Naval Disasters, World War Two and the British Stock Market

Abstract

This paper studies investor sentiment by examining the impact on the British stock market of naval disasters. Since the British Empire was a world power and its navy was held in great regard, Britain was dependent on control of the sea for survival during World War Two and the sinking of capital ships was a huge blow to the fight against the Axis powers. We find that the market was only significantly affected by a handful of naval disasters which have very clear strategic and political importance. The market was generally not affected by other individual disasters or successes, no matter how emotive those disasters were.

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1. Introduction

A modest but growing literature examines the link between wartime events and movements in financial markets. From a historical viewpoint, this is an interesting approach because market reactions give an insight into how events were perceived contemporaneously without the distortions of hindsight. This paper studies the impact on the British stock market of naval disasters, defined as the sinking of key naval vessels (capital ships[1]) in World War Two (WW2). We examine a fully comprehensive set of capital ship losses using a variety of testing procedures. Naval disasters are particularly interesting to study because, unlike many other events, the outcomes are very clear cut, can be precisely dated and can reasonably be considered to be exogenous events. The British market is a good subject for such a study since Britain was a nation dependent on control of the sea for survival, traditionally held the navy in great regard, had well developed financial markets and was contesting maritime control across the globe.

Generally naval disasters are of great potential importance to the stock market for a number of reasons. Firstly, the loss of a capital ship had a substantial detrimental effect on the war effort as such ships were only available in small numbers, represented a substantial proportion of a country's overall naval strength and would take years to replace. Therefore, the loss of a ship was detrimental to the war effort and was a serious threat to British success. Secondly, the human and material loss was very considerable, and in some cases, thousands of men died. The financial value of the ships was enormous[2] to the extent that budgets for building and maintaining capital ships had long been a very significant part of government expenditure[3]. Thus the sudden loss of a ship and subsequent financial loss might have a detrimental effect on the stock market. Thirdly, the ships had a huge prestige value. Churchill demonstrated the importance of capital ships during WW2 by stating "*In all the war I never received a more direct shock"*[4]*,* which was his response to hearing the battleships the Prince of Wales and Repulse had been sunk on 10th December 1941. Similarly, the battleship HMS Hood was the

[1] We take capital ships to be battleships and battle-cruisers (BB) as well as large aircraft-carriers (CV).
[2] The last major class of UK battleships, the King George V class, which consisted of 5 ships and was authorised in the mid 1930s, cost over £50 million (Hough, 1979, p78). This represented well over 1% of the GDP at current prices of the UK in 1935 which was £4.56 billion (Bank of England, 2017). Thus each ship cost over 0.2% of GDP. By contrast the US navy's latest and controversially expensive nuclear powered aircraft carrier Gerald R. Ford launched in 2013 and completedin 2017 will cost under 0.1% of GDP (cost from Congressional Research Service, 2016, and GDP from World Bank, 2017).
[3] See, for example, chapter 4 of Bell (2014) for a discussion of the financial pressures caused by Inter-war naval expenditure.
[4] Churchill (1948-1955).

pride of the British fleet and its loss was felt deeply by the nation, which is reflected in this extract from the Times, "*The destruction of the battle-cruiser Hood is a heavy calamity. With her 42,000 tons displacement she was the largest and more powerful warship afloat… the loss of this mighty unit makes an acknowledged gap in a fighting line that, especially since the defection of our French ally, has had to be stretched round the globe to the utmost limit of its elasticity*[5]*."* Therefore, the pride and prestige effect would have a negative effect on the market as investor confidence would be impacted.

We study the effect naval sinkings had on the British stock market by examining 43 major naval sinkings of WW2. We do this by grouping our sinkings as British ships, Allied ships, Japanese ships, German ships and Axis ships, to determine the level of effect on investor sentiment. We employ an event study analysis to determine the effect these sinkings had on the British stock market and also employ a robust regression analysis to add robustness to our testing procedures[6]. This paper contributes to the literature in several ways. First, we add to the growing literature on how markets react during wars and extend the literature on WW2 Britain, as well as add to the investor sentiment literature. Second, this is the first paper to thoroughly study the impact of naval sinkings during WW2 on the British stock market. Our results initially show that British sinkings, especially carriers, generate negative market returns, while Axis sinkings generate positive investor returns. However, when we exclude the sinking of the Courageous aircraft carrier from our analysis, we find that British sinkings had little or no impact on the British stock market and therefore we conclude that naval sinkings generated little investor reaction in Britain.

2. War Time and Relevant Literature

In this section we discuss the relevant background related to naval warfare and war events and the previous finance literature relating to our study. At the start of the WW2 naval power had been assessed primarily by the number of battleships possessed by a nation since the British admiralty authorised the construction of the revolutionary HMS Dreadnaught in 1905. This warship was far larger and more advanced than existing ships and rendered all existing

[5] The Times, 26th May 1941.
[6] Similar to Urquhart and Hudson (2016).

battleships obsolete (Lambert 1995). Post Dreadnaught battleships generally had a main armament of eight to twelve big guns which could fire a broadside weighing several tons to a range of well over ten miles. They were also very heavily armoured to the extent that they could potentially survive a number of hits from the guns of opposing battleships. Smaller naval ships were completely unable to match battleships in gun duels and the number of battleships became the primarily measure of a navy's power.

These ships were hugely expensive and demanding to construct and maintain. Even the largest economies struggled to build substantial forces of post dreadnaught battleships. Before the First World War there was a huge and enormously emotive naval arms race between Britain and Germany to construct the most powerful possible battleship fleet. The powers were competing on the number of battleship and also on their size and sophistication. This naval rivalry is often considered a major contributory factor to the war. The cost and difficulty of producing the ships can be gauged by the fact that after almost a decade of extreme rivalry and all-out construction by two of the greatest industrial powers Britain possessed approximately a couple of dozen dreadnaughts and Germany somewhat less. Given the small number of ships involved and their enormous power and expense the loss of any ship was of considerable strategic, economic and moral importance.

Although the battleship played a less than decisive role in the First World War it emerged as still the overwhelming determinant of naval power. After the war all the major powers put in hand major programs for the construction of even larger battleships. These promised to be so ruinously expensive that at the Washington naval treaty of 1922 the powers agreed to severe limits on the size of both their fleets and of the ships within the fleets with capital ships being limited to a maximum weight of 35,000 tons (Bell 2014)[7]. Although there was a flurry of construction just before the Second World War as war appeared inevitable (Britain for example laying down five King George V-class battleships) the major powers entered the war with relatively small fleets of battleships with each ship representing a substantial proportion of its naval might. At the start of the war in Europe in 1939 the British Navy possessed 12 operational Battleships with the 5 mentioned above under construction, three battle cruisers and eight aircraft carriers while the Germans possessed 5 (including 3 of the relative small 'pocket

[7] See also Craft (2000) and Hone (1979) for details of how the Treaty affected political relationships, government expenditure and naval procurement.

battleships') with 2 under construction (Konstam 2009). At the start of the war in the Pacific in 1941 the US possessed 17 battleships and Japan 10 (Ellis 1990).

Between the wars the aircraft carrier started to emerge as a rival to the battleship. Normally of similar size and expense to battleships their offensive power was provided by aircraft as opposed to huge guns. The issue of whether aircraft were of more value than big guns and indeed whether aircraft could sink battleships, which were enormously armoured and bristling with anti-aircraft guns, was hugely controversial between the wars.[8] This dispute was certainly not resolved by the start of WW2 and the largest navies of the UK, US and Japan hedged their bets with substantial forces of aircraft carriers as well as battleships. During the war the battleship was shown to be vulnerable to air attack on many occasions and was considered of secondary importance to the aircraft carrier by the end of the war[9]. The aircraft carrier can be considered to have taken over as the modern capital ship but is so expensive that it is only operated in significant numbers by the US navy. In our analysis of war events we look at both battleships and aircraft carriers both because both classes of ship were important and in an effort to determine whether the market was informed about the greater military value of aircraft carriers.

When war broke out in 1939 the British could feel fairly assured in their naval domination in the European theatre. They had a considerable ascendency over Germany in terms of capital ships that were likely to be unassailable in the foreseeable future given the length of time it took to construct such ships. In addition, it was confidently expected that the U-boat (submarine) menace had been largely mastered by technological advances (Bell, 2014, p149). In addition, the navy of their French ally was substantial. However, it soon became clear that the U-boat threat was still very formidable with the early sinking of the Courageous, which was an important aircraft carrier actually engaged in hunting U-boats (Bell, 2014, p149).

The naval situation changed very much for the worse in June 1940 when France surrendered and Italy, which possessed a powerful fleet, entered the war on the axis side. These events made the Mediterranean a highly contested area where the British had to deploy substantial naval forces which, on paper as least, were potentially outmatched by the Italian forces which

[8] See, for example, Hough (1979), Campell (1964) and Hone (1977)

[9] See, for example, Pearlman (2010), Van Tol (1997), Baer (1991) for discussions of the rise in importance of the aircraft carrier.

possessed a strong force of modern battleships (Bell 2014). One aspect of the surrender of France created particular naval difficulties in that its fleet remained in existence and some its most powerful elements were under the control of the Vichy regime. This posed a grave threat in that if they came under German control they could turn the naval balance of power against Britain. This threat was disarmed in the most decisive and ruthless way when the British fleet attacked the French fleet in harbour at Mers-el-Kebir on 3 July 1940 and sank two French battleships and damaged a number of other ships. This action greatly impressed world opinion in a way beyond purely naval matters in that it indicated the British determination to pursue the war to its fullest extent (Gilbert 1989).

In the Mediterranean the Italian navy was very cautiously handled and proved rather ineffective despite its formidable force of capital ships (Ellis 1990). The British gained a decisive advantage when aircraft from the aircraft carrier Illustrious attacked the Italian fleet in the harbour at Taranto on 11 November 1940 and put most of their battleships out of action (Gilbert 1989).

A very dramatic series of events happened in the North Atlantic in May 1941 when the German battleship, Bismarck, perhaps the most powerful battleship in the world at the time, made a sortie aimed at hunting merchant ships.[10] It was intercepted by British ships and quickly destroyed the battlecruiser HMS Hood, the largest and most famous ship in the Royal Navy, and a greater blow to moral could hardly be imagined.[11] A huge naval hunt ensued as the British gave absolute priority to extracting revenge. After a long chase involving many ships and a number of damaging attacks by carrier aircraft, the Bismarck was finally cornered and sunk by British battleships boosting British moral and impacting that of the Germans.[12] After this episode Hitler became much more cautious about the use of capital ships and the serious strategic challenge to the Royal Navy in European waters was effectively ended. For the rest of the European war the British devoted great effects to systematically eliminating the remaining German capital ships (Arnold-Foster 1976).

[10] The final sortie of the Bismarck is covered in detail in Kennedy (1991).
[11] See Kennedy (1991) for a discussion of the fame and prestige of the Hood.
[12] At the news of the sinking of the Bismark it was recorded that in Berlin ‘Mood very dejected’ and ‘Further melancholy beyond words’, Gilbert (1989).

The war in the Far East started with a surprise attack on the American fleet at Pearl Harbour by aircraft from Japanese aircraft carriers. This put most of the US battleships in the theatre out of action giving the Japanese fleet temporary ascendency in the Pacific. By coincidence, the American aircraft carriers were at sea at the time of the attack and were undamaged (Keegan 1990). This proved highly significant in the future as carriers proved more important than battleships in the Pacific. Shortly after Pearl Harbour the British battleship Prince of Wales and battlecruiser Repulse were sunk off the coast of Malaya by Japanese land based aircraft. This was considered a huge shock as it was the first time battleships had been sunk by aircraft whilst at battle stations at sea, something many naval traditionalists had considered impossible[13]. Subsequently the British had to adopt a very defensive naval stance in the Far East until almost the end of the war contenting themselves with protecting vital communication routes in the Indian Ocean (Bell 2014).

In the Pacific the American's were on the defensive strategically until they won a huge and unexpected victory against the odds in the battle of Midway in early June 1942 sinking four Japanese aircraft carriers for the loss of one of their own. After this the Americans were able to use their greater industry power to gradually gain the strategic ascendency. After a hard fought campaign around Guadalcanal they were able to apply their power decisively in two major battles in 1944, the Battle of the Philippine Sea in June 1944 and the Battle of Leyte Gulf in October 1944 which were both very destructive of Japanese capital ships (Arnold-Foster 1976). After the later battle the Japanese were unable to mount a strategic naval challenge and their remaining capital ships could be eliminated by the application of overwhelmingly superior force (Ellis 1990).

There is a substantial and growing literature on the connections between financial markets and wars (see Ferguson, 2008, for a good historical overview of the area). Snyder (1990) shows that if stock prices are determined by flows of expected returns from some real assets and war events have a significant effect on these expected returns, then in a rational framework these events will be recorded in prices The British stock market had long been one of the most important and developed world markets with a robust 'microstructure' for pricing and trading stocks (see Neal and Davis, 2006). Unlike in World War One when the market closed for an

[13] The sinking of Prince of Wales and Repulse and the associated historical debate is covered in detail in Hough (1979).

extended period from 18 Nov 1914 to 4 Jan 1915 (Ferguson, 2008) the British stock market remained open and unaffected by direct government regulation throughout the war (Urquhart and Hudson 2016). Quite a lot of markets were constrained in the wartime UK with rationing and/or price controls on many commodities. The stock market did remain upon throughout the war (unlike in World War One) and there were no legal constraints on price movements. Thus, price discovery was able to take place with prices moving to reflect economic reality and a number of previous academic studies have used this property as outlined in the literature discussed below. Although our data set has no information about trading volume, we can study the volatility of the market before and during WW2 to proxy for liquidity in the market. As seen in Table 2, the standard deviation of returns before WW2 was 0.0080, while during WW2 was 0.0059 which is fall of 26%. However, in the period after WW2, the standard deviation of returns is 0.005407 suggesting a similar level of volatility in the market during the war and after the war.

Chappell and Eldridge (2000) examine the weak-form efficiency of the British stock market by examining the FT30 index during World War Two using unit root testing and the BDS test and find that the market was not efficient while Frey and Kucher (2001) find that the changes in the national sovereignty of European countries during WW2 influenced the bond prices of the countries involved. Similarly, Frey and Kucher (2004) analyse government bonds prices of Germany and Austria traded on the Swiss course during WW2 and show that many war events considered crucial by historians are clearly reflected in government bond prices. However, some events are not reflected in bond prices, such as Germany's capitulation in 1945. Brown and Burdekin (2002) study price series of German bonds which were traded on the London Stock Exchange around the Second World War and find major turning points and trends which are related to war events and the associated political risks. Oosterlinck (2003) studies French bond prices during WW2 and show that they reflect key political and military events. Frey and Waldenström (2004) investigate sovereign debt prices on the Zurich and Stockholm stock exchanges and find that markets appear to work efficiently in that they respond appropriately to turning points in the war, while Occhino et al (2008) assess the welfare costs of the policies that managed payments to Germany during their occupation of France and find that the occupation payments required a severe cut in consumption. Choudhry (2010) shows that many major, historic, wartime events resulted in structural breaks in US stock price

movements and volatility, while Le Bris (2012) studies the effects of World War II upon the French stock market and shows that it led to a significant destruction of market values in real terms although strong financial repression led to a surprisingly short-lived rise of prices until 1943. Hudson and Urquhart (2015) study the major events of WW2 on the British stock market and find only a limited link between war events and market returns although stock returns react more strongly to negative events than positive events, while Urquhart and Hudson (2016) investigate the bombing of the UK during the Blitz period of World War II and find evidence of the existence of a sentiment effect and the local bias hypothesis.

It has long been recognised that the mood, feelings and emotions of investors, broadly termed 'investor sentiment' plays an important role in their decision making and forming judgements. The literature on investor sentiment has shown a diverse range of factors have an important role in investors' decision making. Factors that have been shown to affect stock market sentiment include, for example the amount of daylight (Kamstra et al 2000); levels of sunshine (Hirshleifer and Shumway 2003); temperature (Cao and Wei 2005); and the outcome of sports events (Edmans et al 2007). Much of the literature of sentiment has concerned itself with modest and recurring events such as those examined in the studies outlined above however recently; there has been more research into the influence of more extreme and unpredictable events. Examples of such events include aviation accidents (Kaplanski and Levy 2010) and natural disasters (see for instance Worthington and Valadkhani 2004; Shan and Gong 2012; Ramiah 2013). Some of the most extreme and unpredictable events are related to human conflict and studies of these events are very relevant to our current research.

3. Methodology

In this Section, we explain the methodology adopted in this study to examine the effect of major naval sinkings on British stock returns during WW2.

Initially, we examine the next day return on days following a capital ship sinking to determine their impact on the British stock market as represented by the FT30 index. To further examine the impact of these sinkings on the FT30, we utilise an event study to calculate the abnormal returns on subsequent days after each sinking. Since we are examining an index (the FT30), we utilise the mean-adjusted-returns approach of Brown and Warner (1980) such that;

$$AR_t = R_t - \bar{R} \quad (1)$$

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 (-61; -11)[14] estimation period so that;

$$\bar{R} = \frac{1}{50} \sum_{t=-61}^{-11} R_t \quad (2)$$

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;

$$CAR_t = \sum_{t=T_1}^{T_2} AR_t \quad (3)$$

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. 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 non-normality, which is found in Table 1 for the FT30 data.

Similarly to Urquhart and Hudson (2016), we further our analysis by conducting a regression analysis on the FT30 returns to study how the market reacted following the sinkings of capital ships during WW2. One issue with using regression analysis is that well known seasonal anomalies[15] may be found in stock market data and could skew our results, as evidenced by

[14] Other windows were examined and although quantitatively the results differ slightly, qualitatively they are the same.
[15] For a thorough literature review of seasonal anomalies, see Urquhart and McGroarty (2014).

Zhang and Jacobsen (2013) in the UK. 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 explicitly 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. We employ the most studied and well-known seasonal anomalies; the Monday effect, the January effect, the turn-of-the-month 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, as seen in Table 1. Therefore we use a GARCH(1,1) model to examine the seasonality in our returns. Therefore, we examine whether the seasonal effects are present in our data through a GARCH(1,1) regression such that;

$$\begin{aligned} r_t &= \gamma_0 + \beta . D_{1it} + \varepsilon_t \\ h_t &= c + \alpha_1 . \varepsilon_{t-1}^2 + \alpha_2 . h_{t-1} \end{aligned} \tag{4}$$

Where r_t is the return on the FT30 on day t, γ_0 is the regression intercept, D_{1it} is a dummy variable for the seasonal effect examined, h_t and h_{t-1} are the conditional variance of stock returns at time *t* and *t-1 and εt* and ε_{t-1} are the error terms at time *t* and *t-1* . If the seasonalities are found to be statistically significant at the 5% level, they are included in the proceeding regression analysis. However if the seasonalities are found to be insignificant, we exclude them from our analysis. Therefore we estimate the following equation[16];

$$\begin{aligned} r_t = \alpha + \sum_{i=1}^{5} \gamma_{1i}\, r_{t-i} + \vartheta_i Mon_{it} + \rho_i J_{it} + \mu TOTM_{it} + \sum_{i=3}^{3} \sigma British\ Sinking_{i,t} + \varepsilon_t \\ h_t = c + \delta \varepsilon_{t-1}^2 + \beta h_{t-1} \end{aligned} \tag{5}$$

Where r_t is the return on the FT30 on day *t*, γ_0 is the regression intercept, r_{t-i} 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. $British\ Sinking_{i,t}$ is the dummy variable for a British sinking 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.

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

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 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;

$$r_t = \gamma_0 + \beta . D_{1it} + \kappa h_t + \varepsilon_t \qquad (6)$$

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. We also consider two more commonly used alternative GARCH models, namely the GJR model. The GJR model of Glosten et al (1993) considers that shocks with opposite signs may impact volatility to a different extent and so product terms are added to the variance equation such that;

$$\begin{aligned} h_t &= c + \alpha . \varepsilon_{t-1}^2 + \beta . h_{t-1} + \lambda \varepsilon_{t-1}^2 I_{t-1} \\ \text{where } I_{t-1} &= 1 \; if \; \varepsilon_{t-1}^2 < 0 \\ &= 0 \; otherwise \end{aligned} \qquad (7)$$

If $\lambda > 0$, negative (positive) shocks have a larger impact on the conditional variance than positive (negative) shocks of the same magnitude.

To determine the superior model to employ, we study the R^2, adjusted R^2, AIC and SBIC statistics which all evaluate the appropriateness of our models. The model with the highest R^2 and adjusted R^2, along with the smallest AIC and SBIC statistics, is chosen as the superior model[17]. Therefore, we let the data select the superior and most appropriate model.

4. Data Sources and Description

[17] In each case, all four model evaluators come to the same conclusion of the superior model.

The main stock data used in this study is from the Financial Times 30 index (FT30) from 3rd January 1939 to 2nd September 1945 and is obtained from the Financial Times. The FTSE is similar to the Dow Jones Industrial Average in that it is constructed to capture the range of essence of UK companies to act as a broad measure of market performance. The companies listed in the index are made up of those in the industrial and commercial sectors, and used to exclude the financial sector. The index itself was the precursor to the FTSE100 and was the leading index of its time. The FT30 start date is chosen as this is the date used in the literature by Choudhry (2010) since 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. The end date is 2nd September 1945 as this was when the war was generally considered to have finished as it was when Japan officially surrendered to the Allied forces. Additional data about the returns of the stocks of companies supplying the ship was obtained from the contemporary stock market pages of the London Times newspaper.

Stock returns are calculated the following way;

$$r_t = [In(P_t) - In(P_{t-1})] \tag{9}$$

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

To gauge an overview of how the returns during the war compare to non-war returns, descriptive statistic during WW2 with periods before and after it are compared in Table 1 while Figure 1 and Figure 2 present the prices and log returns over the war period of the FT30.

[Please insert Figures 1 & 2 here]

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 and is compared to the following seven years, the previous four years and the full data period 1935-2009. This study does not have access to data pre-1935 so the pre-war sample period is just four years. Table 1 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 in Britain 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 WW2 (Harrison 1998). The skewness and kurtosis statistics for each subsample show that the frequency distribution of the returns is not normal. 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. 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. The p-values 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 WW2 period for the FT30 generated higher returns than periods before and after it and the full sample, but as with most financial time series data, the returns series is not normal.

[Please insert Table 1 here]

Table 2 presents the capital ships sunk during WW2 that are examined and it is a comprehensive list of the major ships sunk during WW2, which are taken from Heden (2006) and Stephens (1983). The definition of a capital ship is generally not very controversial. We take it to be warships over the 10,000 ton limit imposed on the size of cruisers in the Washington naval treaty of 1922. British ships, including aircraft carriers (CV) and battleships and battlecruisers (BB) are examined as well as Axis ships and allied ships sunk to determine whether the nationality of the ships is significant. Axis ships include German, Italian, Japanese and Vichy French ships while allied ships consist of British and US vessels. When an event occurs on a non-trading day, the next trading is taken as the day the event took place, with the next two trading days being the day after the event and two days after the event. The Barham BB sinking on 25th November 1941 was kept a secret from the mass media until 27th January 1942 when the admiralty informed the press. This was due to the fact that the Germans didn't realise they had sunk the ship and the British admiralty decided to keep it a secret. Therefore we use the 27th January 1942 for this sinking.[18]

[18] The British government did manipulate the mass media during WWII but the major sinkings chosen in our study were too important and large to be suppressed and many of them were reported in the London Times on the following day. For more information about the government agencies that managed the information during wartime Britain, see Jeffery,'MI6' for information on MI6 and Andrews, 'History of MI5' for information on MI5.

[Please insert Table 2 here]

5. Empirical Results

Table 3 presents the descriptive statistics of the next day returns on the days following a naval ship sinking. We can see that the mean return after a British sinking is negative, as is the case following British CV sinkings. However, the mean return after a British BB sinking is positive, suggesting that British CV sinkings had a negative impact on the FT30, while British BB sinkings had little or no impact. When we collate all the British sinkings and US sinkings, we find the mean return is also negative, but not as strong as for all British sinkings indicating that US sinkings had less impact on the FT30. German sinkings however, are shown to generate a positive mean return on the FT30, while Japanese sinkings generate a negative mean return. This suggests that German sinkings were of more importance than Japanese sinkings to the British markets at the time which is in line with both the local bias hypothesis and the supposition that events in the Pacific were of less direct strategic importance to Britain than those in European and Atlantic waters. All Axis sinkings together generate a positive next day return, which is due to the substantial size of the effect of the German sinkings compared to the Japanese sinkings ones.

[Please insert Table 3 here]

To examine our results in more detail, Table 4 reports the CAAR and the Corrado statistic following naval ships sinkings. The results show that the CAARs 1-day and 2-days after a British sinking are negative and insignificant indicating the negative 1-day and 2-day effect of British sinkings. The Corrado statistic however indicates a negative 1-day reaction, but positive reaction 2-days after a British sinking. The 5-day CAAR and Corrado statistics after a British sinking are positive, suggesting that the effect of a British sinking was short-lived. The British CV sinkings support these findings, but also show a negative CAAR 5-days after a sinking. However similar to what was found in Table 2, British BB sinkings had little or no impact on the FT30, with all the CAARs following a British BB sinking positive. The Allied sinkings show no negative reaction following a sinking, indicating that US sinkings had little or no impact on the FT30. The German sinkings however generate a positive reaction, with the CAARs 1-day, 2-day and 5-days all positive, albeit insignificant indicating that German

sinkings had a positive impact on the FT30. Japanese sinkings however show negative CAARs on subsequent days, suggesting that Japanese sinkings had little or no impact on the FT30. Finally if we collate all Axis sinkings, we find that they generate a significant positive 1-day CAAR, and an insignificant positive 2-day CAAR suggesting the positive impact Axis sinkings had on the FT30. Therefore our analysis suggests that British sinkings had a negative, short-lived impact on the FT30, which is driven by the British CV sinkings since British BB sinkings had little or no impact on the FT30. German sinkings had a positive impact on the FT30, while all Axis sinkings had a positive effect on the FT30.

[Please insert Table 4 here]

Table 6 reports the regression analysis, but initially we examine the presence of seasonalities and serial correlation in our data in Table 5. We find statistically significant serial correlation at lag 1, lag 2 and lag 3, while we also find significant evidence of the TOTM, thus these variables are included in our regression analysis. We report only the results for the superior regression model to conserve space, including the diagnostics.[19] The results show that different regression models are superior for different groups of sinkings, thus supporting our procedure of letting the data decide the appropriate model. The British sinking results show an initial 1-day negative reaction, while the 2-day reaction is positive and the 3-day reaction is positive and statistically significant. The British CV sinkings show a 1-day and 2-day negative reaction, with the 1-day coefficient statistically significant indicating the strong negative reaction of the FT30 after a British CV sinking. The British CV 3-day reaction is positive and statistically significant, similar to the British sinkings, indicating that the market reaction was short-lived. The British BB sinkings show a positive reaction, supporting our earlier analysis and indicating no sentiment in the FT30 in response to British battleship sinkings. The Allied sinkings show a 1-day negative reaction, while German, Japanese and Axis sinkings show a 1-day positive reaction, indicating the short-term investor reaction to these sinkings. However the German, Japanese and Axis sinkings sentiment appears to be short-lived, since the 2-days following these sinkings generates a positive coefficient. [20]

[Please insert Tables 5 & 6 here]

[19] All regression models are available upon request.
[20] The coefficient is statistically significant for Japanese and Axis sinkings.

So far, our analysis has grouped the sinkings of WW2 into categories to determine how the nationality of the sinkings affected the British stock market. To examine this more closely, we examine the next day return after each sinking as well as use a t-test to study if the next day returns is statistically different to the other returns. In Table 7, we can see that the Courageous CV sinking generated the largest absolute next day return and this one event may be driving our previous results that the sinking of British ships caused negative investor sentiment, especially British CVs. Also, the Courageous CV next day return is the only statistically significant British sinking indicating its importance. We also find that the returns after the sinking of the Vichy French vessels and the Amagi CV are statistically significant.

There are a number of reasons why some individual sinkings were of particular significance and might have affected the stock market accordingly. In the case of the Courageous, it was very soon after the declaration of war and was a severe blow to the hopes of those who believed a rapid negotiated settlement might still be possible. It also had considerable military significance from both strategic and tactical viewpoints. It showed that U-boats, which had almost caused Britain's defeat in World War I, were still a major threat. This sinking clearly indicated that the confident belief in the Royal Naval that technical advances such as the development of Asdic (Sonar) had largely nullified the effectiveness of U-boats was mistaken.[21] It also showed that the tactic of using large aircraft carriers to hunt U-boats was untenable as the risks to these vital ships far outweighed any potential gains. Finally, it was unquestionably a major blow to British moral and a boost to that of the Germans. Admiral Donitz, the head of the German navy noted in his diary that it was 'a glorious success'(Gilbert 1989). It is possible that particular sinkings might coincide with other important war events which might have influenced the market so we have checked for such events. The sinking of the Courageous coincided with the army of the USSR starting to occupy the Eastern part of Poland whilst the Polish army struggled with German forces. This was unlikely to be seen as a positive development but was not an event of the first order of strategic importance to the UK given that Poland was already clearly defeated and the Nazi-Soviet pact was common knowledge Gilbert 1989).

[21] For a discussion of the Admiralty's optimistic pre-war evaluation of the U-boat threat see P149 (Bell, 2014).

The sinking of the Vichy French vessels was strategically important in that it ensured that Germany could not challenge British naval supremacy by seizing control of the ships. The British action also acted as a very strong signal of their determination to continue the war. There were no other war events of comparable significance coinciding with these sinkings.

There is a significant negative next day return after the sinking of the Amagi CV on the 28th July 1945. This return is of the wrong sign to be attributable to the sinking. This particular movement is likely to be due to the Japanese response to the Potsdam declaration on 26th July 1945 calling for the unconditional surrender of Japan and threatening that if Japan did not surrender, it would face "prompt and utter destruction".[22] The Japanese official response was that of "mokusatsu" meaning "to kill with silence". This led to a swift decision by the Allied forces to carry out the threat of destruction in the manner of the atomic bombs on Hiroshima bombing on 6th August 1945 and Nagasaki on 9th August 1945. Therefore, the significant negative next day return after the Amagi CV can be plausibly attributed to political issues leading to the perceived likely continuation of the war.

We undertake several further analyses to add robustness to our results. Initially, we re-run our analysis but exclude the Courageous CV sinking from our data given the very large size of the subsequent price move. The results are reported in Table 8 where we find that British sinkings now generate a positive next day mean return, as does British CV sinkings. This demonstrates the impact that the Courageous CV sinking was having on our results. We find the same story in our event study statistics, where the CAAR and Corrado statistics on days following a British sinking are now positive and in some instances, statistically significant. The regression analysis reported in Panel C of Table 8 also support this finding, with British sinkings generating positive coefficients on days following a sinking. Therefore, our results suggest that the sinking of the Courageous CV is driving our results and if we exclude this sinking from our analysis, we find little evidence of reaction in the British stock market from British naval disasters.

[Please insert Tables 7 & 8 here]

[22] Potsdam Declaration: Proclamation Defining Terms for Japanese Surrender Issued, at Potsdam, 26th July 1945. National Science Digital Library.

Another robustness check is to exclude sinkings which coincide with other important events in the war, in particular, the Pearl Harbour bombings for the Allied forces and the sinking of the Amagi for the Axis forces. These two events both coincide with the US entering the war and important negotiations at the end of the war respectively. Therefore, in Table 9 we report the results of our analysis having removed these events and show that the qualitative results remain consistent with our previous findings.

[Please insert Table 9 here]

Another robustness check considers the net effect of major battles as opposed to focusing on individual sinkings. It is certainly possible that overall effect of major battles may not be entirely captured by the number of capital ships sunk on each side. For example, Midway was a huge US victory even though a US capital ship was sunk. We incorporate a measure for the outcome of an overall battle by considering the net loss of ships in the battle. We replace the individual losses in battle situations by a single net loss reflecting the outcome of the entire battle. There were actually few major pitched battles in the war and none in European waters. The Battle of the Coral Sea had one US and one Japanese sinking and therefore the net loss for each at this battle was zero. The Battle of Midway and the Battle of Leyte Gulf both resulted in substantial net losses for Japan. After making these adjustments we repeat our regression analysis and report the results in Table 10. We find that our results are qualitatively similar to our previous results.

[Please insert Table 10 here]

Response of Suppliers

An interesting question is to consider how the relevant companies supplying these vessels, as opposed to the whole market, responded to the events we are considering[23]. Potentially the business and earnings of these companies might be affected quite directly by the sinkings although the relationship may not be entirely straightforward and simple as we discuss below.

[23] We would like to thank an anonymous reviewer for this suggestion.

The theoretically expected outcome on the suppliers of a sinking involves a number of complex and interrelated factors. In the broadest terms the navy (Admiralty) aimed to match or exceed the overall capabilities of potential or actual enemies and put forward procurement plans based on this objective. The government would then modify these plans in the light of cost and competing demands from other services (see Bell, 2014, for good overview of this process through the first half of the twentieth century). Ceteris paribus, one can hypothesise that if a British or allied ship was sunk it would alter the balance of power against the UK and tend to make future construction orders more likely. Conversely, if an enemy ship was sunk it would make future orders less likely. The manner of sinking might also have an effect on procurement plans as it would give information about the relative effectiveness of various types of ships and weapon systems. To give an obvious example, the sinking of the Prince of Wales and Repulse battleships by Japanese aircraft would likely not bode well for future battleship orders. In summary, the effect of a sinking on a supplier would need to alter the overall procurement plans approved by the government to the extent that it would change the future profitability of that supplier.

There are a number of other factors to consider. Firstly, it should be pointed out that the sinking of a particular ship would be unlikely to have any implications for the perceptions of the design and construction abilities of any particular shipbuilder. Capital ship designs were determined by naval requirements and then construction to tight specifications was allocated to appropriate shipbuilders. For example, for the last full class of UK battleships completed, the King George V class of 5 ships, each ship was built to the same design in a different yard by a different company. Secondly, the lead times for approving and building capital ships were very long, of the order of years at best. Thus, plans could not be altered quickly in response to war events. Thirdly, for most of the war UK shipbuilders were operating at absolutely full capacity so there was no question of spare capacity being utilised profitably in response to war events. What was feasible was for the priority given to different orders to be changed. In this respect, the priority given to new capital ships, particularly battleships, was quite low throughout the war. Churchill insisted that priority was given to craft that could be completed quickly whether small craft or any capital ships that were well advanced in their construction such as the King George V class (Bell, p220). In March 1941, work on two Lion class battleships was suspended and work on two others cancelled. Ultimately, none of the Lion class battleships were ever finished as it became clear that they would not prove necessary in the war. Aircraft carriers were given more priority. Two large carriers HMS Implacable and HMS Indefatigable which were laid

down in 1939 were completed in 1944 although out of 3 large carriers which were laid down in mid-war two were not completed until the mid 1950s and one was cancelled. In addition, no less than 16 light carriers, which were not generally considered capital ships, were laid down although not all were completed during the war.

Given the forgoing considerations it is not entirely theoretically clear what would be the expected effect of a capital ship sinking on the share price of a particular supplier so this is best resolved empirically. Only a fairly restricted number of companies were capable of supplying capital ships. All UK capital ships built or planned after the 1930s were associated (built or partially built and left uncompleted) with one of the following companies: Swan Hunter and Wigham Richardson (Tyneside yard), John Brown and Company (Clydeside yard), Fairfield Shipbuilding and Engineering Company (Clydeside yard), Vickers-Armstrong (Tyneside and Barrow yards), Cammell Laird (Birkenhead yard) and Harland and Wolff (Belfast yard). Appendix 1 shows where particular ships were constructed. It is unlikely that any other companies would have had the capacity or expertise to build such ships. Four of the associated parent firms were quoted on the London Stock Exchange throughout our period of interest: Cammell Laird, Swann Hunter, Vickers Armstrong and John Brown and so can provide relevant data for our study[24] (see Murphy, 2013, for a discussion of the structure of the industry). Thus we can find empirical data for a very substantial part of the UK shipbuilding industry.

Table 11 has been constructed in a similar manner to Table 7 except that instead of using index returns to give a measure of the returns for the whole marker the returns used are the arithmetic average of the returns of the four shipbuilding firms mentioned above. In general, the pattern of returns are quite similar to those shown by the overall market. There is a correlation of 79% between the two sets of returns. Thus, broadly speaking, the shipbuilding companies do not react very differently from the overall market. In terms, of which individual returns are significant the two tables again give similar results with the sinking of the French battleships on 3 July 1940 no longer being significant and the sinking of the Italian battleships on 11 Nov 1940 becoming significant.

[24] Harland and Wolff had a complex capital structure with more than one class of share some of which were quoted for part of the war but we have not considered these as they are not compatible with the other companies.

If we examine particular aspects of the table we can find evidence about the way that these companies are affected by events. Given the hypothesis that ship orders and company profitability are driven by considerations of keeping an appropriate balance of power in Capital ships one would expect that the sinking of a British ship would be good for the share price of shipbuilders whereas the sinking of the ship of an opposing nation would be bad for the share prices. In fact, the evidence is very strongly against this. After the ten days when British ships were sunk, the shares of the shipbuilders only rose in two instances. After the eight days when British ships sunk enemy ships the market never fell.

Overall, the evidence shows that to a large extent the shares in shipbuilding companies reacted to sinkings in a similar way to the market in general rather than being influenced by their own particular circumstances.

Comparison with the situation in World War One

We have briefly extended our analysis to consider the situation in World War One when the role of the battleship was clearer and more dominant as air power was not yet a significant factor in naval warfare. Appendix 2 shows the capital ships sunk in World War One and when the sinkings were reported in the UK press as determined by a careful search of the records of the London Times. The data reveals that many fewer capital ships were sunk in World War One, despite the UK and German navies being considerable larger. More problematically for our study much of the news was reported with a considerable delay or in some cases not reported in the press at all. This was probably partly a product of slower and more uncertain communications and partly due to news suppression for propaganda purposes. Additionally, in this period, prior to the creation of the FT30, there was no recognised index to measure the overall performance of the market. Given this it is not practical to repeat the empirical analysis that we have undertaken for World War Two.

Nonetheless, some interesting qualitative points can be made regarding the Battle of Jutland which was the major sea battle of the war where the main British and German fleets clashed in the North Sea. This was reported relatively quickly in the press perhaps being too large an event to suppress. The main action was on the afternoon of 31 May 1916 with the first news in the papers appearing on the morning of 3 June after a statement by the British Admiralty at 7pm on Friday 2 June some hours after a German communique. Both sides released quite accurate news of their own losses although the British statement was rather over optimistic

about the damage they had inflicted. This news was clearly considered very important and given the substantial losses confirmed by the British gave rise to some rather concerned articles in the Times. Quite quickly some commentators were pointing out, however, that the strategic position was unchanged in that the larger British navy still commanded the sea and the tactical reverse had not been sufficient to change this.

Given the main news was only released late on Friday evening the first full day of trading was Monday 5 June with market reports in the newspaper on the 6 June. The situation was summarised as follows: 'The later and more favourable accounts of the naval battle enabled the City to throw off completely yesterday any feeling of depression which was engendered by the first Admiralty accounts published on Saturday. Stock markets were quite firm in tone, and the account of business transacted was practically the same as was effected on Monday last week.' (Times, 6 June, 1916, p14). Interestingly, for our research objectives, Vickers and John Brown both closed higher.

In terms of our findings from World War One the data is not extensive enough to draw definite statistically significant conclusions but the evidence from the Battle of Jutland is in accordance with the market being more influenced by the long term strategic situation than by short term tactical effects based on numerical losses and gains of ships.

6. Conclusions and Summary

World War Two (WW2) was a major war that affected the majority of the developed world and naval warfare was a major component of the conflict. Naval capital ships were the primary determinants of maritime control during the war. In addition, the ships were held in very high esteem due to their small number, large cost, the years they took to build and were an embodiment of the power and technological advancement of competing nations.

The aim of this paper was to examine the effect major naval sinkings had on the British stock market and whether British and Axis sinkings caused significant movements in the FT30. The initial results show that the mean next day return after a British sinking is negative, which is attributed to the British aircraft carriers (CV) rather than British battleships (BB). Allied losses taken overall also result in negative next day returns although we can deduce that US losses

are less influential. We also find that German sinkings generate a positive next day return. Axis losses taken overall generate a positive next day return although Japanese sinkings generate a small negative next day return. This our initial results are broadly supportive of the sinkings having the expected effects on the market, aircraft carriers being perceived as more important than battleships and the European theatre being more important than the Pacific.

To examine our results in more detail, we run an event study and show that British sinkings had a negative but short-lived impact on the FT30 which is driven by British CV sinkings since British BB sinkings have little or no impact on the FT30. German sinkings generate positive cumulative abnormal returns. The regression analysis support these results with British sinkings documented a short-term negative impact on the FT30, with British CV generating a significant negative effect. However, when we examine our data in more detail, we find that the sinking of the Courageous CV is driving our overall results regarding British sinkings and once removed, British sinkings had no negative impact on the FT30.

The market was generally not affected by most of the individual disasters or successes, no matter how emotive, giving little support to the presence of sentiment effects. In addition, individual events in the Pacific Theatre had little influence on the market indicating elements of local bias. These results reject our hypothesis that these extreme events should cause some investor sentiment given that many economically unimportant factors have been found to have investor sentiment. This is contrary to the much of the literature that finds disaster events have a negative impact on stock returns, and especially to the study by Kaplanski and Levy (2010) who found a strong degree of investor sentiment associated with unpredictable airplane crashes. This is puzzling in that these naval sinkings are clearly documented to have damaged national pride, caused many deaths and the loss of extremely valuable property and additionally had potentially important strategic consequences. In overall terms capital ship losses were very much more important than individual airplane crashes. Given this the recent literature on the effects of disasters on investor sentiment might need to be reassessed to incorporate a more nuanced view of when these effects are likely to occur.

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Tables

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

Period	Mean	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Obs
1935 - 1938	-0.000245	0.080773	-0.055534	0.008006	0.470900***	21.44520***	12649.58***	890
World War Two	0.000201	0.039688	-0.048412	0.005984	-1.225708***	17.55409***	15466.00***	1704
1946 - 1952	0.000009	0.041925	-0.037166	0.005407	-0.739001***	11.02905***	4946.223***	1780
1935-2009	0.000154	0.107810	-0.124000	0.010581	-0.19629***	12.69284***	75169.29***	19155

Table 2: The major naval disasters studied in this paper. The first column denotes the ship sunk, while the second column reports the nationality. The third column present the date the ship was sunk while the fourth gives a brief description of circumstances of the sinking.

Ship (BB – Battleship; CV Carrier)	Nationality	Sunk Date	Comments
Courageous CV	British	17 Sept 1939	Sunk by U-29 boat near UK, 519 deaths.
Royal Oak BB	British	14 Oct 1939	Sunk at anchor in Scapa Flow by U-47 with the loss of 833 lives.
Graf Spee, Pocket BB (approx 15,000 tons)	German	17 Dec 1939	Scuttled after Battle of River Plate in South America
Glorious CV	British	8 June 1940	Sunk by Scharnhorst and Gneisenau off Norway over 1,200 dead
Provence BB, Bretagne BB	French	3 July 1940	British attacks on Oran and Mers-el-Kebir in North Africa to stop French ships falling into German hands. 1,300 lives lost.
Conte di Cavour BB, Caio Duilio BB, Andrea Doria BB, Littorio BB	Italian	11 Nov 1940	Conte di Cavour BB was sunk by Royal Navy aircraft in Taranto Harbour in Italy The other ships did not fully sink in the shallow harbour and some were repaired
Hood BB	British	24 May 1941	Sunk by Bismark in North Atlantic with only 3 men escaping from crew of 1,419.
Bismarck BB	German	27 May 1941	Sunk by Royal Navy in North Atlantic with only 110 survivors out of a crew of over 2,200.
Ark Royal CV	British	14 Nov 1941	Sunk by U-81 boat near Gibraltar
Barham BB	British	25 Nov 1941	Sunk by U-331 boat in Med. With 862 deaths. The Germans didn't initially realise they had sunk it. Sinking kept secret until 27 January 1942 when admiralty informed the press.
Arizona BB, Oklahoma BB, West Virginia BB, California BB, Nevada BB, Tennessee BB, Maryland BB	US	7 Dec 1941	Pearl Harbour. All the ships except Arizona and Oklahoma were later repaired and brought back into service. About 2,400 US deaths
Prince of Wales BB, Repulse BB	British	10 Dec 1941	Sunk by Japanese aircraft off Malaya, with 327 deaths on Prince of Wales and 508 deaths on Repulse
Valiant BB, Queen Elizabeth BB	British	19 Dec 1941	Sunk in Alexandria harbour in Egypt by Italian divers on manned torpedoes. Sank in shallow water and repaired within a few months although it was kept secret from the press.
Hermes CV	British	9 April 1942	Japanese planes sunk the Hermes in Indian Ocean
Shoho CV	Japanese	7 May 1942	Sunk at the Battle of Coral Sea
Lexington CV	US	8 May 1942	Sunk at the Battle of Coral Sea
Kaga CV, Soryu CV	Japanese	4 June 1942	Battle of Midway
Akagi CV, Hiryu CV	Japanese	5 June 1942	Battle of Midway - over 2000 casualties on Japanese carriers.
Yorktown CV	US	7 June 1942	Battle of Midway
Eagle CV	British	11 Aug 1942	Sunk by U-73 boat
Ryuyi CV	Japanese	24 Aug 1942	Battle of Eastern Solomans
Wasp CV	US	15 Sept 1942	Hit by submarine torpedo
Hornet CV	US	27 Oct 1942	Dive bombers, torpedo bombers and destroyer torpedos
Hiei BB	Japanese	13 Nov 1942	Aircraft and submarine attacks off Guadalcanal
Kishima BB	Japanese	15 Nov 1942	Naval gunfire off Guadalcanal
Mutsu BB	Japanese	8 June 1943	Accidental explosion – over 1,000 deaths – survivors dispersed to remote outposts to suppress the news.
Roma BB	Italian	9 Sept 1943	Sunk by German guided bombs while proceeding to join allies after Italian surrender
Chuyo Escort Carrier (approx 20,000 tons)$^{+}$	Japanese	4 Dec 1943	Sunk by submarine Sailfish southeast of Honshu, Japan.
Scharnhorst BB	German	26 Dec 1943	Sunk by British surface forces in battle of North Cape. Only 36 men were pulled from the icy seas, out of a crew of 1,968
Shokaku CV, Taiho CV, Hitaka CV	Japanese	19 June 1944	Sunk in the Battle of Philippine Sea by submarines and carrier aircraft
Hiyo CV	Japanese	20 June 1944	Sunk in the Battle of Philippine Sea by carrier aircraft
Otaka Escort Carrier^{+}	Japanese	18 Aug 1944	Sunk by submarine Rasher off the Philippine Islands,
Princeton Light Carrier	US	24 Oct 1944	Aircraft but sunk by own forces at Battle of Leyte Gulf
Musahi BB	Japanese	24 Oct 1944	Aircraft sunk in the Battle of Leyte Gulf with approximately 1,000 deaths

Zuikaku CV, Chitose, Light CV, Chiyoda Light CV, Zuiho Light CV, Fuso BB, Yamashiro BB	Japanese	25 Oct 1944	Sunk in the Battle of Leyte Gulf
Tirpitz BB	German	12 Nov 1944	Sunk by RAF Lancaster bombers Approx. 1,000 deaths.
Kongo BB	Japanese	21 Nov 1944	Sunk by Submarine
Unryu CV	Japanese	19 Dec 1944	Sunk by Submarine
Yamato BB	Japanese	7 Apr 1945	The world's biggest battleship sunk by US aircrafts with the loss of nearly 2,500 lives.
Admiral Scheer, Pocket BB	German	10 Apr 1945	Sunk by RAF
Lutzow Pocket BB	German	16 Apr 1945	Made unfit for sea by RAF attack - later scuttled
Hyuga BB, Ise BB Haruna BB, Kaiyo, Escort Carrier[+]	Japanese	24 July 1945	Sunk by carrier aircraft
Amagi CV	Japanese	28 July 1945	Sunk by carrier aircraft

Table 3: The descriptive statistics of returns during World War Two.

Type	Obs	Max	Min	Std Dev	Mean
British	10	0.016737	-0.047662	0.016819	-0.002360
British CV	5	0.003674	-0.047662	0.022063	-0.008299
British BB	5	0.016737	-0.003785	0.007839	0.003584
Allied	16	0.016737	-0.047662	0.013063	-0.000981
German	6	0.004295	-0.000858	0.001675	0.001392
Japanese	17	0.004994	-0.024824	0.006752	-0.000756
Axis	25	0.029801	-0.024824	0.008258	0.001185

Table 4: The cumulative average abnormal returns of the FT30 following various sinkings, with corresponding p-values in brackets. Allied ships sinking includes British and US ships as well as the Italian ship the Roma BB which was sunk on 9th September 1943 when on its way to join the allied forces. Finally Axis sinkings include German and Japanese ships as well as the French ships sunk on 3rd July 1940 and the Italian ships sunk on 11th November 1940. ***, **, * indicate significance at 1%, 5% and 10% respectively.

	Window	CAAR	Corrado
British	[0; 0]	0.0001	-0.3860
		(0.98)	(0.70)
	[0; 1]	-0.0017	-0.0195
		(0.53)	(0.98)
	[0; 2]	-0.0005	0.3629
		(0.88)	(0.72)
	[0; 5]	0.0039	1.6996*
		(0.40)	(0.09)
CV	[0; 0]	0.0020	0.285
		(0.43)	(0.78)
	[0; 1]	-0.0053	0.1871
		(0.15)	(0.85)
	[0; 2]	-0.0065	0.0078
		(0.15)	(0.99)
	[0; 5]	-0.0018	1.3132
		(0.77)	(0.19)
BB	[0; 0]	-0.0019	-0.9699
		(0.49)	(0.33)
	[0; 1]	0.0019	-0.2694
		(0.62)	(0.79)
	[0; 2]	0.0055	0.5600
		(0.25)	(0.58)
	[0; 5]	0.0096	0.9934
		(0.15)	(0.32)
Allied	[0; 0]	0.0009	0.6835
		(0.46)	(0.49)
	[0; 1]	0.0001	1.3034
		(0.94)	(0.19)
	[0; 2]	0.0007	1.1933
		(0.73)	(0.23)
	[0; 5]	0.0022	1.6487*
		(0.46)	(0.10)
German	[0; 0]	0.0004	0.3956
		(0.81)	(0.69)
	[0; 1]	0.0014	0.7667
		(0.56)	(0.44)
	[0; 2]	0.0007	0.2242
		(0.82)	(0.82)
	[0; 5]	0.0002	-0.3140
		(0.96)	(0.75)
Japanese	[0; 0]	0.0008	0.8571
		(0.28)	(0.39)
	[0; 1]	-0.0002	0.6436
		(0.87)	(0.52)
	[0; 2]	-0.0032***	0.0377
		(0.01)	(0.97)
	[0; 5]	-0.0074***	-1.5796
		(0.00)	(0.11)
Axis	[0; 0]	0.0017**	1.3455
		(0.04)	(0.18)
	[0; 1]	0.0027**	1.5467
		(0.02)	(0.12)
	[0; 2]	0.0012	0.9626
		(0.37)	(0.34)
	[0; 5]	-0.0014	-0.7284
		(0.47)	(0.47)

Table 5: Regression results for calendar anomalies. ***, **, * indicate significance at 1%, 5% and 10% respectively.

Monday Effect	January Effect	TOTM Effect	$Returns^{-1}$	$Returns^{-2}$	$Returns^{-3}$	$Returns^{-4}$	$Returns^{-5}$
-0.000147	0.000232	0.000470***	0.003393***	0.002095***	0.000963***	0.000228	0.000496*

Table 6: Regression results for naval sinkings. The value in parentheses is the corresponding t-statistic. ***, **, * indicate significance at 1%, 5% and 10% respectively.

	British	CV	BBs	Allied	German	Japanese	Axis
Model	OLS	OLS	GARCH-M (1,1)	OLS	GARCH(1,1)	OLS	OLS
α	-0.000056	-0.000031	-0.000248	-0.000040	-0.000038	-0.000014	-0.000037
γ_1	0.003008***	0.003034***	0.003050***	0.003016***	0.003017***	0.003022***	0.003037***
γ_2	0.002198***	0.002193***	0.002263***	0.002188***	0.002187***	0.002216***	0.002207***
γ_3	-0.000495**	-0.000520**	-0.000471	-0.000504**	-0.000504	-0.000545**	-0.000541**
μ	0.000728**	0.000714**	0.000718	0.000718**	0.000717	0.000703**	0.000716**
σ_1	-0.001446	0.007144***	0.004199	-0.000826	0.000777	0.000054	0.001052
σ_2	0.001404	-0.000018	0.002753	0.000567	-0.001184	-0.003478***	-0.002745**
σ_3	0.003537***	0.006404***	0.000646	0.000840	0.001642	0.001656	0.001895
κ	-	-	6.700698***	-	-	-	-
c	-	-	0.000018***	-	0.000019***	-	-
δ	-	-	0.150000***	-	0.150000***	-	-
β	-	-	0.600000***	-	0.600000***	-	-
R^2	0.179776	0.184555	0.179566	0.177574	0.177560	0.180591	0.181323
Adjusted R^2	0.176545	0.181343	0.175870	0.174334	0.174321	0.177363	0.178098
AIC	-7.623467	-7.629311	-7.605475	-7.596193	-7.604742	-7.624461	-7.600762
SBIC	-7.598874	-7.604719	-7.568586	-7.611704	-7.570927	-7.599869	-7.616273

Table 7: The individual sinkings next day FT30 index return

Ship	Nationality	Date	Next Day Return
Courageous CV	British	17 Sept 1939	-0.047662***
Royal Oak BB	British	14 Oct 1939	0.016736
Graf Spee, Pocket BB (approx 15,000 tons)	German	17 Dec 1939	0.001336
Glorious CV	British	8 June 1940	0.000000
Provence BB, Bretagne BB	French	3 July 1940	0.029801***
Conte di Cavour BB, Caio Duilio BB, Andrea Doria, BB, Littorio BB	Italian	11 Nov 1940	0.004295
Hood BB	British	24 May 1941	0.000000
Bismarck BB	German	27 May 1941	0.004295
Ark Royal CV	British	14 Nov 1941	0.002494
Barham BB	British	25 Nov 1941	0.001216
Arizona BB, Oklahoma BB, West Virginia BB, California BB, Nevada BB, Tennessee BB, Maryland BB	US	7 Dec 1941	-0.009685
Prince of Wales BB, Repulse BB	British	10 Dec 1941	0.003752
Valiant BB, Queen Elizabeth BB	British	19 Dec 1941	-0.003785
Hermes CV	British	9 April 1942	0.000000
Shoho CV	Japanese	7 May 1942	-0.001298
Lexington CV	US	8 May 1942	0.002594
Kaga CV, Soryu CV	Japanese	4 June 1942	0.004994
Akagi CV, Hiryu CV	Japanese	5 June 1942	0.003729
Yorktown CV	US	7 June 1942	0.003729
Eagle CV	British	11 Aug 1942	0.003674
Ryuyi CV	Japanese	24 Aug 1942	0.000000
Wasp CV	US	15 Sept 1942	0.002350
Hornet CV	US	27 Oct 1942	0.003335
Hiei BB	Japanese	13 Nov 1942	0.000000
Kishima BB	Japanese	15 Nov 1942	0.000000
Mutsu BB	Japanese	8 June 1943	-0.001010
Roma BB	Italian	9 Sept 1943	0.000948
Chuyo Escort Carrier (approx 20,000 tons)$^{+}$	Japanese	4 Dec 1943	0.001967
Scharnhorst BB	German	26 Dec 1943	0.000971
Shokaku CV, Taiho CV, Hitaka CV	Japanese	19 June 1944	0.001776
Hiyo CV	Japanese	20 June 1944	0.000000
Otaka Escort Carrier	Japanese	18 Aug 1944	-0.007099
Princeton Light Carrier	US	24 Oct 1944	0.003630
Musahi BB	Japanese	24 Oct 1944	0.003630
Zuikaku CV, Chitose, Light CV, Chiyoda Light CV, Zuiho Light CV, Fuso BB, Yamashiro BB	Japanese	25 Oct 1944	0.000905
Tirpitz BB	German	12 Nov 1944	0.000888
Kongo BB	Japanese	21 Nov 1944	0.000000
Unryu CV	Japanese	19 Dec 1944	0.002668
Yamato BB	Japanese	7 Apr 1945	0.001714
Admiral Scheer, Pocket BB	German	10 Apr 1945	-0.000858
Lutzow Pocket BB	German	16 Apr 1945	0.001718
Hyuga BB, Ise BB Haruna BB, Kaiyo, Escort Carrier^{+}	Japanese	24 July 1945	0.000000
Amagi CV	Japanese	28 July 1945	-0.024824**

* Capital ships by the Washington naval treaty definition.

Table 8: Robustness check results with the Courageous CV excluded from the analysis. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively.

Panel A: Descriptive Statistics					
	Obs	Max	Min	Std Dev	Average Return
British	9	0.016737	-0.003785	0.005758	0.002676
British CV	4	0.003674	0.000000	0.001845	0.001542
Panel B: Event Study Statistics					
	Window	CAAR		Corrado	
British	[0; 0]	0.0019		0.1449	
		(0.31)		(0.88)	
	[0; 1]	0.0051		0.7826	
		(0.33)		(0.43)	
	[0; 2]	0.0077**		1.3014	
		(0.02)		(0.19)	
	[0; 5]	0.0117***		2.1976	
		(0.01)		(0.03)	
British CV	[0; 0]	0.0067***		1.0277	
		(0.01)		(0.30)	
	[0; 1]	0.0091***		1.2465	
		(0.01)		(0.21)	
	[0; 2]	0.0105***		1.1997	
		(0.01)		(0.23)	
	[0; 5]	0.0143***		1.9845**	
		(0.00)		(0.05)	
Panel C: Regression Results					
		British		British CV	
Model		GARCH-M(1,1)		OLS	
α		-0.000257		-0.000045	
γ_1		0.003036***		0.003011***	
γ_2		0.002265***		0.002209***	
γ_3		-0.000470		-0.000540**	
μ		0.000724		0.000730**	
σ_1		0.002820		0.001261	
σ_2		0.000888		-0.001430	
σ_3		0.002281		0.004348	
κ		6.647734		-	
c		0.000018***		-	
δ		0.150000***		-	
β		0.600000***		-	
R^2		0.179548		0.178553	
Adjusted R^2		0.175853		0.175317	
AIC		-7.605556		-7.621977	
SBIC		-7.568668		-7.597385	

Table 9: Robustness check results with the Pearl Harbour bombing excluded from the analysis. ***, **, * indicate significance at the 1%, 5% and 10% levels respectively.

Panel A: Descriptive Statistics					
	Obs	Max	Min	Std Dev	Average Return
Allied	15	0.016737	-0.047662	0.013291	-0.000437
Axis	24	0.029801	-0.007099	0.006365	0.002269
Panel B: Event Study Statistics					
	Window	CAAR		Corrado	
Allied	[0; 0]	0.2563**		2.77***	
		(0.02)		(0.01)	
	[0; 1]	0.2080		1.3966	
		(0.17)		(0.16)	
	[0; 2]	0.1619		1.1913	
		(0.88)		(0.23)	
	[0; 5]	0.2097		0.94	
		(0.42)		(0.34)	
Axis	[0; 0]	-0.0009		-0.90	
		(0.99)		(0.37)	
	[0; 1]	0.0005		-1.41	
		(0.98)		(0.16)	
	[0; 2]	-0.0432		-1.0098	
		(0.78)		(0.31)	
	[0; 5]	0.3369		0.6437	
		(0.12)		(0.52)	
Panel C: Regression Results					
		Allied		Axis	
Model		OLS		OLS	
α		0.000061		-0.000057	
γ_1		0.003009***		0.003041***	
γ_2		0.002193***		0.0002172***	
γ_3		-0.000500**		-0.000521**	
μ		0.000734**		0.000735**	
σ_1		-0.000200		0.001776	
σ_2		0.000986		-0.002350**	
σ_3		0.001931		0.002054*	
κ		-		-	
c		-		-	
δ		-		-	
β		-		-	
R^2		0.178313		0.181338	
Adjusted R^2		0.175077		0.0178113	
AIC		-7.62169		-7.62537	
SBIC		-7.59709		-7.60078	

Table 10: Regression results for naval sinkings when net losses of battles are considered. The value in parentheses is the corresponding t-statistic. ***, **, * indicate significance at 1%, 5% and 10% respectively.

	Allied	Japanese	Axis
Model	OLS	OLS	OLS
α	-0.000036	-0.000025	-0.000419
γ_1	0.003018***	0.003014***	0.003021***
γ_2	0.002186***	0.002197***	0.002194***
γ_3	-0.000500**	-0.000512**	-0.000521**
μ	0.000714**	0.000715**	0.000723**
σ_1	-0.001325	-0.000074	0.000375
σ_2	0.000733	-0.000721	-0.000812
σ_3	0.000951	0.000225	0.000835
R^2	0.177873	0.177637	0.178559
Adjusted R^2	0.174635	0.174397	0.175323
AIC	-7.62115	-7.62086	-7.62199
SBIC	-7.59656	-7.59627	-7.59739

Table 11: Next day shipbuilding company returns.

Ship	Nationality	Date	Next Day Return
Courageous CV	British	17 Sept 1939	-0.060120***
Royal Oak BB	British	14 Oct 1939	0.010191
Graf Spee, Pocket BB (approx 15,000 tons)	German	17 Dec 1939	0.002029
Glorious CV	British	8 June 1940	-0.007970
Provence BB, Bretagne BB	French	3 July 1940	0.002273
Conte di Cavour BB, Caio Duilio BB, Andrea Doria, BB, Littorio BB	Italian	11 Nov 1940	0.031292**
Hood BB	British	24 May 1941	0.000000
Bismarck BB	German	27 May 1941	0.014401
Ark Royal CV	British	14 Nov 1941	-0.002033
Barham BB	British	25 Nov 1941	-0.001724
Arizona BB, Oklahoma BB, West Virginia BB, California BB, Nevada BB, Tennessee BB, Maryland BB	US	7 Dec 1941	-0.007260
Prince of Wales BB, Repulse BB	British	10 Dec 1941	-0.003597
Valiant BB, Queen Elizabeth BB	British	19 Dec 1941	0.000000
Hermes CV	British	9 April 1942	0.000000
Shoho CV	Japanese	7 May 1942	0.001866
Lexington CV	US	8 May 1942	0.000000
Kaga CV, Soryu CV	Japanese	4 June 1942	-0.000742
Akagi CV, Hiryu CV	Japanese	5 June 1942	0.001984
Yorktown CV	US	7 June 1942	0.001984
Eagle CV	British	11 Aug 1942	0.002358
Ryuyi CV	Japanese	24 Aug 1942	0.006059
Wasp CV	US	15 Sept 1942	0.000000
Hornet CV	US	27 Oct 1942	0.000682
Hiei BB	Japanese	13 Nov 1942	0.003448
Kishima BB	Japanese	15 Nov 1942	0.003448
Mutsu BB	Japanese	8 June 1943	-0.001037
Roma BB	Italian	9 Sept 1943	-0.002232
Chuyo Escort Carrier (approx 20,000 tons)$^{+}$	Japanese	4 Dec 1943	0.002544
Scharnhorst BB	German	26 Dec 1943	0.000000
Shokaku CV, Taiho CV, Hitaka CV	Japanese	19 June 1944	-0.001659
Hiyo CV	Japanese	20 June 1944	0.000000
Otaka Escort Carrier	Japanese	18 Aug 1944	0.001701
Princeton Light Carrier	US	24 Oct 1944	0.008055
Musahi BB	Japanese	24 Oct 1944	0.008055
Zuikaku CV, Chitose, Light CV, Chiyoda Light CV, Zuiho Light CV, Fuso BB, Yamashiro BB	Japanese	25 Oct 1944	0.006535
Tirpitz BB	German	12 Nov 1944	0.005023
Kongo BB	Japanese	21 Nov 1944	0.001087
Unryu CV	Japanese	19 Dec 1944	0.001712
Yamato BB	Japanese	7 Apr 1945	0.010653
Admiral Scheer, Pocket BB	German	10 Apr 1945	0.002801
Lutzow Pocket BB	German	16 Apr 1945	0.003762
Hyuga BB, Ise BB Haruna BB, Kaiyo, Escort Carrier^{+}	Japanese	24 July 1945	-0.006603
Amagi CV	Japanese	28 July 1945	-0.033996**

* Capital ships by the Washington naval treaty definition.

Appendix 1 – UK Companies involved in building capital ships:

Battleships

King George V Class (Completed through the early war years)

Anson – Swan Hunter and Wigham Richardson, Tyneside.

Duke of York, John Brown and Company, Clydeside.

Howe - Fairfield Shipbuilding and Engineering Company, Clydeside.

King George V - Vickers-Armstrong, Tyneside.

Prince of Wales - Cammell Laird, Birkenhead.

Subsequent Ships

Vanguard, John Brown and Company, Clydeside, (completed after the end of the war).

Lion was laid down at Vickers-Armstrong Tyneside (never completed).

Temeraire was laid down at Cammell Laird, Birkenhead (never completed).

Large Carriers

Illustrious - Vickers-Armstrong, Barrow.

Formidable – Harland and Wolff, Belfast.

Victorious - Vickers-Armstrong,Tyneside.

Indomitable - Vickers-Armstrong Barrow.

Implacable - Fairfield Shipbuilding and Engineering Company, Clydeside.

Indefatigable - John Brown and Company Clydeside.

Sixteen Light Carriers were also laid down during the war at various of the ship yards above. Not all were completed before the war ended.

Appendix 2 – Post Dreadnaught Capital Ships sunk in World War One

UK

HMS Audacious sank after hitting a mine 27 October 1914 – The British didn't admit officially to this until after the war when an announcement appeared in the Times although it had actually been filmed by passengers on an American liner.
HMS Invincible (battlecruiser) sank at the Battle of Jutland 31 May 1916.
HMS Indefatigable (battlecruiser) sank at the Battle of Jutland 31 May 1916.
HMS Queen Mary (battlecruiser) sank at the Battle of Jutland 31 May 1916.
HMS Vanguard sank 9 July 1917 – accidental explosion – not reported in the British press for some time.

Germany

SMS Lützow – scuttled after been heavily damaged at the Battle of Jutland 1 June 1916.

France (British ally)

None

Italy (British ally)

Leonardo da Vinci Sunk by explosion, 2 August 1916 (maybe sabotage) – not reported in the British press until months later.

Turkey (German ally)

None

Austro – Hungary (German ally)

SMS Szent István – sunk by torpedo 10 June 1918.
SMS Viribus Unitis – sunk by mine 1 November 1918 technically had just been handed over to new neutral state of State of Slovenes, Croats and Serbs.

Japan (British ally)

Kawachi - Sunk by magazine explosion, 12 July 1918 – not reported in the British press for several days.

Russia (British ally)

Imperatritsa Mariya – sunk by magazine explosion 20 October 1916 – not reported in the British press.

USA (British ally)

None

Figures

Figure 1: FT30 during WW2.

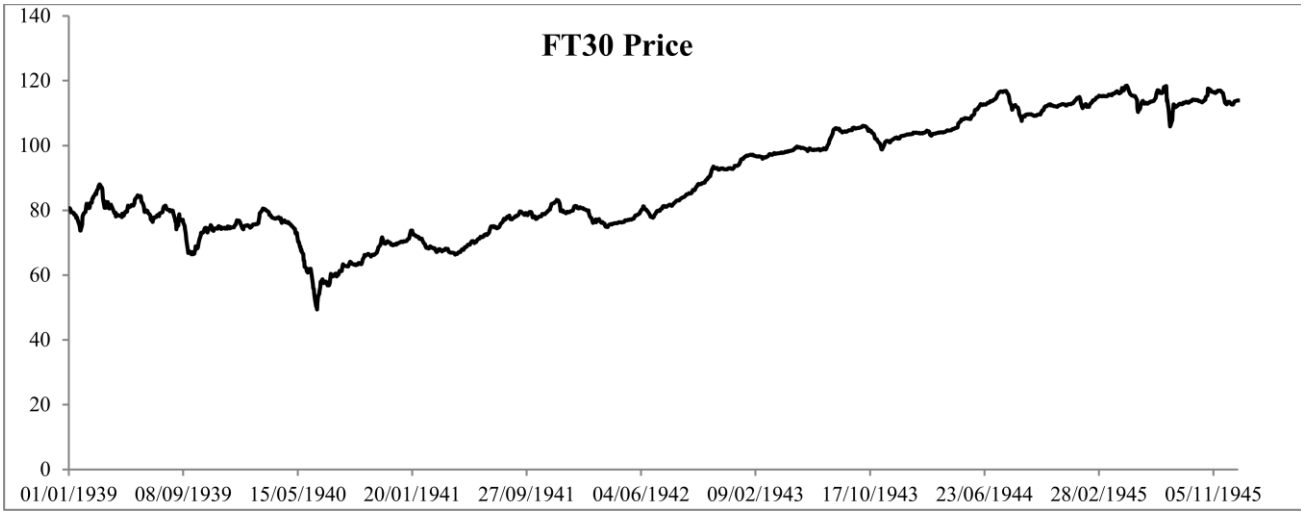

Figure 2: Log returns of the FT30 during WW2.