Event Studies:
Assessing the Market Impact of Corporate Policy

A widespread task in academic and financial research is to describe and evaluate the impact of an economic event. Direct measures, such as market share gain or profit, attributable to such an event lack general applicability. They accrue over a long period and might not capture the direct effects of the event alone, but be distorted by confounding events during the period of examination. To circumvent such issues, event study methodology relies on the stock (or other financial) market’s assessment of the economic event, focusing on the short-term reaction and ignoring the long-term implications. While this approach in itself might not capture the full picture, it has the advantage of being less easily distorted by other events so that one can more confidently attribute stock price performance to a specific event.

An event study measures the stock market’s reaction to a major announcement by a publicly traded firm. Its premise is that investors by trading in response to the event (or its announcement) aggregate information and their assessment of the new realities. Hence, the stock price evolution reflects the market’s collective perception of the event. In fact, the stock market, through trading, converts the event into a return (or the corresponding absolute “dollar-gain”) by using all information available at the time of the announcement, as reflected by informational efficient capital markets. Hence, the underlying assumption is the informational efficiency of capital markets. In particular, one needs to assume the semi-strong form of market efficiency, which requires that prices reflect past prices as well as all other public information. An event study is the converse to this hypothesis: if security prices reflect all currently available information, then price changes must reflect new information.¹

The following description of event study methodology draws on MacKinlay (1997) and Campbell et. al. (1997). Make sure to consult at least the former; the latter is more advanced and might only appeal to statistically more inclined students.

1 Event Definition and Timeline

The first step in an event study is the definition of the event. In most cases, one focuses on the announcement of a major corporate action (M&A transaction, earnings announcement, accounting event, strategic alliance, bankruptcy filing, R&D break-through, etc.), as it releases new information to the stock market rather than the actual underlying event that will often take place much later. Often the announcements are statistically significant while the actual events are statistical non-events.

Two problems typically arise in this context. First, most major corporate announcements that might have a large effect on the stock price are made after the market closes. Since the capital market can only react to the news on the following trading day the earliest, it is essential to include

¹By and large, well-developed, liquid markets such as the US appear to conform to the semi-strong form of informational efficiency.
the next trading day in the analysis of abnormal, i.e., event-specific, returns. Second, it is possible, that the information was not new to at least some market participants. The market might have anticipated the event before it was officially announced, or some market participants might have had some inside information and been trading on it\(^2\). To deal with this issue, the time included before the actual event should be longer when information leakage is more likely.

The time period, during which the abnormal returns are calculated to measure the effects of the event, is called the *event window*. By convention, the day, on which the new information was announced or otherwise revealed, is labelled *day 0*, and the event window is a surrounding interval of varying length. To deal with the problem of fully capturing the event-specific effects, one might want to choose the event window rather large. However another difficulty arises: the longer the event window, the more likely it becomes that a *confounding event* might have had an influence on the stock price. Hence, the event window “should be long enough to capture the significant effect of the event, but short enough to exclude confounding effects.

The time line of an event study usually consists of two parts: the actual event period, surrounding the event day and a preceding estimation period (see Figure 1). Let \( \tau \) be a time index designating a trading day. While the estimation window spans the stock prices in the time from \( \tau = (T_1, T_2) \), with \( L_1 = T_2 - T_1 \) daily stock returns, the event window spans the stock prices in the time from \( \tau = (T_3, T_4) \), with \( L_2 = T_4 - T_3 \) daily stock returns. An alternative estimation window might as well be included in the analysis: Either to cross-check the parameters from the estimation window or to substitute them, in case there are no data available.

In general, the event and estimation windows should not overlap because the normal return estimator should not be influenced by unusual price effects that the event period is supposed to capture. Hence, we always leave a buffer of 30 to 50 days between the estimation and event period so that the normal return estimation is “uncontaminated” by the event under consideration.

\[ T_1 \quad T_2 \quad T_3 \quad T_4 \quad T_5 \quad T_6 \]

![Figure 1: Typical Timeline of an Event Study with Significant Dates](image)

### 2 Computing and Analyzing Abnormal Returns

Underlying event study methodology is the realization that one cannot simply use observed market returns to assess the market’s reaction to an announcement. Instead, one has to isolate the return component attributable to the event from the natural evolution of the firm’s stock price. Hence, one needs to strip out the *systematic part* of the stock price movement from the overall return reaction in order to find the event-specific *unsystematic* return component, called *abnormal returns*.

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\(^2\)It should be noted, that either case is still in line with market efficiency.
The starting point is to calculate the continuously compounded returns of firm $i$ at date $t$ as

$$ R_{it} = \log \frac{P_{it}}{P_{it-1}} = \log(P_{it}) - \log(P_{it-1}) $$

(1)

where $\log$ is the natural logarithm. If one than more firm is involved in the event study, it might be necessary to adjust the stock prices for expected changes due to payments to the stockholder, such as dividend payments or pre-emptive rights in order to compare share price effects of different companies at different times. Suppose, that a cash-dividend of $d_{it}$ is paid at day $t$ to the holder of the stock $i$ at that day. The next day, the price of the stock is expected to fall by $d_{it}$ because of that payment. The return becomes

$$ R_{it} = \log \frac{P_{it} + d_{it}}{P_{it-1}} $$

2.1 Abnormal Returns

As an event study’s objective is to measure the effects of the announcement of unanticipated information on the stock price, one simply calculates the abnormal return $AR_{it}$ of security $i$ at time $t$ attributable to the new information as the difference between the observed and the expected (or predicted) return:

$$ AR_{it} = R_{it} - E[R_{it} | X_t] $$

(2)

where $R_{it}$ is the actual return, $\hat{R}_{it} := E[R_{it} | X_t]$ the expected (or normal) return in the absence of any new information, and $X_t$ the (exogenous) variables used to predict the normal return.

Two different models are use to predict the normal return: the constant mean return model and the market model. In the constant mean return model, security $i$ is assumed to yield a constant return $\mu_i$ on average during the estimation period that fluctuates from day-to-day by a random disturbance term $\xi_{it}$ with zero mean and constant variance $\sigma^2_{\xi_i}$. Hence, the model posits that $R_{it}$, the return of security $i$ in period $t$, is determined by

$$ R_{it} = \mu_i + \xi_{it} $$

$$ E[\xi_{it}] = 0 \quad Var[\xi_{it}] = \sigma^2_{\xi_i} $$

With these distributional assumptions, one simply estimates the normal return $R_{it}$ as the average of the observed daily return or $\hat{R}_{it} = \frac{1}{T} \sum_{t=1}^{T} R_{it}$. The abnormal returns are now simply $AR_{it} = R_{it} - \hat{R}_{it}$.

The most commonly used model for estimating normal returns is the market-model. It is very similar to the CAPM in that it assumes that individual security returns are driven by market returns, i.e., one tries to capture the systematic, non-event specific effects of the security return:

$$ R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} $$

$$ E[\epsilon_{it}] = 0 \quad Var[\epsilon_{it}] = \sigma^2_{\epsilon_i} $$

(3)

where $\epsilon_{it}$ is a mean zero, constant variance error term and $R_{mt}$ the (continuously compounded) return on an appropriately chosen market index such as the S&P 500 or an industry index. The parameters $\alpha_i$ and $\beta_i$ can be estimated by running a simple OLS regression (in Excel: make sure to include an intercept in your regression) so that the normal return is predicted as $\hat{R}_{it} = \hat{\alpha} + \hat{\beta} \hat{R}_{mt}$. 

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As a result, the abnormal return for the market model follows as

\[ AR_{it} = R_{it} - \hat{R}_{it} = R_{it} - (\hat{\alpha}_i + \beta_i \hat{R}_{mt}) \]

This model represents a potential improvement over the constant-mean return model and usually results in better identification of event effects. Campbell et. al. (1997) point out that this effect depends on the \( R^2 \) of the market model regression. The higher the \( R^2 \) the larger is the reduction of the variance of abnormal returns, which makes it more likely to detect possible event effects. Another advantage of the market model lies in its ease of computation with Excel that produces all sorts of useful statistical quantities for further analysis such as residuals and their standard error (very useful that, indeed), \( R^2 \), etc.

2.2 Distributional Properties of Abnormal Returns

Using the market model the abnormal return can now be calculated as:

\[ AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \]

where \( \hat{\alpha}_i \) and \( \hat{\beta}_i \) are the parameters from the OLS regression for security \( i \). Under the null hypothesis \( H_0 \) ,that the event has no impact on the properties of the returns, they will be normally distributed with a zero mean and a variance of

\[ \sigma^2(AR_{it}) = \sigma^2_{\epsilon_i} + \frac{1}{L_1} \left[ 1 + \frac{(R_{mt} - \hat{\mu}_m)^2}{\hat{\sigma}^2_m} \right] \quad (4) \]

where \( L_1 \) is the length of the estimation period, \( R_{mt} \) the market return on date \( t \), \( \hat{\mu}_m \) is the mean market return during the estimation period with length \( L_1 \), \( \hat{\sigma}^2_m \) its variance, and \( \sigma^2_{\epsilon_i} \) the variance of the disturbance term in equation (3).

From equation (4), it follows that the second component of the variance, which is a result of the sampling error in estimating \( \hat{\alpha}_i \) and \( \hat{\beta}_i \), tends towards zero as \( L_1 \) becomes large. As noted in McKinlay (1997, p. 21), the abnormal return observation becomes independent through time and it is safe to assume that abnormal returns are normally distributed with mean zero and variance \( \sigma^2(AR_{it}) \), i.e., they follow \( AR_{it} \sim N(0, \sigma^2(AR_{it})) \). To estimate the abnormal return variance, one simply replaces \( \sigma^2_{\epsilon_i} \) with the variance of the estimation residuals (Excel output: simply square the "standard error" from the regression output) \( \hat{\sigma}^2_{\epsilon_i} \) so that equation (4) is operationalized as

\[ \hat{\sigma}^2(AR_{it}) = \hat{\sigma}^2_{\epsilon_i} + \frac{1}{L_1} \left[ 1 + \frac{(R_{mt} - \hat{\mu}_m)^2}{\hat{\sigma}^2_m} \right] \quad (5) \]

and \( AR_{it} \sim N(0, \hat{\sigma}^2(AR_{it})) \).

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3 The astute reader might have realized that \( R_{i,t} - \hat{R}_{i,t} = R_{i,t} - (\hat{\alpha}_i + \beta_i \hat{R}_{mt}) = \epsilon_{i,t} \), the regression’s residuals. Hence, the abnormal return corresponds precisely to the unsystematic, idiosyncratic return part \( \epsilon_i \) in the CAPM or market model.

4 Note that the \( R^2 \), the coefficient of variation, of typical market models is only about 10%. So, do not get alarmed when you find a low \( R^2 \).
2.3 Statistical Significance

One of the most important questions that arises in an event study is whether the announcement is deemed relevant by investors or not. To investigate investor attitudes, one uses the concept statistical significance of abnormal returns: if investors think that the event is important, the abnormal return reaction should be significantly different from zero. If not, it means that the abnormal and normal returns are virtually indistinguishable (at least by statistical methods) and, hence, the event is a non-event in the eyes of the market. Put differently, the announcement is “no news;” whether it is also “good news” is a different question.

Hence, we assess the results of the preceding abnormal return calculations for their statistical significance. The underlying hypothesis $H_0$ is that there are no abnormal returns during the event period; put differently, we wish to test whether $AR_{it} = 0$. We wish to reject the null hypothesis which we can do if it has a very low probability of occurring on the basis of our abnormal return results (and, more generally, the sample and return model). The most intuitive and simple test is the so-called t-test. One just takes the abnormal return on a given date, divides it by its standard error (the square root of its estimated variance above), and compares the resulting test statistic to the appropriate critical levels. Even better, one can get Excel to do all the work. For $\hat{\sigma}(AR_{it}) = \sqrt{\hat{\sigma}^2(AR_{it})}$, the test statistic is given by

$$z_{it} = \frac{AR_{it}}{\hat{\sigma}(AR_{it})}$$

which, for a large estimation window ($L_1$ larger than 100 days) is normally distributed.\(^5\) Note that the standard deviation used for assessing the statistical significance of the abnormal return is simply the square root of equation (5): $\hat{\sigma}(AR_{it}) \sim \hat{\sigma}_{\tilde{\varepsilon}_i}$. The advantage of doing so is that Excel now delivers to you on a silver platter the standard errors of abnormal returns $\hat{\sigma}(AR_{it})$: it is simply the standard error of the market-model regression $\hat{\sigma}_{\tilde{\varepsilon}_i}$ in its regression output so that you would use this time-invariant number in all your statistical tests. Of course, the drawback is that you might have large market swings in the market around the announcement date so that $R_{mt} - \hat{\mu}_m$ is large and/or a short estimation window. In this case, using the standard error of the regression $\hat{\sigma}_{\tilde{\varepsilon}_i}$ without the correction term biases your result in favor of statistical significance of abnormal returns.

To compute the statistical significance of an abnormal return, simply calculate its $p$ value (short for “probability of the test statistic having occurred under the null hypothesis that the abnormal return is statistically not different from zero”) as $p_{it} = 2(1 - \Phi(|z_{it}|))$ where $\Phi$ is the distribution function of a standard-normal random variable. The smaller $p$, the better for statistical significance and relevance of the news to investors. Ideally, we want $p$ to be smaller than the 10%, 5% or 1% significance levels so as to conclude that abnormal returns are statistically significant at 10%, 5%, or 1%. So, suppose that your $z$-statistic for the abnormal return at date $t$ of security $i$, $z_{it}$, is at the location cell in your Excel spreadsheet; you then simply calculate the $p$ value as $2 \times (1 - NORMSDIST(ABS(cell)))$.

\(^5\)The name t-test comes from the fact that the test statistic is distributed according to Student’s (a pseudonym) $t$ distribution for small $L_1$ (under 50 days, say).
3 Aggregating Abnormal Returns and Shareholder Wealth Effects

Since information transpires gradually, we cannot assume that it is instantaneously released to the market: insiders might have had advance notice of the announcement, rumors might have spread that something is in brewing, or investors might react with delay if the event is hard to analyze (remember Enron’s now infamous conference call with analysts where nobody knew for quite sometime whether Enron had disclosed good or bad news?). Hence, we should aggregate abnormal returns around the event (announcement) date to get a better picture of the event’s total effect on stock returns. Needless to say, to long a window would be counterproductive as other events and news would contaminate our analysis.

To evaluate the full impact of an event or when the effect of an event cannot be precisely attributed to a certain day, abnormal returns should be aggregated over time. Summing abnormal returns around the event date from day $\tau_1$ to $\tau_2$ yields the cumulative abnormal return (CAR) of an event

$$ CAR_i(\tau_1, \tau_2) = \sum_{t=\tau_1}^{\tau_2} AR_{it} $$

(7)

Typical CARs calculated around the event date are the two-day cumulative abnormal returns for the announcement date and the day preceding it, $CAR_i(-1,0)$, the three-day $CAR_i(-1,+1)$, the five-day $CAR_i(-2,+2)$ and the eleven-day $CAR_i(-5,+5)$.

Calculating the precise variance $\sigma_i^2(\tau_1, \tau_2)$ of cumulative abnormal returns is unpleasant. However, for a large enough estimation period one can use the large sample variance without loss of generality

$$ \sigma_i^2(\tau_1, \tau_2) = (\tau_2 - \tau_1 + 1) \sigma_i^2 $$

(8)

which is, once again, easily estimated from the standard error of the residuals (estimation regression output) $\hat{\sigma}_i^2$, as

$$ \hat{\sigma}_i^2(\tau_1, \tau_2) = (\tau_2 - \tau_1 + 1) \hat{\sigma}_i^2 $$

Be careful with the dates $\tau_i$ that enter into the expression with their appropriate sign: $\hat{\sigma}_i^2(-2,2) = (2 - (-2) + 1) \hat{\sigma}_i^2 = 5\hat{\sigma}_i^2$ as it should for a five-date window around the event date 0.

To assess the statistical significance of a CAR, one would follow the same procedure as for ARs. First, compute the standard deviation from the preceding equation or (8) as $\hat{\sigma}_i(\tau_1, \tau_2) = \sqrt{\tau_2 - \tau_1 + 1} \hat{\sigma}_i$, where $\hat{\sigma}_i$ is still the standard error of the regression residuals (standard error of the regression in Excel output). Note that it is simply the regression standard error multiplied by the square root of days in the CAR window. Second, compute the CAR test statistic as

$$ z_i(\tau_1, \tau_2) = \frac{CAR_i(\tau_1, \tau_2)}{\hat{\sigma}_i(\tau_1, \tau_2)} $$

(9)

Finally, compute the $p$ value $p_i(\tau_1, \tau_2) = 2(1 - \Phi(|z_i(\tau_1,\tau_2)|))$ with the help of Excel as $2 \times (1 - NORMSDIST(ABS(cell)))$.

At the end of the day, we would like to know how much shareholder value a deal announcement created or destroyed in monetary terms. Often, the companies involved differ in size so that abnormal returns are not directly comparable, while monetary gains are. To convert these daily abnormal returns and their cumulative analogs into dollars and cents we can use the firm’s market capitalization $K$ on the eve of the event window. Hence, to see the total shareholder wealth effect one computes the cumulative abnormal wealth created by the event by multiplying the appropriate
CAR with the company’s market capitalization on $T_3$, $K_{iT_3}$ around the announcement date

$$W_i(\tau_1, \tau_2) = CAR_i(\tau_1, \tau_2) \cdot K_{iT_3-1}$$

For instance, with an event window starting at $T_3 = -20$, we would calculate the 3 day abnormal wealth effects of a merger announcement for the target $T$ and acquirer $A$ as

$$W_T(-1, +1) = CAR_T(-1, +1) \cdot K_{T-21}$$
$$W_A(-1, +1) = CAR_A(-1, +1) \cdot K_{A-21}$$

and the total shareholder wealth effect of the transaction announcement as $W_{TRANS} = W_T(-1, +1) + W_A(-1, +1)$. The statistical significance of these monetary gains is “inherited” from the CARs.

4 Summary

To measure the shareholder reaction to and wealth impact of major corporate actions (rather: their announcement) we often conduct firm-specific (or transaction-specific) event studies. It is unclear why this very useful tool is not more widely used on Wall Street. My guess is that that the results would often be to embarrassing for the parties involved but then, the financial press loves to bash executives and their financial advisors for corporate actions on the basis of the perceived stock price reaction. So, it is not clear to me what Wall Street would be losing by conducting event studies if only as marketing tools and for damage control.

However, you now know better how to assess a return reaction: it is simply wrong to use realized stock prices as the basis for judging the economic impact of an event. Essentially, the financial press is confusing systematic and unsystematic, event-specific return reaction. One needs to separate the latter from the former. When it comes to event studies, the standard reference is MacKinlay, A. Craig (1997), “Event Studies in Economics and Finance,” Journal of Economic Literature 35: 13-39 posted on the course website. As you can see, the objective is to calculate the abnormal return and wealth created for shareholders by the corporate event around its announcement. Here is a summary of the steps involved that are described in much more detail above:

1. Read MacKinlay (1997) to better understand the steps involved in an event study.
2. Identify the merger, asset disposal, divisional acquisition, bankruptcy, etc. announcement date (news wires, company websites, etc.).
3. On the basis of stock price and market index data collected from sources such as MSN.com or Yahoo! Finance, compute continuously compounded daily returns for company $i$ $R_{it} = \log \frac{P_t}{P_{t-1}}$ for an 10 to 12 month sample period (about 200 to 240 observations).
4. Compute the average daily return for the firm (or firms in case of a merger or sale) up to 60 days before the merger announcement: $\bar{R}_{it} = \frac{1}{T} \sum_{t=1}^{T} R_{it}$. Even better, you could estimate a market model analogous to the CAPM $R_{it} = \beta_{0i} + \beta_{1i} R_{mt} + \epsilon_{it}$ where $R_m$ is the continuously compounded return of the S&P 500. For this endeavor, simply use the Excel regression function (make sure NOT to check the intercept = 0 box) to be found in the Tools - Data Analysis menu. Use 120 or more data points but stop 60 days before the merger announcement.
5. Compute daily abnormal returns around the announcement date as $AR_{it} = R_{it} - \bar{R}_{it}$ from, say, 10 days prior to the announcement to 10 days after, i.e., $t = -10, -9, \ldots, -1, 0, 1, \ldots, 10$. 
If you estimated a market model by regression methods, you need to use the corresponding market returns around the announcement date to derive predicted normal return values $\hat{R}_{it} = \hat{\beta}_0i + \hat{\beta}_1i R_{mt}$. On the basis of your parameter estimates $\hat{\beta}_0i, \hat{\beta}_1i$, plug in the market return realization $R_{mt}$ to obtain the predicted normal return $\hat{R}_{it}$, and, finally, calculate the abnormal return as $AR_{it} = R_{it} - \hat{R}_{it}$.

6. Calculate the statistical significance of the $AR$ and plot the $AR$ for the companies in question indicating which ones are statistical significant.

7. Fix an event window around the announcement date, e.g., from 2 days prior to 2 days after the announcement, say, and calculate the cumulative abnormal return $CAR_i (-2, 2)$ by adding up the abnormal returns: $CAR_i (-2, 2) = \sum_{t=-2}^{2} AR_{it}$. You can repeat the procedure for the three day window from one day before to one day after the announcement, i.e., $CAR_i (-1, 1)$, or, for that matter, any other cumulative abnormal return $CAR_i (\tau_1, \tau_2)$ where $\tau_1$ and $\tau_2$ are the window’s start and end dates, respectively.

8. Determine whether the $CAR$ are statistically significant.

9. Finally, to see the total shareholder wealth effect you compute cumulative abnormal wealth created by multiplying the appropriate $CAR$ with the company’s market capitalization $K_{i-11}$ on $t = -11$, i.e., the eve of the event window around the announcement date: $W_i (\tau_1, \tau_2) = CAR_i (\tau_1, \tau_2) \cdot K_{i-11}$. If more than one company is involved compute the total wealth effect, too.

References
