Earnings Day Variance Ratio
Stock Market Response to Earning Announcements

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Overview: *How do fundamentals matter?*

- Fundamental question: *Do fundamentals matter in security pricing?*
  - Such as earning announcements and accounting reports

- Weak evidence (Literature is long...)
  - R-squares from regressing price changes against earning surprises, and earnings response coefficients (ERC) estimates are low

- Positive (anecdotal) evidence:
  - Commentators talk a lot about earnings.
  - Investors pay a lot attention to earning announcements/calls

- Explanations:
  - Missing variables: Different components of income, balance sheet, and cash flow... all matter for valuation, but to different degrees for different types of firms.
  - Noisy measurements, disagreements on consensus/surprises
  - Nonlinearities: The relation is not linear

- Always a joint test of the particular specification...
Overview: *How do fundamentals matter?*

- One can always add the missing variables and specify a nonlinear relation.
- Many studies do these...
- but practical difficulties abound in estimating such a relation
  - Regressors are measured with error — which lowers the slope estimates
    - People don’t agree on “consensus,” nor on “surprise.”
    - People don’t even agree on what measures/specifications are the relevant ones: earnings or free cashflow? EBIT or EBITDA? DCF, AEM, or RIM?
  - For one individual company, there are simply not enough quarterly observations to estimate an accurate relation.
    - Ten years of history only generate 40 observations, a small sample even for a univariate regression ...
  - Most regressions are done via cross-sectional pooling, assuming that the same response function applies to different types of firms,
    - but this practice either ignores cross-firm differences or necessitates lots of control variables...
- We know fundamentals matter. The question is how to capture/estimate the fundamental contribution accurately, ... and what we do with it.
We measure the contribution of fundamentals not by the R-squares or slopes of any particular regression specification, but by its variance contribution to the stock return.

- How much more does the stock price move, regardless of direction or reason, during earning days than during non-earning days?
- It captures the significance of the fundamental surprise, without needing to know the exact source and direction of the surprise(s).

We use the *Earnings day Variance Ratio* (EDR), the ratio of earnings day stock return squared to the return variance of the previous month, to capture the time-series and cross-sectional variation of fundamentals contribution.

- ERC regressions involve more specifications and hence can potentially be more revealing, IF one can estimate the relation accurately...
- EDR assumes less and hence reveals less about structural details, about allows us to drill down to the details of the impacts.

For valuation, it is more beneficial to rely on a structural model than a regression; but for risk management/option pricing, it suffices to have an accurate estimate of the net impact.
16 years of data from 1999-2014, focusing on the universe included in the S&P 1500 index, firms with extremely small market caps are excluded.

Data sources:
- CRSP: stock price/returns
- IBES: earning announcement date/times, consensus and surprises
- Other explorations: Bloomberg, CIQ, OptionMetrics

Sample: 73,608 viable earnings announcement days across 2,426 companies

Announcements happen on 3,785 different calendar days — Announcements that happen after market are attributed to the next business day.
### Review: Traditional ERC regression

Earning response regression: \( R_{t,i} = \alpha + \beta \ln \left( \frac{CEPS_{t,i}}{EEPS_{t,i}} \right) + e_{t,i} \)

<table>
<thead>
<tr>
<th>Total return response</th>
<th>( \beta )</th>
<th>( R^2 )</th>
<th>Excess return response</th>
<th>( \beta )</th>
<th>( R^2 )</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A: Pooled earnings response regression</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Estimates</td>
<td>0.049 (0.001)</td>
<td>0.051</td>
<td>0.049 (0.001)</td>
<td>0.054</td>
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<tr>
<td><strong>B: Firm-specific earnings response regression</strong></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mean</td>
<td>0.141 (0.106)</td>
<td>0.166</td>
<td>0.140 (0.103)</td>
<td>0.173</td>
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</tr>
<tr>
<td>Std Dev</td>
<td>0.291 (0.205)</td>
<td>0.179</td>
<td>0.293 (0.202)</td>
<td>0.183</td>
<td></td>
</tr>
<tr>
<td>10%</td>
<td>-0.008 (0.018)</td>
<td>0.007</td>
<td>-0.005 (0.017)</td>
<td>0.008</td>
<td></td>
</tr>
<tr>
<td>90%</td>
<td>0.379 (0.214)</td>
<td>0.407</td>
<td>0.376 (0.208)</td>
<td>0.420</td>
<td></td>
</tr>
</tbody>
</table>

- The R-squared for the pooled regression is 5.1-5.4% — The sign is correct on average, but the estimates (both slope and \( R^2 \)) of the effects are low.
- Firm-specific regression generates higher average \( R^2 \), but with large cross-sectional variation.
- Key: How to capture systematic cross-sectional (and time series) variation while reducing sample noise.
## Stock return variance around earning announcement days

<table>
<thead>
<tr>
<th>Days Around</th>
<th>-5</th>
<th>-4</th>
<th>-3</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A. Total return</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann. Variance</td>
<td>0.21</td>
<td>0.20</td>
<td>0.19</td>
<td>0.19</td>
<td>0.23</td>
<td>1.33</td>
<td>0.29</td>
<td>0.21</td>
<td>0.18</td>
<td>0.18</td>
<td>0.17</td>
</tr>
<tr>
<td>Variance Ratio</td>
<td>1.10</td>
<td>1.03</td>
<td>1.03</td>
<td>1.02</td>
<td>1.20</td>
<td><strong>7.04</strong></td>
<td>1.56</td>
<td>1.12</td>
<td>0.96</td>
<td>0.96</td>
<td>0.92</td>
</tr>
<tr>
<td><strong>B. Excess return</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ann. Variance</td>
<td>0.15</td>
<td>0.14</td>
<td>0.14</td>
<td>0.14</td>
<td>0.17</td>
<td>1.28</td>
<td>0.25</td>
<td>0.16</td>
<td>0.13</td>
<td>0.13</td>
<td>0.12</td>
</tr>
<tr>
<td>Variance Ratio</td>
<td>1.09</td>
<td>1.02</td>
<td>1.02</td>
<td>1.01</td>
<td><strong>1.24</strong></td>
<td><strong>9.45</strong></td>
<td><strong>1.86</strong></td>
<td>1.20</td>
<td>0.98</td>
<td>0.98</td>
<td>0.91</td>
</tr>
</tbody>
</table>

- Return variance during non-earning business days averages around 0.19, corresponding to a volatility estimate of 43%.
- Return variance during earning days average at 1.33, 7 times the non-earning day average variance — *Fundamentals matter!*
- The effects are even stronger (9 times) in excess returns, once controlling for market movements.
- Other observations:
  - The average variance is 24% higher than average one day before the announcement — timing issues?
  - The average variance is 86% higher than average one day after. — It takes time to fully digest the meaning of the announcement.
Economic significance of earnings day variance contribution

A. Annualized Variance

B. Variance Ratio

One earnings day generates one and half weeks worth of volatility:
Earnings day variance ratio (*EDR*)

as a more accurate, timely measure of fundamental contribution

- Earnings day is economically/statistically significant in its stock return variance contribution,
  - even if we do not know the specification that links each element of the earnings day announcement (and earnings call) to the stock return
- We propose to use EDR to replace ERC as a more accurate and timely measure of earnings day fundamentals contribution
  - EDR is defined as the ratio of earnings day stock return squared to the return variance over the previous month.

Economic meaning:

- All days are not alike. Earnings days are more important than other usual business days.
- EDR measures the number of usual business days that one earnings day is equivalent to in variance contribution.
- EDR=9 implies: One earnings day is equivalent to 9 business days in variance contribution.
EDR summary statistics

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>10</th>
<th>15</th>
<th>50</th>
<th>75</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Total return EDR</strong></td>
<td></td>
<td></td>
<td>10</td>
<td>15</td>
<td>50</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>Pooled</td>
<td>11.91</td>
<td>34.12</td>
<td>0.07</td>
<td>0.46</td>
<td>2.51</td>
<td>9.97</td>
<td>28.93</td>
</tr>
<tr>
<td>TS Averages</td>
<td>12.36</td>
<td>18.36</td>
<td>1.68</td>
<td>3.98</td>
<td>8.43</td>
<td>15.35</td>
<td>24.81</td>
</tr>
<tr>
<td>CS Averages</td>
<td>12.32</td>
<td>17.33</td>
<td>1.42</td>
<td>3.78</td>
<td>8.33</td>
<td>15.46</td>
<td>25.30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>10</th>
<th>15</th>
<th>50</th>
<th>75</th>
<th>90</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel B. Excess return EDR</strong></td>
<td></td>
<td></td>
<td>10</td>
<td>15</td>
<td>50</td>
<td>75</td>
<td>90</td>
</tr>
<tr>
<td>Pooled</td>
<td>18.03</td>
<td>52.92</td>
<td>0.08</td>
<td>0.60</td>
<td>3.42</td>
<td>14.71</td>
<td>44.53</td>
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<tr>
<td>TS Averages</td>
<td>17.82</td>
<td>23.74</td>
<td>1.80</td>
<td>5.07</td>
<td>12.20</td>
<td>22.80</td>
<td>37.70</td>
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<tr>
<td>CS Averages</td>
<td>18.44</td>
<td>24.20</td>
<td>1.81</td>
<td>5.11</td>
<td>12.87</td>
<td>23.63</td>
<td>38.10</td>
</tr>
</tbody>
</table>

- Average EDR is very high: 12 days when defined on total returns, and 18 days when defined on excess returns.
- Large variation, both cross-sectionally and over time.

  - Understanding the variations is important...
I. Linking EDR to EPS surprises

A. Surprise Magnitude

Higher EPS surprises lead to higher EDR, more so for negative surprises than for positive surprises.

B. Analyst Dispersion

Larger dispersion reduces the significance of the surprise, leading to smaller impacts.
EDR also increases with other surprises

- Regressing any one metric does not capture the whole picture
- EDR captures the aggregate effect of different surprises.
EDR has been increasing over time.

- Earnings announcements contribute increasingly more to stock price variation, from 5 days in 1999 to 50 days in 2014!
- Potential reason: Tightening of regulations over time on the information dissemination process for companies.
Implications of the upward trend in EDR

- What’s the economic meaning of a 50-day EDR?
  - Each year there are 4 earnings announcements, which contribute to over 200 days of variance!
  - The 4 earning days account for a predominant portion of the stock price variation.

- Valuation: The earnings days have the highest signal-to-noise ratio.

- Risk management: Managing the stock portfolio risk comes down to managing the stock price variation during earnings days — Forget about GARCH/stochastic vol, get the earnings day right first!

- Option pricing:
  - A one-week option ahead of an earnings day can be as expensive as a 3-month option.
  - Accurately predicting the EDR is crucial in pricing the options correctly.
  - Dynamic hedge arguments are mostly based on small moves, how do they work (how should they be adjusted) in the presence of large price moves during the earning days?
  - The bi-nodal nature of the surprise also have non-trivial impacts ...
The time-series trend highlights the increasing importance of the earning announcement days.

To accurately predict EDR for each company, it is important to understand how EDR varies, on average, across different types of firms.

EDR aggregates two dimensions of variation:

- The size of the surprise — We have shown that EDR increases with the size of surprise in various accounting measures, and declines with dispersion.

- The strength of response per unit surprise, analogous to ERC coefficient — One can think about the response strength from the perspective of a valuation model. Example:

\[
V_0 = \frac{C_1}{R - g}, \quad V_0 = B_0 + \frac{AE_1}{R - g}
\]
Amir & Lev (1996): Earnings are less informative for high-growth firms — But the announcement and the earnings call are much more than just EPS.

High growth firms tend to have a high multiple.

EDR captures the importance of the earnings day without being earnings (EPS) centric.
Book-to-market has become a commonly-cited “risk-factor” since Fama and French (1993,...)

The residual income model gives it a more fundamental role:

\[
\text{Market value} = \text{Book Value} + \text{Present Value of Residual Income}
\]

- A company’s value is driven not only by how much money it makes, but also by how much asset it has.

High book-to-market implies a smaller contribution from the income statement.
• Higher risk reduces the multiple, and hence the impact

• Higher vol firms will have an even higher vol during earnings days, but not proportionally so.

• Other effects: leakage, investor attention
Other risk metrics

- Beta effect is weak and in the wrong direction: Total/idiomntratic risk is priced?
- Large firms have smaller responses: Higher investor attention and hence smaller surprises?
  - Note the different direction from historical volatility and size.
IV. Predicting future EDR realization

Forecasting correlation with future EDR realization:

<table>
<thead>
<tr>
<th>Quarters</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single</td>
<td>0.101</td>
<td>0.145</td>
<td>0.162</td>
<td>0.177</td>
<td>0.187</td>
<td>0.191</td>
<td>0.194</td>
<td>0.195</td>
</tr>
<tr>
<td>GS6</td>
<td>0.167</td>
<td>0.187</td>
<td>0.194</td>
<td>0.194</td>
<td>0.196</td>
<td>0.195</td>
<td>0.196</td>
<td>0.195</td>
</tr>
<tr>
<td>GS4</td>
<td>0.183</td>
<td>0.192</td>
<td>0.194</td>
<td>0.192</td>
<td>0.192</td>
<td>0.191</td>
<td>0.190</td>
<td>0.189</td>
</tr>
<tr>
<td>GS2</td>
<td>0.179</td>
<td>0.186</td>
<td>0.186</td>
<td>0.183</td>
<td>0.182</td>
<td>0.179</td>
<td>0.178</td>
<td>0.178</td>
</tr>
<tr>
<td>GS6/Single</td>
<td>0.177</td>
<td>0.200</td>
<td>0.209</td>
<td>0.213</td>
<td>0.216</td>
<td>0.216</td>
<td>0.217</td>
<td>0.216</td>
</tr>
</tbody>
</table>

- Moving average: Averaging over the past 8 quarters generates strong prediction.

- Cross-sectional average within sectors also reduces noise and enhances prediction.

- Application: Compare historical average with option implied…
Earnings day (announcements and earnings calls) is important, but it is not just about earnings

- Income statements (Sales, EBITDA), cash flows, and balance sheet (leverage) information
- Past realizations as well as future guidelines

It is important to inspect the earnings day carefully...

Stock response (relative to history) represents a summary aggregate result of all surprises

EDR provides a measure of the response strength without getting into the details of the exact surprises

Along the same lines, ...
Companies tend to report positive earning surprises more than negative ones, potentially due to accounting manipulation.

But the market adjusts for this bias and generates relatively symmetric responses — The stock response is a more accurate measure of the true surprise.
Post earnings announcement drift

- On average, stocks with positive earning surprises outperform those with negative earnings surprises in the following months (Bernard & Thomas (89, 90),...)
- Question is how to measure the surprise.

<table>
<thead>
<tr>
<th>Quintiles</th>
<th>Raw returns</th>
<th>Adjusted returns</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Panel A. Sorted by EPS surprise (ES)</td>
<td></td>
</tr>
<tr>
<td>Quintile</td>
<td>ES</td>
<td>R1M</td>
</tr>
<tr>
<td>Low</td>
<td>-17.40</td>
<td>0.71</td>
</tr>
<tr>
<td>High</td>
<td>73.92</td>
<td>0.97</td>
</tr>
<tr>
<td>High−Low</td>
<td>91.31</td>
<td>0.26</td>
</tr>
<tr>
<td></td>
<td>(12.14)</td>
<td>(0.68)</td>
</tr>
<tr>
<td></td>
<td>Panel B. Sorted by earnings-day excess return (ER)</td>
<td></td>
</tr>
<tr>
<td>Quintile</td>
<td>ER</td>
<td>R1M</td>
</tr>
<tr>
<td>Low</td>
<td>-9.35</td>
<td>0.25</td>
</tr>
<tr>
<td>High</td>
<td>8.74</td>
<td>1.56</td>
</tr>
<tr>
<td>High−Low</td>
<td>18.09</td>
<td>1.31</td>
</tr>
<tr>
<td></td>
<td>(22.91)</td>
<td>(3.48)</td>
</tr>
</tbody>
</table>
Concluding remarks

- Do fundamentals matter? — They do, but not always in the way you think they do.

- Why are ERC estimates much lower than expected?
  - Prices respond to surprises, not changes.
  - Investors do not agree on consensus, nor surprises.
  - Many elements of accounting reports can affect people’s expectation of the inputs for stock valuation.
  - A linear regression is a very crude approximation of many layers...

- What do we do then?
  - Come up with a structural valuation specification that captures the combined effects of the many elements ...
  - Or do not come up with anything at all — Just measure the ex post magnitude of the stock response (EDR), whatever the cause.

- EDR seems to be persistent and predictable, and show systematic variations
  - Before building the perfect model, it is also useful to understand why investors respond more to certain firms than others.
  - For some applications, this is the perfect starting point.
EDR is becoming much larger now than before.

Accurately predicting EDR (maybe also its asymmetry) becomes increasingly important for risk management and option pricing.

We find that we can predict future EDR via historical and cross-sectional average.

Different types of firms show systematically different EDR patterns.

A lot more to think about:

- What else can be incorporated into the EDR prediction?
- How to think about the correlation (dynamics) structure of a portfolio in the presence of events?
- How to re-think asset pricing implications given the importance of earnings days?
  - What pricing phenomenon is driven by trading/liquidity, market sentiment and what is driven by company-level information?