Plan

1. The bubbly economy
2. A lender of last resort
3. The fiscal backstop
4. Financial intermediaries
5. Concluding remarks

The bubbly economy

- Two-period OLG. Generations contain workers/lenders and entrepreneurs/borrowers that maximize:

$$U_t^i = C_{t,t}^i + \beta \cdot E_t C_{t,t+1}^i$$

  – we measure generational welfare as $U_t = \sum_i U_t^i$

- *Workers/lenders* supply one unit of labor when young, receive wage W_t and decide how much to save:

$$C_{t,t}^i = W_t - L_t$$

$$C_{t,t+1}^i = R_{t+1} \cdot L_t$$

  – workers/lenders save by purchasing credit contracts

  – credit contracts offer (possibly contingent) return $R_{t+1} \Rightarrow$ we call $E_t R_{t+1}$ the interest rate

  – workers/lenders maximize utility subject to budget constraints

- *Entrepreneurs/borrowers* sell credit contracts to construct portfolios of capital and bubbles (like real-world firms?):

  – three choices: credit, capital, and bubbles

The bubbly economy (II)

- Entrepreneurs/borrowers invest and produce
  - investment technology:
    - $*$ produce capital for time $t+1$ by investing consumption goods at time t (one-to-one)
    - $*$ capital fully depreciates in production
  - production technology:

$$F(K_t, N_t) = A_t \cdot K_t^{\alpha} \cdot \left(\gamma^t \cdot N_t\right)^{1-\alpha}$$

    - $*$ $\gamma \geq 1$: growth of labor productivity
    - $*$ $A_t \in \{A_L, A_H\}$, with $A_L < A_H$ and $Pr(A_{t+1} \neq A_t) = \eta < 0.5$

The bubbly economy (III)

- Entrepreneurs/borrowers initiate and trade bubbles:
  - intrinsically useless asset: only held for resale, does not promise any payments
- Let B_t denote value of bubbles in period t
  - some bubbles purchased from previous generations of entrepreneurs/borrowers
  - some bubbles initiated by current generation of old entrepreneurs/borrowers
  - aggregate bubble evolves as follows

$$B_{t+1} = R_{t+1}^B \cdot B_t + B_{t+1}^N$$

    where

    * R_{t+1}^B is return to bubbles purchased from generation $t-1$;
    * B_{t+1}^N is the value of bubbles initiated by generation t, "bubble creation"
- Two assumptions:
  - bubble is independent of individual actions
  - B_{t+1}^N is random and non-negative

The bubbly economy (IV)

- Entrepreneurs/borrowers sell credit contracts to workers/savers
- Credit contracts need to be collateralized
  - interest payments can be contingent
  - weak enforcement institutions limit amount of collateral
    - entrepreneurs/borrowers can hide a fraction $1-\phi$ of profits
- Credit or collateral constraint

$$R_{t+1} \cdot L_t \leq \phi \cdot \left[F\left(K_{t+1}, N_{t+1}\right) - W_{t+1} \cdot N_{t+1}\right] + B_{t+1}$$

- Young and old-age budget constraints of entrepreneurs/borrowers given by

$$C_{t,t}^i = L_t - K_{t+1} - B_t$$

$$C_{t,t+1}^i = F\left(K_{t+1}, N_{t+1}\right) - W_{t+1} \cdot N_{t+1} + B_{t+1} - R_{t+1} \cdot L_t$$

- Entrepreneurs/borrowers maximize utility subject to credit and budget constraints
- From now on: lowercase letters to denote variables in efficiency units of labor, e.g. $k_t = \gamma_t^{-1} \cdot K_t$

Markets and prices

- *Labor market:* old entrepreneurs/borrowers (henceforth, borrowers) demand labor from young workers/lenders (henceforth, lenders)

$$w_t = (1-\alpha) \cdot A_t \cdot k_t^{\alpha}$$

- *Market for bubbles:* old borrowers sell bubbles to young borrowers

$$E_t R_{t+1}^B = E_t R_{t+1}$$

- *Credit market:* young lenders give credit to young borrowers

  – supply of credit by young lenders

$$l_t \begin{cases} = w_t & \text{if } \beta \cdot E_t R_{t+1} > 1 \\ \in [0, w_t] & \text{if } \beta \cdot E_t R_{t+1} = 1 \end{cases}$$

  – demand for credit by young borrowers

$$R_{t+1} = \begin{cases} \alpha \cdot A_{t+1} \cdot k_{t+1}^{\alpha-1} & \text{if } E_t b_{t+1}^N \geq (1-\phi) \cdot \alpha \cdot E_t A_{t+1} \cdot k_{t+1}^{\alpha} \\ \dfrac{\phi \cdot \alpha \cdot A_{t+1} \cdot k_{t+1}^{\alpha} + b_{t+1}}{\gamma^{-1} \cdot l_t} & \text{if } E_t b_{t+1}^N < (1-\phi) \cdot \alpha \cdot E_t A_{t+1} \cdot k_{t+1}^{\alpha} \end{cases}$$

Equilibrium dynamics

- Collapse previous equations as follows:

$$k_{t+1} \begin{cases} = \dfrac{1-\alpha}{\gamma} \cdot A_t \cdot k_t^{\alpha} - \dfrac{b_t}{\gamma} & \text{if } \beta \cdot E_t R_{t+1} > 1 \\ \in \left[0, \dfrac{1-\alpha}{\gamma} \cdot A_t \cdot k_t^{\alpha} - \dfrac{b_t}{\gamma}\right] & \text{if } \beta \cdot E_t R_{t+1} = 1 \end{cases} \qquad \text{(Supply of funds)}$$

$$E_t R_{t+1} = \min \left\{\alpha \cdot E_t A_{t+1}, E_t \left\{(\phi \cdot \alpha + n_{t+1}) \cdot A_{t+1}\right\}\right\} \cdot k_{t+1}^{\alpha-1} \qquad \text{(Demand of funds)}$$

$$b_{t+1} = \frac{E_t R_{t+1} + u_{t+1}}{\gamma} \cdot b_t + n_{t+1} \cdot A_{t+1} \cdot k_{t+1}^{\alpha} \qquad \text{(Bubble dynamics)}$$

where

- u_{t+1} is unexpected component of bubble returns: $u_{t+1} \equiv R_{t+1}^B - E_t R_{t+1}^B$
- n_{t+1} is value of new bubbles as a share of output: $n_{t+1} \equiv \dfrac{b_{t+1}^N}{A_{t+1} \cdot k_{t+1}^{\alpha}}$

- Equilibria:
  - propose stochastic process for bubble shocks $\{u_t, n_t\}$, satisfying $E_t u_{t+1} = 0$, $b_t \geq 0$ and $n_t \geq 0$
  - search for sequence of state variables $\{k_t, b_t\}$ that satisfies dynamic system with $k_t \geq 0, b_t \geq 0$
  - bubbleless equilibrium with $\{u_t, n_t\} = \{0, 0\}$ always exists
  - but there are others!

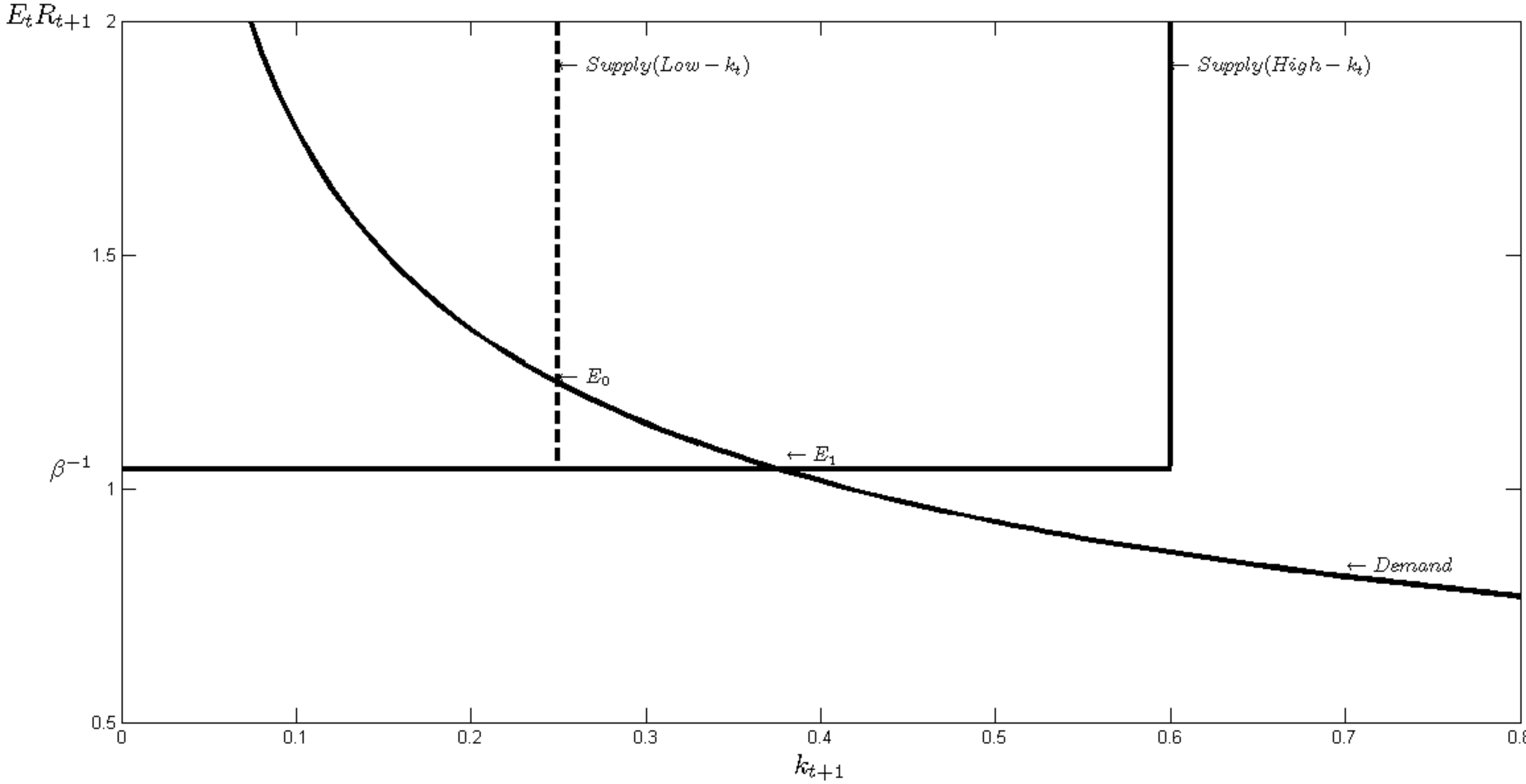


Figure 3: Demand and supply of funds for investments

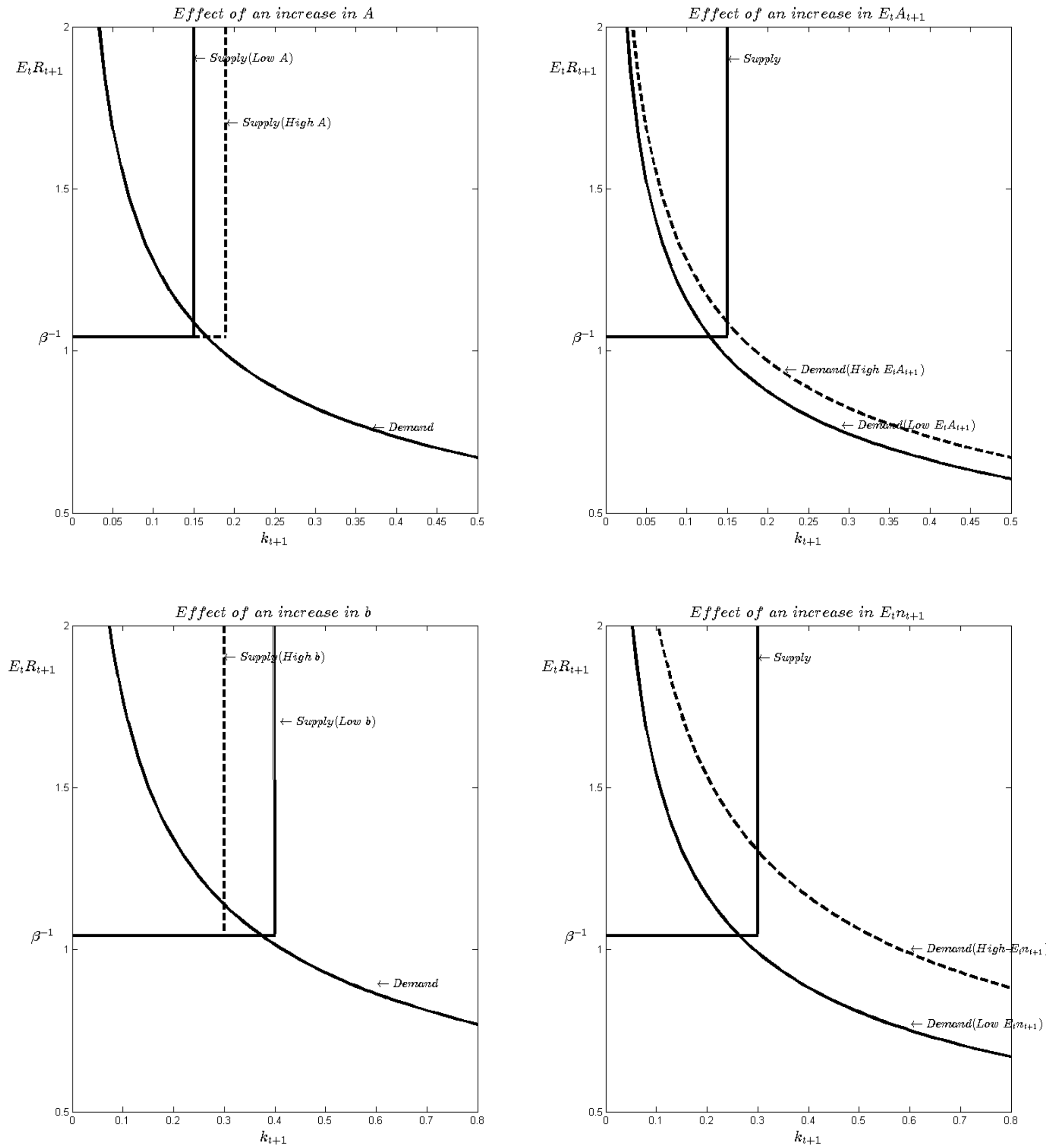


Figure 4: Demand and supply of funds in the presence of shocks

Bubbly equilibria

- Borrowers wish to purchase bubbles $\Leftrightarrow$ they grow as fast as the interest rate
- Borrowers can afford to purchase bubbles $\Leftrightarrow$ they do not grow faster than the economy
- Thus, bubbles can only exist if the rate of interest is lower than the growth rate of the economy
  - bubbles raise the interest rate $\Rightarrow$ condition must hold in bubbleless equilibrium
- Two possibilities:
  - interest rate is low because there is too much investment
  - interest rate is low because financial frictions limit fundamental collateral
    - focus on this last possibility, assuming

$$\frac{1}{2} < \alpha < \frac{1}{1+\phi}$$

Bubbly equilibria

- *Example 1*: economy with quiet bubble, $\{u_t, n_t\} = \{0, n\}$ for all t
  - constant productivity, $A_t = A$ for all t
- Main insight: there is an "optimal" size of the bubble

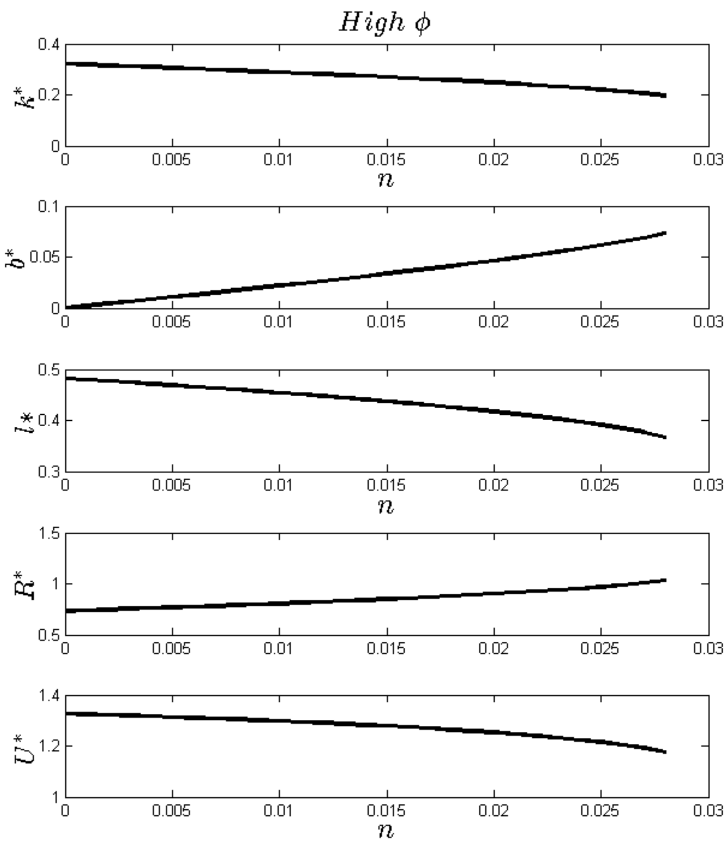


Figure 5: Deterministic Steady States

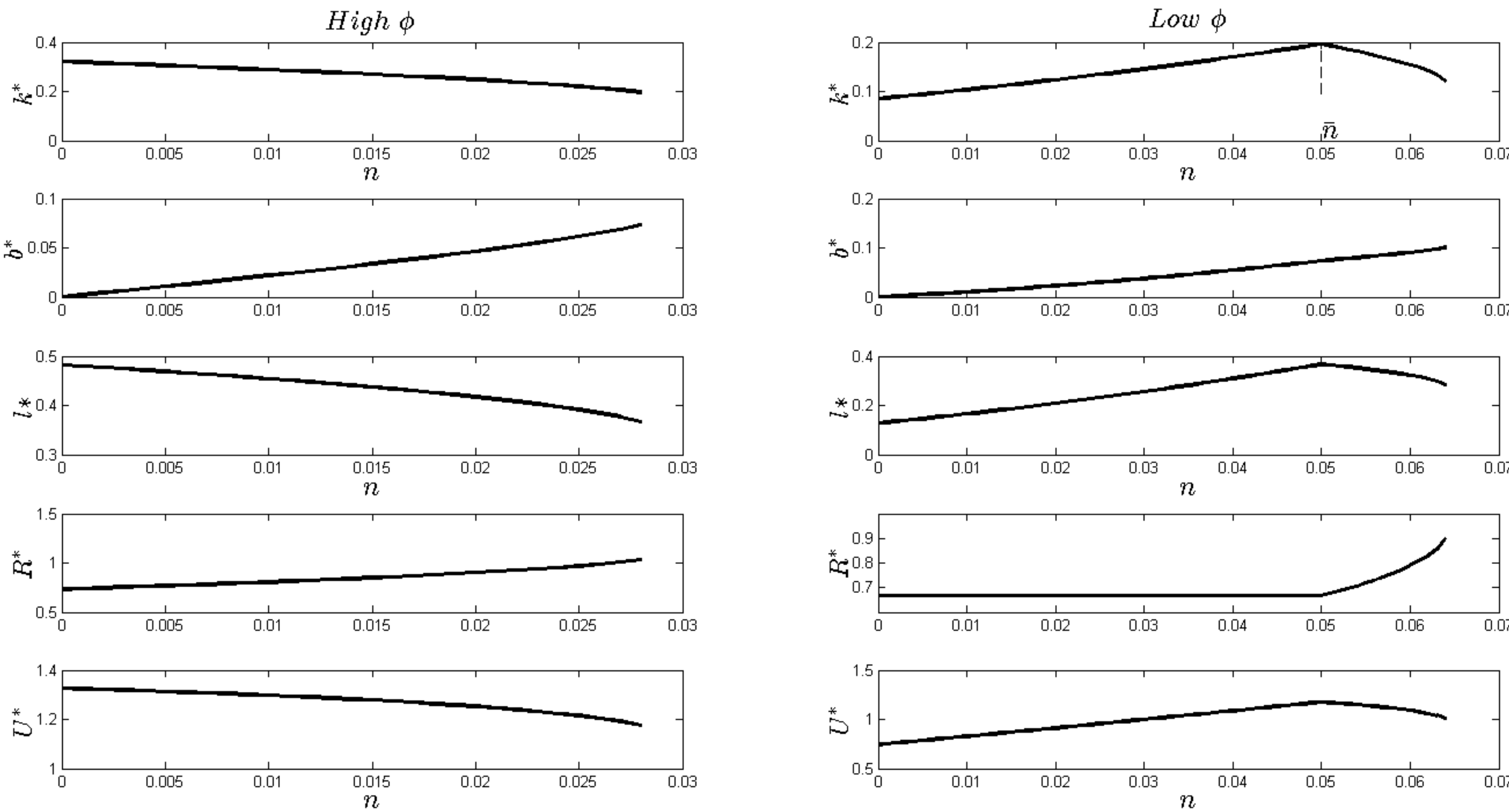


Figure 5: Deterministic Steady States

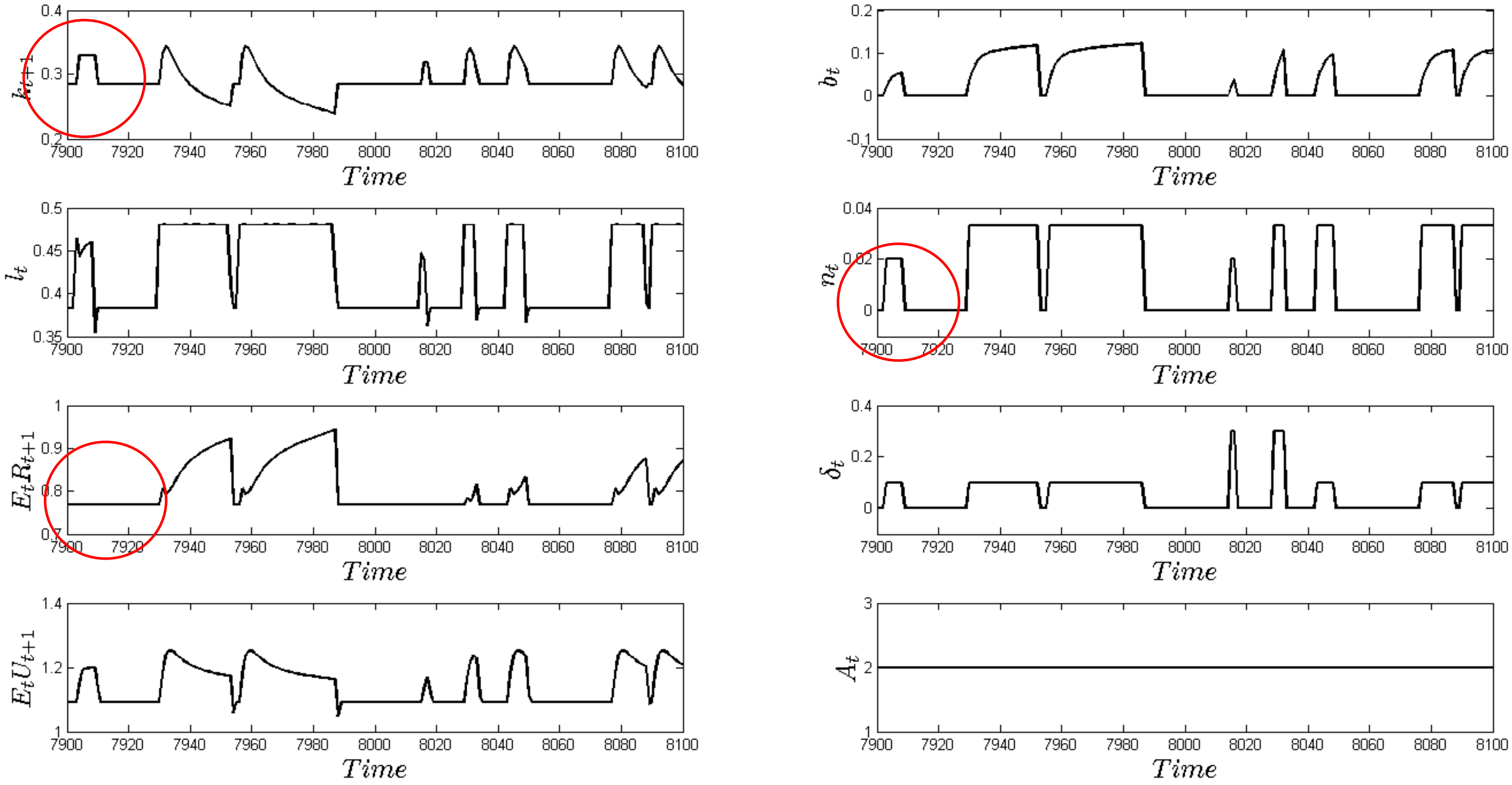
Bubbly equilibria (II)

- *Example 2*: economy with bubbly episodes:
  - constant productivity but different types of bubbles
  - ε probability that a bubble pops up
  - δ is the probability of the bubble bursting
  - types of bubble:

Size\Risk	safe	risky
small	(n_S, δ_S)	(n_S, δ_R)
large	(n_L, δ_S)	(n_L, δ_R)

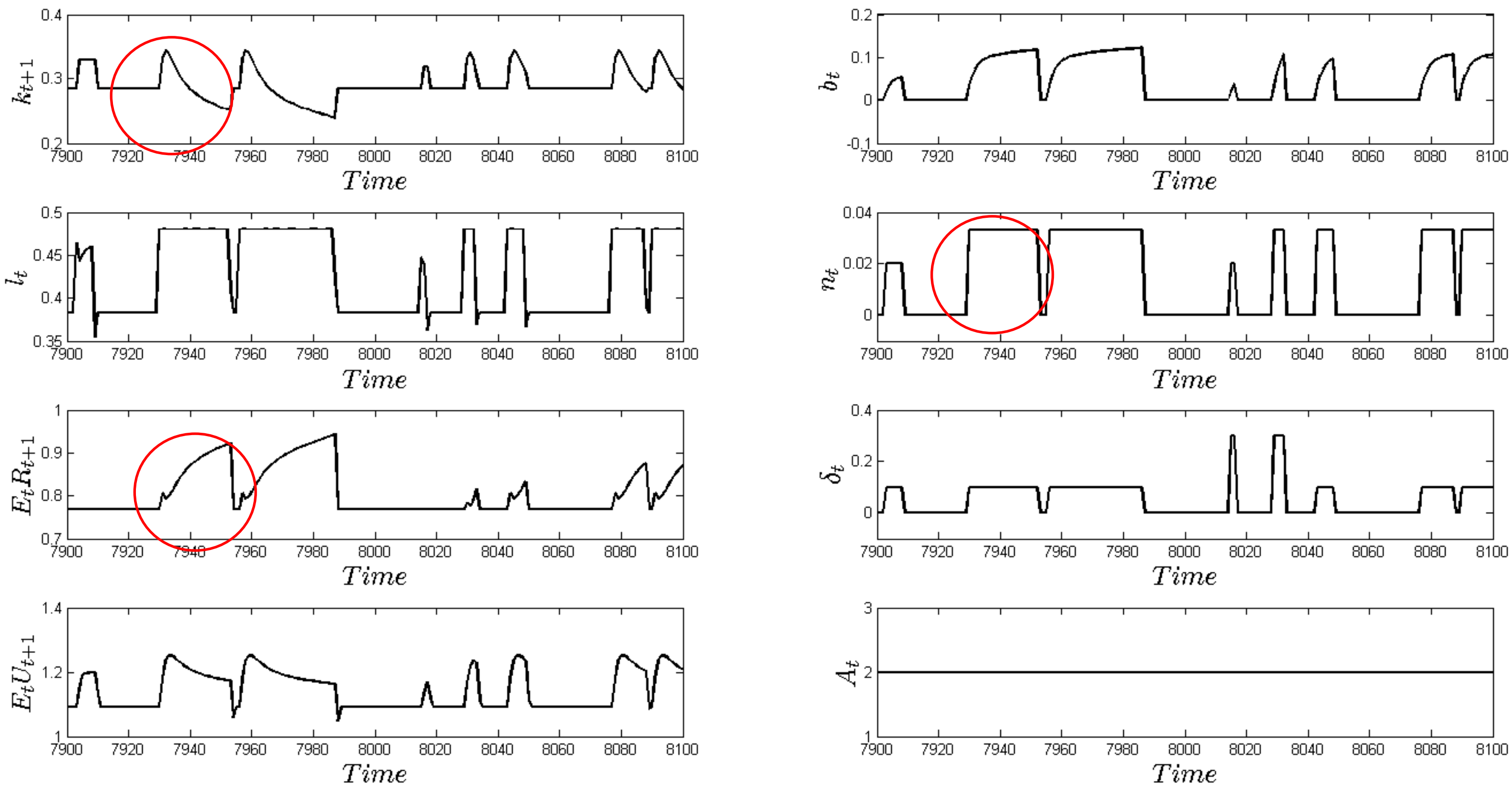
  - simulate 10,000 periods of steady state behavior

- Main insights:
  - bubbly episodes give rise to macroeconomic fluctuations
  - the distance between equilibrium and "optimal" bubble varies over time in a complex way



		Summary Statistics
k_{t+1}	μ	0.297
	$s.d.$	0.027
E_tU_{t+1}	μ	1.136
	$s.d.$	0.079

Figure 6: Simulated economy with bubble shocks and constant productivity

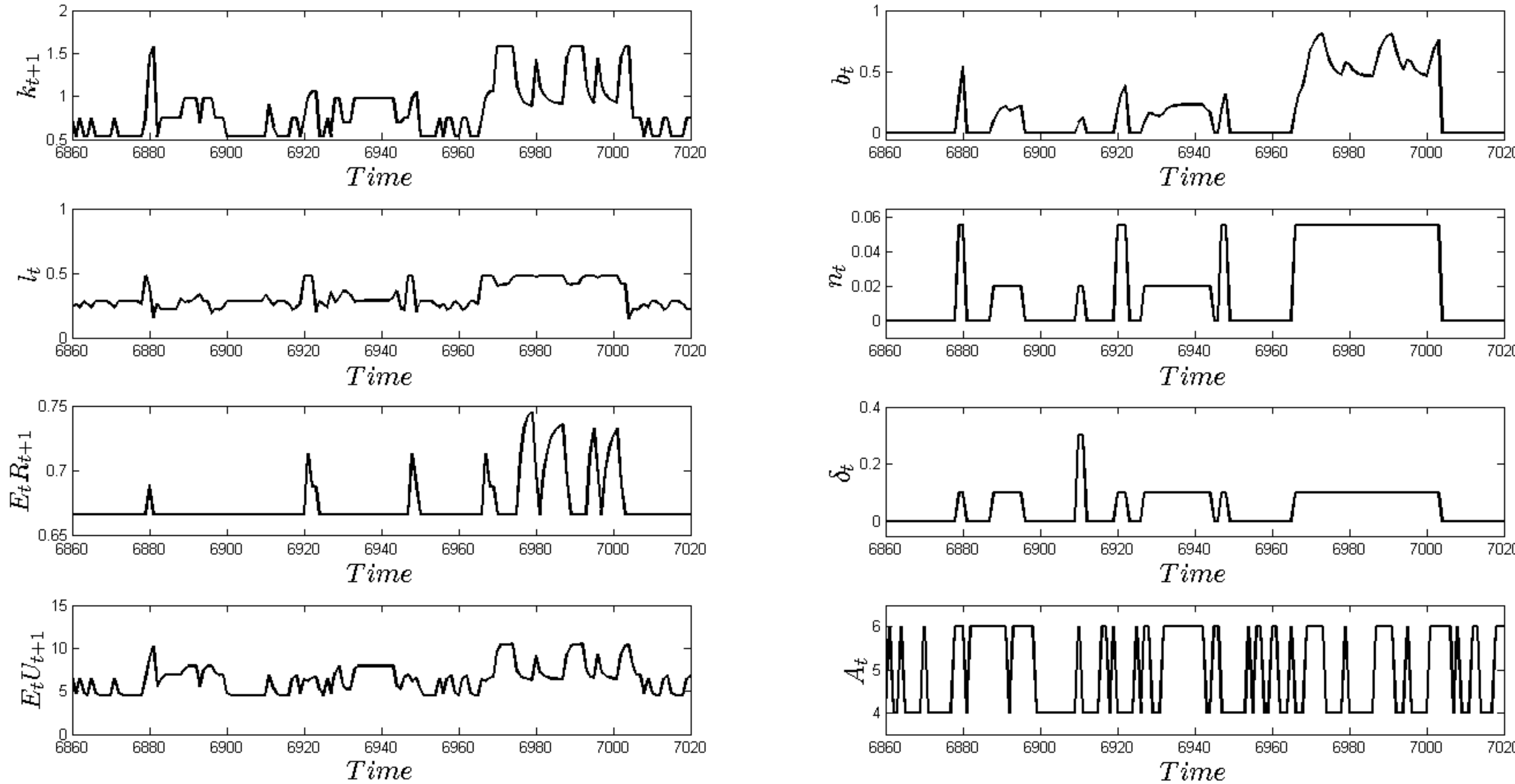


		Summary Statistics
k_{t+1}	μ	0.297
	$s.d.$	0.027
E_tU_{t+1}	μ	1.136
	$s.d.$	0.079

Figure 6: Simulated economy with bubble shocks and constant productivity

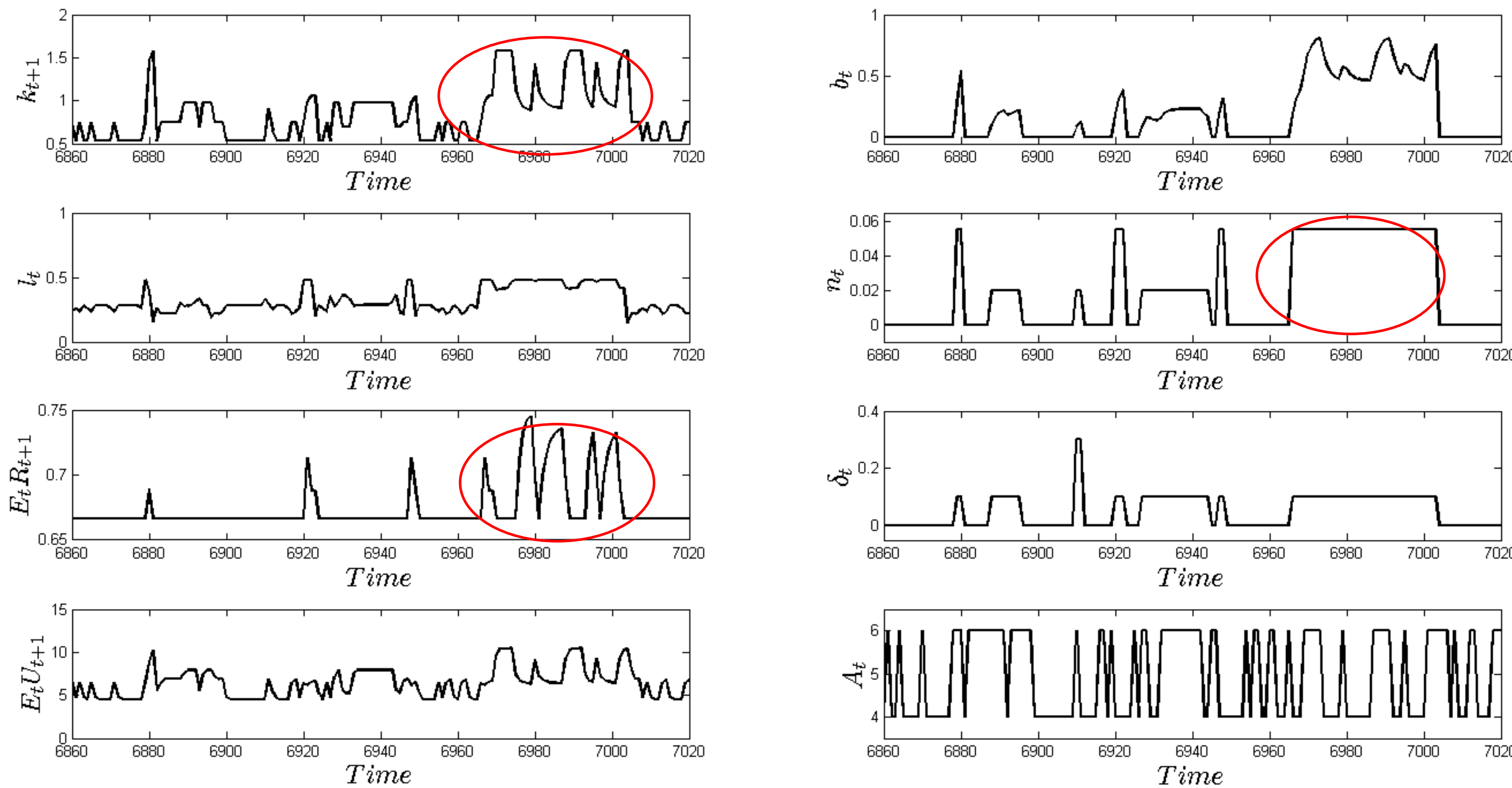
Bubbly equilibria (III)

- *Example 3*: economy with bubbly episodes and productivity shocks
- Main insights:
  - a bubble that is "too small" when $A_t = A_H$ might be "too large" when $A_t = A_L$
  - relative strength of crowding-in and crowding-out effects depends on fundamentals
- The bubble that attains full intermediation:
  - grows during booms and shrinks during recessions
  - accentuates effects of productivity shocks



		Summary Statistics
k_{t+1}	μ	0.809
	$s.d.$	0.288
E_tU_{t+1}	μ	6.396
	$s.d.$	1.618

Figure 7: Simulated economy with bubble and productivity shocks



		Summary Statistics
k_{t+1}	μ	0.809
	$s.d.$	0.288
$E_t U_{t+1}$	μ	6.396
	$s.d.$	1.618

Figure 7: Simulated economy with bubble and productivity shocks

A lender of last resort

- Bubbly economy: shortage of fundamental collateral
  - bubbles can help, but they can also hurt capital accumulation and growth
- Can policy provide the optimal amount of collateral?
  - introduce agency to manage collateral through credit market interventions
- Lender of last resort (LOLR) that
  - taxes borrowing by young borrowers / subsidizes repayment by old borrowers
  - no direct effect on bubble, but allow for management of collateral

Bubbly economy with LOLR

- Let S_t denote transfers to old borrowers, financed by taxes X_t on young borrowers:
  - S_t possibly contingent, i.e. guarantees
  - no bailouts, i.e. no net transfers to borrowers from other agents
  - balanced budget: $S_t = X_t$
- No direct impact on lenders
- Wealth of borrowers affected: policy provides resources

$$S_{t+1}^N \equiv S_{t+1} - E_t R_{t+1} \cdot X_t$$

  to borrowers of generation t, "collateral creation" by LOLR

- Borrower credit constraint becomes:

$$R_{t+1} \cdot L_t \leq \phi \cdot \left[F\left(K_{t+1}, N_{t+1}\right) - W_{t+1} \cdot N_{t+1} \right] + B_{t+1} + S_{t+1}$$

Markets and prices with a LOLR

- *Labor market:* as before
- *Market for bubbles:* as before
- *Credit market:*
  - supply of credit by young lenders: as before
  - demand for credit by young borrowers affected by intervention

$$R_{t+1} = \begin{cases} \alpha \cdot A_{t+1} \cdot k_{t+1}^{\alpha-1} & \text{if } E_t\left(b_{t+1}^N + s_{t+1}^N\right) \geq (1-\phi) \cdot \alpha \cdot E_t A_{t+1} \cdot k_{t+1}^{\alpha} \\ \dfrac{\phi \cdot \alpha \cdot A_{t+1} \cdot k_{t+1}^{\alpha} + b_{t+1} + s_{t+1}}{k_{t+1} + \gamma^{-1} \cdot (b_t + s_t)} & \text{if } E_t\left(b_{t+1}^N + s_{t+1}^N\right) < (1-\phi) \cdot \alpha \cdot E_t A_{t+1} \cdot k_{t+1}^{\alpha} \end{cases}$$

Dynamics and welfare with a LOLR

- Collapse previous equations as follows:

$$k_{t+1} \begin{cases} = \dfrac{(1-\alpha)\cdot A_t \cdot k_t^{\alpha} - b_t - s_t}{\gamma} & \text{if } \beta \cdot E_t R_{t+1} > 1 \\ \in \left[0, \dfrac{(1-\alpha)\cdot A_t \cdot k_t^{\alpha} - b_t - s_t}{\gamma}\right] & \text{if } \beta \cdot E_t R_{t+1} = 1 \end{cases} \qquad \text{(Supply of funds)}$$

$$E_t R_{t+1} = \min\left\{\alpha \cdot E_t A_{t+1}, E_t\left\{(\phi \cdot \alpha + n_{t+1} + m_{t+1}) \cdot A_{t+1}\right\}\right\} \cdot k_{t+1}^{\alpha-1} \qquad \text{(Demand of funds)}$$

$$b_{t+1} = \frac{E_t R_{t+1} + u_{t+1}}{\gamma} \cdot b_t + n_{t+1} \cdot A_{t+1} \cdot k_{t+1}^{\alpha} \qquad \text{(Bubble dynamics)}$$

$$s_{t+1} = \frac{E_t R_{t+1}}{\gamma} \cdot s_t + m_{t+1} \cdot A_{t+1} \cdot k_{t+1}^{\alpha} \qquad \text{(Policy dynamics)}$$

  where

  – m_{t+1} is the policy instrument, value of s_{t+1}^N as a share of output: $m_{t+1} \equiv \dfrac{s_{t+1}^N}{A_{t+1} \cdot k_{t+1}^{\alpha}}$

- Dynamic effects of LOLR policy mimic those of bubble shocks

  – past policy choices embedded in s_t: reduce supply of funds for investment

  – future policy choices as captured in m_{t+1}: raise collateral and demand for investment

- Construction of equilibria as before, *given* stochastic process $\{m_t\}$ for policy

Policy

- LOLR can replicate any equilibrium of original economy
  - consider economy characterized by process $\{u_t, n_t\}$ and corresponding bubble b_t
  - it is possible to replicate equilibrium under alternative process $\{\hat{u}_t, \hat{n}_t\}$, and corresponding bubble $\hat{b}_t$, by setting m_t

$$m_t \cdot A_t \cdot k_t^{\alpha} = \frac{\hat{u}_t \cdot \hat{b}_{t-1} - u_t \cdot b_{t-1}}{\gamma} + (\hat{n}_t - n_t) \cdot A_t \cdot k_t^{\alpha}$$

- If markets provide too little collateral or too much of it....consider policies to stabilize it!
- In particular, set $\{m_t\}$ to satisfy

$$E_t \{m_{t+1} \cdot A_{t+1}\} = \beta^{-1} \cdot k_{t+1}^{1-\alpha} - E_t \{(\phi \cdot \alpha + n_{t+1}) \cdot A_{t+1}\}$$

$$k_{t+1} = \frac{(1-\alpha) \cdot A_t \cdot k_t^{\alpha} - b_t - s_t}{\gamma}$$

  - stabilizes $E_t R_{t+1} = \beta^{-1}$ at all times in all periods
  - guarantees full intermediation of wages

- "Leaning against the wind": policy rule
  - 'complements' bubble when collateral is scarce by subsidizing credit
  - 'counteracts' bubble when collateral is abundant by taxing credit

Bubbly equilibria with policy

- *Example 1*: economy with quiet bubble, $\{u_t, n_t\} = \{0, n\}$ for all t

- Let n^* denote the optimal bubble in this example

- Effects of proposed policy rule $\Rightarrow$ set $m = n^* - n$ in all periods

  – policy raises steady state level of capital and welfare and sets $\beta \cdot E_t R_{t+1} = 1$

  – if bubble is small, policy raises intermediation by setting $m > 0$

  – if bubble is large, policy lowers interest rate by setting $m < 0$

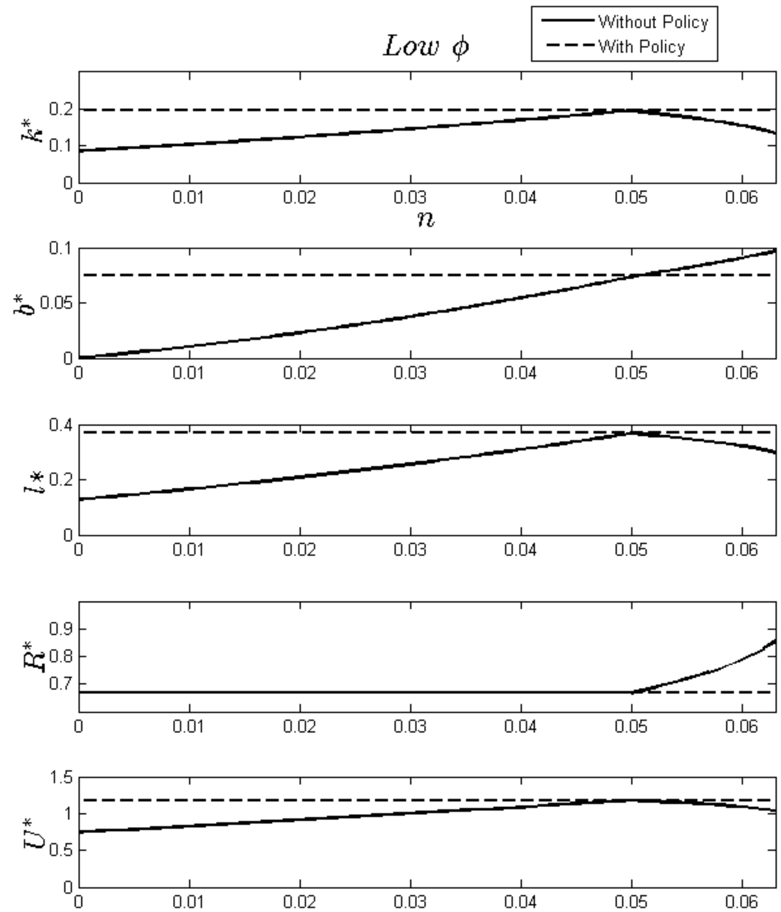


Figure 8: Effect of policy in an economy with bubble shocks and constant productivity

Bubbly equilibria with policy (II)

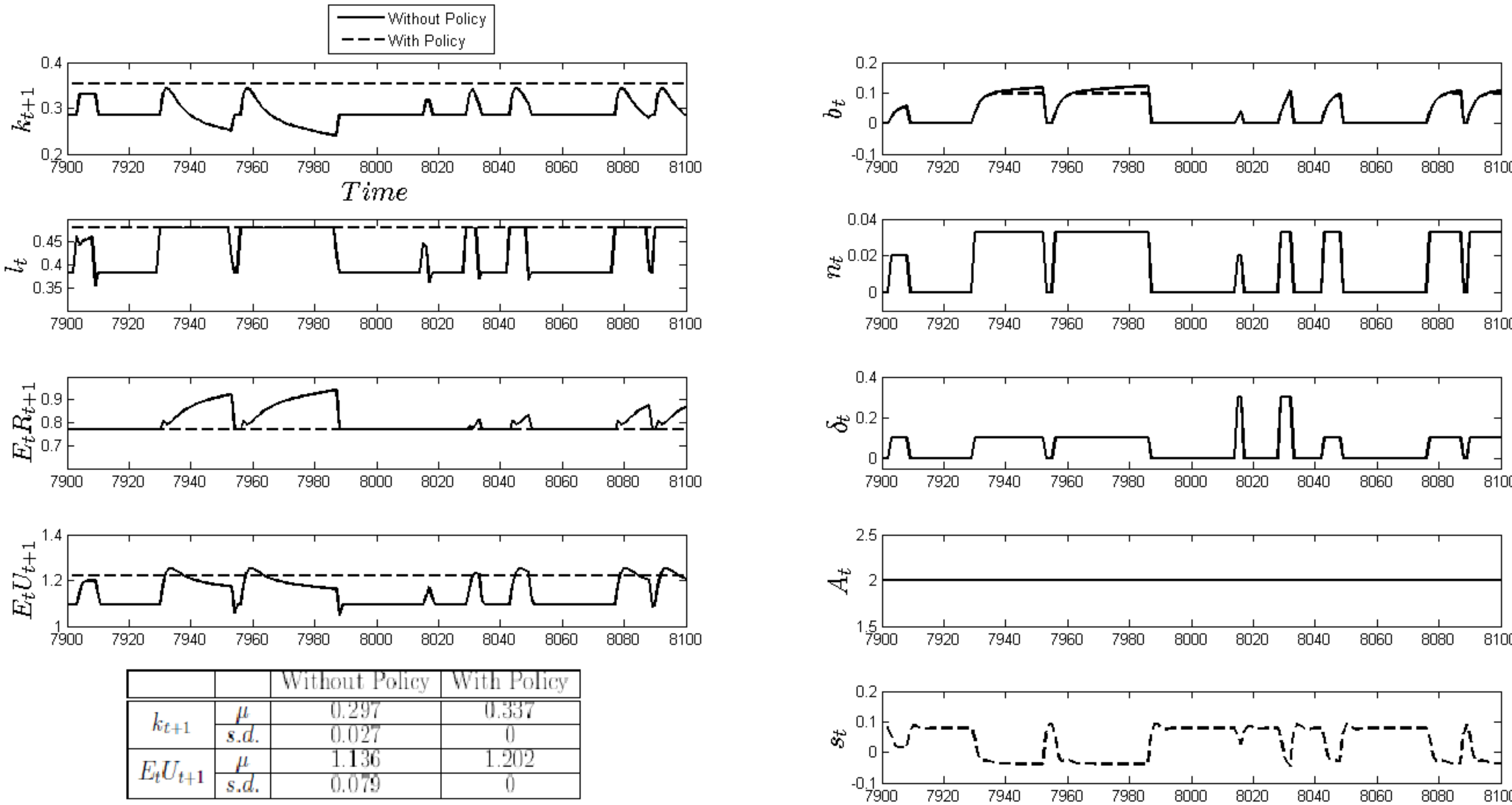
- *Example 2*: economy with bubbly episodes

- Same as before, policy rule sets

$$m_t \cdot A_t \cdot k_t^{\alpha} = (n^* - n_t) \cdot A_t \cdot k_t^{\alpha} - \frac{u_t \cdot b_{t-1}}{\gamma}$$

  to replicate allocation that would arise under quiet bubble $\{0, n^*\}$

- This policy rule
  - sets $\beta \cdot E_t R_{t+1} = 1$ in all periods
  - stabilizes and raises steady state level of capital
  - stabilizes steady state consumption and raises average welfare
  - Note: not everyone is happy!

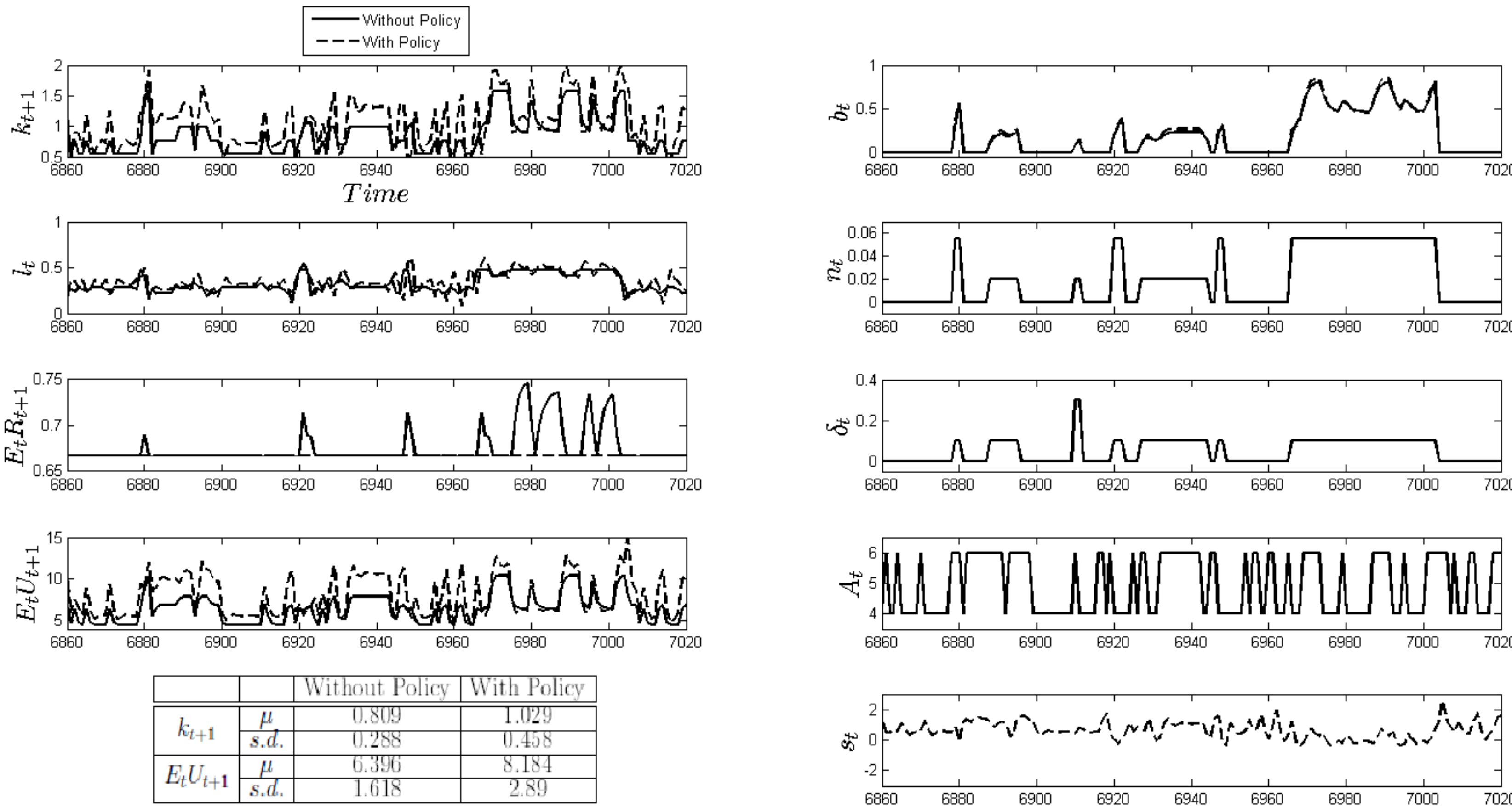


		Without Policy	With Policy
k_{t+1}	μ	0.297	0.337
	$s.d.$	0.027	0
$E_t U_{t+1}$	μ	1.136	1.202
	$s.d.$	0.079	0

Figure 9: Simulated economy with bubble shocks and constant productivity (with and without policy)

Bubbly equilibria with policy (III)

- Economy with productivity shocks (A):
  - collateral is relatively scarce during booms
  - effects of rule are more complicated due to fundamental uncertainty
- Proposed policy rule
  - raises average capital stock and welfare
  - effect on volatility is ambiguous:
    - stabilizes effects of bubble shocks
    - amplifies effects of productivity shocks



		Without Policy	With Policy
k_{t+1}	μ	0.809	1.029
	$s.d.$	0.288	0.458
$E_t U_{t+1}$	μ	6.396	8.184
	$s.d.$	1.618	2.89

Figure 10: Simulated economy with bubble and productivity shocks (with and without policy)

Fiscal backstop

- Consider LOLR has a taxation "capacity" τ: $s_t < \tau$ in all periods
- Policy rule might require public debt
  - what changes? not much, but debt purchases voluntary
- Does lender demand for debt at t depend on expected demand at $t+1$?
  - is public debt a bubble?
  - if so, ability to intervene depends on sentiment (just like market credit)

Fiscal backstop

- Consider LOLR has a taxation "capacity" τ: $s_t < \tau$ in all periods
- Policy rule might require debt: let D_t denote debt payments at t
  - LOLR budget constraint becomes
$$S_t + D_t \leq X_t + q_t D_{t+1}$$
    where q_t is the price of a unit of public credit or debt
- Now, additional market for public credit: in equilibrium,
$$q_t = \frac{1}{E_t R_{t+1}}$$
- Use D^N_{t+1} to denote
$$D^N_{t+1} \equiv D_{t+1} - E_t R_{t+1} \cdot D_t,$$
  i.e., resources that debt policy transfers to generation t
  - D^N_{t+1} is the difference between the debt that generation t inherits and the debt it leaves behind
  - if $D^N_{t+1} > 0$, debt policy creates collateral in period t
  - if $D^N_{t+1} < 0$, debt policy destroys collateral in period t

Fiscal backstop (II)

- Law of motion of the system now given by:

$$k_{t+1}\begin{cases} = \dfrac{(1-\alpha)\cdot A_t \cdot k_t^{\alpha} - b_t - s_t - d_t}{\gamma} & \text{if } \beta \cdot E_t R_{t+1} > 1 \\ \in \left[0, \dfrac{(1-\alpha)\cdot A_t \cdot k_t^{\alpha} - b_t - s_t - d_t}{\gamma}\right] & \text{if } \beta \cdot E_t R_{t+1} = 1 \end{cases} \qquad \text{(Supply of funds)}$$

$$E_t R_{t+1} = \min\left\{\alpha \cdot E_t A_{t+1}, E_t\left\{\left(\phi\cdot\alpha + n_{t+1} + m_{t+1}^S + m_{t+1}^G\right)\cdot A_{t+1}\right\}\right\}\cdot k_{t+1}^{\alpha-1} \quad \text{(Demand of funds)}$$

plus bubble and subsidy dynamics, where

  - m_{t+1}^G is the new policy instrument, value of d_{t+1}^N as a share of output: $m_{t+1}^G \equiv \dfrac{d_{t+1}^N}{A_{t+1}\cdot k_{t+1}^{\alpha}}$

- Everything as before!

  - any subsidy policy s_t' can be replicated with subsidy and debt policy $s_t + d_t = s_t'$
  - fast-growing debt (i.e. $d_{t+1}^N > 0$) makes it possible to provide subsidies with low taxes
  - but is debt prone to roll over crises, like bubbles?

Fiscal backstop (III)

- Is debt prone to roll-over crises?
- Consider equilibrium under optimal policy rule ($\beta \cdot E_t R_{t+1} = 1$)
- Maximum payments that can be credibly promised at $t+1$ given by

$$d_t \leq \beta \cdot \tau + \gamma \cdot \beta^2 \cdot E_t \{d_{t+1}\}$$

so that, iterating forward,

$$d_t \leq \tau \cdot \beta \cdot \sum_{n=0}^{\infty} (\gamma \cdot \beta)^n + \beta \cdot \lim_{s \to \infty} (\gamma \cdot \beta)^s E_t d_{t+s}.$$

- But $\gamma \cdot \beta > 1$: fiscal backstop unlimited!
  - same conditions that make bubbles possible imply fiscal backstop is unlimited
  - intuition: fiscal revenues grow at rate γ, which is higher than the interest rate
    - no matter how small τ is, NPV of taxation is infinite
    - unbounded backing for LOLR's debt

Discussion

- How naive is this view?
  - LOLR may face credibility issues, reducing the extent to which it can pledge future revenues
  - LOLR may be inefficient in taxing/distributing resources
  - both factors limit its ability to replicate the optimal bubble
- But main insight remains
  - given limitations, choose desired/feasible level of intervention
  - desired intervention can always be financed by LOLR

Extensions

- Up to this point:
  - bubbly collateral matters to sustain credit
  - LOLR can improve on market outcomes through credit market interventions
- Sometimes not just size, but also type of bubble matters
- Two extensions: introduce
  - financial intermediaries: collateral needed to sustain both, loans and deposits
  - risk averse lenders: risky and safe collateral have different properties
  - message: it is not just total collateral that matters, but also its location and type

Extension 1: financial intermediaries

- Assume $A_t = 1$ and $\phi = 0$
- Introduce intermediaries: subset of individuals that can lend to borrowers
  - in markets for deposits, sell credit contracts to lenders at deposit rate $E_t R^D_{t+1}$
  - in markets for loans, purchase credit contracts from borrowers at lending rate $E_t R^L_{t+1}$
- Deposit (B^D_t) and loan (B^L_t) bubbles, traded by intermediaries and borrowers, evolve according to

$$B^D_{t+1} = R^{BD}_{t+1} \cdot B^D_t + B^{ND}_{t+1}$$
$$B^L_{t+1} = R^{BL}_{t+1} \cdot B^L_t + B^{NL}_{t+1}$$

  where R^{BD}_{t+1} and R^{BL}_{t+1} are returns to bubbles purchased from generation $t-1$; and B^{ND}_{t+1} and B^{NL}_{t+1} reflect bubble creation.

- Both loan and deposit contracts must be collateralized, so that

$$R^D_{t+1} \cdot D_t \leq B^D_{t+1}$$
$$R^L_{t+1} \cdot L_t \leq B^L_{t+1}$$

- Equilibrium in markets for bubbles requires:

$$E_t R^{BD}_{t+1} = E_t R^D_{t+1}$$
$$E_t R^{BL}_{t+1} = E_t R^L_{t+1}$$

Extension 1: financial intermediaries

- Collapse previous equations as follows:

$$k_{t+1} \begin{cases} = \dfrac{(1-\alpha)\cdot k_t^{\alpha} - b_t^D - b_t^L}{\gamma} & \text{if } \beta \cdot E_t R_{t+1}^D > 1 \\ \in \left[0, \dfrac{(1-\alpha)\cdot k_t^{\alpha} - b_t^D - b_t^L}{\gamma}\right] & \text{if } \beta \cdot E_t R_{t+1}^D = 1 \end{cases}$$

$$E_t R_{t+1}^D = \min\left\{E_t R_{t+1}^L, \frac{E_t n_{t+1}^D \cdot k_{t+1}^{\alpha}}{k_{t+1} + \gamma^{-1} \cdot b_t^L}\right\}$$

$$E_t R_{t+1}^L = \min\left\{\alpha, E_t n_{t+1}^L\right\} \cdot k_{t+1}^{\alpha-1}$$

$$b_{t+1}^D = \frac{E_t R_{t+1}^D + u_{t+1}^D}{\gamma} \cdot b_t^D + n_{t+1}^D \cdot k_{t+1}^{\alpha}$$

$$b_{t+1}^L = \frac{E_t R_{t+1}^L + u_{t+1}^L}{\gamma} \cdot b_t^L + n_{t+1}^L \cdot k_{t+1}^{\alpha}$$

where $\left\{u_{t+1}^j, n_{t+1}^j\right\}$ are the bubble-return and creation shocks of bubbles of type $j \in \{L, D\}$

- Main insight: not just amount, but also distribution of collateral matters
- Economy may find itself in region of partial intermediation because
  - intermediaries have insufficient collateral
    - deposit bubble creation ($n_{t+1}^D > 0$) is expansionary, loan bubble creation ($n_{t+1}^L > 0$) is contractionary
  - borrowers have insufficient collateral
    - loan bubble creation ($n_{t+1}^L > 0$) is expansionary

Extension 2: risk-averse lenders

- Assume $A_t = 1$ and $\phi = 0$
- Assume fraction ρ of lenders is risk-averse, with preferences

$$U_t^i = C_{t,t}^i + \beta \cdot \min_t C_{t,t+1}^i$$

- Borrowers sell two types of credit contracts, safe and risky, with constraints

$$R_{t+1}^R \cdot L_t^R + R_{t+1}^S \cdot L_t^S \leq B_{t+1}$$

$$R_{t+1}^S \cdot L_t^S \leq \min_t B_{t+1}$$

- Assume high ratio of risky/safe collateral
  - wages of risk-neutral lenders fully intermediated
  - wages of risk-averse lenders only partially intermediated

Extension 2: risk-averse lenders

- Model collapses to:

$$k_{t+1} = \beta \cdot \min_t b_{t+1} + (1-\rho) \cdot \frac{1-\alpha}{\gamma} \cdot k_t^{\alpha} - \frac{b_t}{\gamma}$$

$$E_t R_{t+1}^R = \frac{E_t n_{t+1} \cdot k_{t+1}^{\alpha} - \min_t b_{t+1}}{k_{t+1} - \beta \cdot \min_t b_{t+1}}$$

$$b_{t+1} = \frac{E_t R_{t+1}^R + u_{t+1}}{\gamma} \cdot b_t + n_{t+1} \cdot k_{t+1}^{\alpha}$$

- Main insight:
  - it is not total stock of bubbly collateral that matters, only safe fraction
  - increase in safe collateral ($\min_t n_{t+1}$): expansionary
  - increase in risky collateral ($E_t n_{t+1} - \min_t n_{t+1}$): contractionary
  - policy implications

Concluding remarks

- Credit booms and busts are a fact of life in modern economies
- Widespread view among macroeconomists: fluctuations in collateral are an important part of story
- We build on this view to derive the following results:
  - economies with binding borrowing constraints: fundamental and bubbly collateral
    - both types of collateral drive credit
    - bubbly collateral driven by sentiments or expectations
  - bubbly collateral raises credit ("crowding-in") but diverts part of it away from investment ("crowding-out")
    - "optimal" bubble size trades off these two effects to maximize long-term output and welfare
  - markets are generically unable to provide the optimal amount of bubbly collateral
    - LOLR can replicate "optimal" bubble allocation through credit market interventions
- Limitations:
  - perfect information: how do we know whether fluctuations are driven by fundamental or bubbly collateral?
  - exogeneity of fundamental collateral: in reality, collateral is "produced" by the financial system through screening and monitoring of borrowers