The Use of Event Studies in Finance and Economics

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Any views are the author’s and not necessarily those of the Federal Reserve Bank of Atlanta or the Federal Reserve System.
Overview of Event Studies

- Event studies examine the effect of some event or set of events on the value of assets
  - Loosely speaking, a t-test of the change in price of some asset
  - Unexpectedly large increase or decrease
    - relative to standard deviation of typical change
Overview of Event Studies

- Value of assets
  - Firms’ stock prices are the most common
  - Exchange rates
  - Bond prices
  - Key thing needed is frequent trading relative to the “event window”
Overview of Event Studies

- Event or set of events
  - Stock splits
  - Earning announcements
  - Merger or takeover announcements
  - Regulatory change
    - Recent U.S. banking legislation allowing commercial banks to have investment banking operations
    - Introduction of pollution regulations
Overview of Event Studies

- What makes something an event?
  - Some change, development, announcement that may produce a relatively large change in the price of the asset over some period
    - Define an event window – a period over which the event occurs
    - Define an estimation window – a period over which parameters are estimated
    - Want the event window to be short relative to the estimation window
Formal Definition of Event Window

- Estimation window ranges from $T_0$ through $T_1$
- Event window ranges from $T_1$ through $T_2$
- Post-event window ranges from $T_2$ through $T_3$

- Index returns in time ($\tau$)
  - Estimation window
    - $\tau$ ranges from $T_0 + 1$ through $T_1$
  - Event window
    - $\tau$ ranges from $T_1 + 1$ through $T_2$
  - Post-estimation window
    - $\tau$ ranges from $T_2 + 1$ through $T_3$

- Following Campbell, Lo and MacKinlay (1997, Ch. 4 notation)
How Estimate Return Due to Event?

- Estimate return due to event
  - “Abnormal” return
  - Test is based on Abnormal return divided by Standard deviation of normal return
  - How measure abnormal return?
    - Have return during the event window
    - Estimate normal return
    - Return during the event window minus normal return is the abnormal return
    - Have to have estimate of normal return
How Estimate Return Due to Event?

- No underlying theory of asset prices
  - Average return
    - Constant-average return
  - Market model

\[
R_{i\tau} = \alpha_i + \beta_i R_{m\tau} + \varepsilon_{i\tau}
\]

\[
E\varepsilon_{i\tau} = 0 \quad \text{Var}[\varepsilon_{i\tau}] = \sigma^2
\]

- How does market model differ from Capital Asset Pricing Model?
  - No imposition of constraints from theory in market model
  - Just using this to “allow for” changes in firm i’s stock price relative to the market
How Estimate Return Due to Event?

- Theoretical models of asset prices
  - Capital Asset Pricing Model
    - Constant risk-free rate $R_r$
    - $R_{i\tau} = R_f + \beta_i (R_{m\tau} - R_f)$
    - Imposes constraint on constant term relative to market model
  - Arbitrage Pricing Theory
    - Elegant, appealing theoretically and empirically
    - Little advantage in event study
Econometrics of Estimating Return Due to Event

- Use market model as basis

\[ R_{i\tau} = \alpha_i + \beta_i R_{m\tau} + \varepsilon_{i\tau} \]

- Ordinary least squares (OLS) is unbiased and efficient

- How calculate abnormal return in event window?

  - Estimate market model equation by OLS using data from estimation window

  - Calculate possible abnormal return in event window
Econometrics of Estimating Return Due to Event

- Estimated equation

  \[ R_{i\tau} = \hat{\alpha}_i + \hat{\beta}_i R_{m\tau} + \hat{\varepsilon}_{i\tau} \]

  - the “hats” denote estimated values
  - for estimation window, \(\tau\) ranges from \(T_0+1\) to \(T_1\)

- Calculate potential abnormal returns

  \[ \hat{\varepsilon}_{i\tau} = R_{i\tau} - \hat{\alpha}_i - \hat{\beta}_i R_{m\tau} \]

  - for event window, \(\tau\) ranges from \(T_1+1\) to \(T_2\)
Econometrics of Estimating Return Due to Event

- Properties of potential abnormal returns

  - Conditional on the hypothesis that abnormal returns are zero
    - Same statistical model

  - \( \mathbb{E} \varepsilon_{iτ} = 0 \) and

\[
\begin{bmatrix}
\hat{\alpha}_i \\
\hat{\beta}_i
\end{bmatrix}
\begin{bmatrix}
\hat{\alpha}_i \\
\hat{\beta}_i
\end{bmatrix}
= \mathbb{V}_i = \sigma_{\varepsilon_i}^2 \left[ I + X^*_i (X'_i (X'_i X_i)^{-1} X^*_i) \right]
\]

- \( X \) is the matrix of constants and market returns for the estimation period and \( X^* \) is the same matrix for the event window
Econometrics of Estimating Return Due to Event

- Aggregate returns over time and across firms
  - Over time to get “cumulative abnormal return” in event window
    - Can and usually do aggregate across different time periods to see if effect develops over time and, if so, when
    - We’ll ignore this for simplicity
  - Across firms to get one test statistic for hypothesis
    - Usually hypothesis applies to many firms, not necessarily for the same dates
Econometrics of Estimating Return Due to Event

- Aggregate over time

\[ CAR_i = \sum_{\tau = T_i + 1}^{T_2} \hat{E}_{i\tau}^* \]

\[ \text{Var}[CAR_i] = \hat{\sigma}_{CAR,i}^2 = 1'V_i1 \]

\[ L_2 = T_2 - (T_1 + 1) + 1 = T_2 - T_1 \]

- \( CAR_i \) is Cumulative Abnormal Return for firm \( i \)

- Under the null hypothesis of no abnormal return, the abnormal return is zero and the distribution of \( \frac{CAR_i}{\hat{\sigma}_{CAR,i}} \) is Student’s \( t \) with \( L_2-2 \) degrees of freedom
Econometrics of Estimating Return Due to Event

- Aggregate across firms
  - Exact statistic depends on whether or not the abnormal returns are independent or dependent
  - Suppose independent for simplicity

\[
\text{CAR} = N^{-1} \sum_{i=1}^{N} \text{CAR}_i
\]

\[
\text{Var}[	ext{CAR}] = \sigma^2_{\text{CAR}} = N^{-2} \sum_{i=1}^{N} \hat{\sigma}^2_{\text{CAR},i}
\]

- Under the null hypothesis, the distribution of \( \frac{\text{CAR}}{\sigma_{\text{CAR}}} \) is asymptotically normal with zero mean and unit variance
Usefulness of Event Studies

- Event studies have been used to look at almost every issue in corporate finance
  - Stock splits
  - Dividend changes
  - Stock issuance
- Firms’ activities more generally
  - Merger and spinoff announcements
  - Hiring or firing of high-level officers
- Regulation
  - Changes in banking regulations
  - Changes in pollution regulations
Usefulness of Event Studies

- Can examine who gains and who loses from changes in regulation

- Securities and Exchange Commission uses event studies to determine if there has been insider trading before an announcement
  - How?

- Major econometric issue that could arise in an event study
  - The event date may not be independent of the behavior of the stock price
    - Low recent returns may cause something to happen that determines the event.
    - In short, event date is endogenous
    - Evidence is that this issue is unimportant
Usefulness of Event Studies

- Event studies are not a substitute for thought any more than are vector autoregressions
References

I have followed the notation and included at points a more straightforward exposition of the material in the best single reference of which I am aware: