The Business Cycle Component of US Asset Returns

David Backus (NYU), Bryan Routledge (CMU), and Stanley Zin (CMU)

Rimini Centre for Economic Analysis | July 7, 2009
Outline

Data: cyclical properties of US asset prices and returns

Theory: numerical example [“Bansal-Yaron plus”]
Cyclical properties of US asset prices and returns

Cross correlations for financial indicators and economic growth

- Returns: logs of gross returns
- Excess returns: differences in logs of gross returns

Economic growth

- Monthly: \( \log x_t - \log x_{t-1} \)
- Or year-on-year: \( \log x_{t+6} - \log x_{t-6} \)
- Computed from: industrial production, consumption, employment

US data, monthly, 1960 to present
Equity returns (monthly growth)
Equity returns (yoy growth)
Equity returns (variations)

Year-on-Year Growth

Real

Monthly

1990 and After

Backus, Routledge, & Zin (NYU & CMU)
Cyclical component of US returns
Term spread (monthly growth)

### Data

<table>
<thead>
<tr>
<th>Lead or Lag in Months</th>
<th>Cross Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>−24</td>
<td>0.00</td>
</tr>
<tr>
<td>−18</td>
<td>0.00</td>
</tr>
<tr>
<td>−12</td>
<td>0.00</td>
</tr>
<tr>
<td>−6</td>
<td>0.00</td>
</tr>
<tr>
<td>0</td>
<td>0.00</td>
</tr>
<tr>
<td>6</td>
<td>0.00</td>
</tr>
<tr>
<td>12</td>
<td>0.00</td>
</tr>
<tr>
<td>18</td>
<td>0.00</td>
</tr>
<tr>
<td>24</td>
<td>0.00</td>
</tr>
</tbody>
</table>

### Backus, Routledge, & Zin (NYU & CMU)

Cyclical component of US returns
Term spread (variations)

Term Spread

Cross Correlation

Lead or Lag in Months

Short Rate

Cross Correlation

Lead or Lag in Months

Year-on-Year Growth

Cross Correlation

Lead or Lag in Months

1990 and After

Cross Correlation

Lead or Lag in Months

Backus, Routledge, & Zin (NYU & CMU)
Cyclical component of US returns
Think about this for a minute...
Excess returns: equity (yoy)
Excess returns: Fama-French portfolios (yoy)

Small

Big

Low Book-to-Market

High Book-to-Market

Backus, Routledge, & Zin (NYU & CMU)  Cyclical component of US returns
Excess returns: industries (yoy)

- **Machinery**
  - Leads: 
  - Lags: 

- **Automobiles**
  - Leads: 
  - Lags: 

- **Food**
  - Leads: 
  - Lags: 

- **Drugs**
  - Leads: 
  - Lags: 

Backus, Routledge, & Zin (NYU & CMU)
Excess returns: bonds (yoy)
Theoretical economy

Take a breath

What do we need?
  ▶ Variation in risk and/or price of risk
  ▶ ... tied to economic growth

Bansal-Yaron plus
  ▶ Representative agent exchange economy
  ▶ Recursive preferences (Kreps-Porteus/Epstein-Zin/Weil)
  ▶ Loglinear process for consumption growth
  ▶ Stochastic volatility
  ▶ Interaction between growth and volatility
Theoretical economy

Take a breath

What do we need?

- Variation in risk and/or price of risk
- ... tied to economic growth

Bansal-Yaron plus

- Representative agent exchange economy
- Recursive preferences (Kreps-Porteus/Epstein-Zin/Weil)
- Loglinear process for consumption growth
- Stochastic volatility
- **Interaction between growth and volatility**
Kreps-Porteus preferences

Equations

\[ U_t = [(1 - \beta)c_t^\rho + \beta \mu_t(U_{t+1})^\rho]^{1/\rho} \]
\[ \mu_t(U_{t+1}) = (E_t U_{t+1}^\alpha)^{1/\alpha} \]
\[ \alpha, \rho \leq 1 \]

Interpretation

\[ IES = 1/(1 - \rho) \]
\[ CRRA = 1 - \alpha \]
\[ \alpha = \rho \Rightarrow \text{additive preferences} \]
Consumption growth

Consumption growth follows from

\[
\log g_t = g + e^\top x_t \\
x_{t+1} = Ax_t + a(v_t - v) + v_{t}^{1/2} Bw_{t+1} \\
v_{t+1} = (1 - \varphi_v) v + \varphi_v v_t + bw_{t+1}
\]

Note
- \( A \) generates predictable component
- \( v_t \) is stochastic
- \( a \) generates interaction
Kreps-Porteus pricing kernel

Marginal rate of substitution

\[ m_{t+1} = \beta \left( \frac{c_{t+1}}{c_t} \right)^{\rho-1} \left( \frac{U_{t+1}}{\mu_t(U_{t+1})} \right)^{\alpha-\rho} \]

If \( \alpha = \rho \)

- Second term disappears
- No roles for volatility or predictable consumption growth
Expectations and certainty equivalents

Example: let $\log x \sim N(u_t, v_t)$

Expectations and certainty equivalents for lognormals

$$E(x) = \exp(u_t + v_t/2)$$
$$E(x^\alpha) = \exp(\alpha u_t + \alpha^2 v_t/2)$$
$$\mu(x) = \left[E(x^\alpha)\right]^{1/\alpha} = \exp(u_t + \alpha v_t/2).$$

Effect of risk is multiplicative — additive in logs
Role of recursive preferences I

Suppose consumption growth is

$$\log x_t = \log x + \sum_{j=0}^{\infty} \chi_j w_{t-j}$$

Pricing kernel

$$\log m_{t+1} = \text{constant} + [(\rho - 1)\chi_0 + (\alpha - \rho)(\chi_0 + X_1)]w_{t+1}$$

$$+ (\rho - 1) \sum_{j=0}^{\infty} \chi_{j+1} w_{t-j}$$

$$X_1 = \sum_{j=1}^{\infty} \beta^j \chi_j \quad \text{(predictable component)}$$
Role of recursive preferences II

Suppose

$$\log U_{t+1} = u_t + \nu_t^{1/2} w_{t+1}$$

Pricing kernel gets new terms

$$\log m_{t+1} = \log \beta + (\rho - 1) \log (c_{t+1}/c_t)$$

$$+ \left[ (\rho - \alpha)/2 \right] \alpha \nu_t + (\alpha - \rho) \nu_t^{1/2} w_{t+1}$$
Theoretical excess returns

Transparent loglinear solution
- We love this, but won’t bore you with the details

Excess returns depend on
- Volatility ($v_t$)
- Innovations in consumption growth and volatility ($w_{t+1}$)
- **Not:** expected future consumption growth ($x_t$)!
Excess returns: numerical example

- Cross correlation
- Volatility
- Excess return on equity

Backus, Routledge, & Zin (NYU & CMU)

Cyclical component of US returns
Summary and extensions

Summary

▶ Data: excess returns correlated with future growth
▶ Model: ditto via stochastic volatility

Fixups and extensions

▶ Model dividends explicitly
▶ Production economies: volatility acts like shock to discount factor, affects consumption and labor supply
Related work (some of it)

Evidence on financial indicators of business cycles

- Ang-Piazzesi-Wei, Estrella-Hardouvelis, King-Watson, Rouwenhorst, Stock-Watson

Kreps-Porteus pricing kernel

- Hansen-Heaton-Li, Weil

Stochastic volatility and returns

- Atkeson-Kehoe, Gallmeyer-Hollifield-Zin, Naik, Primiceri-Schaumburg-Tambalotti
Earnings and dividends (yoy)
Growth: several flavors (yoy)

- Industrial Production
- Nonfarm Employment
- Consumption: Total
- Consumption: Services