demographics / preferences
  - can we distinguish between TFP and investor sentiment shocks in recent past?
  - Carvalho et al. (2011)