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Monetary Policy and a Stock Market Boom-Bust Cycle

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- Stock Market Boom-Bust Cycle:

  - Episode in Which:

    - Stock Prices, Consumption, Investment, Employment, Output Rise Sharply and then Fall
    - Sometimes Such an Episode is Referred to as an ‘Overinvestment Boom’

  - Examples:

    - US in 1920s and 1930s
    - Japan in 1980s
    - US in 1990s

...

- We Explore a Version of Beaudry-Portier Theory of Boom-Bust Cycle
  - Boom-Bust Cycle Triggered by:
    - Expectation that Technology Will Be Strong in The Future
    - An Expectation that is Ultimately Not Realized
  - Example:
    - A Widespread Belief that Fiber-Optic Cable Would Generate Huge Returns Led to Huge Investment in Fiber Optic Cable, Investment That Ex-post was ‘Excessive’.

Findings

- Monetary Policy May be Key to Full Understanding of Boom-Bust Cycle.

- Argument in a Nut-Shell:

  – Begin with an Attempt to Build a Non-Monetary Theory of Boom-Bust Cycle

    ∗ With Investment Adjustment Costs, Habit Persistence, Variable Capital Utilization, Can Almost Get Successful Theory

    ∗ However, Miss on Stock Market. Theory Implies a Stock Market *Drop*

  – When We Incorporate Monetary Factors Into the Analysis, We Finally Obtain a Successful Theory.

Outline

- Boom-Bust Cycle in Non-Monetary Economy.
  - Simplest of All RBC Models
    - No Boom-Bust Cycle at All!
  - RBC Model with Investment Adjustment Costs, Capital Utilization and Habit Persistence
    - Partial Theory of Boom-Bust Cycle
- Boom-Bust Cycle In Monetary Economy

Non-Monetary Economy

- Household Preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{\left[\left(C_t - bC_{t-1} \right) \left(1 - h_t \right)^{\psi} \right]^{1-\gamma}}{1-\gamma}.$$

- Production Function:

$$Y_t = K_t^{\alpha} \left(\exp \left(z_t \right) h_t \right)^{1-\alpha}$$

- Physical Capital Accumulation:

$$K_{t+1} = (1-\delta)K_t + (1 - S\left(\frac{I_t}{I_{t-1}} \right))I_t.$$

- Resource Constraint:

$$C_t + I_t \leq Y_t$$

- Technology Evolution:

$$z_t = \rho z_{t-1} + \varepsilon_{t-8} + \xi_t.$$

Simple RBC Model

- No adjust costs in investment:

$$S \equiv 0$$

- No Habit Persistence:

$$b = 0$$

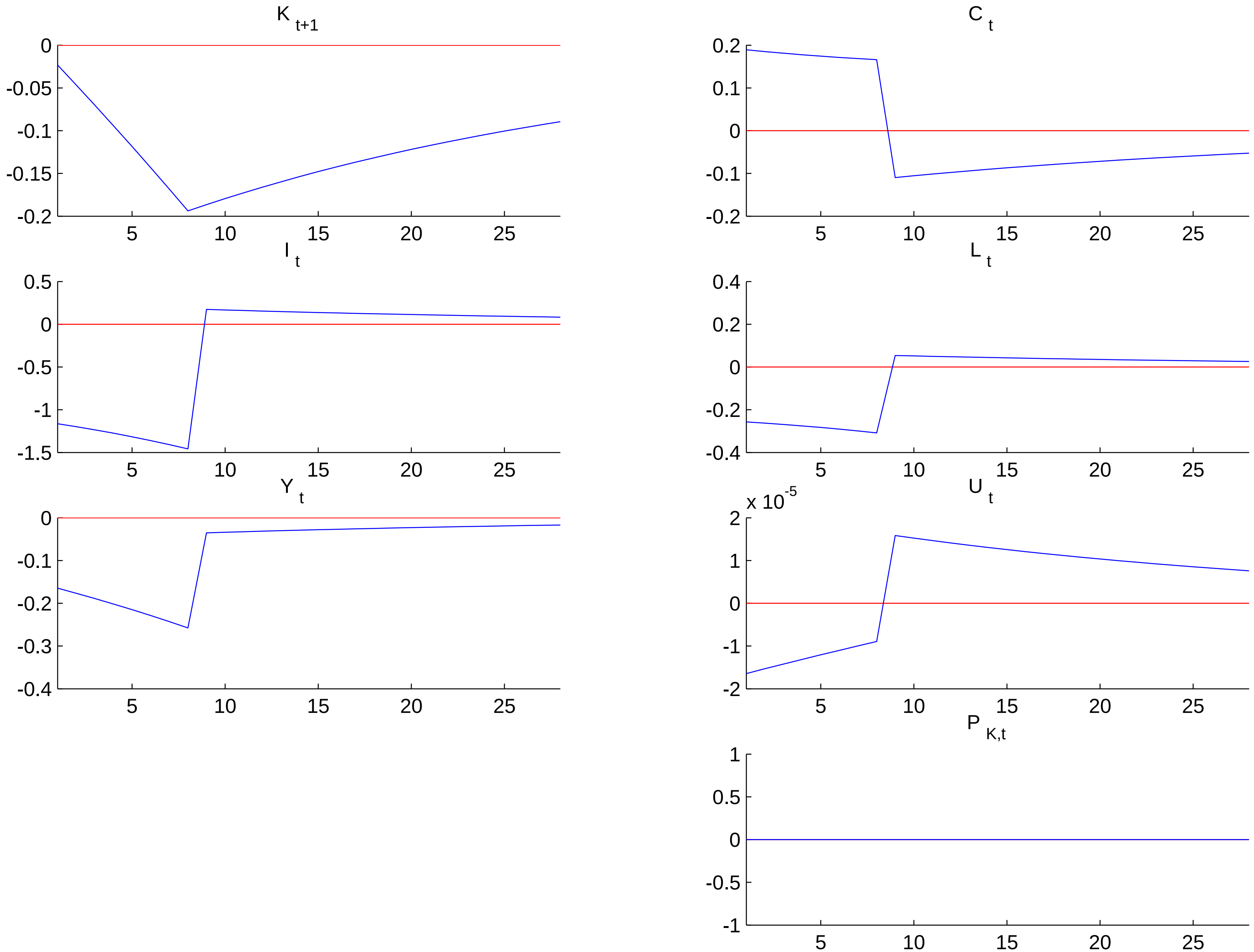
- Other Parameters:

$$\alpha = 0.36,\ \beta = 1.03^{-.25},\ \delta = .02,\ \gamma = 1,\ \psi = 2.3.$$

- Signal of Future Improvement in Technology Leads to:
  - Fall in Employment
  - Fall in Investment
  - Rise in Consumption
  - Price of Capital is Constant
- Terrible Model of Boom-Bust Cycle!

IRFs: Anticipated shock to technology is not realized (Logs)

Standard RBC Model



RBC Analog of ACEL Model

- Investment Adjustment Costs:

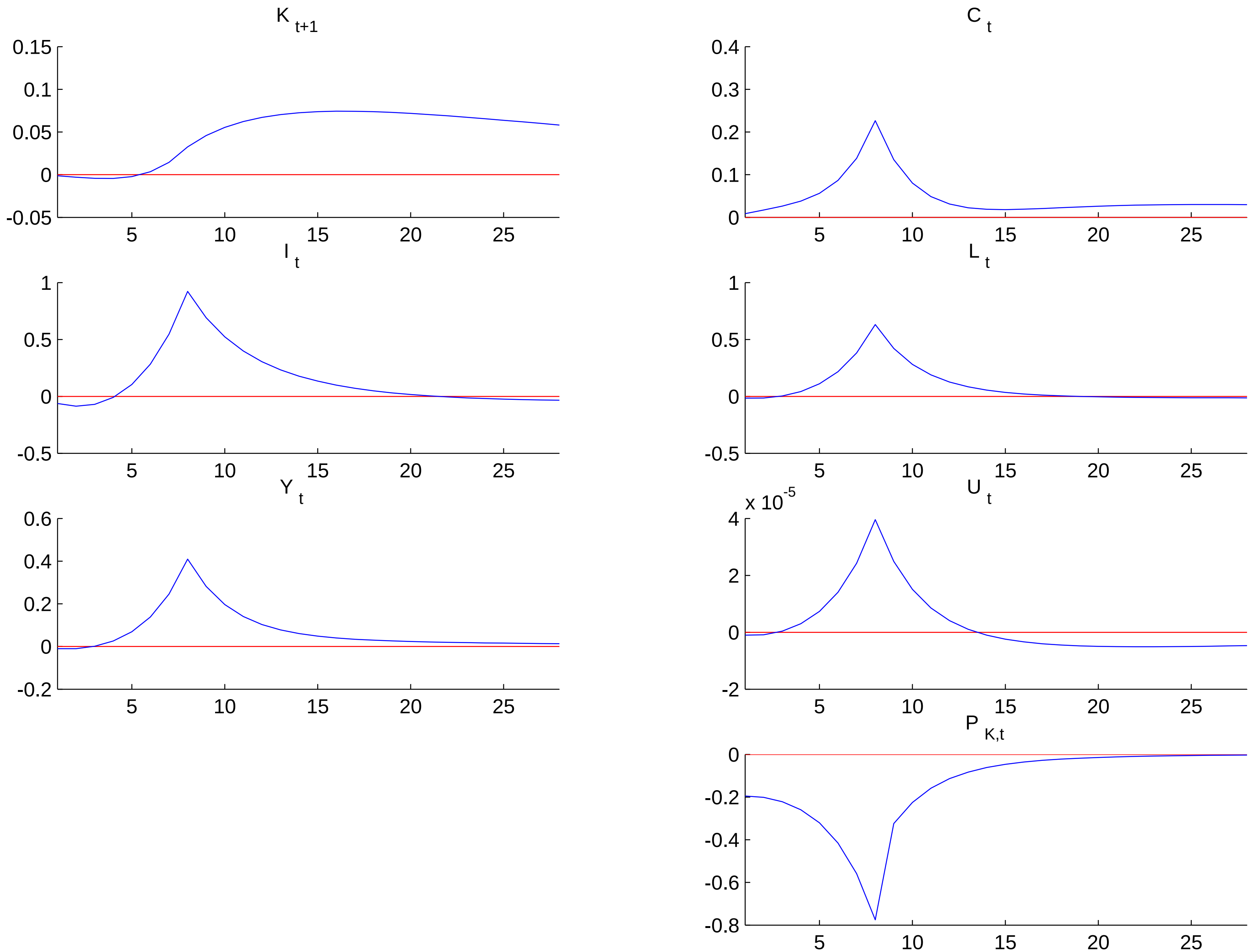
$$S = S' = 0 \text{ in Steady State}$$
$$S'' = 5 \text{ in Steady State}$$

$$b = 0.75$$

- Now Have a Better Theory of Boom-Bust Cycle.

IRFs: Anticipated shock to technology is not realized (Logs)

RBC Model With Habit Persistence and Investment Adjustment Costs, But No Variable Capital Utilization

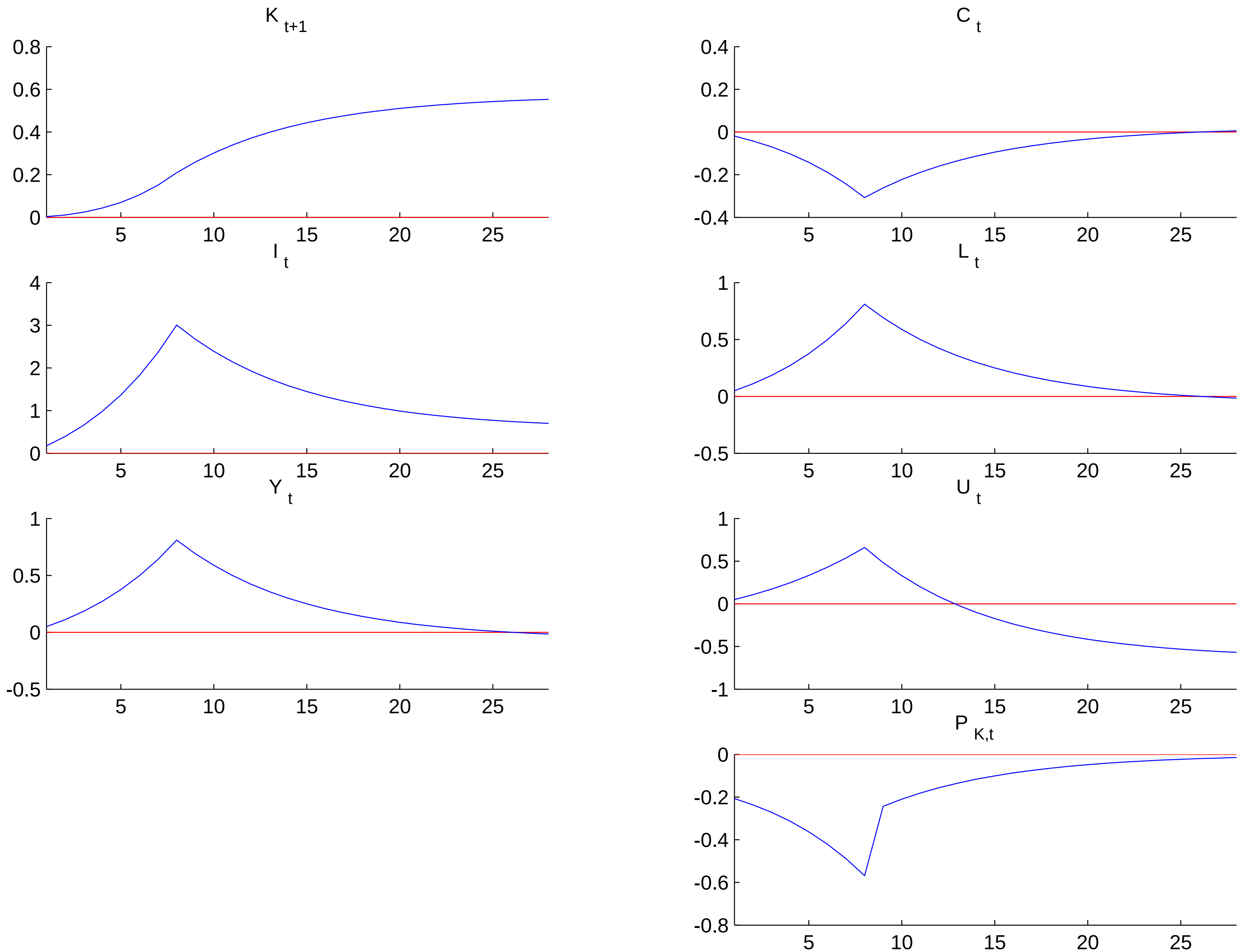


Diagnosing Results

- Role of Habit Persistence: Major
  - Ensures that Consumption Rises In Boom Part of Cycle
- Role of Investment Adjustment Costs: Major
  - Ensures that Investment Rises in Boom Part of Cycle
- Puzzle: Why Does the Theory Imply a *Fall* in Stock Market?????

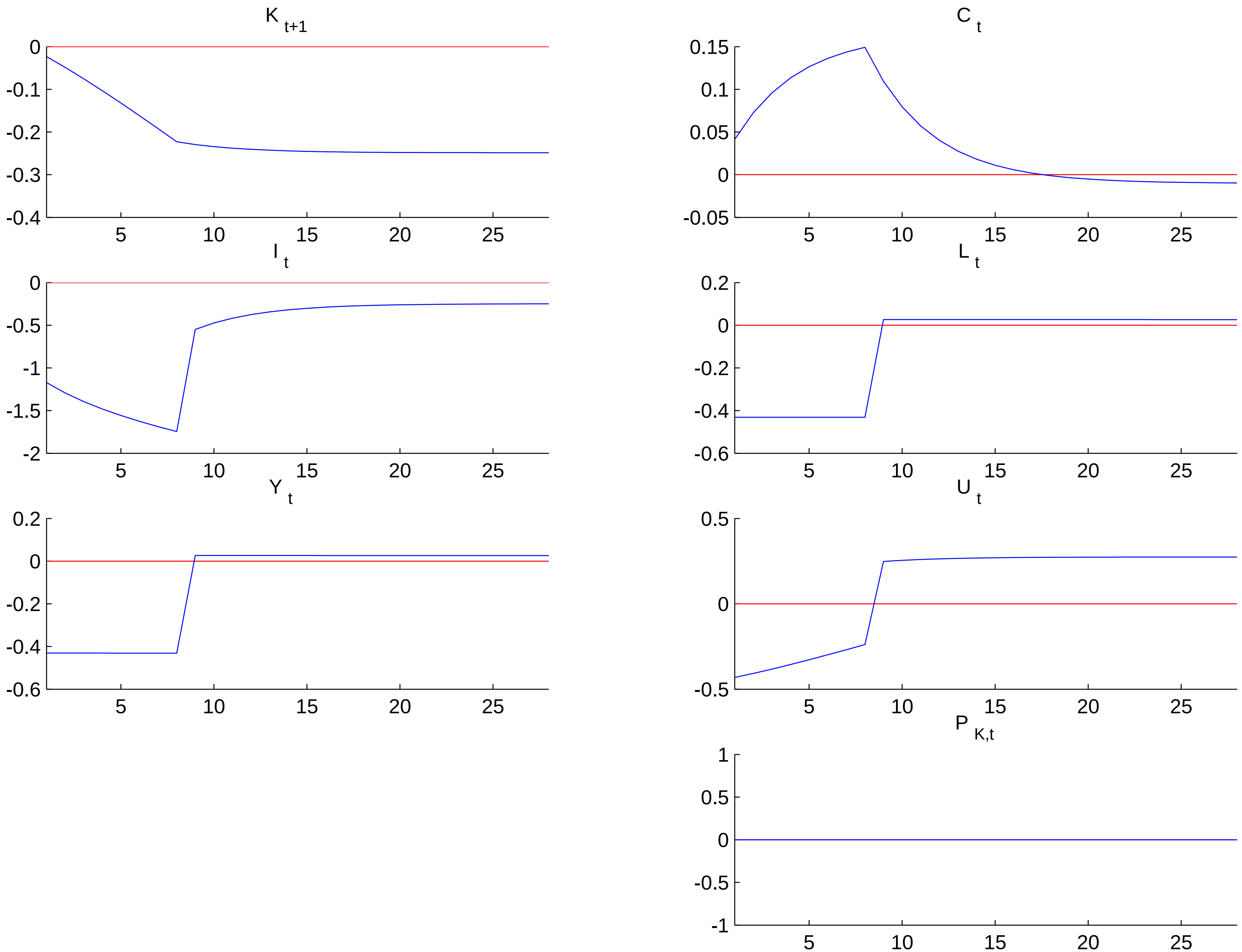
IRFs: Anticipated shock to technology is not realized (Logs)

RBC Model with Investment Adjustment Costs, Variable Capital Utilization, No Habit Persistence in Consumption



IRFs: Anticipated shock to technology is not realized (Logs)

RBC Model with Variable Capital Utilization, Habit Persistence, No Adjustment Costs in Investment



Some Capital Theory

- In a Production Economy, Price of Capital ('Stock Market') Satisfies **TWO** Relations
  - Usual Present Discounted Value Relation ('Demand Side')
  - Tobin's q Relation ('Supply Side')
  - Tobin's q Is Very Useful.
- First, We Derive the Usual Present Discounted Value Relation
- Then, Tobin's q

- Lagrangian:

$$\sum \beta^t \{ \frac{\left[(C_t - bC_{t-1}) (1 - h_t)^{\psi} \right]^{1-\gamma}}{1-\gamma} + \lambda_t \left[(K_t)^{\alpha} (z_t h_t)^{1-\alpha} - C_t - I_t \right]$$
$$+ \mu_t \left[(1-\delta) K_t + (1 - S\left(\frac{I_t}{I_{t-1}} \right)) I_t - K_{t+1} \right] \}$$

- Consumption first order condition:

$$\lambda_t = (C_t - bC_{t-1})^{-\gamma} (1 - h_t)^{\psi(1-\gamma)} - \beta b (C_{t+1} - bC_t)^{-\gamma} (1 - h_{t+1})^{\psi(1-\gamma)}.$$

- First order condition with respect to K_{t+1}:

$$\mu_t = \beta \left[\lambda_{t+1} \alpha (K_{t+1})^{\alpha - 1} (z_{t+1} h_{t+1})^{1-\alpha} + \mu_{t+1} (1 - \delta) \right].$$

- Divide both sides of K_{t+1} FONC by λ_t:

$$\frac{\mu_t}{\lambda_t} \;=\; \beta\frac{\lambda_{t+1}}{\lambda_t}\left[\alpha\left(K_{t+1}\right)^{\alpha-1}\left(z_{t+1}h_{t+1}\right)^{1-\alpha}+\frac{\mu_{t+1}}{\lambda_{t+1}}\left(1-\delta\right)\right].$$

- 'Time t Price of Capital, K_{t+1}' (Tobin's q) :

$$\frac{\mu_t}{\lambda_t} \;=\; \frac{\frac{dU_t}{dK_{t+1}}}{\frac{dU_t}{dC_t}}=\frac{dC_t}{dK_{t+1}}.$$

- Rewrite Fonc for K_{t+1}:

$$P_{k',t} \;=\; \beta\frac{\lambda_{t+1}}{\lambda_t}\left[\alpha\left(K_{t+1}\right)^{\alpha-1}\left(z_{t+1}h_{t+1}\right)^{1-\alpha}+P_{k',t+1}\left(1-\delta\right)\right].$$

- Repeating Fonc for K_{t+1}:

$$P_{k',t} \;=\; \beta \frac{\lambda_{t+1}}{\lambda_t} \left[\alpha \left(K_{t+1}\right)^{\alpha-1} \left(z_{t+1} h_{t+1}\right)^{1-\alpha} + P_{k',t+1} \left(1-\delta\right) \right].$$

- Note:

$$\beta \frac{\lambda_{t+1}}{\lambda_t} \;=\; \frac{1}{1+r_{t+1}}.$$

  – So, Price of Capital:

$$P_{k',t} \;=\; \frac{1}{1+r_{t+1}} \left[\alpha \left(K_{t+1}\right)^{\alpha-1} \left(z_{t+1} h_{t+1}\right)^{1-\alpha} + P_{k',t+1} \left(1-\delta\right) \right],$$

- Repeating:

$$P_{k',t} \;=\; \frac{1}{1+r_{t+1}}\left[\alpha\left(K_{t+1}\right)^{\alpha-1}\left(z_{t+1}h_{t+1}\right)^{1-\alpha}+P_{k',t+1}\left(1-\delta\right)\right],$$

With Rental Market for Capital:

$$P_{k',t} \;=\; \frac{1}{1+r_{t+1}}\left[R^{k}_{t+1}+P_{k',t+1}\left(1-\delta\right)\right].$$

- Repeating:

$$P_{k',t} \;=\; \frac{1}{1+r_{t+1}}\left[R^k_{t+1} + P_{k',t+1}\left(1-\delta\right)\right].$$

- Recursive Substitution, Gives Usual Present Discounted Value Relation:

$$\begin{aligned}
P_{k',t} &= \frac{1}{1+r_{t+1}}R^k_{t+1} + \frac{(1-\delta)}{1+r_{t+1}}P_{k',t+1} \\
&= \frac{1}{1+r_{t+1}}R^k_{t+1} + \frac{(1-\delta)}{1+r_{t+1}}\left[\frac{1}{1+r_{t+2}}R^k_{t+2} + \frac{(1-\delta)}{1+r_{t+2}}P_{k',t+2}\right] \\
&= \frac{1}{1+r_{t+1}}R^k_{t+1} + \frac{(1-\delta)}{\left(1+r_{t+1}\right)\left(1+r_{t+2}\right)}R^k_{t+2} + \frac{(1-\delta)}{1+r_{t+1}}\frac{(1-\delta)}{1+r_{t+2}}P_{k',t+2} \\
&= \ldots \\
&= \sum_{i=1}^{\infty}\left(\prod_{j=1}^{i}\frac{1}{1+r_{t+j}}\right)\left(1-\delta\right)^{i-1}R^k_{t+i}.
\end{aligned}$$

- Now, Go for SECOND Relation that Price of Capital Must Satisfy in Economy Where Capital I Produced (Tobin's q)
- First Order Condition of Lagrangian with Respect to I_t:

$$
\begin{aligned}
-\lambda_t + \mu_t(1 - S\left(\frac{I_t}{I_{t-1}}\right)) - \mu_t S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}} \\
+\beta\mu_{t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2 &= 0.
\end{aligned}
$$

- Rewriting this, taking into account the definition of the price of capital,

$$
P_{K',t} = \frac{1}{1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}} - \left(\frac{1}{1+r_{t+1}}\right)\frac{P_{K',t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2}{1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}}.
$$

- Repeating...

$$P_{K',t} = \frac{1}{1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}} - \left(\frac{1}{1+r_{t+1}}\right)\frac{P_{K',t+1}S'\left(\frac{I_{t+1}}{I_t}\right)\left(\frac{I_{t+1}}{I_t}\right)^2}{1 - S\left(\frac{I_t}{I_{t-1}}\right) - S'\left(\frac{I_t}{I_{t-1}}\right)\frac{I_t}{I_{t-1}}}.$$

$$= \text{Static Marginal Cost + Dynamic Part}$$

- This Expression Clarifies Why $P_{K',t}$ Falls During Boom Phase of Boom-Bust Cycle
  - Anticipated High Future Investment Implies there is an Extra Payoff to Current Investment.
  - Under Competition, This Extra Payoff Would Lead Sellers of Capital to Sell at a Lower Price.

Analysis in Monetary Economy

- Incorporate Above Ideas into A Monetary Economy (Analog of ACEL Model Already Discussed)

- Taylor Rule:

$$R_t = 1.5 E_t \pi$$

- Findings:

  – Boom in Consumption, Investment, Output Greatly Amplified

  – There is Also a Stock Market Boom

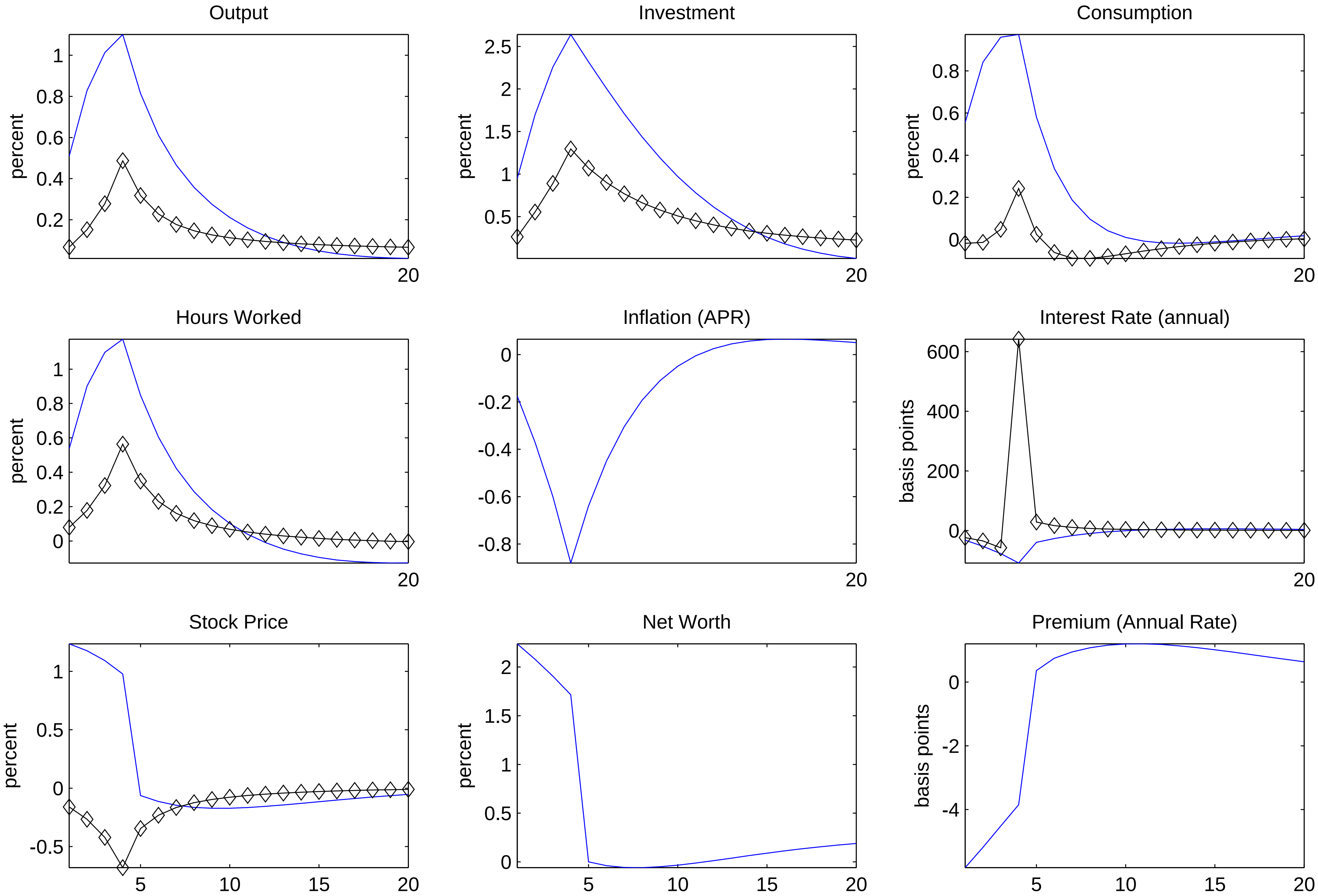
    ∗ Reason:

      · In Monetary Economy, Boom Accompanied By Low Inflation

      · Low Inflation Leads to Monetary Expansion (‘Taylor Principle’)

      · Monetary Expansion Creates Stock Market Boom, and Amplifies Response of Consumption, Investment, Employment, Etc.

Response in RBC Model (diamonds) and Monetary Model With Taylor Rule With Coefficient of 1.5 on Expected Inflation
To a Technology Shock Expected 4 Quarters Later That Does Not Occur



Policy Implications

- Not Yet Worked Out, So Not Sure!

- Important Consideration: Boom-Bust Cycle Studied Here Rare Event

  - Do Not Necessarily Want to Base Policy on Rare Events

- Possibly, With Real Interest (Natural) Rate in Model, Monetary Policy Would Not Trigger a Boom

  - This Will Be Investigated

  - Consider other Factors in Taylor Rule