Monetary Policy and Bubbles in a New Keynesian Model with Overlapping Generations

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December 2018

Motivation

- Asset price bubbles: ubiquitous in the policy debate...
    - key source of macro instability
    - monetary policy: cause and cure

...but absent in workhorse monetary models
    - no room for bubbles in the New Keynesian model
    - no discussion of possible role of monetary policy

Motivation

- Asset price bubbles: ubiquitous in the policy debate...

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  ...but absent in workhorse monetary models

  - no room for bubbles in the New Keynesian model
  - no discussion of possible role of monetary policy

- Present paper: modification of the basic NK model to allow for bubbles
- Key ingredients:

  (i) overlapping generations of finitely-lived agents
  (ii) transitions to inactivity ("retirement")

Related Literature

- *Real* models of rational bubbles: Tirole (1985),..., Martín-Ventura (2012)
- Monetary models with bubbles: Samuelson (1958),..., Asriyan et al. (2016) $\Rightarrow$ flexible prices
- New Keynesian models with overlapping-generations: Piergallini (2006), Nisticò (2012), Del Negro et al. (2015) $\Rightarrow$ no discussion of bubbles
- Monetary policy and bubbles in sticky price models:

- Bernanke and Gertler (1999, 2001): ad-hoc bubble
- Galí (2014): 2-period OLG, constant output
- Present paper:
    - many-period lifetimes
    - variable employment and output
    - nests standard NK model as a limiting case

A New Keynesian Model with Overlapping Generations

- Individual survival rate: γ (Blanchard (1985), Yaari (1965))
- Two types of individuals:

  - "Active": manage own firm, work for others.
  - "Retired": consume financial wealth

- Probability of remaining active: υ (Gertler (1999))
- Labor force (and measure of firms): $\alpha \equiv \frac{1-\gamma}{1-\upsilon\gamma} \in (0, 1]$

Consumers

- Complete markets (including annuity contracts)
- Consumer's problem:

$$\max E_0 \sum_{t=0}^{\infty} (\beta\gamma)^t \log C_{t|s}$$

$$\frac{1}{P_t} \int_0^{\alpha} P_t(i) C_{t|s}(i) di + E_t\{\Lambda_{t,t+1} Z_{t+1|s}\} = A_{t|s} \; [+W_t N_{t|s}]$$

$$A_{t|s} = Z_{t|s}/\gamma$$

Firms

- Technology:

$$Y_t(i) = \Gamma^t N_t(i)$$

  where $\Gamma \equiv 1 + g \geq 1$.

- Price-setting à la Calvo

Labor Markets and Inflation

- Wage equation:

$$\mathcal{W}_t = \left(\frac{N_t}{\alpha}\right)^{\varphi}$$

where $\mathcal{W}_t \equiv W_t/\Gamma^t$ and $N_t \equiv \int_0^{\alpha} N_t(i)di$.

- *Natural* level of output: setting $1/\mathcal{W}_t = \mathcal{M}$

$$Y_t^n = \Gamma^t \mathcal{Y}$$

with $\mathcal{Y} \equiv \alpha \mathcal{M}^{-\frac{1}{\varphi}}$. *Remark*: invariant to bubble size.

Asset Markets

- Aggregate stock market

$$Q_t^F = \sum_{k=0}^{\infty} (\upsilon\gamma)^k E_t\{\Lambda_{t,t+k} D_{t+k}\}$$

Remark: same discount rate as labor income.

- Aggregate bubble:

$$Q_t^B = B_t + U_t$$

where $B_t \equiv \sum_{s=-\infty}^{t-1} Q_{t|s}^B \geq 0$ and $U_t \equiv Q_{t|t}^B \geq 0$

- Equilibrium condition:

$$Q_t^B = E_t\{\Lambda_{t,t+1} B_{t+1}\}$$

Characterization of Equilibria

- Balanced Growth Paths
- Bubble-Driven Fluctuations around a Balanced Growth Path

Balanced Growth Paths

- Aggregate consumption function

$$\mathcal{C} = (1-\beta\gamma)\left[\mathcal{Q}^B + \frac{\mathcal{Y}}{1-\frac{\Gamma\upsilon\gamma}{1+r}}\right]$$

- In equilibrium ($\mathcal{C} = \mathcal{Y}$):

$$1 = (1-\beta\gamma)\left[q^B + \frac{1}{1-\frac{\Gamma\upsilon\gamma}{1+r}}\right]$$

where $q^B \equiv \mathcal{Q}^B/\mathcal{Y}$.

- Bubbleless BGP ($q^B = 0$)

$$\frac{\Gamma\upsilon}{1+r} = \beta$$

Remark #1: r increasing in υ

Remark #2: $\upsilon < \beta \Leftrightarrow r < g$

Balanced Growth Paths

- Bubbly BGP:

$$q^B = \frac{\gamma(\beta - \frac{\Gamma \upsilon}{1+r})}{(1-\beta\gamma)(1 - \frac{\Gamma \upsilon \gamma}{1+r})} > 0$$

$$u = \left(1 - \frac{1+r}{\Gamma}\right) q^B \geq 0$$

where

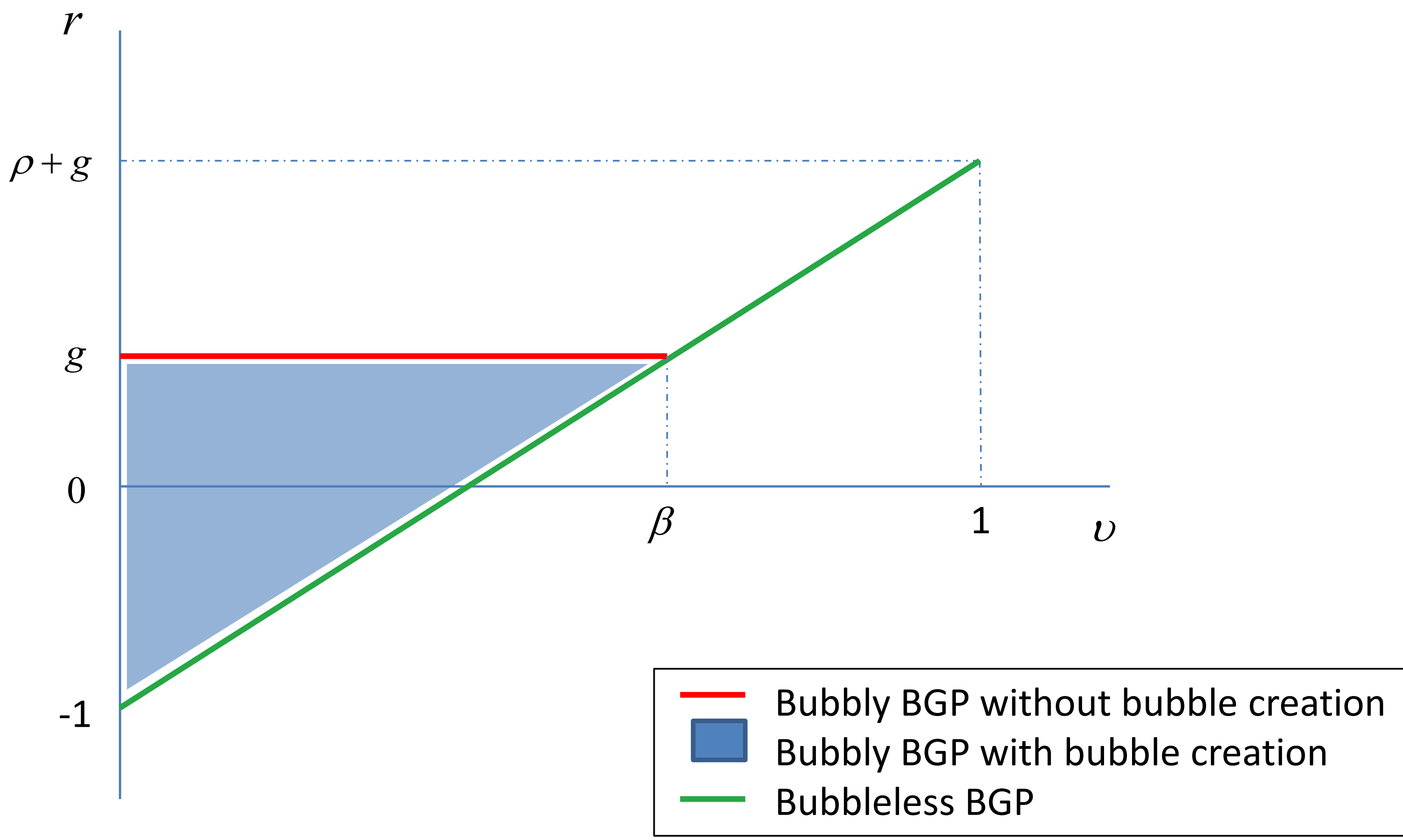
$$\frac{1+r}{\Gamma} \leq 1 \Leftrightarrow r \leq g$$

$$\frac{\Gamma \upsilon}{1+r} < \beta \Leftrightarrow r > r_0$$

- Existence condition:

$$\upsilon < \beta$$

Figure 1. Balanced Growth Paths



Equilibrium Dynamics (I)

- Goods market clearing:

$$\widehat{y}_t = \widehat{c}_t$$

- Aggregate consumption function:

$$\widehat{c}_t = (1 - \beta\gamma)(\widehat{q}_t^B + \widehat{x}_t)$$

where

$$\widehat{x}_t = \Lambda\Gamma\upsilon\gamma E_t\{\widehat{x}_{t+1}\} + \widehat{y}_t - \frac{\Lambda\Gamma\upsilon\gamma}{1 - \Lambda\Gamma\upsilon\gamma}(\widehat{i}_t - E_t\{\pi_{t+1}\})$$

with $\Lambda \equiv \frac{1}{1+r}$

- Aggregate bubble dynamics:

$$\widehat{q}_t^B = \Lambda\Gamma E_t\{\widehat{q}_{t+1}^B\} - q^B(\widehat{i}_t - E_t\{\pi_{t+1}\})$$

Equilibrium Dynamics (II)

- New Keynesian Phillips curve

$$\pi_t = \Lambda\Gamma\upsilon\gamma E_t\{\pi_{t+1}\} + \kappa\widehat{y}_t$$

- Monetary Policy

$$\widehat{i}_t = \phi_\pi \pi_t + \phi_q \widehat{q}_t^B$$

- *Assumption*: no fundamental shocks, focus on bubble-driven fluctuations

Bubble-Driven Fluctuations

- Implied dynamic IS equation:

$$\widehat{y}_t = \Phi E_t\{\widehat{y}_{t+1}\} - \Psi(\widehat{i}_t - E_t\{\pi_{t+1}\}) + \Theta \widehat{q}_t^B$$

- Equilibrium dynamics

$$\mathbf{A}_0 \mathbf{x}_t = \mathbf{A}_1 E_t\{\mathbf{x}_{t+1}\}$$

where $\mathbf{x}_t \equiv [\widehat{y}_t, \pi_t, \widehat{q}_t^B]'$ and

$$\mathbf{A}_0 \equiv \begin{bmatrix} 1 & \Psi\phi_\pi & \Psi\phi_q - \Theta \\ -\kappa & 1 & 0 \\ 0 & q^B\phi_\pi & 1 + q^B\phi_q \end{bmatrix} \quad ; \quad \mathbf{A}_1 = \begin{bmatrix} \Phi & \Psi & 0 \\ 0 & \Lambda\Gamma\upsilon\gamma & 0 \\ 0 & q^B & \Lambda\Gamma \end{bmatrix}$$

- Conditions for stationary, bubble-driven fluctuations

Figure 2. Determinacy and Indeterminacy Regions

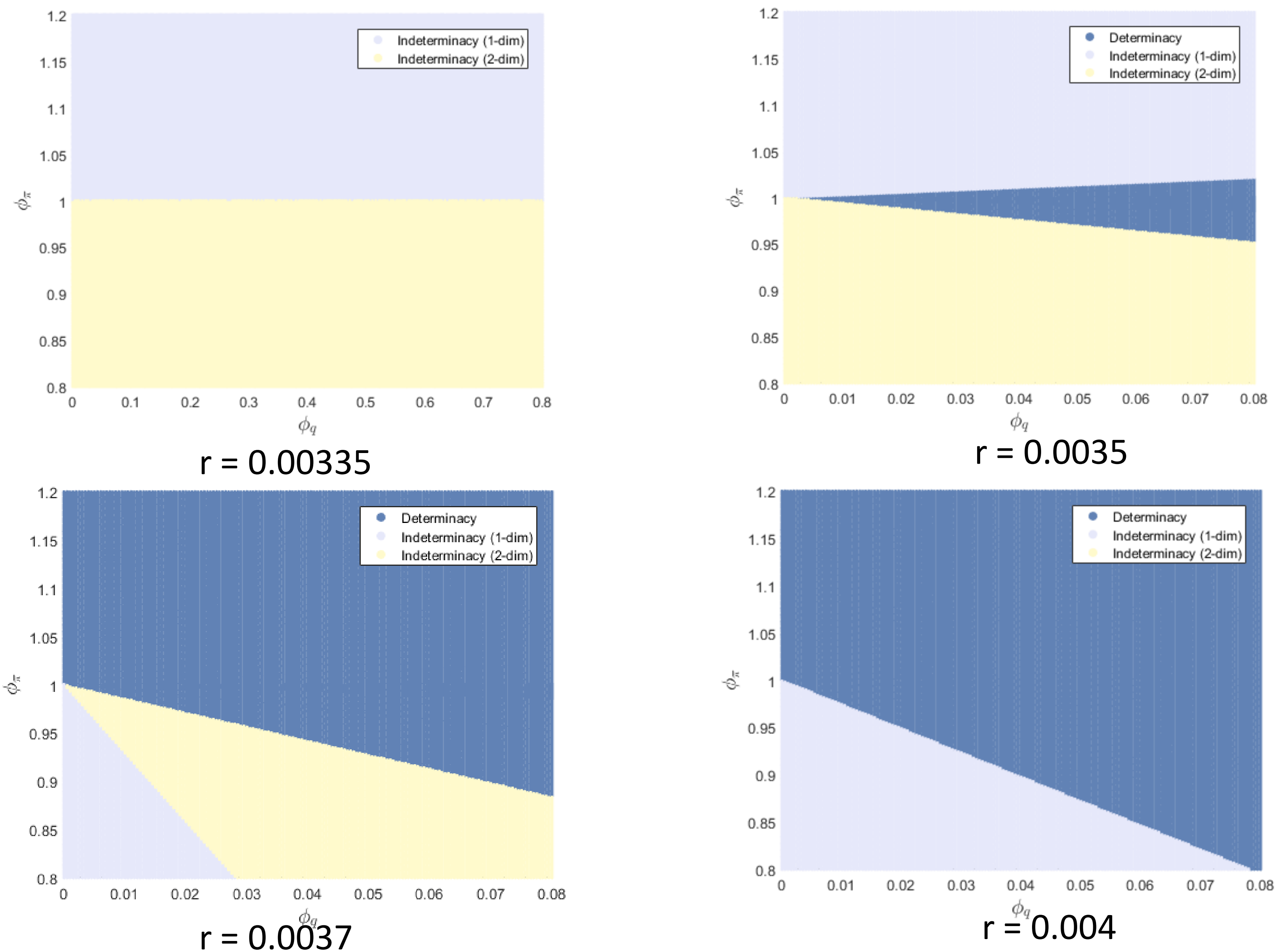
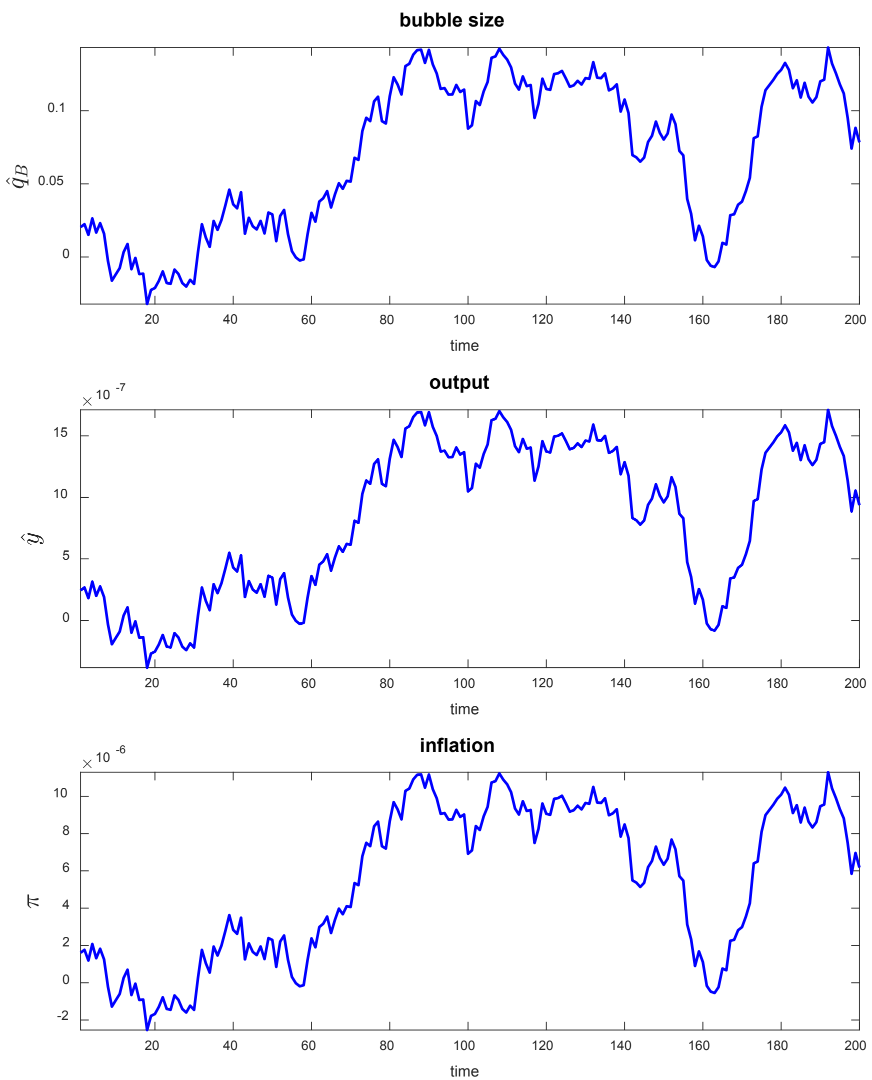


Figure 3. Simulated Bubble-Driven Fluctuations Around a Bubbly BGP



An Example with an Stochastic Bubble

- Assumed bubble process:

$$q_t^B = \begin{cases} \frac{\upsilon}{\beta\delta} q_{t-1}^B + u_t & \text{with probability } \delta \\ u_t & \text{with probability } 1-\delta \end{cases}$$

where $\{u_t\} > 0$ is white noise with mean $\overline{u} \gtrsim 0$.

- Equilibrium output and inflation:

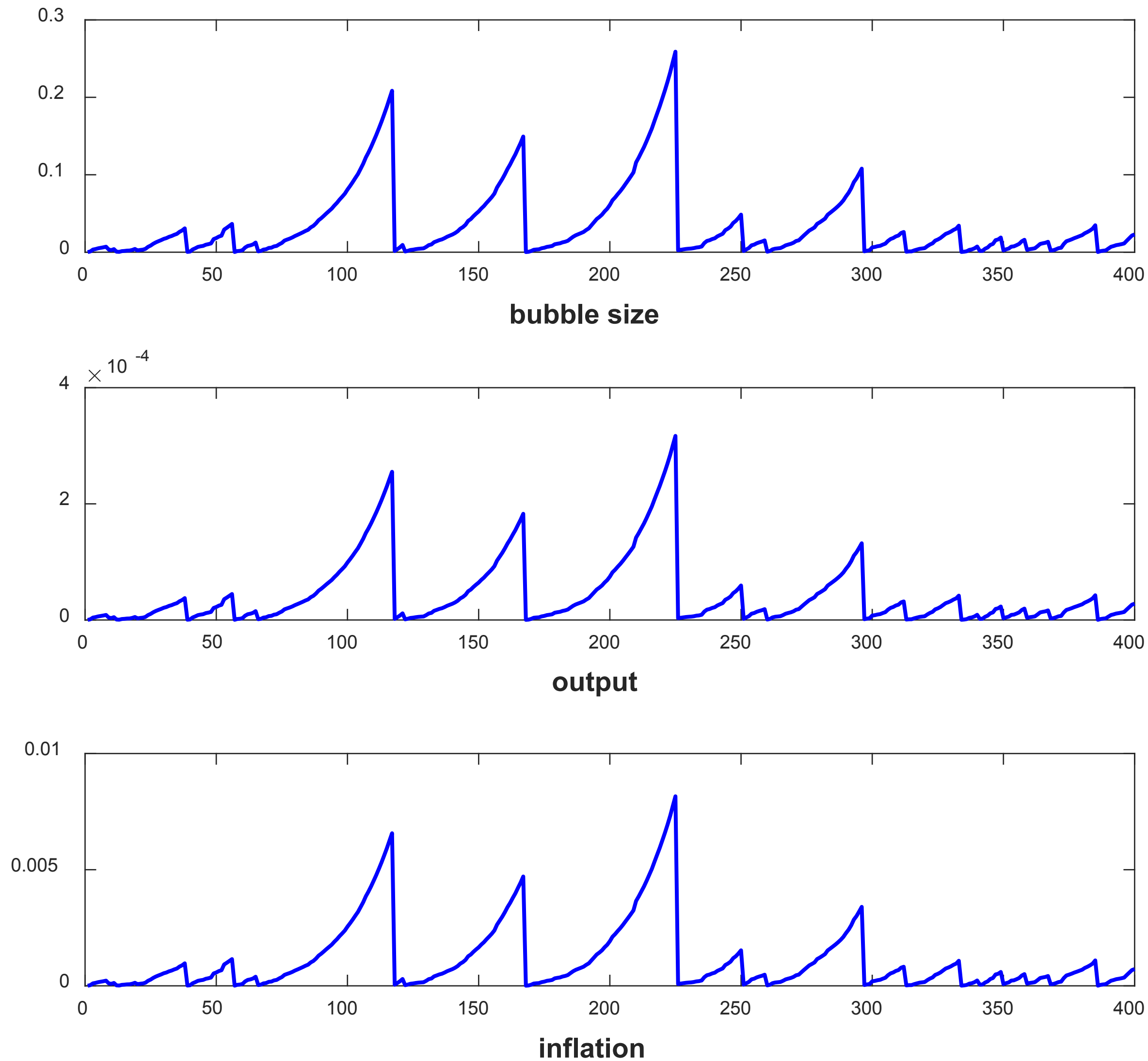
$$\widehat{y}_t = (1-\beta\gamma)\Omega(\Theta - \phi_q)q_t^B$$

$$\pi_t = \kappa\Omega(\Theta - \phi_q)q_t^B$$

where $\Omega \equiv 1/[(1-\beta\gamma)(1-\upsilon/\beta) + \kappa(\phi_\pi - \upsilon/\beta)] > 0$.

- Simulated bubble driven fluctuations ($\phi_\pi = 1.5, \phi_q = 0$) (*)

Figure 5. Simulated Bubble-Driven Fluctuations around the Bubbleless BGP



Bubbles and Monetary Policy Design

- Assumption: inflation and output gap stabilization mandate
- *Strategy #1*: "leaning against the bubble" to rule out bubble-driven fluctuations

Figure 4.
The Effectiveness of "Leaning against the Bubble" Policies

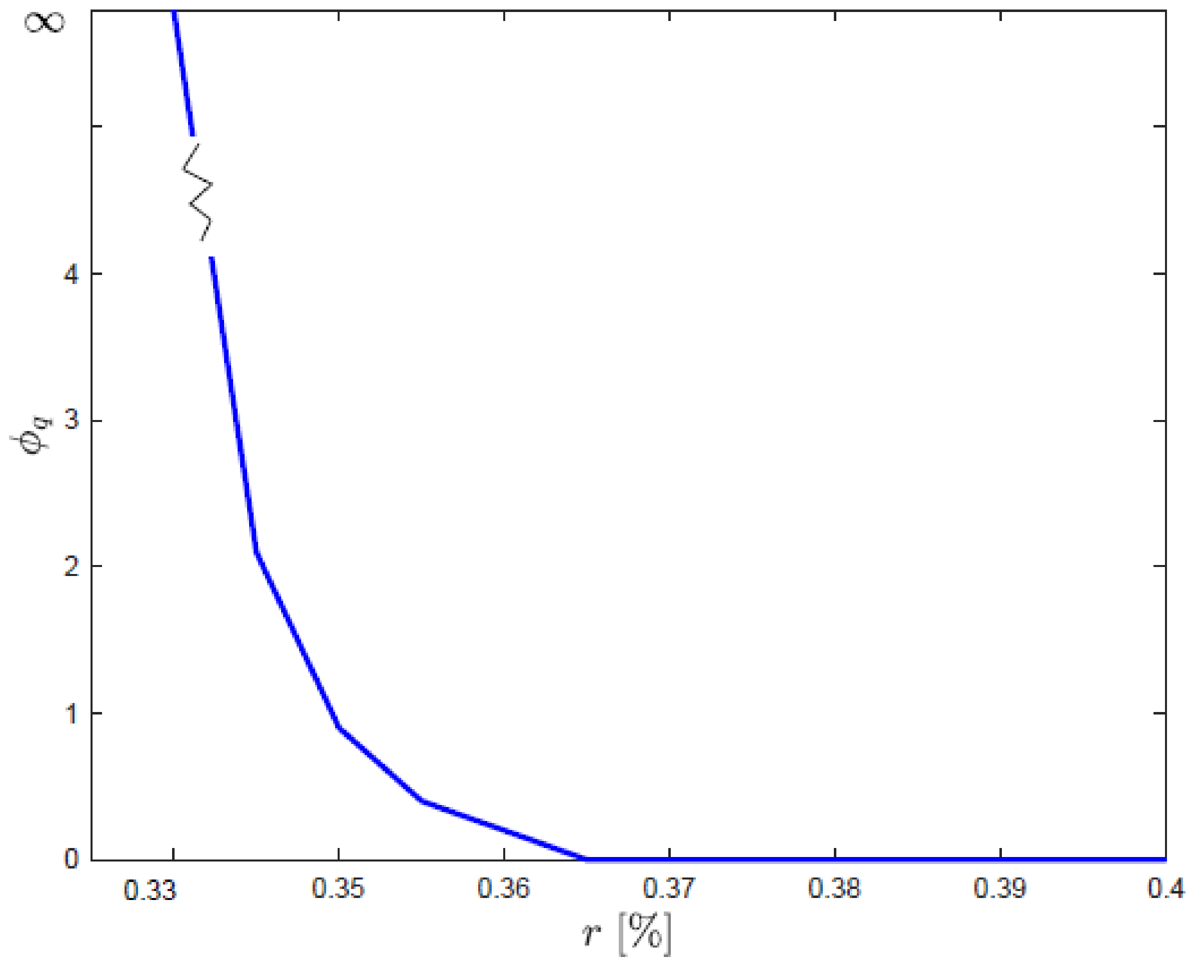
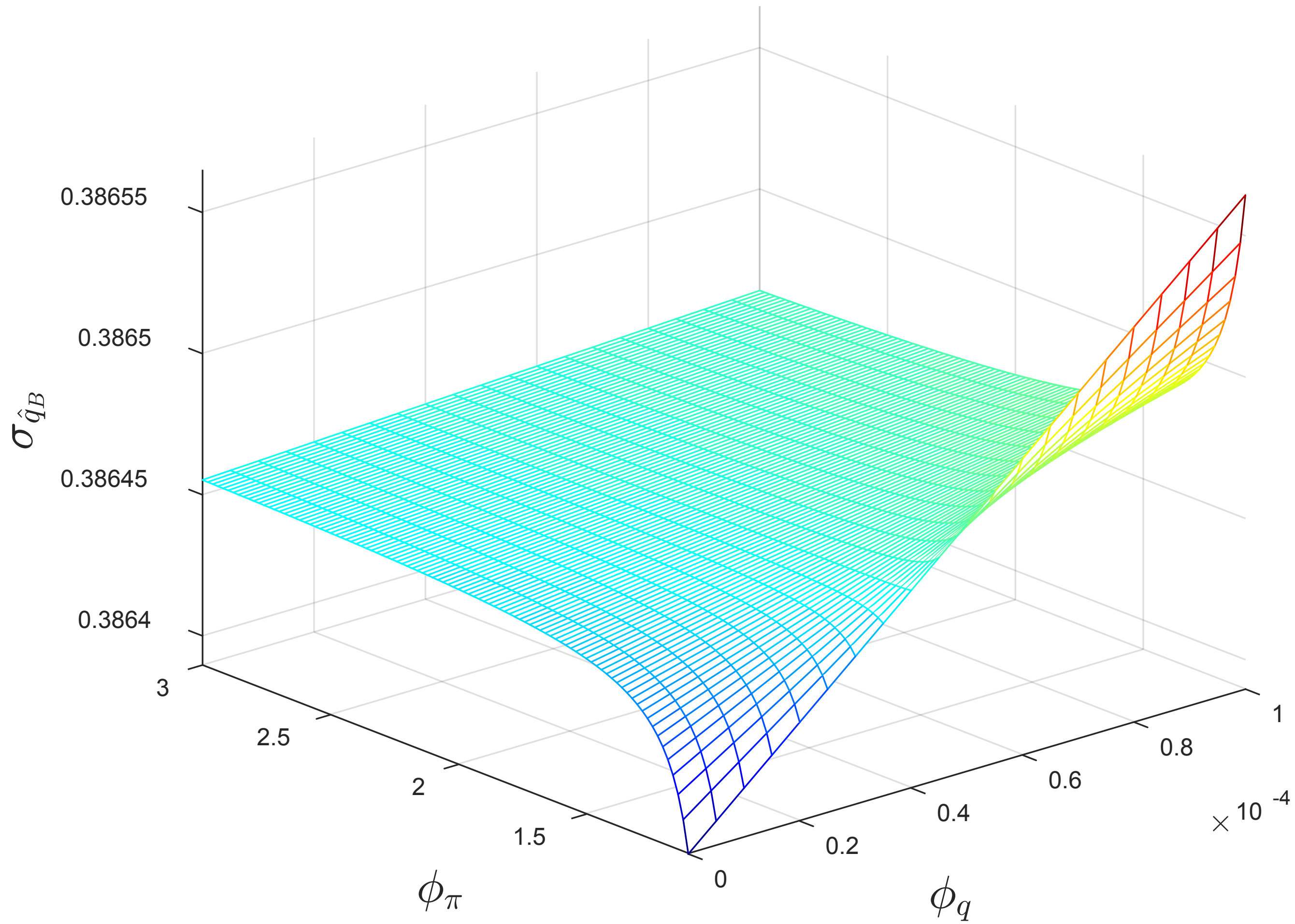


Figure 7. Bubble-Driven Fluctuations: Monetary Policy and Bubble Volatility

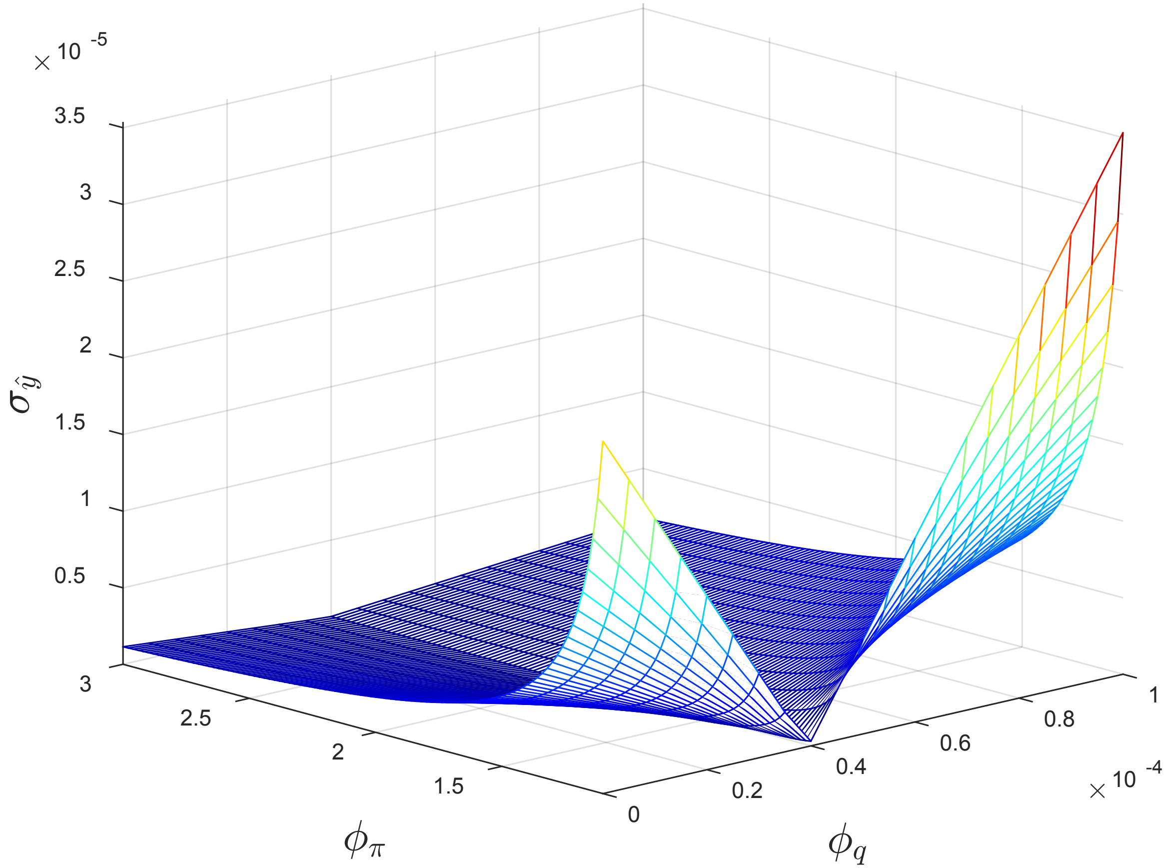


Bubbles and Monetary Policy Design

- Assumption: inflation and output gap stabilization mandate
- *Strategy #1*: Hard "lean against the bubble policy" to rule out bubble-driven fluctuations
- *Strategy #2*: Neutralize effects of bubble fluctuations on aggregate demand

$$\widehat{i}_t = \phi_\pi \pi_t + (\Theta/\Psi)\widehat{q}_t^B$$

Figure 6. Bubble-Driven Fluctuations: Monetary Policy and Macro Volatility



Bubbles and Monetary Policy Design

- Assumption: inflation and output gap stabilization mandate
- *Strategy #1*: "Lean against the bubble policy" to rule out bubble-driven fluctuations
- *Strategy #2*: Neutralize effects of bubble fluctuations on aggregate demand

$$\widehat{i}_t = \phi_\pi \pi_t + (\Theta/\Psi)\widehat{q}_t^B$$

- *Strategy #3:* Direct inflation targeting

$$\widehat{i}_t = \phi_\pi \pi_t$$

with ϕ_π arbitrarily large

Concluding Remarks

- Bubbly equilibria may exist in the NK model once we depart from the infinitely-lived representative consumer assumption. Room for bubble-driven fluctuations.
- More likely in an environment of low natural interest rates.
- No obvious advantages of "leaning against the bubble" policies (relative to inflation targeting), plus some risks (e.g. may amplify bubble fluctuations)
- Need for instruments alternative to interest rate policy?
- Caveats/potential extensions

(i) *Rational* bubbles. But non-rational bubbles can be readily accommodated.
(ii) ZLB has been ignored. Potential interesting interaction with bubbles (e.g. by raising underlying natural rate, bubbles may lower the risk of hitting the ZLB).
(iii) No role for credit supply factors; may be needed to boost the size of bubble effects.