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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*
    - Story About Why this is So Is Interesting
  - Next Step: Incorporate Monetary Factors Into the Analysis....

Findings ...

– Adopt a Monetary Economy Much Like ACEL Model

- ∗ Model Monetary Policy as a Simple Taylor Rule:

$$R_t = \alpha + 1.5E_t\pi_{t+1}$$

- ∗ Then, Have a Complete Theory of Boom-Bust Cycle!

- ∗ 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.

- Implications for Monetary Policy Will Be Discussed at the End

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:

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

- Physical Capital Accumulation:

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

- Resource Constraint:

$$C_t + I_t + a(u_t)K_t \leq Y_t$$

- Technology Evolution:

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

Simple RBC Model

- No adjust costs in investment:

$$S \equiv 0$$

- Capital Utilization Constant:

$$u_t \equiv 0$$

- No Habit Persistence:

$$b = 0$$

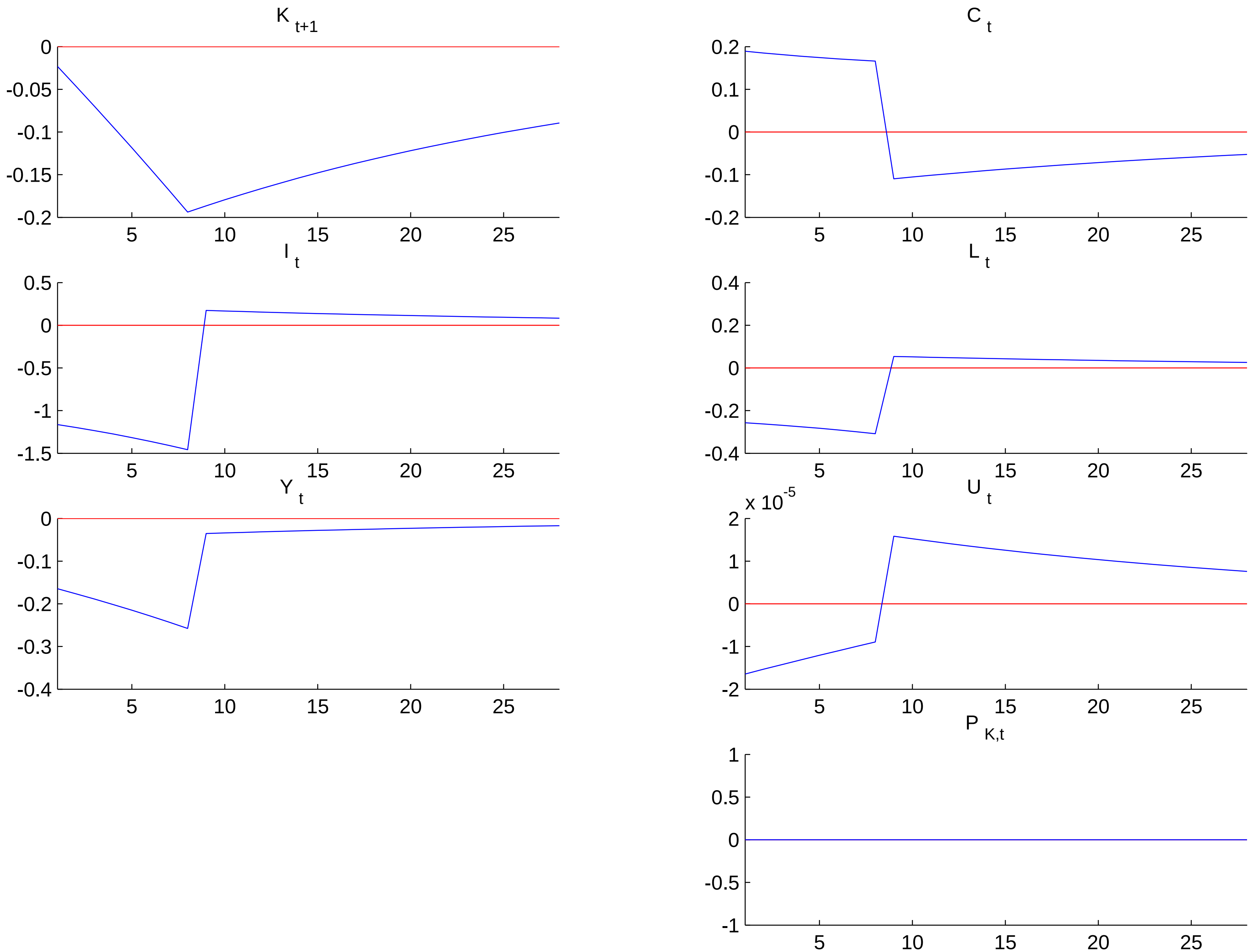
- Other Parameters:

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

- 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:

$$\begin{aligned} S &= S' = 0 \text{ in Steady State} \\ S'' &= 5 \text{ in Steady State} \end{aligned}$$

- Cost of Varying Capital Utilization:

$$\begin{aligned} u_t &= 1 \text{ in Steady State} \\ \frac{a''}{a'} &= 0.0001 \text{ in Steady State} \end{aligned}$$

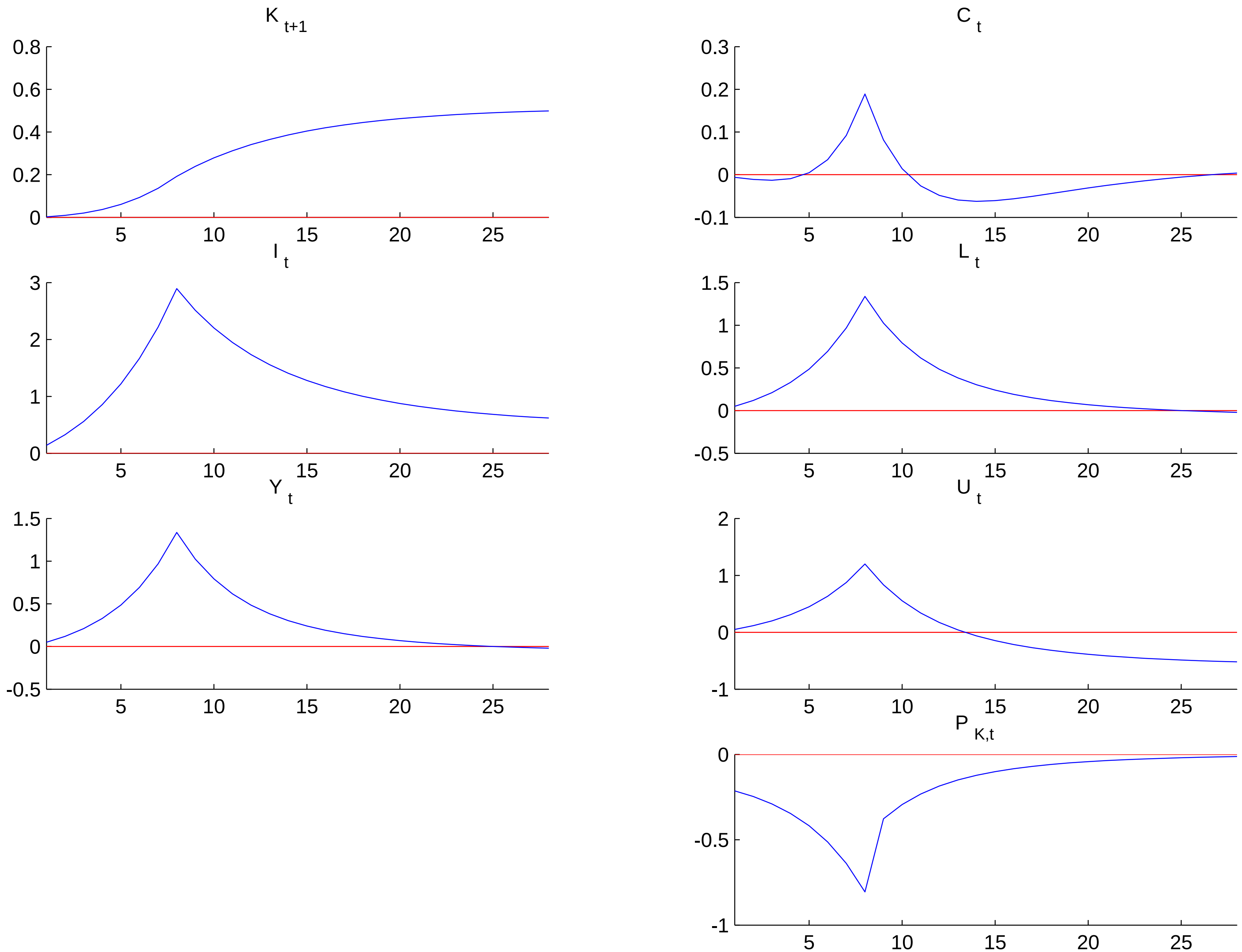
- Habit Persistence:

$$b = 0.75$$

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

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

Non-Monetary Model with Adjustment Costs in Investment Change, Habit Persistence, Variable Capital Utilization

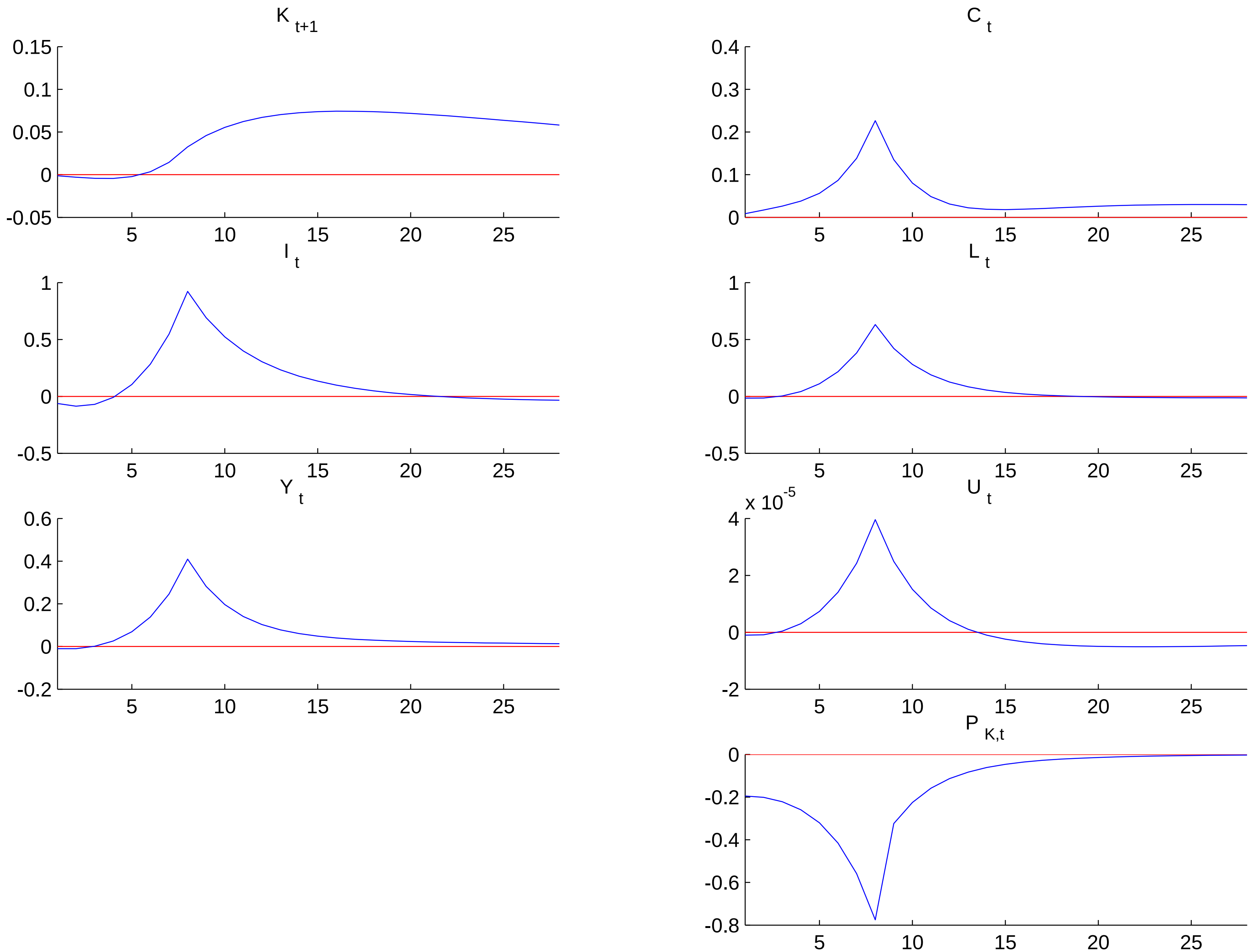


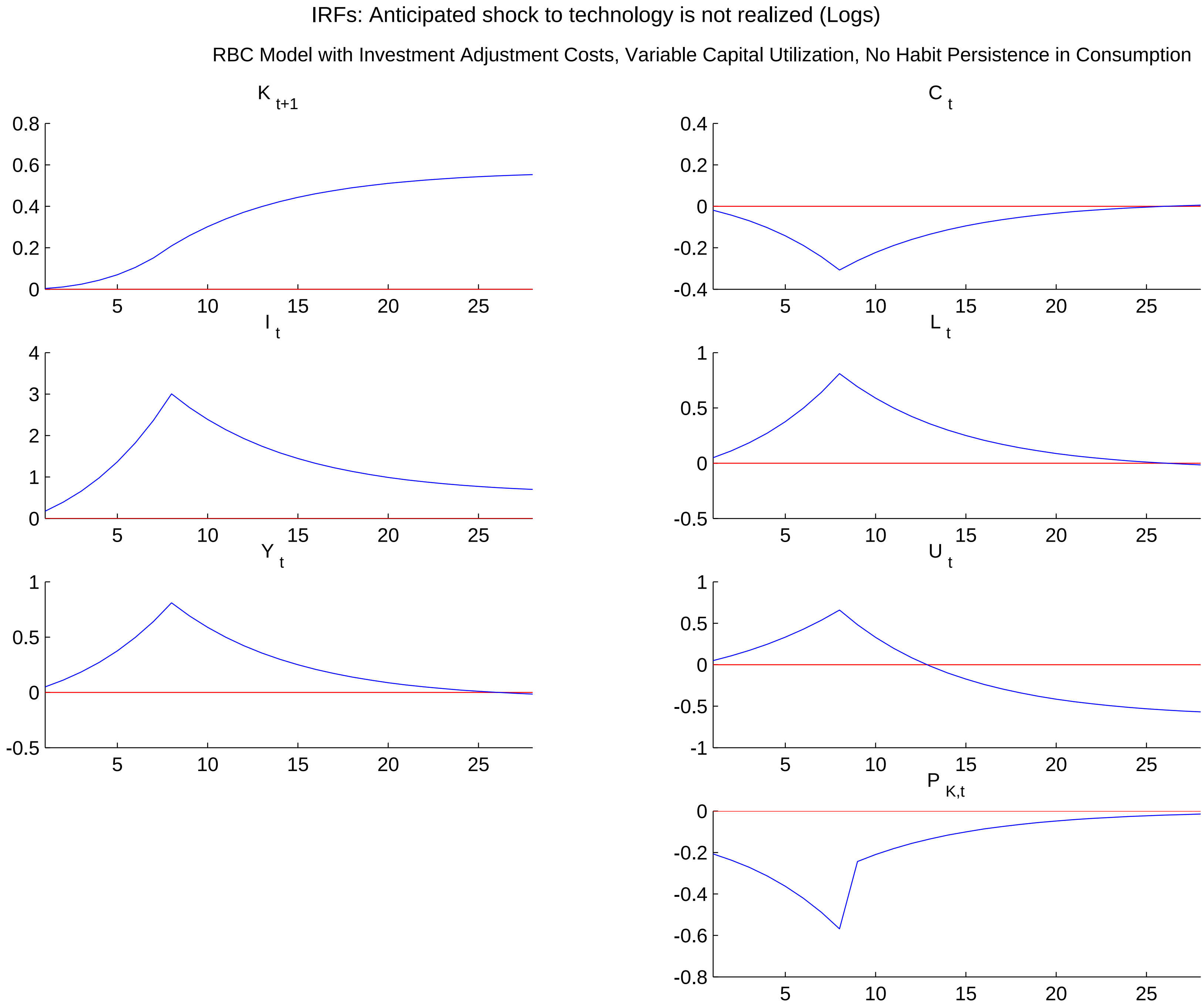
Diagnosing Results

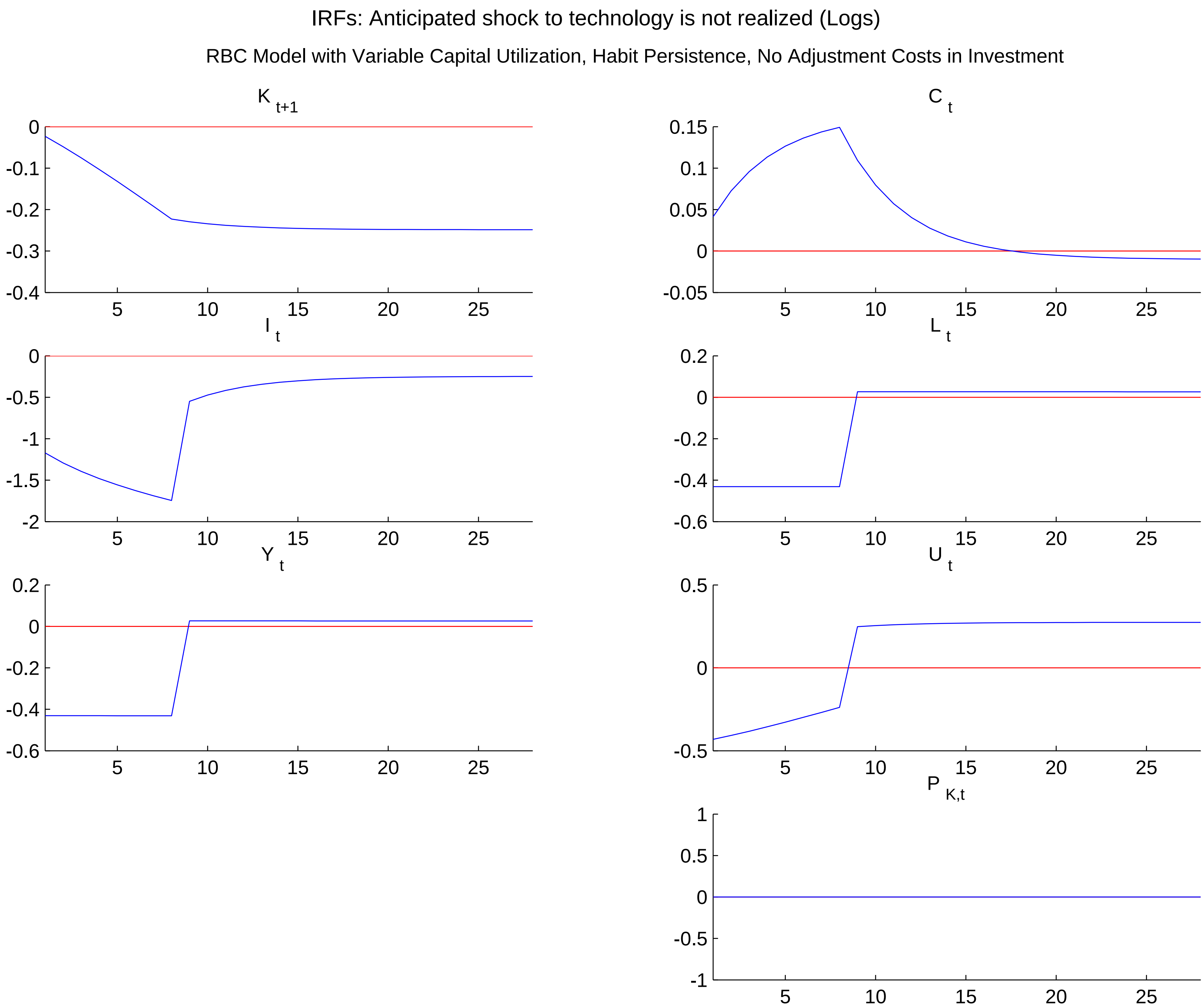
- Role of Variable Capital Utilization:
  - Fairly Minor: Helps Investment to Rise Immediately
- Role of Habit Persistence: Major
  - Ensures that Consumption Rises In Boom Part of Cycle
- Role of Investment Adjustment Costs: Major
  - Ensures that Investment Rises in Boom Part of Cycle
- Puzzle: Why Does the Theory Imply a *Fall* in Stock Market?????

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

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




IRFs: Anticipated shock to technology is not realized (Logs)
RBC Model with Investment Adjustment Costs, Variable Capital Utilization, No Habit Persistence in Consumption
K t+1
C t
I t
L t
Y t
U t
P K,t


IRFs: Anticipated shock to technology is not realized (Logs)
RBC Model with Variable Capital Utilization, Habit Persistence, No Adjustment Costs in Investment
K t+1
C t
I t
L t
Y t
U t
P K,t

Diagnosing Results

- Role of Variable Capital Utilization:
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- Role of Habit Persistence: Major
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Some Capital Theory

- In a Production Economy, Price of Capital ('Stock Market') Satisfies **TWO** Relations
  - Usual Present Discounted Value Relation
  - Tobin's q Relation
  - 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:

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

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

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

Some Capital Theory ...

- Repeating...

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

- 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

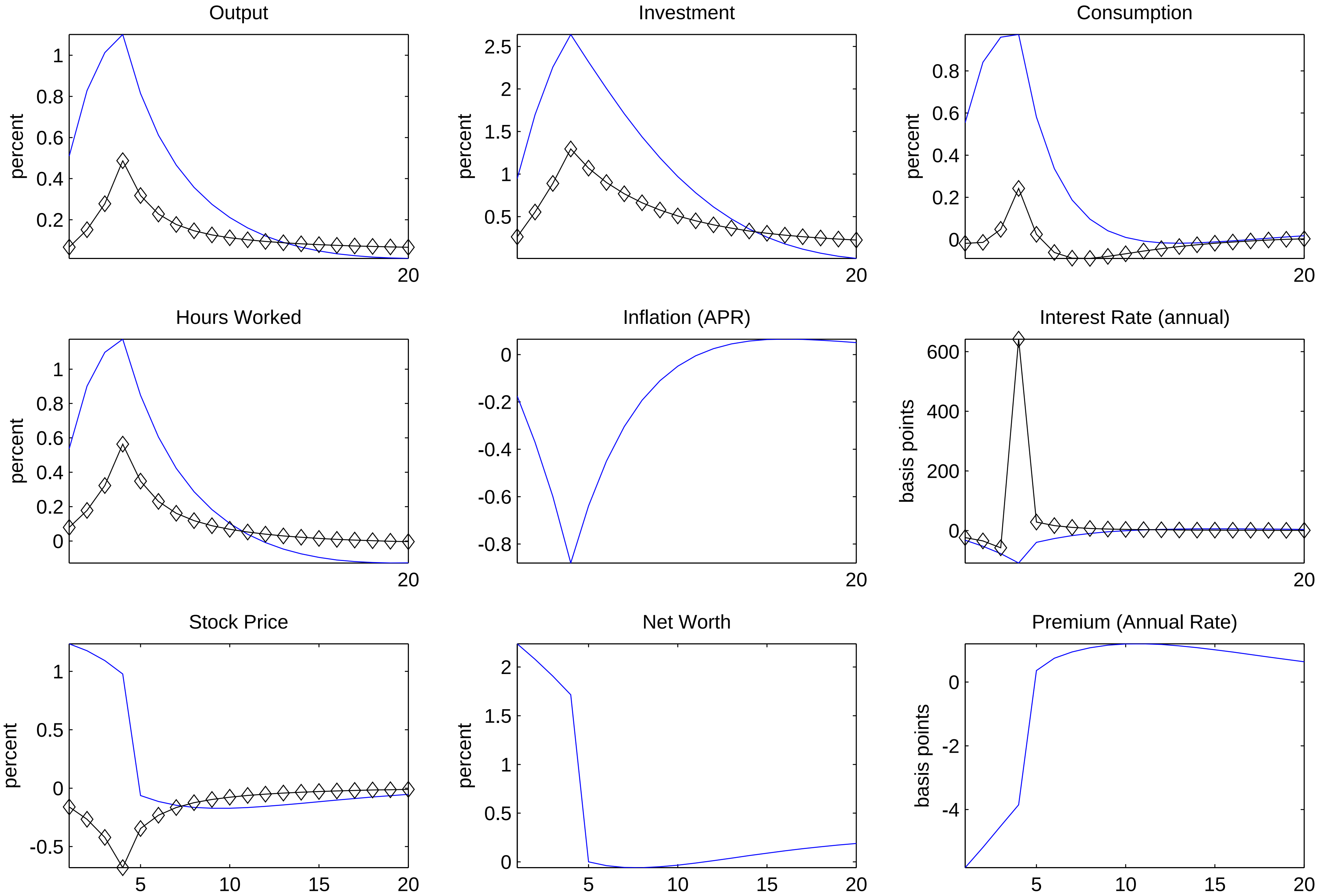
- Incorporate Above Ideas into A Monetary Economy (Analog of ACEL Model Already Discussed)

- Taylor Rule:

$$R_t = 1.5E_t\pi$$

- Findings:
  - Boom in Consumption, Investment, Output Greatly Amplified
  - There is Also a Stock Market Boom

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