

The Use of Event Studies in Finance and Economics

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Fall 2001

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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”

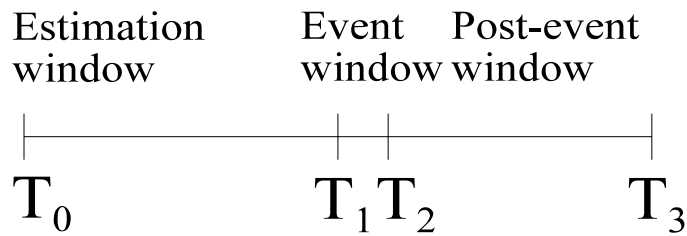
Overview of Event Studies

- 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



- $(T_0 \dots T_1]$ is estimation window
- $(T_1 \dots T_2]$ is event window
- $(T_2 \dots T_3]$ is post-event window
- Index returns in time (τ)
 - Estimation window
 - τ ranges from T_0+1 through T_1
 - Event window
 - τ ranges from T_1+1 through T_2
 - Post-estimation window
 - τ 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

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

- $E \varepsilon_{i\tau} = 0$ $\text{Var}[\varepsilon_{i\tau}] = \sigma^2$
- 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_f
 - $$R_{i\tau} = R_f + \beta_i (R_{m\tau} - R_f)$$
 - 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

- $$R_{i\tau} = \alpha_i + \beta_i R_{m\tau} + \varepsilon_{i\tau}$$

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

- 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, τ 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, τ 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

- $E \boldsymbol{\varepsilon}_{i\tau} = 0$ and

- $$E \begin{bmatrix} \hat{\alpha}_i \\ \hat{\beta}_i \end{bmatrix} \begin{bmatrix} \hat{\alpha}_i & \hat{\beta}_i \end{bmatrix} =$$

$$\mathbf{V}_i = \sigma_{\varepsilon_i}^2 [\mathbf{I} + \mathbf{X}_i^* (\mathbf{X}_i' (\mathbf{X}_i' \mathbf{X}_i)^{-1} \mathbf{X}_i^{*'})]$$

- \mathbf{X} is the matrix of constants and market returns for the estimation period and \mathbf{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

$$CAR_i = \sum_{\tau=T_1+1}^{T_2} \hat{\varepsilon}_{i\tau}^*$$

$$\text{Var}[CAR_i] = \hat{\sigma}_{CAR,i}^2 = \mathbf{1}'\mathbf{V}_i\mathbf{1}$$

$$L_2 = T_2 - (T_1 + 1) + 1 = T_2 - T_1$$

- 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

$$C\bar{A}R = N^{-1} \sum_{i=1}^N CAR_i$$

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$$\text{Var}[C\bar{A}R] = \sigma_{C\bar{A}R}^2 = N^{-2} \sum_{i=1}^N \hat{\sigma}_{CAR,i}^2$$

- Under the null hypothesis, the distribution of $C\bar{A}R/\sigma_{C\bar{A}R}$ 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:

Campbell, John Y., Andrew W. Lo, and A. Craig MacKinlay. 1997. *The Econometrics of Financial Markets*. Princeton: Princeton University Press, Chapter 4.