

# Getting Away With It?

## The Cost of the Saudi Arms Bribery to BAE\*

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### Abstract

BAE Systems is Europe's largest arms firm yet it was surrounded by bribery allegations in the 2000s. I study share price fluctuations following events where it emerged that BAE allegedly bribed Saudi officials. An announcement of a UK investigation into BAE yielded a significant abnormal return of  $-2.9\%$  and discontinuation of this investigation due to national security concerns showed an abnormal return of  $+3.4\%$ . This implies investors feared that the alleged bribery would be revealed, yet BAE managed to get away with it. I also find a potential illegal "inside information" effect.

## 1 Introduction

BAE Systems plc is a British arms company and Europe's largest arms producer by revenue. Its most valuable contract – estimated £20bn – was initially signed in 1985 between Saudi-Arabia and UK governments and is known as "Al-Yamamah" (*the dove*). BAE acts as the prime contractor and was consequently involved in negotiations from the start.

This report is an event study examining fluctuations in BAE's share price following 10 important events that brought new information concerning the alleged bribery of Saudi officials by BAE employees concerning Al-Yamamah. Did investors fear UK and US governmental investigations into BAE, knowing that the alleged bribery would be found? Or did they believe BAE when they denied any form of illegal activity?

Literature that also uses corruption/conflict events in conjunction with financial market data is for example DellaVigna and La Ferrara (2010), who develop a framework for detecting illegal arms trade by looking at financial markets. Dube *et al.* (2008) look at top-secret coup authorisations by the CIA and stock market fluctuations. Lastly, Guidolin and La Ferrara (2007) look at civil wars in developing countries and use stock market prices to conclude that

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\*I am grateful to three anonymous referees for their helpful suggestions. All remaining errors are mine.

conflict increases certain companies' value, which is an interesting finding that partly motivates the conclusions of this report. On a technical level classical event study papers such as Fama *et al.* (1969), looking at share price information incorporation, and MacKinlay (1997) on financial market event studies have proven valuable.

However, literature is shallow on analysing bribery and corruption in a single firm setting in conjunction with quantitative stock market data. This paper contributes to the literature by examining share price effects of alleged bribery at the world's third-largest arms firm. It has never been officially proven that BAE bribed Saudi officials, though BAE was fined a record \$400M for bribery and corruption in other cases than Al-Yamamah. The fine's press statement explicitly noted that "*with high probability BAE officials could have been aware of bribery in Al-Yamamah*" (DoJ, p. 13, 2010).

The remainder of this paper is structured as follows: in Section 2 I explain the quantitative and qualitative data used and set out the estimation methods. In section 3 I present the results and robustness checks. I conclude with a summary and further research suggestions.

## 2 Data and Methodology

Using the classical event study approach used by e.g. Fama *et al.* (1969), I want to assimilate returns on BAE's stock price following news events taking place between 2003 and 2010 concerning bribery allegations in the Saudi arms deal. See table 1 for a detailed overview of the events<sup>1</sup>.

Insert table 1 here

I solely focus on events that relate to BAE's Al-Yamamah deal, are traceable to a specific date and are (eventually) in the public domain. I assume that investors update their beliefs (buy and sell) immediately once they are informed. No other events took place in the event window, which I have ascertained through Google News for external news and through the Bloomberg Terminal for BAE dividend and earnings announcements. It is important that this condition holds, because the effects of the target events may get distorted otherwise.

Having identified the events of interest, I then perform a regression on BAE's stock returns controlling for the general market return, the FTSE100, over a certain estimation window to find which parts of the return are "normal". Following MacKinlay (1997) I set the estimation window for each event to 120 days. The estimating equation is specified as

$$\begin{aligned} R_t &= \alpha_t + \beta_1 R_{mt} + \varepsilon_t \\ E(\varepsilon_t) &= 0 & \text{var}(\varepsilon_t) &= \sigma_{\varepsilon_t}^2 \end{aligned} \tag{1}$$

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<sup>1</sup> All event dates were extracted from an official House of Commons document, references to newspaper articles were cross-checked. All financial data was extracted from a professional Bloomberg Terminal.

where  $R_t$  is the daily, log linearized, return on BAE's share price.  $\alpha_t$  is the intercept,  $R_{mt}$  is the daily, log linearized, return of the FTSE100 benchmark and  $\varepsilon_t$  is the error term.

I use this statistical model over more sophisticated economic models as the CAPM or the APT as the power of those models are restricted by interpretation biases, which are non-existent in statistical models (MacKinlay, *ibid*).

Using (1) I compute the predicted return by extrapolating the regression line beyond the estimation window into the adjacent event window, as depicted in graph 1.

Insert graph 1 here

The event window consists of the event date extended by a few days (depending on the news) before the event to capture information leakage and after the event to capture delayed belief updates.

The abnormal return (2) is then calculated as the actual return minus the predicted return.

$$AR_t = R_t(\text{observed}) - E(R_t|X_t) \quad (2)$$

Where  $AR_t$  is the abnormal return,  $R_t(\text{observed})$  is the observed daily return on the BAE stock and  $E(R_t|X_t)$  is the normal, expected, performance obtained using the benchmark described in (1). It is common practice to accumulate abnormal returns observed in the event window to get a complete overview capturing the aspects described above.

$$CAR_t = \sum AR_t, \text{ event window} \quad (3)$$

I expect to observe cumulated abnormal returns,  $CAR_t$ , in all event windows, as these events are of large potential impact on BAE's reputation, current and future revenue. Consequently this should affect investors' valuations of BAE which in turn cause share price movements.

In order to make inferences from the abnormal returns one first needs to test the statistical significance of the finding. I do so by following Patell (1976), who takes an alternative approach than the standard t-test. Because the normal performance predictions for the event window are actually out-of-sample predictions, forecast errors may arise. Consequently, Patell (*ibid*) asserts that abnormal returns need to be standardised using standard errors adjusted for the forecast error:

$$SAR_t = \frac{AR_t}{S(AR_t)} \quad (4)$$

Where  $SAR_t$  denotes standardised abnormal returns,  $AR_t$  denotes abnormal returns obtained by (2) and  $S(AR_t)$  are the adjusted standard errors given by

$$S(AR_t) = \hat{\sigma}_{AR_t} \sqrt{1 + \frac{1}{M_i} + \frac{(R_{mt} - R_{m,EW})^2}{\sum_{t=EW_{min}}^{EW_{max}} (R_{mt} - R_{m,EW})^2}} \quad (5)$$

In (5)  $\hat{\sigma}_{AR_t}$  is the standard deviation of the abnormal returns in the estimation window,  $M_i$  are the observations in the estimation window (120 in this paper),  $R_{mt}$  denotes the market return and  $R_{m,EW}$  is the average market return over the estimation window.

Accumulating the standardised abnormal returns in a similar fashion to (3) to get  $CSAR_t$ , the cumulative standardised abnormal returns:

$$CSAR_t = \sum \frac{AR_{t,event\ window}}{S(AR_t)} \quad (6)$$

Finally the Patell test, following a t-distribution with  $M_i - d$  degrees of freedom, is conducted by performing (7)

$$t_{Patell} = \sum \frac{CSAR_t}{\sigma_{CSAR_t}} \quad (7)$$

Where  $CSAR_t$  are the cumulative standardised abnormal returns given by (6) and  $\sigma_{CSAR_t}$  is the standard deviation given by

$$\sigma_{CSAR_t} = \sqrt{\frac{M_i - d}{M_i - 2d}} \quad (8)$$

Where  $M_i$  are the observations in the estimation window (120 in this paper),  $d$  are the number of parameters estimated in the market model (2 in this paper).

### 3 Estimation Results and Robustness Checks

Table 2 reports the findings for the 10 events using the data and methods describe above. I report findings for each event separately in a different column in a chronological order. As expected, almost all events – except event 10 – show unadjusted abnormal returns in excess of 1%, indicating the bribery allegations had a large effect over and above the general market return. Moving down the rows, I report Patell’s Standardised Cumulative Abnormal Returns,

also depicted in graph 2. All events – except event 2, but including event 10 – show abnormal returns in excess of 1%, validating the immediate belief update assumption. In general there was no major ex-ante or ex-post share price adjustment in the event window.

An explanation for the reversal of the significance of the (standardised cumulative) abnormal returns for event 2 and 10 may be found in the nature of the events: event 10 concerns a 51-page press statement, which took more than a day to digest, whereas event 2 concerns a TV programme that may have been less detrimental to BAE than anticipated.

Insert table 2 and graph 2 here

Event 3 exposed that the UK government was investigating bribery at BAE, which would also blame high placed Saudi Officials. Newspapers reported that Saudi officials threatened the UK to halt the bribery investigation within 10 days, or else BAE may lose a £10bn Eurofighter deal. Losing such a large contract would create a snowball effect: BAE, consequently its suppliers and ultimately the UK labour market would be negatively affected.

However, UK officials explicitly denied that the fraud investigation played a role in the contract negotiations. Moreover, Saudi officials also denied exercising any pressure, which PM Tony Blair confirmed. Nevertheless, investors attached greater value to the newspaper articles and deemed it a credible threat. Consequently they sold BAE shares, leading to a standardized cumulative abnormal return of -2.9%.

The relief of investors when the investigation was dropped, event 4, was large witnessing the cumulative standardized abnormal return of +3.9%. The discontinuation happened 2 trading days after the rumoured Saudi ultimatum – even though officials denied such ultimatum.

Both findings validate the notion that investors feared an investigation into BAE which may have exposed illegal activity and could have led to severe negative effects such as fines, bad reputation and deprived future revenue.

Results of events 6-8, concerning possible further governmental investigations into bribery at BAE, show significant abnormal returns of similar magnitude as above, confirming that investors feared any formal investigation into BAE's alleged bribery practices.

Those fears were not ungrounded, witnessing event 9; a record \$400M fine for bribery charges other than Al-Yamamah. I expected such a large fine to have a negative effect, yet it showed standardized cumulative abnormal return of +2.4%. I interpret this that investors were content with the fine – “it could have been worse” – perhaps this was perceived as a small cost for the large benefits yielded. Moreover, it also meant no further legal investigations could be started, including no new investigation into Al-Yamamah.

In total, 7 out of 10 events show significant abnormal returns at the 5% level using a Patell t-test. This is consistent with the notion that investors were shocked by the news and support the no illegal insider information effects claim for these events. The 3 events which did not exhibit significant abnormal returns pose questions why investors were not shocked

by the news. Especially event 1 exhibits interesting characteristics when testing for potential inside information effects, as reported in table 3.

Insert table 3 here

During private information exchange between the newspaper the Guardian and BAE the stock market showed an abnormal return of -3.72% on Tuesday, whilst BAE executives were aware of publication of severe detrimental news. It is beyond the scope of this report to soundly conclude whether there were illegal insider information effects, but it is certainly worth further research.

### *Robustness checks*

Table 4 presents results from robustness checks by testing for various common econometric issues.

Insert table 4 here

Firstly I perform a Dickey-Fuller test for unit roots on the dependent variable  $R_t$  from equation (1), where I reject the null hypothesis of a unit root and conclude that this series is stationary and not trending. Secondly, I perform an alternative Durbin-Watson test to detect autocorrelation. I fail to reject the null hypothesis of no autocorrelation, hence this is not an issue undermining the results. Thirdly, I conduct a Portmanteau test for white noise in the residuals, where I also fail to reject the null hypothesis of mean-zero expected residuals. Finally, I test the market return variable for homoscedasticity – constant variance in the error terms – using the Breusch-Pagan test, where the null hypothesis is homoscedastic errors. I reject the null hypothesis at the 5% significance level for events 3 and 4, meaning that heteroskedasticity might induce wrong standard errors on the market return variable and make a type 2 error. However, heteroskedasticity only affects standard errors and leaves the coefficient unaffected, hence the abnormal returns are consistent. Though, for completeness, I use Hubert-White sandwich estimators throughout.

The last row of table 4 presents the results of the nonparametric GRANK test (Kolari and Pynnonen, 2011), which differs from the parametric Patell T-test since it does not assume normally distributed abnormal returns. Hence, it is argued that the GRANK test has superior power. However, in 8 of 10 instances the GRANK test confirms the Patell test, from which I conclude that the Patell test is appropriate for this report. The nature of the 2 inconsistencies may be found in event-induced volatility, though this is beyond this report's scope to further investigate.

I rely on the correct specification of the market model in order to compute predicted and abnormal returns. I use the returns of the FTSE100 as a benchmark, as that is the index of

the London Stock Exchange where BAE is listed. However, the FTSE100 is a basket of widely diversified firms, so in order to capture any idiosyncratic – industry specific – events that may affect BAE’s share price, I extend the baseline market model given by (1). I construct a portfolio of the 10 largest arms firms<sup>2</sup> in the world and compute the daily average return. The extended market model estimating equation is

$$R_t = \alpha_t + \beta_1 R_{mt} + \beta_2 R_{CLPf} + \varepsilon_t \quad (9)$$

where  $R_t$  is the daily, log linearized, return on BAE’s share price.  $\alpha_t$  is the intercept,  $R_{mt}$  is the daily, log linearized, return of the FTSE100 benchmark,  $R_{CLPf}$  is the daily, log linearized, return of the control portfolio and  $\varepsilon_t$  is the error term.

Insert table 5 here

Table 5 reports the results using (9). The main conclusion is that the coefficient of the control portfolio is insignificant in 7 of the 10 instances, implying that the baseline market model, (1), performed well and no significant idiosyncratic effects were present in the estimation windows.

The 3 events where the control portfolio return was significant are events 3-5, which took place within 50 days of each other. Hence their estimations windows overlap and this indicates part of the returns are explained by idiosyncratic news in late 2006.

I recalculate the abnormal returns and perform significance tests for these 3 events, and still observe abnormal returns in excess of 1%. However, when cumulating the returns I find that event 5, PM’s Speech & BAE bosses named suspects, shows an insignificant abnormal return of +0.23%. Previously uncaptured effects of idiosyncratic events in the estimation window caused the cumulative abnormal return to be too small to be significant. Events 3 and 4 still exhibit significant abnormal returns of -3.45% and +5.26% respectively.

For all but event 5 the results are consistent with Brown and Warner (1985) who conclude that more sophisticated and extended models tend to yield similar results as simpler market models.

## 4 Concluding Discussion

In summary, this report takes an event study approach to examine investors’ reactions to events concerning bribery at BAE Systems in relation to the Al-Yamamah deal with Saudi-Arabia. I identify 10 events that meet the requirements of being tractable, expect to impact

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<sup>2</sup> Lockheed Martin, Boeing, Raytheon, General Dynamics, Northrop Grumman, EADS, United Technologies, Finmeccania, L-3 Communications and Thales.(Sipri, 2013)

the share price and were in the public domain. For these events I calculate abnormal returns of BAE's share price, using a traditional market model with the FTSE100 as benchmark.

I find that investors were shocked by news concerning possible governmental investigation into BAE's alleged bribery practices. This indicates that investors feared the results of such investigation, as potential illegal practices could be uncovered that could stifle BAE's reputation and future revenue. However, the 2006 UK bribery investigation into BAE was discontinued, officially due to national security concerns, unofficially due to pressure from high-placed Saudi officials. A large positive abnormal return indicates that investors were extremely relieved when the investigation was discontinued, confirming the hypothesis that investors feared an investigation. It also offers an interesting insight into investors' investment decisions; these were based on newspaper articles rather than official statements from both UK and Saudi governments.

In total, 7 out of 10 events exhibit significant cumulative abnormal returns, which is consistent with the notion that investors were shocked by the news and no illegal insider information effects were present at these events. This is as expected, as a stock at the London Stock Exchange is closely monitored to detect possible illegal inside information effects. The other 3 events warrant further research for illegal inside information effects, especially the event which marks the start of the bribery allegations. I find a large abnormal return 2 days before publication, whilst only BAE and the Guardian executives were aware of the forthcoming publication.

Further research suggestions are to compare the discounted net present value of the £10bn Eurofighter deal with the abnormal returns, and conduct an in-depth event study of the aforementioned potential illegal inside information effect, using tick and derivatives data in order to identify suspicious trade flows and soundly conclude whether there was illegal trading.

To conclude, investors feared governmental investigation into BAE's alleged bribery practices, worried about potential discoveries. However, due to power-play from Saudi officials halting a UK investigation, investors and BAE managed to get away with it and avoid significant costs.



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## Appendix

**TABLE 1: OVERVIEW OF EVENTS**

| #  | Event date                  | Name                                    | Summary  |
|----|-----------------------------|---|--|
| 1  | Thursday, 11 September 2003 | First serious accusation article        | The Guardian publishes the first serious accusation article without BAE comments. See Table 3 for further details.   |
| 2  | Tuesday, 05 October 2004    | BBC 2 Broadcast                         | BBC 2 programme "Money" broadcasts interviews with (ex) insiders on BAE's secret slush fund on prime time national television.   |
| 3  | Wednesday, 29 November 2006 | UK Government under pressure            | The Telegraph reports Saudi-Arabia halted negotiations of a £10bn Eurofighter jet deal, awaiting discontinuation of a UK bribery investigation at BAE. Saudi and UK officials deny such pressure, yet it emerges that the UK has been given 10 days to drop the investigation. |
| 4  | Friday, 15 December 2006    | Investigation dropped                   | Investigation is dropped, citing national security risks. "No weight has been given to economic interests, nor has any other governmental body interfered."  |
| 5  | Tuesday, 16 January 2007    | PM's speech & BAE bosses named suspects | Tony Blair, PM, supports the discontinuation: "relationship with Saudi-Arabia was at stake." The Guardian publishes an article that senior executives of BAE, rather than BAE as a company, were being investigated in relation to fraud.                                      |
| 6  | Tuesday, 26 June 2007       | US launches investigation               | The US Dept. of Justice launches its own investigation into BAE.   |
| 7  | Thursday, 10 April 2008     | High Court decision                     | The High Court ruled that the Serious Fraud Office's (SFO) decision to discontinue its investigation was unlawful. The SFO appeals this decision.  |
| 8  | Wednesday, 30 July 2008     | House of Lords decision                 | The House of Lords ruled that the SFO's decision to discontinue the investigation was indeed lawful.   |
| 9  | Friday, 05 February 2010    | \$400M fine                             | BAE receives a record breaking fine of \$400M to settle with US DoJ and SFO for other corruption investigations than Al-Yamamah.   |
| 10 | Monday, 01 March 2010       | US DoJ Press Statement                  | US DoJ releases 51-page press statement on \$400M fine: where it side notes: "very high probability that BAE officials were aware that payments were used as bribes."  |

**Notes:** This table presents a chronological summary of events relating to bribery allegations concerning BAE's Al-Yamamah contract. No other important events for BAE took place on these dates. I assume investors update their beliefs (buy/sell) immediately once they became aware of these events. Source: House of Commons (2010), references were cross-checked.

**TABLE 2: SIGNIFICANCE OF ABNORMAL RETURNS**

|  | (1)<br>First serious<br>accusation<br>article | (2)<br>BBC 2<br>Broadcast | (3)<br>UK Gov't<br>under<br>pressure | (4)<br>Investigation<br>dropped | (5)<br>PM's speech<br>& BAE bosses<br>named<br>suspects | (6)<br>US launches<br>investigation | (7)<br>High Court<br>decision | (8)<br>House of<br>Lords<br>decision | (9)<br>\$400M<br>fine | (10)<br>US DoJ<br>Press<br>Statement |
|--|---|---------------------------|--------------------------------------|---------------------------------|---|-------------------------------------|-------------------------------|--------------------------------------|-----------------------|--------------------------------------|
| Event<br>window  | (-2,1)  | (-1,1)                    | (-3,1)                               | (-1,1)                          | (-1,1)  | (-1,1)                              | (-1,1)                        | (-1,2)                               | (-1,1)                | (-1,1)                               |
| Observed<br>Return   | -2.33%  | -2.33%                    | 2.80%                                | 6.63%                           | 1.05%   | -8.12%                              | -4.98%                        | 2.41%                                | 1.57%                 | 1.25%                                |
| Predicted<br>Return  | -0.13%  | 0.76%                     | 1.09%                                | 0.55%                           | -0.91%  | -0.55%                              | -0.73%                        | 1.27%                                | -0.82%                | 0.51%                                |
| Abnormal<br>Return   | -2.20%  | -3.09%                    | 1.71%                                | 6.09%                           | 1.96%   | -7.57%                              | -4.25%                        | 1.14%                                | 2.39%                 | 0.74%                                |
| Standardized<br>Abnormal<br>Return                                   | -0.974  | -2.079                    | 1.402                                | 4.936                           | 1.601   | -7.377                              | -2.839                        | 0.795                                | 2.064                 | 0.686                                |
| Cumulative<br>Standardized<br>Abnormal<br>Return                     | -1.263  | -0.6632                   | -2.896                               | 3.889                           | 2.477   | -5.704                              | -2.746                        | 2.652                                | 2.442                 | 1.169                                |
| Patell T-test<br>Statistic   | -1.274  | -0.667                    | -2.921***                            | 3.922***                        | 2.498**   | -5.752***                           | -2.770***                     | 2.675***                             | 2.463**               | 1.179                                |
| <b>Market model</b> ( <i>robust standard errors in parentheses</i> ) |   |                           |                                      |                                 |   |                                     |                               |                                      |                       |                                      |
| Market<br>Return<br>coefficient                                      | 1.171<br>(0.157)                              | 1.378<br>(0.199)          | 1.121<br>(0.149)                     | 1.073<br>(0.165)                | 1.286<br>(0.162)  | 1.177<br>(0.117)                    | 0.662<br>(0.090)              | 0.671<br>(0.094)                     | 0.517<br>(0.099)      | 0.449<br>(0.092)                     |
| intercept  | 0.001<br>(0.002)                              | 0.000<br>(0.001)          | 0.000<br>(0.001)                     | 0.000<br>(0.001)                | 0.001<br>(0.001)  | 0.000<br>(0.001)                    | 0.000<br>(0.001)              | 0.000<br>(0.001)                     | 0.000<br>(0.001)      | 0.001<br>(0.001)                     |
| Estimation<br>window   | 120   | 120                       | 120                                  | 120                             | 120   | 120                                 | 120                           | 120                                  | 120                   | 120                                  |

\*\*Significant at 5% level, \*\*\* Significant at 1% level

**Notes:** This table presents the significance of the abnormal returns for the 10 events. The Patell T statistic indicates that 7 of the 10 events exhibit significant cumulative standardized abnormal returns, indicating investors feared governmental investigation. This is also an indication that no inside information effects were present at these events. Consequently, this poses questions for the other 3 events.

**TABLE 3: TESTING FOR POTENTIAL “INSIDE INFORMATION” EFFECTS, 2003**

| Day        | Daily return | Abnormal return | Event  |
|------------|--------------|-----------------|--|
| Mon-08-Sep | 2.36%        | 1.26%           | The Guardian alleges BAE of creating a £20m “slush fund” to bribe Saudi officials, in private. |
| Tue-09-Sep | -4.35%       | <b>-3.72%</b>   | BAE said – in private – they needed more time to “evaluate these claims”.                      |
| Wed-10-Sep | -0.29%       | -0.10%          | Still no comment from BAE.   |
| Thu-11-Sep | -2.33%       | -2.20%          | The Guardian publishes the article without BAE’s comment.                                      |

**Notes:** This table zooms in on event 1, “First serious accusation article”, looking at the movement of the returns between the private exchange of information, between the Guardian newspaper and BAE, versus the public revelation. BAE executives were aware of the Guardian allegations 3 days before the market. On Tuesday I observe an abnormal return of -3.72%, whilst no one else than BAE and Guardian employees were aware of the news. This abnormal return needs to be scrutinised further in order to soundly conclude whether there was a potential illegal inside information effect.

**TABLE 4: ROBUSTNESS TESTS**

|   | (1)<br>First<br>serious<br>accusation<br>article | (2)<br>BBC 2<br>Broadcast | (3)<br>UK Gov't<br>under<br>pressure | (4)<br>Investigation<br>dropped | (5)<br>PM's speech &<br>BAE bosses<br>named suspects | (6)<br>US launches<br>investigation | (7)<br>High<br>Court<br>decision | (8)<br>House of<br>Lords<br>decision | (9)<br>\$400M<br>fine | (10)<br>US DoJ<br>Press<br>Statement |
|---|--|---------------------------|--------------------------------------|---------------------------------|--|-------------------------------------|----------------------------------|--------------------------------------|-----------------------|--------------------------------------|
| Dickey-Fuller for stationarity<br>(MacKinnon P-value)   | -9.725<br>(0.000)                                | -11.811<br>(0.000)        | -10.092<br>(0.000)                   | -10.310<br>(0.000)              | -9.322<br>(0.000)                                    | -9.946<br>(0.000)                   | -12.463<br>(0.000)               | -11.803<br>(0.000)                   | -9.563<br>(0.000)     | -9.557<br>(0.000)                    |
| Durbin-Watson for autocorrelation<br>(Prob> Chi2)       | 0.614<br>(0.433)                                 | 0.015<br>(0.903)          | 0.000<br>(1.000)                     | 0.002<br>(0.997)                | 0.088<br>(0.766)                                     | 0.055<br>(0.815)                    | 0.488<br>(0.485)                 | 1.538<br>(0.215)                     | 0.985<br>(0.321)      | 0.956<br>(0.328)                     |
| Portmanteau for white noise<br>(Prob> Chi2)             | 20.180<br>(0.996)                                | 29.046<br>(0.900)         | 26.762<br>(0.946)                    | 21.932<br>(0.991)               | 18.632<br>(0.998)                                    | 46.809<br>(0.213)                   | 25.804<br>(0.960)                | 21.657<br>(0.992)                    | 25.426<br>(0.965)     | 24.024<br>(0.979)                    |
| Breusch-Pagan for<br>heteroskedasticity<br>(Prob> Chi2) | 0.840<br>(0.359)                                 | 0.140<br>(0.705)          | 4.420<br>(0.036)                     | 3.920<br>(0.048)                | 2.270<br>(0.132)                                     | 1.190<br>(0.275)                    | 0.230<br>(0.630)                 | 0.050<br>(0.821)                     | 2.120<br>(0.146)      | 0.160<br>(0.692)                     |
| GRANK T-test statistic                                  | -1.607   | -1.234                    | -6.497***                            | 2.571***                        | 9.256***   | 1.543                               | -5.039***                        | 5.585***                             | 6.890***              | 5.965***                             |

\*\*\* Significant at 1% level

**Notes:** This table presents test results for common econometric problems of the market model, given by (1), and reports an additional nonparametric test statistic to validate the Patell T-test. The number of observations is 120 consistently, the significance level is 5% unless otherwise mentioned.

Dickey-Fuller: The null hypothesis of a unit-root (non-stationary series) is rejected for the return variable. Thus, the series is not trending.

Durbin-Watson: The null hypothesis of no autocorrelation (error term correlation) cannot be rejected for each event.

Portmanteau: The null hypothesis of white noise (expected zero mean) cannot be rejected for each event.

Breusch-Pagan: The null hypothesis of homoscedasticity (constant variance of residuals) cannot be rejected for events 1-2 and 5-10. I conclude heteroskedasticity is present at events 3 and 4 but this does not cause an issue for the results as the coefficients are unaffected and the standard errors are not used.

GRANK T-test: This nonparametric test statistic<sup>3</sup> replicates the same conclusion as the Patell T-test for 8 of 10 events; only for events 6 and 10 it contradicts the Patell test. An explanation for this may be event-induced volatility that clutters the Patell test, but it is beyond this report's scope to further investigate this. In general, I conclude that the Patell test is reliable.

<sup>3</sup> Given by  $T_{GRANK} = \sqrt{120} * \frac{MeanRank_{evt} - MeanRank_{est\&evt}}{\sqrt{\frac{\sum_{t=1}^N (Rank_t - MeanRank)^2}{N_{est\&evt\ wdw s}}}}$

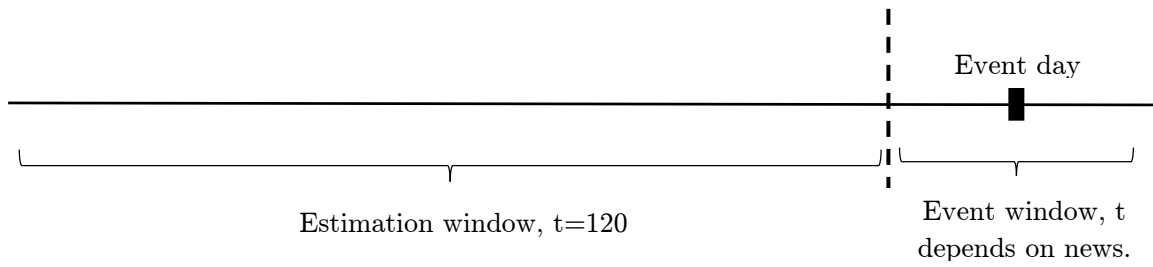
**TABLE 5: EXTENDED MARKET MODEL**

|                                  | (1)<br>First serious<br>accusation<br>article | (2)<br>BBC 2<br>Broadcast | (3)<br>UK Gov't<br>under<br>pressure | (4)<br>Investigation<br>dropped | (5)<br>PM's speech<br>& BAE<br>bosses named<br>suspects | (6)<br>US launches<br>investigation | (7)<br>High<br>Court<br>decision | (8)<br>House<br>of Lords<br>decision | (9)<br>\$400M<br>fine | (10)<br>US DoJ<br>Press<br>Statement |
|----------------------------------|---|---------------------------|--------------------------------------|---------------------------------|---|-------------------------------------|----------------------------------|--------------------------------------|-----------------------|--------------------------------------|
| Market return                    | 1.278<br>(0.151)                              | 1.296<br>(0.254)          | 0.954<br>(0.175)                     | 0.969<br>(0.175)                | 1.129<br>(0.164)  | 1.159<br>(0.133)                    | 0.591<br>(0.126)                 | 0.680<br>(0.108)                     | 0.499<br>(0.155)      | 0.316<br>(0.115)                     |
| Control<br>portfolio return      | 0.022<br>(0.195)                              | 0.175<br>(0.212)          | 0.344**<br>(0.140)                   | 0.360**<br>(0.142)              | 0.427**<br>(0.142)                                      | 0.027<br>(0.133)                    | 0.225<br>(0.160)                 | 0.037<br>(0.135)                     | -0.004<br>(0.184)     | 0.165<br>(0.145)                     |
| Intercept                        | 0.001<br>(0.002)                              | 0.000<br>(0.001)          | 0.000<br>(0.001)                     | 0.000<br>(0.001)                | 0.001<br>(0.001)  | 0.000<br>(0.001)                    | 0.001<br>(0.001)                 | 0.000<br>(0.001)                     | 0.000<br>(0.001)      | 0.001<br>(0.001)                     |
| Observed<br>Return               |   |                           | 2.80%                                | 6.63%                           | 1.05%   |                                     |                                  |                                      |                       |                                      |
| Predicted<br>Return              |   |                           | 1.33%                                | 0.58%                           | -0.66%  |                                     |                                  |                                      |                       |                                      |
| Abnormal<br>Return               |   |                           | 1.47%                                | 6.06%                           | 1.71%   |                                     |                                  |                                      |                       |                                      |
| Cumulative<br>Abnormal<br>Return |   |                           | -3.45%                               | 5.26%                           | 0.23%   |                                     |                                  |                                      |                       |                                      |
| GRANK<br>T-test statistic        |   |                           | -6.983***                            | 3.394***                        | -.514   |                                     |                                  |                                      |                       |                                      |
| Estimation<br>window             | 120   | 120                       | 120                                  | 120                             | 120   | 120                                 | 120                              | 120                                  | 120                   | 120                                  |

\*\*Significant at 5% level, \*\*\* Significant at 1% level

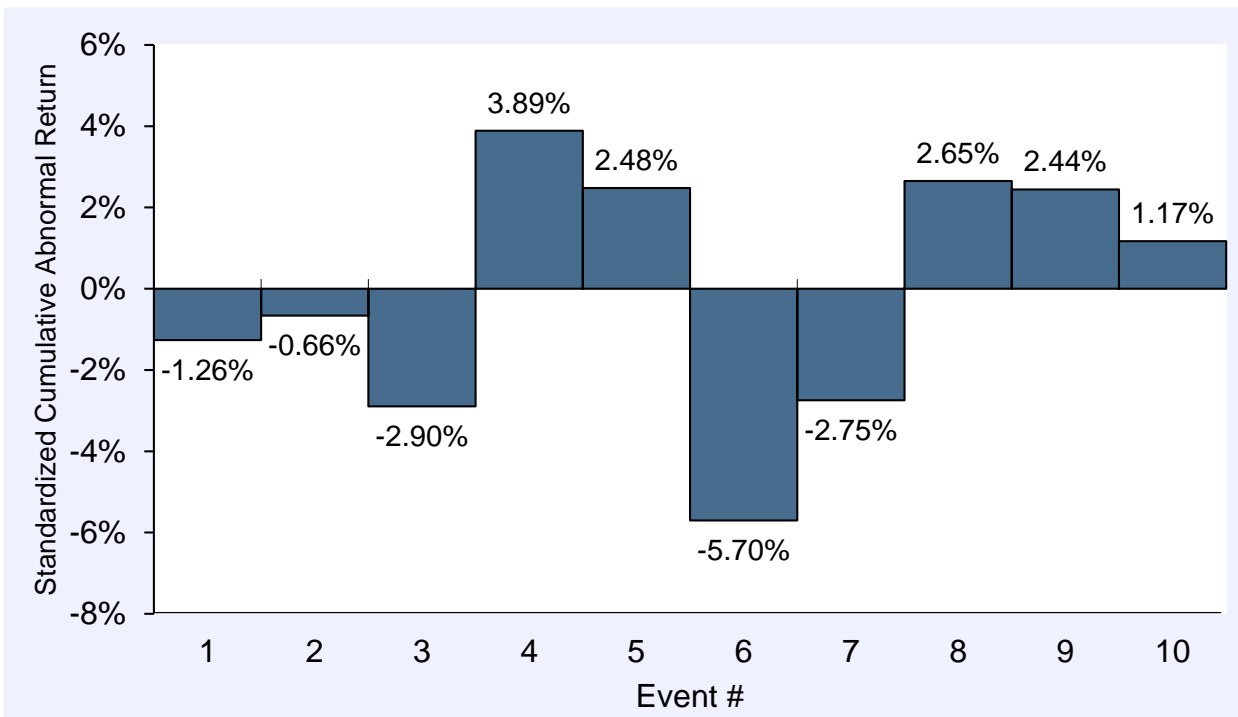
**Notes:** This table presents results of the extended market model. The control portfolio coefficient is insignificant at events 1-2 and 6-10. I recalculate the predicted and abnormal returns for the other events. It shows that the abnormal returns of event 3 and 4 are still significant at the 1% level, whereas event 5 turns out insignificant. This indicates that earlier significance of event 5 was caused by previously uncaptured idiosyncratic events. I do not use the Patell method since this requires advanced manipulation for the extra variable in the market model, which is beyond this report's scope.

**GRAPH 1: ESTIMATION AND EVENT WINDOW**



**Notes:** This graph depicts the basis of an event study. The market returns of the estimation window are regressed on the returns of the BAE share, after which the normal, expected, performance for the event window is estimated. Consequently the abnormal returns for the event window are calculated by subtracting the expected returns from the observed returns.

**GRAPH 2: CUMULATIVE ABNORMAL RETURNS PER EVENT**



**Notes:** This graph depicts Patell's Standardized Cumulative Abnormal Returns per event in chronological order.