Stock Price Cycles and Business Cycles

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October 2019
New technologies often associated with aggregate instability:
- 1990’s dotcom; 1920’s auto/aviation/electricity, 19th cent. railways
- booms: output + employment + stock prices
- booms followed by output falls & spectacular asset price collapses
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Aggregate instability associated with low real rates: Taylor (2007)
- secular decline in safe interest rates (Laubach & Williams)
- repeated stock price boom-bust cycles over past 30 yrs....
Figure: Price cycles in the S&P 500 (Q1:1985-Q4:2014)
Simple economic model: technology shocks only driving force
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Model quantitatively replicates

- behavior of postwar U.S. business cycle
- volatility of postwar U.S. stock prices
Introduction

- **Simple economic model**: technology shocks only driving force

- Model quantitatively replicates
  - behavior of postwar U.S. business cycle
  - volatility of postwar U.S. stock prices

- Generates occasional boom-bust cycles in stock prices & ec. activity
Model predicts likelihood of boom-bust episodes to be
- higher in periods of **high productivity growth**
- higher in periods of **low real interest rates**
- higher following a previous boom: **tendency to repeat cycles**
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Large booms feature ‘Minsky moment’:
Persistent undershooting: depressed ec. activity & stock prices
Key Model Ingredient: Extrapolation

- Only ’non-standard’ model feature:
  - Subjective expectations about capital gains in the stock market

\[ P_{t+1} = E P_t + \gamma P_{t-1} + \beta E P_{t-1} + \gamma E P_{t-1} \]

Rationalizable as Bayesian learning: \( \gamma > 0 \) is the Kalman gain
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- *Some* amount of extrapolation from past capital gains:

\[
E_t^P \left[ \frac{P_{t+1}}{P_t} \right] = E_{t-1}^P \left[ \frac{P_t}{P_{t-1}} \right] + g \left( \frac{P_t}{P_{t-1}} - E_{t-1}^P \left[ \frac{P_t}{P_{t-1}} \right] \right)
\]

Rationalizable as Bayesian learning: \( g > 0 \) is the Kalman gain.
Survey Data and Extrapolative Expectations

Figure: UBS survey expectations versus adaptive prediction model
Extrapolation as Amplification

- Fundamental shocks $\Rightarrow$ move stock prices

Stock price movements amplified by extrapolation

Stock price movements translate into real economy: high capital price trigger investment $\Rightarrow$ output & hours worked

Amplification stronger when interest rates low or tech growth high
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- Fundamental shocks $\Rightarrow$ move stock prices
- Stock price movements **amplified** by extrapolation
- Stock price movements translate into real economy:
  - high capital price trigger investment $\Rightarrow$ output & hours worked
  - $\Rightarrow$ **financial accelerator without financial friction**
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**Amplification** stronger when interest rates low or tech growth high
• Time-separable household preferences

\[ E_0^P \sum_{t=0}^{\infty} \beta^t (\log C_t - H_t) \]

• Standard 2-sector production structure

\[ Y_{C,t} = K_t^{\alpha_z} (Z_t H_{c,t})^{1-\alpha_c} \]
\[ Y_{I,t} \propto (Z_t H_{i,t})^{1-\alpha_c} \]

• Technology shocks (only source of randomness):

\[ Z_t = \gamma Z_{t-1} \varepsilon_t \]
## Quantitative Performance: Real Variables

<table>
<thead>
<tr>
<th>Moment</th>
<th>Data (StdDev)</th>
<th>Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sigma(Y)$</td>
<td>1.72 (0.25)</td>
<td>1.83</td>
</tr>
<tr>
<td>$\sigma(C)/\sigma(Y)$</td>
<td>0.61 (0.03)</td>
<td>0.67</td>
</tr>
<tr>
<td>$\sigma(I)/\sigma(Y)$</td>
<td>2.90 (0.35)</td>
<td>2.90</td>
</tr>
<tr>
<td>$\sigma(H)/\sigma(Y)$</td>
<td>1.08 (0.13)</td>
<td>1.06</td>
</tr>
<tr>
<td>$\rho(Y, C)$</td>
<td>0.88 (0.02)</td>
<td>0.84</td>
</tr>
<tr>
<td>$\rho(Y, I)$</td>
<td>0.86 (0.03)</td>
<td>0.89</td>
</tr>
<tr>
<td>$\rho(Y, H)$</td>
<td>0.75 (0.03)</td>
<td>0.70</td>
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</tbody>
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## Quantitative Performance: PD-Ratio and Return Volatility

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<tr>
<th>Moment</th>
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<tbody>
<tr>
<td>$E[P/D]$</td>
<td>152.3 (25.3)</td>
<td>149.95</td>
</tr>
<tr>
<td>$\sigma(P/D)$</td>
<td>63.39 (12.39)</td>
<td>44.96</td>
</tr>
<tr>
<td>$\rho(P/D)$</td>
<td>0.98 (0.003)</td>
<td>0.97</td>
</tr>
<tr>
<td>$\sigma(r^e)$</td>
<td>7.98 (0.35)</td>
<td>7.07</td>
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## Comovement: PD-Ratio with Real Side/Expectations

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<tr>
<td>$\rho(P/D, H)$</td>
<td>0.51 (0.17)</td>
<td>0.79</td>
</tr>
<tr>
<td>$\rho(P/D, I/Y)$</td>
<td>0.58 (0.31)</td>
<td>0.69</td>
</tr>
<tr>
<td>$\rho(P/D, E^P[r^e])$</td>
<td>0.79 (0.07)</td>
<td>0.52</td>
</tr>
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## Equity Premium & Risk-Free Rate Volatility

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<tr>
<td>$E[r^e]$</td>
<td>1.87 (0.45)</td>
<td>1.25</td>
</tr>
<tr>
<td>$E[r^f]$</td>
<td>0.25 (0.13)</td>
<td>0.78</td>
</tr>
<tr>
<td>$\sigma(r^f)$</td>
<td>0.82 (0.12)</td>
<td>0.06</td>
</tr>
</tbody>
</table>
Belief-Driven Propagation (Estimated Model)

- $m_{c,t}$
- $Q_{c,t}$
- $K_{c,t+1}$
- $W_t$
Model predicts more boom-bust episodes with high technology growth or low real interest rates

Equilibrium capital price equation (slightly simplified):

\[ Q_t = X_t^{1/\beta} \gamma m_t, \]

where

- \( m_t \): subjective capital gain expectations
- \( E_P_t[Q_t + 1/Q_t] \): end. variable that depend on parameters, technology, path of capital stock
- \( \beta \): discount factor (\( \beta < 1 \))
- \( \gamma \): gross aggregate growth rate (\( \gamma > 1 \))
- \( X_t \): end. variable that depend on parameters, technology, path of capital stock
Model predicts more boom-bust episodes with high technology growth or low real interest rates

Equilibrium capital price equation (slightly simplified):

\[ Q_t = \frac{X_t}{1 - \beta \gamma \cdot m_t}, \]

where

\[ m_t : \text{subjective capital gain expectations } E_t^P [Q_{t+1} / Q_t] \]

\[ \beta : \text{discount factor } (\beta < 1) \]

\[ \gamma : \text{gross aggregate growth rate } (\gamma > 1) \]

\[ X_t : \text{end. variable that depend on parameters, technology, path of capital stock} \]
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- Higher technology growth or higher discount factor:
  - \( \beta \gamma \) moves closer to 1
  - \( \beta \gamma \cdot m_t \) closer to one
  - any given movement in \( m_t \) generates larger price effect
  - fundamental price movements get amplified more!
  - more boom-bust episodes
Higher Steady-State Safe Rate (1.4% vs. 0.8%)
The Effects of Initial Conditions

- 8 pos. shocks
- 4 pos. shocks, depressed initial condition

$Q_c$ vs. time (years)
Conclusions

- Extrapolation in asset markets:
  A powerful amplification mechanism of fundamental shocks

- Simple and otherwise standard model:
  Quantitatively consistent with BC & stock price evidence

- Model features boom and bust cycles:
  Persistent over & under-shooting of long-run growth trends
  Higher risk of booms with strong tech. growth / low real rates