War and stock markets: The effect of World War Two on the British Stock Market

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Abstract

This paper studies the effect of World War Two (WWII) on the British stock market. It contributes to the literature in several ways. First, this paper thoroughly investigates the impact of historically major events on the British stock market using a variety of empirical approaches in order to ensure a comprehensive examination of the impact of WWII on British stock returns. We utilise an event study of pre-selected historically major events, an investigation of the possible causes of the largest price movements as well as utilising an endogenous procedure testing for structural breaks. Secondly we extend the literature on behavioural finance and investor sentiment in extreme circumstances. In particular we examine the 'negativity effect', documented by Akhtar et al (2011) and determine whether stock returns reacted more strongly to negative events or positive events. Overall we find limited evidence of strong links between war events and market returns although there is support for the 'negativity effect'.

Keywords: Investor Sentiment; WWII; Structural Breaks; Event Study; FT30

JEL Classification: G10; G11; G12; G14

1. Introduction

World War Two (WWII) was a global war that began in 1939 and ended in 1945 which involved almost all of the world's great powers. With more than 100 million people serving in military units, it was the most widespread war in history and the deadliest conflict (Sommerville 2008). The effect of the war was long-lasting for Britain with over 450,000 lives lost and more than a quarter of Britain's national wealth spent during the war. As 55% of the British labour force had been employed in war production, Britain faced huge unemployment issues and austerity in the post-war years (Harrison 1998).

Surprisingly given the magnitude of the events concerned and the expanding literature on event studies and investor sentiment, the effect of the war on financial markets has been relatively little examined in the financial literature. A handful of studies have explored the impact of the war on markets, such as Frey and Kucher (2000, 2001) and Choudhry (2010), but none of them examine WWII's impact on Britain. The British stock market is a good setting for such a study since Britain was heavily involved in the war from the beginning and although there was a significant threat of invasion and defeat for a period (after the collapse of France in 1940) and the civilian population was subjected to very heavy air and missile attacks, the markets remained open throughout the war.

The paper contributes to the literature in several ways. First, this paper thoroughly investigates the impact of historically major events on the British stock market using a variety of empirical approaches. Secondly we extend the literature on behavioural finance and investor sentiment in extreme circumstances. In particular we examine the 'negativity effect' and determine whether stock returns reacted more strongly to negative events or positive events.

We take several different approaches in our empirical analysis to make sure our findings are robust with respect to the methodology employed. Initially, we pre-select 22 major positive and negative events and determine whether they had a significant impact of stock prices through an event study analysis. Secondly we examine events associated with the largest stock market moves during the war. Finally, we follow Choudhry (2010) and apply a structural break test to stock returns to explore the location of structural shifts in returns and volatility and determine whether such shifts are associated with events of WWII.

We are able to contribute to the growing literature documenting a ‘negativity effect’, as coined by Akhtar et al (2011), where stock returns react significantly to bad news but insignificantly to good news. Akhtar et al (2011) examined the announcement of good/bad sentiment news on the Australian All Ordinaries Index and found that news creating bad sentiment was associated with a significant negative announcement day effect, while good news was associated with no effect. Similar ‘negativity effects’ are also supported in the literature by Kaplanski and Levy (2010) who find that the stock market losses of aviation disasters are substantially larger than that of the actual costs of the disasters, while Edmans et al (2007) find a country’s unexpected loss in a sporting event causes a significant negative reaction in the stock market which is not mirrored by a significant position reaction to an unexpected win. We are well placed to investigate this phenomenon in rather extreme circumstances where the events involved are of great importance.

The rest of the paper is set up in the following manner. Section 2 presents a literature review of investor sentiment as well outlining the major relevant events of WWII. Section 3 presents the methodology used while section 4 presents the data. Section 5 contains the empirical results while Section 6 summarises the findings and provides conclusions.

2. Literature Review

2.1. Investor Sentiment Literature

Event studies that examine the effect of particular events on the stock market have been well documented in the literature, with many routine and seemingly economically unimportant events having been shown to have a significant effect on stock returns, such as cloud cover, (Saunders 1993) daylight (Kamstra et al 2000; 2003), sunshine (Hirshleifer and Shumway 2003), temperature (Cao and Wei 2005) and even sports results (Edmans et al 2007). With such strong and varied evidence of small and economically unimportant events having effects on returns, it is quite surprising that some very major events such as armed conflict have not received the same level of attention in the academic literature. A few types of major events, not directly related to conflict have been explored such as airplane crashes (Barrett et al 1987; Davidson et al 1987; Kaplanski and Levy 2010), hurricanes (Lamb 1995, 1998; Angbazo and Narayanan 1996; Huerta and Perez-Liston 2010), earthquakes (Shan and Gong 2012) and Tsunamis (Ramiah 2013).

In terms of armed conflict, there has recently been growing attention in the financial literature to the influence of terrorist attacks on capital markets. Abadie and Gardeazabel (2003) study the case of the Basque region in Spain and find evidence that terrorism related news has a significant impact on equity prices. They use three event study methods to estimate Basque firms' abnormal return following new announcements related to peace talks during the cease-fire around 1998. They find that following the release of good news the Basque portfolio outperformed the non-Basque portfolio and following the release of bad news the Basque portfolio underperformed the non-Basque portfolio. Carter and Simkins (2004) examine the effect of the September 11th attacks on New York in 2001 and find large significant negative abnormal returns for airfreight firms and international airlines. Further Chen and Siems (2004) examine the US capital markets response to various terrorism attacks dating back to 1915 and up to the September 11th attacks in 2001. They show that these attacks had a significant negative impact on the US capital markets but that they are more resilient than in the past and recover sooner from terrorist attacks than other global markets. Charles and Darné (2006) perform a study on the impact of the September 11th attacks in 2001 on international stock markets by estimating abnormal price changes using an outlier detection method based on an ARIMA model. This model has the ability to identify whether the changes in the market are endogenous, exogenous, permanent or temporary. The results show that the September 11th bombings produced outliers in all indices examined with the US markets less affected by the attack than other international markets. Further, Nikkinen and Vahamaa (2010) examine the behaviour of the FTSE100 index around the terrorist attacks of September 11th 2001, the 2004 attacks in Madrid and the July 7th attacks in London in 2005. They show that terrorism had a strong adverse effect on stock market with a pronounced downward shift in the expected value of the FTSE 100 and that these attacks caused 3 of the 5 largest daily increases in implied volatility from January 2000 through to December 2005. Brounrn and Derwall (2010) examine the effects of terrorist attacks on stock markets, using a dataset that covers all significant events that directly relate to major economies of the world. Using an event study, they show that terrorist attacks produce mildly negative price effects which rebound within in the first week of the aftermath. They also show that reactions are strongest for local markets and industries that are directly affected by the attack. Kollias et al (2011) examine the effect of the bomb attacks in Madrid on 11th March 2004 and in London on 7th July 2005 on the equity sectors. They find significant negative abnormal returns across the majority of sectors in the Spanish markets but not so for London. Further they find that the market rebound was much quicker in London compared to the Spanish markets and that the bombings had only a transitory impact on returns and volatility that did not last for a long period. Coleman (2012) examines the nine major bombings attributed to Al Qaida since 1998 and find that the markets takes well under one trading day to fully price in a completely unexpected attack, indicating semi-strong market efficiency.

Although wars are often much higher impact events than terrorist attacks, the literature on financial markets and wars is limited, with very little written on WWII. Schneider and Troeger (2006) examine the effect of political developments within three war regions from 1990 to 2000 using data from the CAC, DJIA and FTSE. They show that the conflicts caused a negative reaction in the three markets, with the notable exception of the Gulf war on the DJIA. In terms of WWII, Choudhry (2010) investigates the DJIA to determine endogenously the structural breaks during the war by examining price changes and volatility through an exponentially weighted moving average. He distinguishes between two possible types of breaks; turning points and blips. Turning points are breaks that cause a price change in the same direction for at least five days, while blips are breaks that cause a price change in the same direction for less than five days. The results show that many events deemed by historians as important are reflected in the data as turning points. However, some major events are only blips (German invasion of Poland), or fail to generate a break point (Battle of Britain, Invasion of France, Operation Market Garden[1] etc). The paper concludes by stating that news seen as good by investors tends to increase the price the next day after the event and for the next five working days and leads to a fall in volatility. Frey and Kucher (2000) examine the prices of the government bonds of five European countries traded on the Swiss bourse during WWII. They find that the loss and gain of national sovereignty during WWII influenced the bond prices of the countries involved. Further, Frey and Kucher (2001) analyse government bond prices of Germany and Austria traded on the Swiss bourse during WWII. They show that war events considered crucial by historians are clearly reflected in government bond prices; however some events, such as Germany’s capitulation in 1945, are not reflected in bond prices.

2.2. Relevant Major Events of WWII

In this section we give a brief summary of the main events during the war. This is to give perspective to our study and to justify our later selection of major events. Given the purpose

[1] An airborne attempt to seize the Rhine bridges by the allies from 17th - 25th September 1944.

of this paper we have necessarily taken a somewhat British centric view with limited emphasis on war theatres where Britain had little direct involvement such as the Pacific and Eastern Europe.

WWII officially began for Britain with the invasion of Poland by Germany and the subsequent declarations of war by France and Britain along with several Commonwealth countries on Germany on 3rd September 1939. British troops were deployed to the Continent but neither side launched major operations against the other until 1940. Germany invaded France, Belgium, the Netherlands and Luxembourg on 10th May 1940, with the Netherlands and Belgium overrun in a few days. British troops evacuated the continent at Dunkirk on 27th May 1940 and on 10th June 1940 Italy invaded France, declaring war on France and Britain. The alliance between Germany, Italy and later Japan (after Pearl Harbour) is generally referred to as the Axis alliance with Britain and the other opposing powers being referred to as the Allies. France fell under the control of the Axis, and Germany began a campaign for air superiority over Britain, the 'Battle of Britain' to prepare for an invasion across the English Channel. The campaign failed and the invasion was cancelled however this marked the beginning of the Blitz – a period of heavy bombing of British cities with the aim of breaking civilian morale and disrupting war production which again proved not to be decisive. After the fall of France Britain and the Commonwealth stood alone against the Axis powers and the only major land action took place in North Africa.

The war expanded considerably in summer 1941 when Germany rapidly invaded and took over the Balkans and then launched a huge invasion of the USSR. Hungary, Slovakia and Romania also joined the Axis. On 7th December 1941 Japan attacked the American fleet at Pearl Harbour and American and British forces throughout the Pacific and South-East Asia. This led to the Allied nations declaring war on Japan and the US formally entering the war. Initially there was great Japanese success against the Allies in the land and naval battles as they took over much of the Pacific region, as well as Malaysia, Singapore, Burma, Philippines and Java.

The area controlled by the Axis reached its greatest extent in 1942 but this was also the year the tide began to turn. The dominance of Japan in the Pacific was halted at the Battle of Midway, where the US sunk 4 carriers, one cruiser and destroyed 248 carrier aircraft. The British advanced decisively against the Germans and Italians in North Africa in a campaign which ultimately led to the expulsion of the Axis powers from the African continent. Towards the end of the year the Soviet forces surrounded the German 6th Army at Stalingrad leading to its eventual surrender in February of the following year.

The Allies gained momentum in 1943 and in September of that year, invaded and seized Italy following an armistice with Italian leaders. With German defeats in Eastern Europe, the Allied invasion of Italy and American victories in the Pacific, the Axis was in strategic retreat on all fronts in 1943. The Allies advance continued in Asia and the Pacific and on 6th June 1944 (known as D-Day), the Allies invaded France which led to the defeat of German forces in France. Paris was liberated on 25th August 1944 and the German forces were pushed back and although an attempt to advance into northern Germany ended in failure, German forces were continually retreating. Meanwhile in the Pacific, the US defeated the Japanese Navy and captured key Western Pacific islands during 1944 and 1945. The war in Europe concluded with the capture of Berlin by Soviet and Polish troops and the German unconditional surrender on 8th May 1945. Japan officially surrendered on 15th August 1945 after the Hiroshima and Nagasaki nuclear bombings on the 6th and 9th August 1945 respectively. Estimates of total casualties of the war vary, but most suggest some 60 million people died of which 20 million were soldiers and 40 million were civilians[2]. WWII altered the social structure and political alignment of the world and the United Nations (UN) was a direct result of the war to prevent future conflicts and foster international cooperation.

3. Methodology

In this section we detail the methodology associated with our event study of pre-selected events, our study of events associated with the largest stock market moves during the war and our structural break analysis.

3.1. Event Study

To examine the major events of WWII on the British stock market, we examine the effect of major WWII events on abnormal stock returns and stock return volatility through an event study using regression analysis.

[2] Beevor (2012).

In the literature, there are many methodologies used for modelling abnormal returns in event studies. Since we are examining an index, we utilise the mean-adjusted-returns approach of Brown and Warner (1985). This approach computes daily excess returns of the FT30 by;

$$AR_t = R_t - \bar{R} \tag{1}$$

Where AR_t is the abnormal return for the stock index at time *t*, R_t is the actual observed rate of return for this index, and $\bar{R}$ is the mean return of the index daily returns in the (-30; -11) estimation period so that;

$$\bar{R} = \frac{1}{20}\sum_{t=-30}^{-11} R_t \tag{2}$$

Initially, the event day abnormal returns are calculated. Given that the event date is at t = 0, and following Kollias et al (2011), longer event windows are examined by computing the cumulative average abnormal returns (CARs) ten (*t* = 10), five (*t* = 5), two (*t* = 2) and one (*t* = 1) days following the event. The CARs are estimated using the following equation;

$$CAR_t = \sum_{t=T_1}^{T_2} AR_t \tag{3}$$

Where T_1 is the event day and T_2 is consequently 5 or 10 days after the event. We report the cumulative average abnormal returns (CAARs), which are the average of the CARs for each event studied. We study the parametric t-statistic as well as the Sign test. The sign test (Cowan 1992) studies the ratio of positive cumulative abnormal returns during the event window to number over the estimation window such that;

$$t_s = \frac{p_0^+ + p_{est}^+}{\sqrt{p_{est}^+(1 - p_{est}^+)/N}} \tag{4}$$

where p_0^+ is the ratio of positive cumulative average abnormal returns during the event window and p_{est}^+ is the ratio of positive cumulative average abnormal returns during the estimation window. We also utilise the non-parametric Corrado test (1989), where the basic principle involves the conversion of abnormal returns into a sequential rank. As ranks are generally not substantially distant from another, ranked distributions are less prone to problems caused by non-normality, which is found in Table 1 for the FT30 data.

3.2. Regression Analysis

To further our analysis, we conduct regression analysis on the FT30 returns to study how the market reacted following major positive and negative events. However is well known that seasonal anomalies[3] are found in stock market data and could skew the results. To account for these seasonal effects in the data, we include dummy variables in the mean equation of our regression, however unlike previous studies, we do not assume all of the seasonal effects exist in our data. We pre-test the data to determine which seasonal effects are evident and only include the significant seasonal effects found in the data before the regression analysis. The seasonal effects are examined over the period from the beginning of the FT30 to the end of the war. The seasonal effects examined are the well-known Monday effect, January effect, turn-of-the-month effect, tax year effect, as well as serial correlation in the returns. It is also well known that stock market data is volatile and has time dependence variance. The time dependency of the error variance violates one of the basic Gauss-Markov assumptions for linear regression, therefore making the estimation of OLS regressions invalid. Therefore we use GARCH modelling (Bollerslev 1986) which allows for time-varying volatility and adds robustness to the results. To study the effect of major events on stock returns, we add dummy variables to the mean equation. Thus the main seasonal effects are examined through a GARCH(1,1) regression such that;

$$\begin{aligned} r_t &= \gamma_0 + D_{1it} + \varepsilon_t \\ h_t &= c + \alpha.\varepsilon_{t-1}^2 + \beta.h_{t-1} \end{aligned} \tag{5}$$

Where r_t is the return on the FT30 on day t, γ_0 is the regression intercept, and D_{1it} is a dummy variable for the seasonal effect examined. In order to study whether the returns of the British stock market was affected by the major positive and negative events, we estimate the following equation[4]:

$$r_{it} = \gamma_0 + \sum_{i=1}^{5} \gamma_{1i}\, r_{t-i} + \gamma_{2i} Mon_{it} + \gamma_{3i} J_{it} + \gamma_4 TOTM_{it} + \sum_{i=3}^{3} \gamma_5 NE_{i,t} + \sum_{i=3}^{3} \gamma_6 PE_{i,t} + \varepsilon_t \tag{6}$$

[3] For a thorough literature review on seasonal anomalies, see Urquhart and McGroarty (2014).

[4] If all the seasonal effects are found. If some are not found, they are not included in the final regression.

$$h_t = c + \alpha.\varepsilon_{t-1}^2 + \beta.h_{t-1}$$

Where r_t is the return on the FT30 on day t, γ_0 is the regression intercept, r_{t-1} is the return on day t-i. Mon_{it} is a dummy variable for the Monday effect. J_{it} is the dummy variable for the January effect where i = 1 for the first 15 days in January. $TOTM_{it}$ is a dummy variable for the turn-of-the-month days and T_{it} is a dummy variable for the first five days of the tax year. NE_{it} is the dummy variable for a negative event while PE_{it} is the dummy variable for a positive event. In the conditional variance equation, ε_t is the error term with conditional mean zero and conditional variance h_t. However, if any of the seasonal effects are not found to be significant, they are excluded from the subsequent regression analysis.

Nevertheless, many other alternative GARCH models have been proposed and need to be considered since Charles (2010) notes that the choice of model plays an important role because results differ depending on the model used. Therefore we also consider an exponential GARCH (EGARCH) model, introduced by Nelson (1991) which allows negative and positive shocks to have different effects. Under EGARCH(1,1) the conditional variance is given by;

$$log.h_t = c + \alpha\left[\frac{|\varepsilon_{t-1}| - \sqrt{2/\pi}}{\sqrt{h_{t-1}}}\right] + \beta.\log(h_{t-1}) + \gamma.\frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \tag{7}$$

This model has the advantage of not needing to impose the non-negativity constraint on the model parameters and also allowing for asymmetries in the relationship between volatility and returns. To determine whether this model is appropriate, we use the AIC statistic and compare it to the other models. We also examine the GARCH-M model of Engle et al (1987) which considers the possibility of a trade-off between returns and risk by including the conditional standard deviation h_t in the mean equation. Thus our mean equation takes the following form;

$$r_t = \gamma_0 + D_{1it} + \kappa h_t + \varepsilon_t \tag{2}$$

If $\kappa > 0$, then there is a positive trade-off between risk and return, as suggested by portfolio theory. The significance of κ then determines whether the extended model is appropriate as well as the AIC statistic. We also consider two more commonly used alternative GARCH models, namely the TGARCH model. The TGARCH model of Glosten et al (1993) considers that shocks with opposite signs may impact volatility to a different extend and so product terms are added to the variance equation such that;

$$h_t = c + \alpha.\varepsilon_{t-1}^2 + \beta.h_{t-1} + \sum_{v=1}^{r} \lambda_v T_{t-v}\varepsilon_{t-v}^2 + \qquad (8)$$

where T_{t-v} is a dummy that takes the value 1 if $\varepsilon_{t-v}^2 < 0$ and 0 if $\varepsilon_{t-v}^2 \geq 0$. If $\lambda_v > 0(\lambda_v < 0)$, negative (positive) shocks have a larger impact on the conditional variance than positive (negative) shocks of the same magnitude. This model is appropriate if the asymmetry parameter is statistically significant and the AIC statistic is lower than the other models.

4.3. Study of events associated with the largest stock market moves

The above analysis examines the impact of pre-determined major events and on the FT30. However, it might be argued that these events are deemed important with regards to the outcome of the war by historians with the benefit of a certain degree of hindsight. They may not have been considered as important to investors at the time. Even more importantly, there may be a number of events that were considered important for investors that the previous analysis has ignored. Further, the stock market may have experienced large changes in prices throughout the war period that were not directly associated with the war. Therefore we follow Kaplanski et al (2010) and find the ten best and worst trading days during the war period and determine whether they are associated with a war event.

4.4. Structural Break Analysis

We also examine the structural breaks during the war period in a similar way to Choudhry (2010), to pick up any events that the previous analyses have ignored. Breaks in a time-series are shocks that permanently affect the series, and that do not occur each period. That is, while some shocks permanently shift the trend function of a series, the majority of shocks have only a temporary effect. Thus events during the course of WWII that produced permanent and temporary effects on the British stock market are examined. Zivot and Andrews (1992) provide a test that takes into account possible structural shifts in a series, and its intercept. The test can be formalised by;

$$InP_t = \alpha_0 + \beta t + \alpha_1 DU_t + \alpha_2 DTB_t + \alpha_3 DT_t + \rho InP_{t-1} + \sum_{i=1}^{N} \psi_i \Delta InP_{t-1} + u_t \quad u_t \sim (0, \sigma^2) \tag{9}$$

Where InP_t is the log of the FT30 index at time t, if T_b is the break point, $DTB_t = 1$ if $t = T_b + 1$ (otherwise it is equal to zero), $DU_t = 1$ if $t > T_b$, zero otherwise, and $Dt_t = (t - T_b)$ if $t > T_b$, zero otherwise. Thus this test allows a change in both the intercept and the slope of the trend function. Dummies DTB_t, DU_t, *and* DT_t allow for a break in the level of the trend function, in the slope, and for breaks in both the level and the slope respectively. Thus this test is more powerful than a number of other structural break tests (for example the Chow test). The Zivot Andrews test also includes lags of ΔInP_t to eliminate potential serial correlations.

According to Willard et al (1996), one of the main problems of finding a break in a series is determining the length of the break. This test only assumes a single break point in the series, thus if two breaks happen within a short space of time there may be difficulty in finding both, or it may locate one with an inflated effect. This problem can be addressed by investigating potential breaks that last for periods shorter than the rest of the remaining sample period. As the period gets shorter, it becomes easier for a break to be labelled as long lasting. Thus there is a trade off in choosing between a short time period and a long period for analysis; as the period gets shorter breaks may falsely be deemed long lasting and as the period gets longer important breaks may be missed. In this investigation the search for potential breaks in the FT30 is based on a three-month sample size with a rolling window of two weeks and one month, similar to Choudhry (2010).

4. Data

The empirical tests employ daily closing prices for FT30 data from 3rd January 1939 to 31st December 1945 which represents the WWII period. Although the war did not officially begin until 3rd September 1939, many of the leading players had been planning for the outbreak of war for some time and saw it as only a matter of time. Stock returns are calculated the following way;

$$r_t = [In(P_t) - In(P_{t-1})] \times 100 \tag{10}$$

where $In(P_t)$ is the natural logarithm of the index at time *t*.

Figure 1 and 2 present the log prices and log returns over the war period. The index dropped heavily and reached its lowest point in 1940 which coincides with the period when the war was at its worst for Britain after the fall of France and when invasion seemed distinctly possible. Similarly volatility reached a high in this period. After the low point of 1940 the index tended to rise, albeit with some setbacks, and volatility remained relatively subdued until near the end of the war.

Summary statistics for the FT30 before the war, during the war period and after the war are presented in Table 1. The war period from 1939 to 1945 is compared to the following seven years, the previous four years and a long period 1935-2009. This index was only compiled in 1935 so the pre-war sample period is limited to four years. The table shows that the mean returns during the war period are greater than the mean returns after the war period and for the full sample, while the mean returns before the war were negative. The reason why the mean returns during the war are greater than the returns after the war may be explained by the fact that Britain in the post-war years were days of austerity and of fuel shortages, which strangled production and dragged the market lower than it had been during WWII (Harrison 1998). Table 1 shows that the war period, as well as the post-war period, has significant left skewed data which is what is generally found in stock markets (see for example Premaratne and Bera 2001). All of the subsamples have kurtosis coefficients that are greater than three and significant, indicating a leptokurtic distribution. Thus the skewness and kurtosis coefficients for each subsample indicate that the returns series deviates from the normal distribution at 1% significance, indicating the non-normal nature of the data. Further, the Jarque-Bera statistic is computed to further assess the extent of non-normality in the distributions of the returns series. The probabilities of the JB statistic for each subsample are all less 0.01 which is statistically significant at 1% and confirms that the distribution of the returns of each subsample is not normal. Thus the WWII period for the FT30 generated higher returns than the periods before and after it and the full sample, but as with most financial time series data, the returns series is not normal.

Table 2 documents the major positive and negative events examined, along with the rationale for choosing them as major events and are taken from Beevor (2012). The main criteria for the chosen events are that they are believed by historians to have significantly and directly contributed to the outcome of the war for Britain. For example, the Nazi invasion of Poland which led to the declaration of war from the allies is generally deemed to be the official beginning of the war and so is an important event. On the other hand, the Battle of Midway is not chosen as even though it was important for victory in the Pacific, it was fought by the US and Japan far away from Britain and was not deemed of primary importance to British investors at the time.

5. Empirical Results

5.1. Event Study

Following the event study, Table 3 reports the CAARs and statistically significance levels for the 0, 1, 2, 5 and 10-day event windows related to positive and negative events during WWII. To add robustness to our testing we also include two non-parametric tests, namely the Corrado rank test and the Sign test. The results show that the day of the positive events generates a negative CAAR, which is statistically insignificant at the 5% significance level. However the 1-day following a positive event generates a CAAR that is positive although it is again insignificant according to the parametric and nonparametric tests. The rest of the event windows generate mixed signs for the CAARs with none statistically significant, suggesting that positive events of WWII caused a short-term positive insignificant reaction to the FT30, but this reaction did not last past 1-day. The major negative event results show that the day of the negative event generated a positive CAAR, possibly due to the fact that news of the negative event may not have reached British shores on the day of the event. However the CAARs for days following a negative event are all negative and statistically significant at the 5% level according to the non-parametric Corrado test, and at the 10% level according to the Sign test. The magnitude of the CAARs is less as the event window increases indicating the negative reaction of the market to negative events decreases over time. Therefore our results show that positive events had an initial 1-day positive but insignificant effect on the FT30, while negative events had a longer-term and significant negative reaction on the FT30 during WWII.

5.2. Regression Results

The next step in the analysis is to examine the impact of the major events of WWII on the stock returns and stock volatility through regression analysis. Initially we investigate the existence of seasonal effects in the data. Table 4 reports that there is significant evidence of the TOTM effect and serial correlation up to lag three in stock returns, while there is no significant evidence of serial correlation in any other lag or seasonal anomalies. Thus we include serial correlation up to lag three and the TOTM effect in the regression analysis reported in Table 5. We report the GARCH(1,1), TGARCH(1,1), GARCH-in-Mean(1,1) and EGARCH(1,1) regression results with their respective AIC statistics. We find that the GARCH(1,1) results show that after one day, major positive events had a significant positive effect on the FT30 and that the reaction did not last as the subsequent days generate negative coefficients. We also show that major negative events had a significant negative impact on the FT30 for two days after the event. The TGARCH(1,1) results support these findings and generates a lower AIC statistic than the GARCH(1,1) model, indicating that it is more appropriate than the TGARCH(1,1). However the GARCH-in-Mean(1,1) has a higher AIC statistic, as well as insignificant GARCH-in-Mean parameter, indicating its inappropriateness. Finally the EGARCH(1,1) model is estimated and is shown to be the most appropriate, with the smallest AIC statistic. The results from the EGARCH(1,1) support the previous findings, that positive events had an initial significant positive effect on the FT30 and that negative events had a two-day significant negative effect on the FT30.

The analysis of pre-determined events has shown that the British stock market has reacted more to major negative events than major positive events. This is consistent with the 'negativity effect' documented by Akhtar et al (2011), who finds that the equity market reacts significantly to the announcement of bad sentiment news but fails to react to the announcement of good sentiment news.

5.3. Study of events associated with the largest stock market moves

Table 6 reveals that the largest changes in the FT30 during WWII cannot be generally explained by the pre-determined major events. The exceptions to this is the large negative return experienced on the 24th June 1940 which is the next trading day after the fall of France. We search for other events of lesser but substantial importance that might be possible explanations for the other changes and these are set out in the table. There are plausible explanations for 7 of the 10 negative changes but only 2 of the 10 positive changes. The 18th September 1939 is the next trading day after the Courageous aircraft carrier was sunk, while the 3.02% increase on the 4th July 1940 could be attributed to the Royal Navy's sinking of the Provence and Bretagne Battleships which occurred the previous day. The fall of 2.45% on 30th July 1945 is the first trading day after the Japanese aircraft carrier Amagi was sunk by

US forces, however this fall is much more likely to be the effect of the surprise election result on the 26th July 1945 in which Winston Churchill lost office and the socialist Clement Attlee won power. On the basis of this analysis large price moves are often not associated with important war events and this seems to be more the case for positive rather than negative price moves.

5.4. Structural Break Analysis

We follow Choudhry (2010) and find the structural breaks during the war period using a rolling-window Zivot-Andrews (1992) test. Table 7 presents the structural break dates, any important event(s) associated with the date, the change in the stock price between the day of the event and the day after, and the sum of the change in price over the next five working days. Five working days[5] are used because of the high intensity of the war, in which many battles and conflicts were fought very close to each other, in order to avoid over lapping, and to also capture the potential long-run effect of each major battle or event. The analysis finds a total of 76 breaks in the data, with only 42 of breaks statistically significant and reported. The breakpoint found on 20th June 1940 was a few days after Germany had entered Paris and results in a 2.33% one-day fall in price and a 9.48% fall in price over the next 5-days. The delay could be due to the news reaching British investors and using the notation of Choudhry (2010) this represents a turning point. All of the other structural breakpoints found cannot be associated with a major event of the war thus suggesting that WWII's impact on the FT30 was limited. These results are quite different to the ones found by Choudhry (2010), who used the same testing procedure to find that major events during WWII for US data as represented by the Dow Jones Industrial Average (DJIA). Choudhry (2010) found that the majority of events deemed as important by historians were picked up in the structural break test on the DJIA.

7. Conclusion

Event studies have been examined extensively in the finance literature although the majority of studies have dealt with seemingly insignificant and economically unimportant events. Extreme events have arguably not received sufficient attention and this paper investigates a period containing many of the most extreme events in history, WWII. WWII provides an

[5] Similar to Choudhry (2010).

opportunity to examine how stock returns react during the most extreme of all circumstances, where the sovereignty of nations and investor's lives are at risk. This period, particularly the situation in Britain, has been relatively little investigated in the literature. The British stock market is a good setting for such a study due to the heavy involvement of Britain in the war, the relative uncertainty of the outcome for the country and the good availability of data.

As the events of WWII could clearly be either adverse or positive for the countries concerned investigating them enables an examination of the 'negativity effect' documented by Akhtar et al (2011). We utilise a well-established event study methodology, where we examine the CAARs after major positive and major negative events of WWII. We initially use regression analysis after accounting for seasonal effects in the data to examine the effect of the major events on stock returns and stock return volatility, and finally we use the methodology of Choudhry (2010) to find structural shifts in FT30 returns. The results show that major negative events had a significant negative effect on stock returns on days following the event, while major positive events had a positive 1-day insignificant impact on the FT30, confirming the 'negativity' effect of Akhtar et al (2011). Our regression analysis of stock returns finds that positive events caused a 1-day significant positive reaction while negative events generated a 2-day significant negative reaction. Overall, we find support for a 'negativity effect' with prices being more strongly affected by negative than positive events.

Following Choudhry (2010), we use the Zivot-Andrews (1992) structural breakpoint tests to determine endogenously the structural breaks during the WWII period. The results show that only one of the wartime events classified as important resulted in a structural break and contrast with the results of Choudhry (2010) who found that the majority of breaks found in the DJIA were important events of the war period. The difference between our results and those of Choudhry is quite considerable and begs explanations which may point to further research. One possibility is that the DJIA was more efficient than the FT30 and reacted to major events of the war in a more appropriate and timely manner. Offer possible, and perhaps related, explanations might relate to the fact that Britain had a rather different war experience to the US. Britain was a significant risk of defeat in 1940 and this was associated with a clear market low and very high market volatility. On the other hand defeat was never a likely outcome for the US. It could be after the risk of national defeat had receded British investors were so relieved that individual engagements were generally treated as less significant. Another possible explanation is that the importance of trading in the British stock market during the war was relatively downgraded since many investors were either at war, engaged in war work or distracted by being under physical attack from bombing or missiles.

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Figures and Tables

Figure 1: Log of FT30 index during the WW2 period.

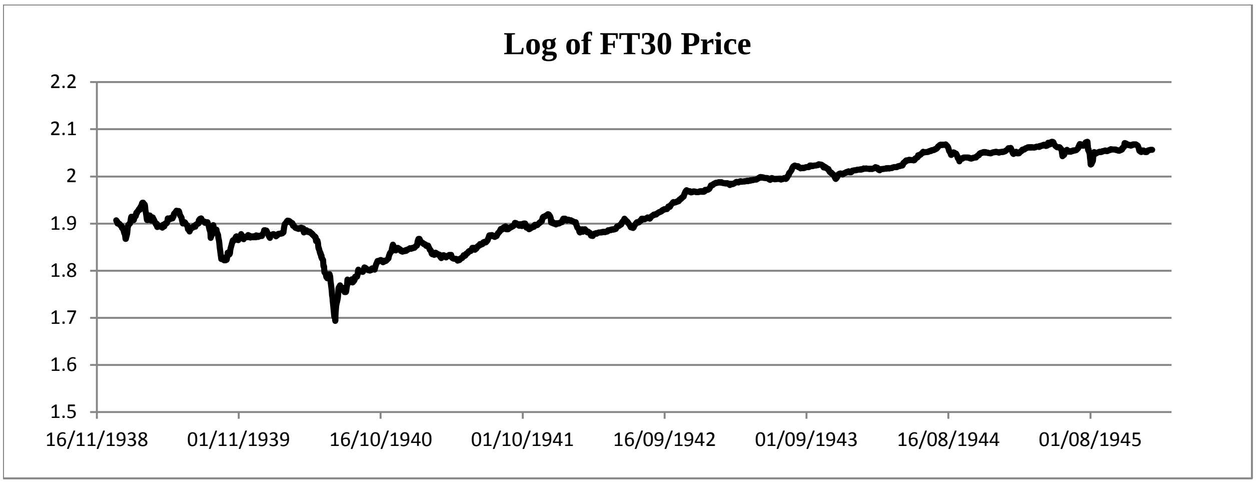

Figure 2: Log returns of the FT30 during the WW2 period.

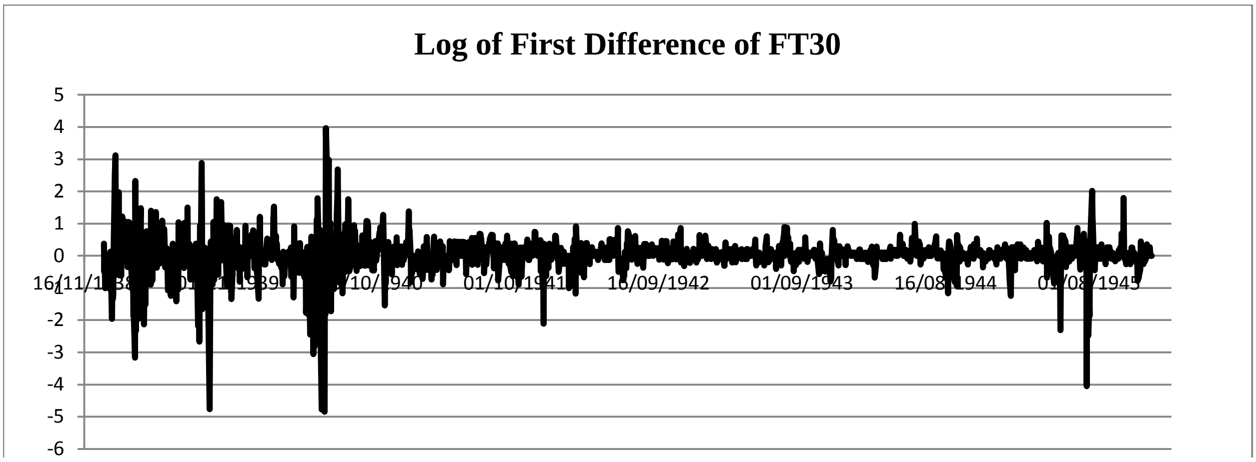

Table 1: Descriptive Statistics of daily returns during World War Two of the FT30. Significance tests are only applied to the Jarque-Bera statistics. ***, **, * indicate significance at 1%, 5% and 10% respectively.

Period	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Obs
Pre-war	-0.024512	8.077310	-5.553400	0.800579	0.470902	21.44522	12649.62***	890
World War Two	0.019502	3.968770	-4.841220	0.588138	-1.215715	17.99533	17173.25***	1786
Post-war	0.017118	10.78119	-12.40017	1.114202	-0.193052	11.34741	50139.67***	17233
Full sample	0.015471	10.78119	-12.40017	1.065027	-0.198897	12.21842	70625.14***	19909

Table 2: The major war events studied in this paper with a brief note about the rationale behind choosing each event. Panel A documents the negative events while Panel B shows the positive events studied.

Date	Event	Rationale
Panel A: Negative Events		
23rd Aug 1939	Nazis and Soviets sign Pact	Russia and Germany sign a non-aggression Pact to ensure Germany would not have to fight a war on two fronts.
1st Sep 1939	Germany invades Poland	The Nazis invade Poland which leads to the declaration of war from the Allies.
3rd Sep 1939	Britain, France, Australia and New Zealand declare war on Germany	British Ambassador in Germany Neville Henderson delivered the British declaration of war to German Foreign Minister Joachim von Ribbentrop, effective at 1100 hours. British Commonwealth nations of New Zealand and Australia followed suit and France also declared war later on this day.
27th Sep 1939	Warsaw falls to Germany	Warsaw, Poland fell to the Germans after two weeks of siege. The Polish government in exile was established in Paris, France.
10th May 1940	Germany invades France, Belgium, Luxembourg and the Netherlands	Germany invaded France as well as Belgium, Luxembourg and the Netherlands.
15th May 1940	Surrender of Holland	The Netherlands surrendered to Germany at 1015 hours; Dutch General Winkelman signed the surrender document.
10th June 1940	Italy declares war on Britain and France	Italy declared war on France and Britain, to be effective on the following day.
14th June 1940	Fall of Paris	In France, German troops captured the open city of Paris without any opposition. To the north, the coastal city of Le Havre fell under German control. To the east, the German 1st Army broke through the Maginot Line near Saarbrücken. Also on this date, all remaining British troops in France were ordered to return.
10th July 1940	Start of the Battle of Britain	A large German aerial formation attacked one of the eight British convoys in the English Channel. Upon detecting the incoming aircraft, four squadrons of British fighters were launched to counter the attack. At the end of the battle, seven British aircraft were destroyed and one of the ships was sunk. The Germans lost 13 aircraft and this surprising victory led to the British announcing that 10th July was the start of the Battle of Britain.
7th Sep 1940	Start of the Blitz	German bombers attacked London as the new Operation Loge commenced. During the day, 53 German bombers were shot down, as was 21 BF 109 fighters; the British lost 27 fighters. Overnight, German bombers continued to attack the East End, which saw 490 killed and 1,200 wounded on this day. This would mark the first of 57 consecutive nights of German bombings on the British capital.
7th Dec 1941	Pearl Harbour	360 Japanese carrier aircraft attack Pearl Harbour sinking or damaging 8 battleships, 3 cruisers, 3 destroyers, 1 anti-aircraft training ship, 1 minelayer. In total 2,459 were killed of which 57 were civilians.
Panel B: Positive Events		
31st Oct 1940	Battle of Britain won	According to a British Air Ministry pamphlet published in 1941, this date was the official end of the Battle of Britain, but bombings in London would continue.
8th Dec 1941	US joins Allied forces	United States declared war on Japan after Franklin Roosevelt's "a date which will live in infamy" speech. United Kingdom, Canada, Costa Rica, Dominica, Haiti, Honduras, Nicaragua, Free France, and the Dutch government-in-exile also declared war on Japan. Meanwhile, China declared war on both Germany and Italy; China had been fighting with Japan since July 1937.
2nd Feb 1943	Germans surrender to Stalingrad in the first big defeat of Hitler's armies	The last of the German Sixth Army surrendered in Stalingrad, Russia.
25th July 1943	Moussolini's government overthrown	The Fascist Grand Council in Rome voted 19 to 7 for King Vittorio Emanuele III to retake command of the Italian military from Mussolini. Mussolini was arrested immediately.
8th Sep 1943	Badoglio signs armistice with the Allies made public	Italy signs a treaty with the Allies to support them against Germany.
12th Aug 1944	Battle of Normandy won	The German failure to successfully defend the Normandy area from the Allied liberation forces in essence doomed Hitler's dream of a Nazi controlled "Fortress Europe" and marked the beginning of the end for Germany.
25th Aug 1944	Liberalisation of Paris	The French 2nd Armoured Division entered Paris, France. De Gaulle moved his headquarters into the War Ministry in Paris on the same day with the approval of Eisenhower.
21st Oct 1944	Massive German surrender at Aachen, Germany	German troops surrender at Aachen, Germany.
30th Apr 1945	Hitler commits suicide	The recently married Hitler and Braun committed suicide in Berlin, Germany.
2nd May 1945	German troops in Italy surrender	German troops in Italy surrendered in accordance with secret negotiations, followed by an announcement for the cessation of hostilities.
7th May 1945	Unconditional surrender of Germany	General Jodl signed the unconditional surrender of all German forces to the Allies, to take effect the following day at Eisenhower's headquarters near Rheims, France.

Table 3: Cumulative average abnormal returns of the FT30 from major positive and negative events. Parametric t-test p-values, as well as non-parametric Corrado and Sign test p-values also reported. ***, **, * indicate significance at 1%, 5% and 10% respectively with respect to the parametric t-statistic.

	Pos:Neg	CAAR	Prob	Corrado Rank	Prob	Sign Test	Prob
Positive Events							
[0; 0]	06:05	-0.211	0.37	-0.4238	0.67	0.6364	0.52
[0; 1]	05:06	0.2058	0.54	0.3869	0.70	0.0303	0.98
[0; 2]	06:05	-0.216	0.60	-0.5695	0.57	0.6364	0.52
[0; 5]	05:06	-0.012	0.98	-12,552	0.21	0.0303	0.98
[0; 10]	06:05	0.3984	0.61	-10,804	0.28	0.6364	0.52
Negative Events							
[0; 0]	03:08	0.202	0.48	-12.403	0.21	-16.910*	0.09
[0; 1]	03:08	-0.226	0.58	-26.310***	0.01	-16.910*	0.09
[0; 2]	03:08	-0.228	0.65	-25.634***	0.01	-16.910*	0.09
[0; 5]	02:09	-0.032	0.96	-28.576***	0.00	-22.949**	0.02
[0; 10]	03:08	-0.067	0.94	-41.951***	0.00	-16.910*	0.09

Table 4: Pre-regression results for the known market anomalies during the war period. ***, **, * indicate significance at 1%, 5% and 10% respectively.

	Monday Effect	January Effect	TOTM Effect	$Returns^{-1}$	$Returns^{-2}$	$Returns^{-3}$	$Returns^{-4}$	$Returns^{-5}$
Returns	-0.014705 (-1.06)	0.023224 (0.96)	0.047011*** (3.14)	0.339660*** (13.83)	0.210748*** (7.84)	0.096846*** (3.58)	0.023351 (0.89)	0.049869* (1.91)

Table 5: GARCH (1,1) model estimation results. ***, ** and * indicate significant at 1%, 5% and 10%.

		GARCH(1,1)	EGARCH(1,1)	GARCH-Mean(1,1)	TGARCH(1,1)
Conditional Mean Equation	γ_0	0.014148*	0.012926	0.011325	0.017162**
		(1.75)	(1.63)	(1.20)	(1.99)
	R_{t-1}	0.282339***	0.274185***	0.282687***	0.282059***
		(10.49)	(10.33)	(10.48)	(10.01)
	R_{t-2}	0.134508***	0.141113***	0.135325***	0.128748***
		(4.28)	(4.84)	(4.31)	(4.10)
	R_{t-3}	0.018573	0.029185	0.020664	0.013579
		(0.64)	(0.74)	(0.70)	(0.46)
	TOTM	0.032283**	0.038398***	0.031945*	0.034658**
		(1.96)	(2.69)	(1.94)	(2.15)
	PE1	0.221047***	0.195223***	0.221827***	0.226878***
		(4.12)	(3.36)	(4.13)	(4.39)
	PE2	-0.045731	-0.072364	-0.046124	-0.043061
		(-0.48)	(-0.79)	(-0.48)	(-0.46)
	PE3	-0.085494	-0.121504	-0.086482	-0.081140
		(-0.85)	(-1.07)	(-0.85)	(-0.80)
	NE1	-0.646024**	-0.583528***	-0.662152**	-0.651763**
		(-2.30)	(-3.00)	(-2.30)	(-2.50)
	NE2	-0.741529***	-0.565567***	-0.751426***	-0.756265***
		(-3.04)	(-2.90)	(-3.06)	(-3.30)
	NE3	0.187749	-0.009434	0.167918	0.224737
		(0.60)	(-0.04)	(0.53)	(0.74)
	κ	-	-	0.033974	-
				(0.69)	
Conditional Variance Equation	c	0.004028***	-0.380160***	0.004034***	0.003691***
		(6.82)	(-17.74)	(6.81)	(6.69)
	α	0.255713***	0.424013***	0.255871***	0.292933***
		(13.42)	(20.28)	(13.40)	(12.06)
	β	0.778171***	0.955290***	0.777962***	0.777773***
		(57.51)	(163.40)	(57.30)	(57.73)
	λ	-	-	-	-0.061057**
					(-2.50)
	γ	-	0.025944**	-	-
			(2.21)		
Diagnostic	AIC	0.848388	0.848296	0.849038	0.847858

Table 6: Rates of return on the best and worst trading days. Reported are the ten highest rate of return and the ten lowest rates of return on the FT30 from 3rd January 1939 to 31st January 1945. The fourth column provides possible explanations for the market movement based on reports in the Times of London that morning. The fifth column reports if these days coincided with an event corresponding to a major event covered in this study.

Date	Largest Positive Returns	Largest Negative Returns	Possible War Event Explanation	Major Event Day?
30/01/1939	2.54	-	Speech by Chamberlain the British Prime Minister appealing for peace but affirming achievements in rearmament and war preparations	No
31/01/1939	3.12	-	-	No
20/03/1939	-	-3.17	A British note sent to Germany protesting the illegality of German action in Czechoslovakia	No
21/03/1939	2.32	-	-	No
24/08/1939	-	-2.66	First trading day after the Nazi Soviet Pact	Yes
29/08/1939	2.88	-	-	No
18/09/1939	-	-4.77	First trading day after the British Aircraft Carrier Courageous was sunk	No
28/05/1940	-	-3.05	-	No
30/05/1940	-	-2.83	-	No
17/06/1940	-	-4.77	Reynard cabinet resigned in France and replaced by the Petain regime – rumours of French peace negotiations with Germany	No
21/06/1940	-	-2.80	-	No
24/06/1940	-	-4.84	France surrendered on 22nd June (Saturday) and this was the next trading day.	Yes
27/06/1940	3.97	-	-	No
28/06/1940	3.63	-	-	No
01/07/1940	2.04	-	-	No
04/07/1940	2.98	-	Day after British sinking's of the French Provence and Bretagne Battleships to prevent them falling under German control	No
26/07/1940	2.68	-	-	No
26/07/1945	-	-4.05	Atlee succeeds Churchill as British Prime Minister	No
30/07/1945	-	-2.48	First trading day after Churchill leaves office	No
08/08/1945	2.02	-	-	No

Table 7: Test results for the Zivot-Andrews (1992) structural break test. *** and ** indicate significance at 1% and 5%.

Date	Minimum t-statistic	One-day % change in price	5-day % change in price	Possible Explanations for breaks
16/03/1939	-4.3994***	-1.85%	-3.52%	Day after The Nazis take Czechoslovakia
25/05/1939	-4.0988***	1.09%	1.96%	-
12/07/1939	-2.2119***	0.39%	0.51%	-
08/08/1939	-3.0134***	-0.25%	-1.48%	-
15/09/1939	-4.3730***	-1.66%	-5.59%	-
29/12/1939	-5.1954***	0.67%	0.80%	-
20/02/1940	-5.4536***	1.18%	1.45%	-
20/06/1940	-5.2964***	-2.33%	-9.48%	A few days after Germany entered Paris
20/08/1940	-5.0663***	1.14%	1.14%	Two days after Hitler declares a blockade of the British Isles
07/11/1940	-3.3122***	0.88%	2.85%	Two days after the re-election of Roosevelt as US president
14/01/1941	-4.3442***	0.56%	1.56%	-
14/03/1941	-3.8812***	-0.59%	-1.76%	-
08/07/1941	-5.2848***	0.68%	1.80%	-
05/12/1941	-4.3324***	0.12%	0.24%	German attack on Moscow is abandoned
09/02/1942	-4.8279***	0.00%	-0.25%	-
16/03/1942	-2.3072***	-0.13%	-0.26%	-
04/06/1942	-3.5868***	0.13%	1.40%	Heydrich, one of the highest ranking Nazis, dies
18/06/1942	-4.0473***	-0.13%	-0.75%	-
05/08/1942	-6.1273***	0.25%	0.86%	-
29/09/1942	-4.7036***	-0.12%	0.82%	-
02/11/1942	-4.9379***	0.22%	0.89%	Day after Operation Supercharge (Allies break Axis lines at El Alamein)
31/12/1942	-3.6339***	0.00%	0.00%	Battle of the Barents Sea between German and British ships
08/03/1943	-4.3001***	0.21%	0.42%	-
04/05/1943	-3.7123***	0.20%	0.41%	-
16/07/1943	-5.5234***	0.40%	1.21%	-
30/09/1943	-2.8093***	0.19%	0.38%	-
25/10/1943	-2.3951***	-0.29%	-0.86%	-
08/11/1943	-4.9540***	-0.40%	-0.79%	-
25/02/1944	-5.9467***	-0.67%	-0.96%	-
26/04/1944	-5.1353***	0.47%	0.66%	-
02/06/1944	-3.2445***	1.00%	1.56%	-
20/07/1944	-3.7759***	0.35%	0.88%	-
07/09/1944	-3.9559***	-0.81%	-1.79%	-
24/10/1944	-4.9422***	0.36%	0.36%	A few days after the massive German surrender at Aachen, Germany
08/01/1945	-4.9064***	0.35%	0.88%	During the German withdrawal from the Ardennes
31/01/1945	-4.4354***	-0.35%	0.27%	-
10/04/1945	-2.7061***	-0.17%	0.26%	-
23/04/1945	-5.1081***	0.00%	0.43%	A couple of days after the Soviets reached Berlin
22/05/1945	-7.9018***	-1.04%	-1.13%	-
26/07/1945	-7.5797***	-3.97%	-3.73%	Atlee succeeds Churchill as British Prime Minister
08/10/1945	-5.6814***	-0.09%	-0.35%	Soviets declares war on Japan
30/10/1945	-3.5356***	-0.26%	-0.51%	-