Motivation

1. Evidence on short-term return continuation
   - Positive short-term serial correlation in returns
   - Tendency for past winners to outperform past losers
   - Price drift in same direction of initial shock after public news

2. Evidence on long-term return reversals
   - Negative long-run serial correlation in returns
   - Tendency for past winners to underperform past losers in the long run
   - Ability of price-scaled variables to forecast returns

3. Violation of efficient market hypothesis

4. Challenge to the standard risk-based models
Existing Stories

1. Rational theories generally fail:
   - Predict reversals or momentum, but not both: Wang (1993, 1994)
   - Predict momentum, not reversals: Berk et al. (1999), Johnson (2002)

2. Behavioral theories: underreaction and overreaction
   - Daniel et al. (1998): overconfidence and self-attribution
   - Barberis et al. (1998): conservatism and representativeness heuristic
   - Hong and Stein (1999): news watchers and momentum traders
Two types of investors: informed and uninformed (Wang (1994))

Informed and uninformed investors trade a stock and a riskfree bond

Informed investors access to a nontraded private investment opportunity correlated with the stock

Informed investors have private information about the stock including signals about future dividend realizations which we call *advance information*

Competitive rational expectations equilibrium

Different trading motives: *speculative trading* and *rebalancing trading*; *adverse selection*
Informed investors learn good news about dividends at $t+1$.

Dividends may or may not be higher because news are noisy; on average dividends increase.
Informed investors learn good news about dividends at t+1.

Stock price increases, but fails to reflect the present value of future dividends, underreacting to news, for two reasons:

Dividends may or may not be higher because news are noisy; on average dividends increase.
Informed investors learn good news about dividends at t+1

Stock price increases, but underreacts to news for two reasons:

Price does not fully incorporate the good news as uninformed investors underestimate the potential for high dividends

Dividends may or may not be higher because news are noisy; on average dividends increase

Likely returns will be high again at t+1
Informed investors learn good news about dividends at $t+1$.

Dividends may or may not be higher because news are noisy; on average dividends increase.

Stock price increases, but underreacts to news for two reasons:

1. Price does not fully incorporate the good news as uninformed investors underestimate the potential for high dividends.

2. Informed investors' hedging demand kicks in; good news for stock are also good news for their other investments; leads to rebalancing selling and downward price pressure.

Likely returns will be high again at $t+1$. 

Likely returns will be high again at $t+1$. 

Albuquerque and Miao (BU)

Advance Information and Asset Prices

June 2008
Informed investors learn good news about dividends at $t+1$

Stock price increases, but underreacts to news for two reasons:

Momentum occurs as high returns in $t$ are followed by high returns in $t+1$

Dividends may or may not be higher because news are noisy; on average dividends increase

When news materializes prices and dividends revert to long run mean

Return reversal occurs at $t+2$
As advance information (or “intangible information”) is incorporated into prices, prices may move even if accounting variables (or “tangible information”) do not.

When advance information materializes, prices revert back to their long run mean.

Thus, the “intangible” component of price helps forecast return reversals as found empirically by Daniel and Titman (2006).

Also explain the post-earnings announcement drift.
The Model

- All investors are myopic and have time-\( t \) utility:
  \[
  E_t \left\{ -e^{-\gamma W_{t+1}} \right\}
  \]

- All investors have access to the following two assets:
  - Risk-free asset pays gross return \( R \geq 1 \)
  - Risky stock trades at price \( P_t \) and generates earnings
    \[
    D_t = F_t + \epsilon_t^D.
    \]

The persistent component is

\[
F_t = a_F F_{t-1} + \epsilon_t^F, \quad 0 < a_F < 1.
\]

Excess return on the stock is \( Q_t = P_t + D_t - RP_{t-1} \).
The Model

- Informed investors access to nontraded private investment opportunity à la Wang (1994), with excess returns of:

\[ q_{t+1} = Z_t + \varepsilon_{t+1}^q, \]

\[ Z_t = a_Z Z_{t-1} + \varepsilon_t^Z, \quad 0 < a_Z < 1 \]

- Shocks are normally distributed with zero means and constant variances. Shocks are iid except for \( E(\varepsilon_t^D \varepsilon_t^q) = \sigma_{Dq} > 0 \)
Uninformed investors’ information set is

\[ \mathcal{F}_t^u = \{D_s, P_s : s \leq t\} \]

Informed investors’ information set is:

1. Single piece of advance information:

\[ \mathcal{F}_t^i = \{D_s, F_s, P_s, Z_s, S_s : s \leq t\}, \quad S_t = \varepsilon_{t+k}^D + \varepsilon_t^S \]

2. Multiple pieces of advance information:

\[ \mathcal{F}_t^i = \{D_s, F_s, P_s, Z_s, (S_s^n)_{n=1,\ldots,k} : s \leq t\}, \quad S_t^n = \varepsilon_{t+n}^D + \varepsilon_t^{S^n} \]
Rational Expectations Equilibrium

- Uninformed investors’ demand of the risky asset:
  \[
  \theta^u_t = \frac{1}{\gamma} \frac{E^u_t [Q_{t+1}]}{\text{Var}^u_t (Q_{t+1})}
  \]

- Informed investors’ demand of the risky asset:
  \[
  \theta^i_t = \frac{E^i_t [Q_{t+1}]}{\gamma \left( \sigma^i_Q \right)^2 \left( 1 - (\rho^i_{Qq})^2 \right)} - \frac{\rho^i_{Qq} E^i_t [q_{t+1}]}{\gamma \sigma^i_Q \sigma_q^i \left( 1 - (\rho^i_{Qq})^2 \right)}
  \]

- Risky stock is in fixed supply, so asset market clearing is:
  \[
  \lambda \theta^i_t + (1 - \lambda) \theta^u_t = 1
  \]

- Focus on stationary equilibrium
Informed investors have no advance information (Wang (1994)):

\[ \mathcal{F}^i_t = \{ D_s, F_s, P_s, Z_s : s \leq t \} \]

In equilibrium

\[ P_t = -p_0 + \frac{a_F}{R - a_F} F_t - p_i Z_t - p_{u1} (F_t - \hat{F}^u_t) \]

Equilibrium is not fully revealing; uninformed investors make forecast errors \( F_t - \hat{F}^u_t \) and \( Z_t - \hat{Z}^u_t \) which are perfectly positively correlated.
Benchmarks without Advance Information

Trading strategies

- Excess stock returns

\[ Q_{t+1} = e_0 + e_{i2} Z_t + e_{i1} (F_t - \hat{F}_t^u) + b_Q \varepsilon_{t+1}, \]  

(1)

- Informed investors’ stock demand

\[ \theta^i_t = f^i_0 - f^i_Z Z_t + f^i_F (F_t - \hat{F}_t^u) \]

- Uninformed investors’ stock demand

\[ \theta^u_t = f^u_0 + f^u_Z \hat{Z}_t^u \]
Benchmark without Advance Information

Stock return momentum and reversals

- Serial correlation in returns:
  \[ E[Q_{t+n} | Q_t] = e_0 + (Ra_Z - 1) a_Z^{n-1} f_Q Q_t \]

  \( e_0, f_Q > 0 \) are constants

- Determined by \( \text{Cov}(Z_t, Q_t) \)

- Stock returns display momentum if \( Ra_Z - 1 > 0 \), otherwise stock returns display reversal
Impulse Response Function
Shock to expected returns to private investment

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Advance Information and Asset Prices  
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Define earnings surprises as $D_t - E^u_{t-1}(D_t)$. Then,

$$E[Q_{t+n}|D_t - E^u_{t-1}(D_t)] = e_0 + a^{n-1}_Z d_1 [D_t - E^u_{t-1}(D_t)]$$

$e_0, d_1 > 0$ are constants

- Uninformed investors interpret a positive earnings surprise as an increase in $F_t \iff$ Raise $\hat{F}^u_t$ and $\hat{Z}^u_t$
- Informed investors take speculative sale positions
- Uninformed investors buy to accommodate informed investors’ speculative trades, in anticipation of a high return in the next period.
Single Piece of Advance Information

Solution strategy

- Guess state vector

\[ x_t = \left( F_t, Z_t, \varepsilon_{t+k}^D, \ldots, \varepsilon_t^D, \varepsilon_{t+k}^q, \ldots, \varepsilon_{t+1}^q \right)^T \]

- Both investor types face learning problems
- Guess equilibrium price function

\[ P_t = p_0 + p_i \hat{x}_t^i + p_u \hat{x}_t^u , \]  \hspace{1cm} (2)

- Solve for optimal portfolio given guess for price and state vector
- Use market clearing condition to verify guess
The equilibrium stock price is:

\[ P_t = -p_0 + \frac{a_F}{R - a_F} F_t - p_{i2} Z_t - p_{u1} (F_t - \hat{F}_t^u) \]

\[ + \sum_{j=1}^{k} \left\{ \frac{1}{R_j} E_t^i \left[ \epsilon_{t+j}^D \right] - p_{u,j+2} \left( E_t^i \left[ \epsilon_{t+j}^D \right] - E_t^u \left[ \epsilon_{t+j}^D \right] \right) \right\} \]

\[ + \sum_{j=1}^{k} \left\{ -\frac{e_{i2}}{R_j} E_t^i \left[ \epsilon_{t+j}^q \right] - p_{u,j+k+3} \left( E_t^i \left[ \epsilon_{t+j}^q \right] - E_t^u \left[ \epsilon_{t+j}^q \right] \right) \right\} \]

\[ e_{i2} > 0 \text{ iff } Cov_t^i (Q_{t+1}, q_{t+1}) > 0 \]
Uninformed investors learn using only $\mathcal{F}_t^u = \{D_s, P_s : s \leq t\}$:
- Unexpected high dividends are noisy signal of high persistent dividends $F_t$
- Unexpected high prices are noisy signals of high persistent dividends $F_t$ and advance information and low persistent off-market factors $Z_t$

Informed investors learn about future earnings:

$$E_t^i \left[ \varepsilon_{t+k-j}^D \right] = \frac{\sigma_D^2}{\sigma_S^2 + \sigma_D^2} S_{t-j}, \quad 0 \leq j \leq k - 1$$

$$E_t^i \left[ \varepsilon_{t+k-j}^q \right] = \frac{\sigma_{Dq}}{\sigma_S^2 + \sigma_D^2} S_{t-j}, \quad 0 \leq j \leq k - 1$$
Single Piece of Advance Information

Trading strategies

- Uninformed investors’ stock demand

\[
\theta^u_t = f^u_0 + f^u_Z (\hat{Z}^u_t + E^u_t [\varepsilon^q_{t+1}])
\]

- Informed investors’ stock demand

\[
\theta^i_t = f^i_0 + f^i_Z (Z_t + E^i_t [\varepsilon^q_{t+1}]) + f^i_F (F_t - \hat{F}^u_t)
\]

\[
+ \sum_{j=1}^k \left\{ f^i_{Dj} \left( E^i_t [\varepsilon^q_{t+j}] - E^u_t [\varepsilon^D_{t+j}] \right) - f^i_{qj} \left( E^i_t [\varepsilon^q_{t+j}] - E^u_t [\varepsilon^q_{t+j}] \right) \right\}
\]

\[
f^u_Z > 0 \text{ and } f^i_Z < 0 \text{ iff } \text{Cov}_t(Q_{t+1}, q_{t+1}) > 0
\]
In model without advance information momentum occurs if 
$Ra_Z - 1 > 0$, otherwise reversals occur

Let $a_Z$ be small so that reversals occur, absent of advance information
In model without advance information momentum occurs if $Ra_Z - 1 > 0$, otherwise reversals occur.

Let $a_Z$ be small so that reversals occur, absent of advance information.

Advance information introduces new effect; let $k = 1$:

- Good advance information increases price by $E_t^i \left( \varepsilon_{t+1}^D \right) / R$
- Uninformed investors underestimate news, $E_t^i \left( \varepsilon_{t+1}^D \right) - E_t^u \left( \varepsilon_{t+1}^D \right) > 0$, leading to speculative trades by informed investors.
- Informed investors rebalance because $E_t^i \left( \varepsilon_{t+1}^q \right)$ increases leading to stock sales and downward price pressure.
- Uninformed investors buy, driving up next period stock returns.
- As good information materializes next period and rebalancing trades are reversed.
Impulse Response Function
Shock to advance information

- 0.5
- 0.4
- 0.3
- 0.2
- 0.1
- 0.05
- 0
- 0.05
- 0.1
- 0.15
- 0.2
- 0.25
- 0.3
- 0.35
- 0.4
- 0.5

- 20 2 4 6 8 10

Time

- 20 2 4 6 8 10

Time

- 0.5
- 0
- 0.5
- 1
- 1.5
- 2
- 2.5
- 10^{-3}

Time

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June 2008
Single Piece of Advance Information

**Table 1.**

**MOMENTUM AND REVERSAL EFFECTS**

\[ Q_{t+n} = a_n + b_n Q_t + \varepsilon_{t,n} \]

<table>
<thead>
<tr>
<th>( n \setminus k )</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>One period, ( b_n )</td>
<td>Cumulative</td>
<td>One period, ( b_n )</td>
<td>Cumulative</td>
</tr>
<tr>
<td>1</td>
<td>0.0337</td>
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<td>3</td>
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<td>-0.0161</td>
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<td>4</td>
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<td>-0.0145</td>
</tr>
<tr>
<td>5</td>
<td>-0.0130</td>
<td>-0.0274</td>
<td>-0.0131</td>
</tr>
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</table>
Let $k = 2$. Suppose that at every period, informed agents learn

$$S^1_t = \varepsilon_{t+1}^D + \varepsilon_t^{S_1}$$
$$S^2_t = \varepsilon_{t+2}^D + \varepsilon_t^{S_2}$$

Suppose that $\sigma^2_{S_2} > \sigma^2_{S_1}$, so that signals become increasingly more precise.

Two extreme cases

- If $\sigma^2_{S_2} = \infty$, model reverts back to the case where $k = 1$
- If $\sigma^2_{S_2} = 0$, there is no trading and no serial correlation in returns
Table 3. **MOMENTUM AND REVERSAL IN STOCK RETURNS**

\[ Q_{t+n} = a_n + b_n Q_t + \epsilon_{t,n} \]

<table>
<thead>
<tr>
<th>( \sigma_{S_1} )</th>
<th>0.1</th>
<th>0.2</th>
<th>0.30</th>
</tr>
</thead>
<tbody>
<tr>
<td>One period, ( b_n )</td>
<td></td>
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<tr>
<td>Cumulative</td>
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<tr>
<td>( \sigma_{S_2} = 1 )</td>
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Study rational expectations, heterogeneous agent model with asymmetric information

Introduce advance (Intangible) information about earnings materializing in the future

Provide unified theory of short-term momentum and long-term reversal effects

Model also explains post-earnings announcement drift

Future work: Public advance information, sticky information, trading volume implications