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

- Production Function:
  \[ Y_t = (u_t K_t)^\alpha (\exp(z_t) h_t)^{1-\alpha}. \]

- 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:
  \[ \alpha = 0.36, \beta = 1.03^{-0.25}, \delta = 0.02, \gamma = 1, \psi = 2.3. \]

• 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:

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

- Cost of Varying Capital Utilization:

\[ u_t = 1 \text{ in Steady State} \]
\[ \frac{a''}{a'} = 0.0001 \text{ in Steady State} \]

- 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
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

L_t

Y_t

I_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

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C_t

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• Puzzle: Why Does the Theory Imply a *Fall* in Stock Market??????
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 $q$
Some Capital Theory ...

- Lagrangian:

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

- 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 \( K_{t+1} \):

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

• Divide both sides of $K_{t+1}$ FONC by $\lambda_t$:

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

• ‘Time $t$ Price of Capital, $K_{t+1}$’ (Tobin’s $q$):

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

• Rewrite FONC for $K_{t+1}$:

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

• Repeating Fonc for $K_{t+1}$:

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

• Note:

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

– So, Price of Capital:

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

• Repeating:

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

With Rental Market for Capital:

\[
P_{k',t} = \frac{1}{1 + r_{t+1}} \left[ R_{t+1}^{k} + P_{k',t+1} (1 - \delta) \right].
\]
Some Capital Theory ...

- Repeating:

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

- Recursive Substitution, Gives Usual Present Discounted Value Relation:

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