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Mohamad, Azhar

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Empirical Essays on Short Selling

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Azhar Mohamad

Bangor Business School
Bangor University

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Abstract

This thesis sets out to analyse empirically the impact of: i) short selling on stock returns; ii) the UK Financial Services Authority's (FSA) short selling ban on stock prices, market quality as well as contagion, and iii) short selling on Exchange Traded Fund's (ETF) returns. A distinction is made between two types of shorts: valuation and dividend arbitrage shorts. Employing an event-study methodology, the empirical results indicate that, whilst large increases in short interest in valuation shorts are associated with significant negative abnormal returns, large increases in dividend arbitrage shorts are less informative. This may imply that these two different types of shorts are executed by two different sets of traders, who are scrutinizing two different sets of information. With respect to dividend arbitrage shorts, however, the informational content of short interest is dependent on the state of the economy. Regarding the impact of the FSA's short-selling ban on stock prices and market quality, the current study finds no evidence that the FSA's objective of protecting market quality was achieved through its prohibition of the short selling of financial stocks. Nevertheless, with regard to the FSA's concerns over cross-sectoral contagion, there is evidence that the short-selling ban may have been successful in preventing contagion, thereby protecting capital market stability. In relation to the informational content of ETF short interest, the present study finds that high increases in short interest are followed by positive abnormal returns, while low increases in short interest are followed by negative abnormal returns. The results indicate that ETF's short interest does not carry informational content similar to that contained in the short interest on individual stocks and different types of players are involved in the ETF market, namely, the hedgers and speculators.

Chapter 1

Introduction

1.1 Background Information

The issue whether or not short selling impacts financial markets has always been a topical matter for discussion and dispute among financial markets' participants. In recent years, the increasing research interest in the subject of short selling has been accompanied by a greater availability of high-quality and high-frequency data. In the US, for example, recent research has had the opportunity to utilize high-frequency short-selling order flow data (e.g., Boehmer, Jones, and Zhang, 2008) and tick-by-tick data (e.g., Diether, Lee, and Werner, 2009). Further, the sudden interest in short selling has been intensified by the reactions of financial market regulators around the world to falling, gyrating markets. At the height of the financial crisis, in September 2008, the UK financial market regulator, the Financial Services Authority (FSA) enacted a ban on the short selling of financial stocks. Short selling has become a subject of debate between proponents and dissenters. Regulators and researchers have started to pay more attention to short sellers.

This thesis focuses on three different aspects of short selling in the UK market: the informational content of short interest, the effect of the short-selling ban on market quality and finally, the informational content of exchange-traded funds' (ETF) short interest[1]. The present study is motivated by the ongoing debate between academics and traders regarding the informational role of short interest. From academics' point of view, short sellers are sophisticated traders with crystal balls allowing them to possess superior information about the stocks. Despite the additional shorting costs incurred, short sellers anticipate benefits from the shorts; they actually believe that the stock price is going to drop. From the traders' stand point however, a high level of short interest sends a bullish signal, because they believe that the majority of people are usually wrong during market turns, and because short interest represents the latent future demand for stocks. Thus, the fundamental question for investors at large is the following: Is it better to trade alongside and gang up with short sellers, or to trade against them? The current study addresses this important question by examining the relationship between short selling and stock returns.

Often, short selling is associated with notoriety and short sellers tend to have a bad name. Since the 17th century, stock exchange regulators around the world have imposed different types of anti-shorting laws to curb short selling. In the UK, the latest form was imposed by the FSA on 19th September 2008, when a ban on short selling certain financial sector stocks was enacted. The FSA claimed that the short selling of financial stocks may have implications for market confidence and lead to a contagion effect on related stocks. It

[1]An ETF is a special security that tracks a basket of stocks. The benefit of this instrument is that an ETF investor gets immediate exposure by going long or short on this instrument, as the ETF is an efficient hedging tool.

explicitly stated that the financial sector exerts a strong influence on non-financial sectors and that failing to address this 'interconnectedness' may jeopardize the equity market as a whole.

The issue of whether short selling in ETFs leads to predictable changes in ETF prices provides an interesting motivation, yet an unexplored research question, for short sellers, academics and regulators alike. Conventionally, according to Diamond and Verrecchia's (1987) rational expectations model, an increase in the short interest in a stock is often viewed as a signal that the stock price is going to fall, since market participants may believe that short sellers possess significant private information. On the one hand, ETFs are similar to stocks, in that, to short an ETF, sellers have to incur borrowing costs. On the other hand, an ETF is a special security; it is quite different from an individual stock in the sense that it tracks a basket of stocks. A competing theory by Gastineau (2004, 2008) suggests there may be no informational content in the short selling of ETFs as it may be largely motivated by tax and arbitrage-related reasons.

1.2 Prior Literature on Short Selling

The present study examines three distinct extant literatures on short selling. The theoretical framework on the informational content of short interest is offered by Diamond and Verrecchia's (1987) 'private information hypothesis', which predicts that unusually large increases in the announced short interest is bad news. Empirical exercises undertaken to address this issue typically test whether the announced short interest gives a bearish, bullish or neutral signal. The majority of prior empirical studies provide support for the private information hypothesis in that unusually large increases in the announced short interest are followed by a period of negative abnormal returns (e.g. Senchack and Starks, 1993; Choie

and Hwang, 1994; Asquith and Meulbroek, 1995; Aitken, Frino, McCorry, and Swan, 1998; Desai, Ramesh, Thiagarajan, and Balachandran, 2002; Asquith, Pathak, and Ritter, 2005; Boehmer et al., 2008; Diether et al., 2009). Some studies, however, find that announced short interest does not give a direct signal and argue, in line with Gastineau (2004, 2008), that this is for arbitrage and tax-related reasons (e.g. Biggs, 1966; Mayor, 1968; Whitmarsh, 1972; Dyl, 1978; Brent et al., 1990; Au, Doukas, and Onayev, 2009).

Another theoretical framework on short selling centres on short sale constraints and stock returns. Miller (1977) hypothesizes that constraining pessimists without constraining optimists result in an upward bias in stock prices. In a similar vein, Figlewski (1981) hypothesizes that a high level of short interest predicts overpricing in individual stocks. Jarrow (1980), on the other hand, argues that relative risky asset prices could rise or fall, depending upon the underlying parameters in the economy and investor expectations. As regards a short-selling constraint in the form of prohibition, Diamond and Verrecchia (1987) contend that this will not result in overpricing because investors, being rational, adjust their valuations accordingly. However, they argue, the prohibition of short selling will affect market quality adversely, as informed investors as well as uninformed ones will also be eliminated from participating in the market.

The lack of literature on the informational content of short selling ETFs is mainly due to the unavailability of high-frequency data until recently, and secondly because of the nature of ETFs, in that they are special securities that track baskets of stocks. By going long or short on this type of security, an ETF investor gets exposure to the broad or a specific sectoral market immediately. The fact that both hedgers and speculators can short ETFs makes the

informational content of increases in the ETF short interest ratio a difficult and interesting subject of study. Based on Diamond and Verrecchia's (1987) model of private information, one would argue that large increases in the ETF short interest should be interpreted as bearish signals. On the other hand, Gastineau (2004, 2008) argues that this is not necessarily the case, given the special characteristics of ETFs. This study aims to provide pioneering research by examining the information content of the short interest of ETFs.

1.3 Objectives of the Study

The broad and specific objectives of this study can be outlined as follows:

1. To examine the informational content of short interest in the UK. In particular, the present study aims to:
    - measure the short-term daily abnormal returns for valuation and dividend arbitrage shorts sub-samples following the announcement of large increases in short interest and compare the cumulative returns of the two samples over different event windows;
    - compare the average abnormal returns of the above sub-samples over different event windows for the overall period of study;
    - compare the two sub-samples' abnormal returns over different event windows and different sub-periods, namely before and after the financial crisis of 2008/2009 as well as before and after the enactment of the short-selling ban.

2. To provide robustness checks on the informational content of short interest in the UK by examining whether shorting anomaly persists and whether short-term, daily negative

abnormal returns and alphas are sensitive to the methodology or assumed model for expected returns. In particular the present study aims to:

- compare the event-study abnormal returns, cumulative abnormal returns and alphas between top and bottom one percentile of increases in short interest, with respect to different:

  a) model for expected returns, whether it is Fama and French (1993) three factor model, Market model, Capital asset pricing model, Jensen alpha and Fama French alpha;

  b) event-study estimation windows: 60 vs. 120 days;

  c) weightings: equal vs. value weighting.

3. To investigate the effect of the short-selling ban on stock prices, market quality and contagion. In particular, the present study aims to:

   - measure the impact of the imposition as well as the removal of the short-selling ban on the daily abnormal returns of the stocks that were subject to the ban and of a matched sample, and draw comparisons between the two samples;
   - assess the impact of the imposition as well as the removal of the short-selling ban on market quality measures, namely, volatility, volume traded and bid-ask spread, and draw comparisons between the two samples;
   - identify a contagion effect from financial to non-financial sectors in two high-volatility periods, namely, at the onset of the short-selling ban and while the ban was in force.

4. To examine the informational content of ETF short interest. In particular, the present study aims to:

   - measure the short-term daily returns of sorted portfolios following the announcement of large and small increases in ETF short interest;
   - compare the average and cumulative returns between sorted portfolios for 30 days following the announcement of large and small increases in ETF short interest;
   - measure the cumulative returns of a strategy involving long and short ETF portfolios that experience large and small increases in short interest.

1.4 Research Design

Data

The short-selling data used in this study are specific to the UK market and sourced from Euroclear, covering the period from September 2003 to April 2010. In the case of covered short selling, sellers have to borrow the securities before executing the short, thus this study uses stock-lending data as a proxy for short interest[2]. This approach has also been employed by Au et al. (2009) and discussed in detail by Thomas (2006). This study defines the short interest ratio as the number of stocks on loan divided by the number of stocks available to be loaned through Euroclear. An increase in short interest is defined as a simple arithmetic increase in this ratio from one day to the next. The accounting and financial market data are sourced from Bloomberg and Datastream.

[2]The stock lending process is an integral part of short-selling practice in the UK. The concept is described in detail in the next chapter of this thesis: 'Literature Review on Short Selling'.

Research Design

To achieve the broad and specific objectives outlined in the previous section, this study adopts the following research design:

1. To examine the informational content of short interest in the UK.

- Daily short interest ratios and increases in the ratios are calculated for all observations for every day in the period. After the sampling process, the observations are separated into two sub-samples: valuation and dividend arbitrage shorts[3].
- The short-term event day abnormal returns following large increases in short interest are measured according to Fama and French (1993), with the estimation period ranging from day -115 to -16 and the event period ranging from day -15 to +30.
- A comparison is made between the two sub-samples as regards average abnormal returns over several periods: (a) the overall period from 1 September 2003 to 16 April 2010; (b) between before and after the start of financial crisis period; (c) between before and after the period of the short-selling ban.

2. To examine whether short-term, daily negative abnormal returns and alphas are sensitive to the methodology or assumed model for expected returns.

- Daily short interest ratios and increases in the ratios are calculated for all observations for every day in the period. Take the top (largest) and bottom (smallest) one percentile of increases in short interest.
- Test for differences in mean abnormal returns and alphas with respect to different:

[3]The sampling process is described in detail in the third chapter of this thesis: 'Short Selling and Stock Returns'

a) model for expected returns

b) event-study estimation windows: 60 vs. 120 days;

c) weightings: equal vs. value weighting.

3. To investigate the effect of the short-selling ban on stock prices, market quality and contagion.

- Bloomberg newswires covering news on the short-selling ban are followed in sequence to determine the correct number of stocks that were subject to the ban. This information is further cross-checked with the FSA's website.
- The number of stocks subject to the ban was 35; the ban was later removed on 30 of them, while 5 of the stocks were delisted during the ban. A matched sample of stocks is created based on two criteria: (a) short interest ratio; (b) market capitalization of stocks. Means and Wilcoxon rank sum tests are performed to ensure there is no significant difference between the two samples in terms of the matching criteria.
- The samples' abnormal returns are measured according to Brown and Warner (1985) with the estimation period ranging from day -70 to -11 and the event period from day -10 to +30. The market quality measures used are volatility, volume and bid-ask spread. The average abnormal returns and market quality measures are compared between the two samples, following the imposition and removal of the short-selling ban.
- In assessing the contagion effect, this research adopts Forbes and Rigobon's (2002) framework, in which the heteroskedasticity-adjusted correlation is calculated as a measure of the linkage between financial and non-financial sectors during high-

volatility periods. Contagion is deemed to have occured if the adjusted correlation during the high-volatility period is greater than the correlation during the low-volatility period. The low-volatility period, as a benchmark, is defined as the seven and half months 'stable' period before the high-volatility period. The high-volatility period is defined as the five and half months 'turmoil' period started from the onset of and during short-selling ban period.

4. To examine the informational content of ETF short interest.

- Daily short interest ratios and increases in the ratios are calculated for all observations for every day in the period. Different observations have different increases in the ratios for each day, so we have different portfolios each day depending on whether the ratios went up or down that day The positive increases in short interest are kept in the samples and these observations are sorted into ten deciles (portfolios), with Decile 1 and Decile 10 denoting the lowest and highest positive increases in the short interest respectively.
- The day where increases in short interest are calculated is termed as day 0. So, following day 0, subsequent daily logarithmic returns are calculated and accumulated for each portfolio.
- The average and cumulative returns of the ten portfolios are compared for the 30 days following day 0 to show under- or over-performance of the ETF portfolios.
- The returns of a strategy involving long and short ETF portfolios that experience high and low increases in short interest are accumulated to show a potentially profitable strategy.

1.5 Main Empirical Results

The main objectives of this study are to examine the informational content of short interest, the impact of a short-selling ban and possible contagion, and the informational content of ETF short interest, in the context of the UK market. The study finds that large increases in short interest are followed by periods of strong abnormal returns for valuation shorts. For valuation shorts, the market seems to adjust rapidly, but not instantaneously, to the arrival of the short interest information. Valuation shorts yield cumulative abnormal returns of 1.48 percent on average over the 15 trading days following a large increase in short interest, suggesting profits could be made from a strategy of short selling following the disclosure of large increases in short interest for valuation short stocks. Thirdly, dividend arbitrage shorts appear to be less informative. This study also examines the impact of the 2008/09 financial crisis on the informational content of short interest and finds similar levels of informational content in short interest (for valuation shorts) throughout the period of the data sample. With respect to dividend arbitrage shorts, however, the informational content of short interest is dependent on the state of the economy. Taken together, the empirical results provide support for the conjecture of Diamond and Verrecchia (1987): unusually large increases in short interest are followed by a period of negative abnormal returns. These results are also broadly consistent with other prior studies (e.g. Senchack and Starks, 1993; Desai et al., 2002; Asquith et al., 2005), suggesting that some informational content is associated with short interest.

The results of robustness checks on the informational content of short interest indicate that shorting anomaly persists and short-term, daily negative abnormal returns as well as alphas are not sensitive to the assumed model for expected returns, and to the choice of estimation windows. However, the results for alphas for the smallest bottom one percentile of increases

in short interest are sensitive to the choice of weightings. It appears value and equal weightings yield different results for the smallest increases in short interest portfolio. The conflicting results may necessitate disclosure of both weightings.

Turning to the impact on stock prices and market quality from the ban on short selling, the main results show that the average abnormal return on stocks that were subject to the ban, on the day the ban was imposed on each stock, was 1.62 percent. Over a 30-day period, however, the difference between the returns on stocks that were subject to the ban, and the returns on a matched sample, was insignificant. This suggests that the effect of the ban may have been short-lived. Even though short sellers were prohibited from shorting the stocks, long sellers were still able to liquidate their holdings. The stocks that were subject to the ban appear to have experienced a decline in market quality, as measured by volatility and liquidity. When the ban was lifted, the price of the stocks that had been subject to the ban fell by an average of 13.65 percent over the first three days. Over a longer period of 30 days, however, these losses were recovered. By and large, the evidence is consistent with Diamond and Verrecchia's (1987) hypothesis that there is lower market quality and no overpricing effect following the imposition of a ban on short selling. Although there is some evidence in favour of Miller's (1977) overpricing hypothesis, both when the ban was imposed and when it was lifted, in both cases any effect was transitory and short-lived. Within 30 days of the imposition of the ban, and within 30 days of its removal, the difference in average cumulative abnormal returns between the stocks that were subject to the ban and the matched samples becomes negligible, and statistically insignificant. These findings are consistent with previous UK studies that report a deterioration in market quality. When the short-selling ban was imposed, the stocks that were subject to the ban registered higher volatility, lower

standardized volume and a wider bid-ask spread on average than their counterparts in the matched samples.

In examining the informational content of ETF short interest, the main findings show over-performance and under-performance of ETFs following high and low increases in short interest. This finding counters Diamond and Verrecchia's (1987) prediction and contrasts significantly with prior studies on high increases in short interest documented by Senchack and Starks (1993) and Choie and Hwang (1994). Gastineau (2008) argues that ETF is an efficient risk management tool, and is widely used by risk managers to hedge their portfolios. In a similar vein, this study posits that different types of players are involved in shorting ETFs. The high increases in ETF short interest might be due to hedgers' balancing positions, whereas the low increases in short interest might be due to speculators' speculative positions. The hedgers short because they are bullish and the speculators short because they are bearish. Interestingly, this interpretation of the results points to an executable trading opportunity, that is, to go against the hedgers and to gang up with the speculators; this translates into a strategy of going long on the portfolios with the highest increases in short interest and short on those with the lowest increases.

1.6 Contributions Made by this Thesis

The main contribution of this thesis is to provide new evidence regarding the informational content of short interest in the UK equity and ETF markets, as well as on the contagion effect during the imposition of a short-selling ban. With respect to the first essay, on 'short selling and stock returns', this thesis makes the following specific contributions:

- This study is the first to use high-frequency data to examine the informational content of short interest. A previous UK study by Au, Doukas and Onayev (2009) uses low-frequency, weekly horizon data. The main methodological advantages of a high-frequency dataset, that is, a daily dataset, include the ability to control for contaminating events and to employ an event study methodology for a more detailed investigation of the informational content of short interest (Thomas, 2006).
- This study is the first to investigate the informational content of valuation and dividend arbitrage shorts separately. The previous study on the level of short interest (Au et al., 2009) uses stock-lending data as a proxy, but does not separate the sample into those stock-lending data associated with dividend arbitrage (dividend arbitrage shorts) and those involving pure bets on price falls (valuation shorts). The separation of dividend arbitrage shorts and valuation shorts in the present study allows us to compare the informational content of the two types of short position.
- Finally, this study also considers whether large increases in short interest convey the same information during different states of the economy, namely, before and after the recent financial crisis, as well as before and after a short-selling ban.

With reference to the second essay, this study examines the impact of the enactment of a short-selling ban in the UK using a more complete dataset and provides evidence of a contagion effect, which has been a major concern for the FSA. Specifically,

- this study is the first to use a complete list of 35 stocks that were subject to the ban on short selling. Previous studies (e.g., Clifton and Snape, 2008; Marsh and Niemer, 2008; Hansson and Fors, 2009) examined smaller, incomplete samples. Studies by

Beber and Pagano (2012) and Frino, Leece, and Lepone (2011), on the other hand, make comparisons at a country level rather than a firm level.

- This study is the first to create a matched sample of stocks for which short selling was permitted, using the short interest ratio and market capitalization as the matching criteria. We argue that it would not be appropriate to compare a lightly shorted stock that was subject to the ban with a heavily shorted one that was not subject to any restriction on short selling, as superficial comparisons are likely to obscure true differences and give rise to misleading conclusions.
- This study is the first to investigate cross-sectoral contagion from the financial sector to non-financial sectors. Concern over cross-sectoral contagion was cited by the FSA as a motivating factor for the imposition of the ban. The findings suggest that, while this measure did not contribute effectively towards the regulatory aims of protecting market quality, it was successful in mitigating contagion, thereby promoting capital market stability.

Last but not least, in relation to the third essay, this study examines the impact of announcements of increases in short interest in the ETF market. These are the specific contributions made by the study in this regards:

- This is the first study that investigates the information content of ETF shorting, either in the UK, or in other jurisdictions. In the US, ETF short interest data are not publicly available; this constraint makes studying the informational content of ETF shorting impossible in the US. The greater availability of high-quality, high-frequency ETF short interest data in the UK has made this study possible.

- This study is the first to offer interpretation of high and low increases in ETF short interest; due to the uniqueness of ETFs as an efficient hedging tool, high increases in short interest may be due to hedgers' positions while low increases in short interest may be attributed to speculators' trading positions.
- Finally, given the bullish (bearish) signals given by high (low) increases in ETF short interest, this study is the first to suggest a profitable trading opportunity in the UK ETF market by going long on ETFs that experience high increases in short interest and short on ETFs that experience low increases in short interest.

1.7 Organization of the Thesis

Following this introduction, Chapter 2 presents a review of the short-selling literature. In particular, it explores the history of short selling and anti-shorting measures from the 17th century up to the present day and defines the key concepts in the literature as well as explaining the stock-lending market in the UK. In addition, the chapter reviews the prior studies on the informational content of short interest and short selling. Chapter 3 focuses on the informational content of short interest by separating valuation and dividend arbitrage shorts and studying them in different states of the economy. Chapter 4 provides robustness checks on informational content of short interest in the UK. Chapter 5 investigates the effect of the recent short-selling ban on price and market quality, and tests for a contagion effect between financial and non-financial sectors before and during the ban. Chapter 6 examines the informational content of ETF short interest. Finally, Chapter 7 provides a summary, the implications and limitations of the study, and suggestions for future research.

Chapter 2

Literature Review on Short Selling

2.1 Introduction

Short selling is perhaps one of the most controversial subjects discussed by market participants and regulators of financial markets. Undeniably, short selling is the best strategy for placing a bet that the stock price is going to fall when investors and speculators are pessimistic and have a bearish view about the company's future performance. In general, a short sale is costlier to execute than a long sale, thus academics regard this constraint as consistent with a limit-to-arbitrage setting, and this fundamentally explains the stock returns anomaly associated with short selling.

History tends to remember short selling vividly. In the US, for example, people still remember how 'boy plunger' Larry Livingston, also known as Jesse Livermore, raided and shorted Wall Street in 1929 before the Great Depression and then, just as everyone else lost money, he made a fortune of $100 million from short-selling profits (Lefèvre, 2005). While some market players might consider short selling to be perfectly legal and morally acceptable,

a larger proportion seems to find it offensive and destructive. Chales Geisst, a financial historian, for instance, writes in the preface to Lefèvre's book, *Reminiscences of a Stock Operator*:

> "Short-selling became understood as a means through which companies could be stolen from the rightful owners by those intent on destroying their value. When rumours began that a plunger like Livingston decided to short a stock, other small investors also plunged in. These were the proverbial "suckers": small investors of various stripes who never had a distinct idea about the market except to follow someone else's lead." (p. 15)

Perhaps this explains how short selling has gained a bad name and why it is often associated with hostility.

The objective of the present chapter is to provide a review of the literature on short selling. In particular, it seeks to offer definitions of different types of short selling, to describe the history of short selling as well as anti-shorting laws and to elaborate on the stock-lending market in the UK. In addition, this chapter explains the distinct literature on the informational content of short selling and short-selling constraints. The chapter is organized as follows: The next section defines key concepts used in this research, such as covered and naked short selling. Histories of short selling and anti-shorting laws are discussed in Sections 2.3 and 2.4, respectively. The UK stock-lending market is described in Section 2.5. Section 2.6 examines the theoretical framework and empirical evidence on short selling, and finally Section 2.7 offers concluding remarks.

2.2 Definitions of Concepts

This section defines the term 'short selling' used in the present study. Short selling is the sale of a security that the seller does not own. There are two types of short selling: covered short selling and naked short selling. The UK's Financial Services Authority (FSA) defines

covered short selling as *"a series of transactions where the short sellers normally borrow the number of shares that are being sold short, so that they can be delivered to buyers at settlement"* (FSA Discussion Paper DP09/1, p. 6). Naked short selling, on the other hand, is defined as *"a series of transactions where the short sellers sells shares they do not own, without having to set aside any shares to settle the transaction"* (FSA Discussion Paper DP09/1, p. 6). Throughout this study, the term 'short selling' is used to refer to 'covered' short selling and not 'naked' short selling. In the UK context, the ban on short selling only applies to covered short selling and not to naked short selling as the FSA believes that a ban on naked short selling would significantly impair the ability of market makers to function properly. In addition, the FSA has stated that it is certain that naked short selling is not a source of any problems (FSA, 2009). This study also examines the informational content of the shorting of an exchange traded fund (ETF). An ETF is a special security that tracks a basket of stocks. Its benefit is that an ETF investor gets immediate exposure by going long or short on this instrument, since the ETF is an efficient hedging tool.

In the UK, stock lending is an integral part of the covered short-selling process. To illustrate, let us assume that Seller X intends to short sell a share in company ABC, X must then find an existing owner of ABC shares, Lender Y, who is both able and willing to lend X the shares. Having negotiated the loan of the shares, X may then short sell the borrowed shares to any willing buyer, Z. The short seller (or borrower of the shares), X, must deposit collateral with the lender, Y, equal to 102 percent of the market value, with the amount marked to market daily. A small proportion, around 2 percent, is normally collateralized with Treasury securities, and the rest as cash. If the lender is a US broker-dealer then an additional 50 percent margin is normally required. In the UK as well as in Europe, transactions collateralized with cash are less common but they are increasing (Makinson Cowell, 2005).

Where lenders take securities as collateral, they are paid a fee by the borrower. A wide range of securities are likely to be accepted by the lender including government bonds, corporate bonds, convertible bonds and equities. A lender will require from the borrower a margin on top of the value of the collateral, usually 5 percent, in order to provide a buffer against market fluctuations in the values of the securities lent and the collateral received. Where lenders are given cash as collateral, they pay the borrower interest at a specified rate, known as the rebate rate. The lender will, in turn, invest the collateral at market rates. The fee the borrower pays is therefore the difference between the risk-free rate and the rebate rate. In return, the borrower receives both the lent securities and a relatively risk-free return on their collateralized cash. According to Makinson Cowell (2005), stock-lending fees in the UK can be as low as five basis points per annum (of the total value of the loan), or as high as 400 basis points, or even more in extreme circumstances. The great majority of transactions are at the lower end of this range, with the average fees in the UK market at around 14 basis points. Small capitalization stocks will usually demand the highest fees.

2.3 History of Short Selling

Short selling began as early as the 17th century. Bris, Goetzmann and Zhu (2004) document that, in February 1609, a group of well-connected Dutch businessmen, led by one of the original subscribers to the Dutch East India Company, Isaac Le Maire, formed a secret association, the 'Groote Companie', to short the shares in the East India Company in anticipation of the incorporation of a rival French-chartered trading firm. Le Maire and his colleagues sold shares forward in a 'blanco' transaction, promising future delivery in one or two years. Over the next twelve months, their profits mounted, as East India Company shares dropped by 12 percent, angering shareholders who inevitably learned of their plan. In January of 1610, a year after the formation of the 'Groote Companie' and only eight years

after the official founding of the Amsterdam bourse, the first regulation against short selling was enacted. Prices of the shorted stocks rebounded, a rival French company was not formed and Isaac Le Maire never succeeded in disentangling himself from the litigation that ensued. The Dutch government later banned all short sales in order to curtail the activities of the bears, although the Amsterdam bourse maintained that the decline in the East India stock was due to poor business conditions and not short selling.

In the US, Chancellor (2001) presents an interesting account of the events of the infamous Mississippi and South Sea bubbles, the collapses of which have often been blamed on short selling. In Lousiana, in 1716, John Law, a Scottish adventurer, economic theorist and financial wizard, who was a friend of the regent, the Duke d'Orléans, established a bank with the authority to issue notes. A year later, he established a company and obtained for it exclusive privileges to develop the vast French territories in the Mississippi River valley of North America. Law's company also soon monopolized the French tobacco and African slave trades, and by 1719 his company held a complete monopoly on France's colonial trade. Law also took over the collection of French taxes and the minting of money; in effect, he controlled both the country's foreign trade and its finances. Given the potential profits involved, public demand for shares in Law's company increased sharply, sending the price for a share from 500 to 18,000 livres (the French currency at the time). By 1719, following a general stock market boom across Europe, state-issued public securities, or *billets d'état*, had also risen sharply in value. Law planned to cancel out the vast public debt accumulated during the later years of Louis XIV's reign by selling his company's shares to the public in exchange for *billets d'état*. The French government took advantage of this situation by printing increased amounts of paper money. In 1720, the stock markets plummeted and so did the shares in Law's company. There was high inflation, and both the paper money and

the *billets d'état* began to lose their value. Short sellers and John Law himself became the scapegoats.

In 1720, South Sea, a British company, was given the opportunity to take over the national debt of the Kingdom of Great Britain. The company had been founded in 1711 and mainly traded in slaves. King George I became the governor of the company in 1718 and the company started paying 100 percent interest on its stocks. When South Sea was given a green light to take over the national debt, its stock price rose dramatically, from 128p to more than 1000p, in a matter of six months. Three months later, the price dropped to 124p, dragging other government stocks with it. Thirteen years later, a British member of parliament, Sir John Barnard, proposed a bill with the aim to:

> "prevent the wicked, pernicious, and destructive practice of stock-jobbing whereby many of his Majesty's good subjects have been directed from pursuing their lawful trades and vocations to the utter ruin of themselves and their families, to the great discouragement of industry and to the manifest detriment of trade and commerce." (Chancellor, 2001, p. 1)

The bill was passed in 1734 as Sir John Barnard's Act and banned the use of futures, options, and the short selling of British Government stocks (Harrison, 2003).

2.4 Anti-Shorting Laws

Short selling was extremely unpopular in the US in the 1930s, and characterized as being inhuman, un-American and against God; Lamont (2004), for example, when referring to the practice, quotes proverbs 24:17 *"Do not rejoice when enemy falls, do not let your heart be glad when he stumbles"*. Anti-shorting laws in the form of the uptick rule and the Investment Company Act (1940) were passed to deter US mutual funds from shorting. Elsewhere, anti-shorting laws were imposed on 28th August 1997 in Malaysia, although short selling had been

allowed on approved stocks a year before this (Lamba and Ariff, 2006). Earlier, though, before short selling had been deemed permissable in 1996, hostility towards short sellers had been clearly reflected when the Malaysian Finance Ministry proposed mandatory caning as a punishment for the offence of short selling (although the proposal was not passed) (Lamont, 2004).

It is interesting to note how short sellers still seem to be blamed for more recent events. Lamont (2004), for example, noted that following the September 11, 2001 attack on the World Trade Centre in the US, the US Securities Commission and other agencies investigated the claim that whoever responsible for the attack had shorted stocks or bought puts to take advantage of their prior knowledge. Within two weeks of the attacks, the Cable News Network (CNN) reported that regulators had observed that someone had manipulated the financial markets ahead of the terror attack in the hope of profiting from it. Despite the claim, the agencies found no evidence of terrorist shorting. The Belgian Finance Minister, Didier Reynders, also said that there were strong suspicions that the UK markets had been used for speculative trading prior to the attacks. The UK's FSA again dismissed the allegation[4].

In the UK, in 2002, the FSA consulted the general public on the best means to enhance transparency in short selling.[5] The regulators considered a few mechanisms, namely, (i) marking and reporting short sales for cash equities, (ii) full disclosure of short positions in both cash and derivatives markets, (iii) data on securities lending as a proxy for short selling, (iv) disclosure of short sales beyond a certain threshold, (v) disclosure of 'naked' short sales,

[4]"Evidence for informed trading on 9/11 attacks"; http://www.bloomingtonalternative.com/node/10604
[5]FSA Discussion Paper DP17, 2003.

and (vi) disclosure of directors' short sales. Some factions among the public suggested deterrent-type anti-shorting measures such as tick rules, as have been implemented in the US, but this idea was not pursued further by the regulator for several reasons[6]. First, the FSA felt that tick rules would hamper market efficiency by removing the orderly price correction of overvalued securities. Second, it was of the opinion that it had an adequate market abuse regime to deal with potentially manipulative practices. Finally, tick rules require certain infrastructures to be put in place, incurring substantial costs. To be effective, tick rules require a marking regime to be operated by market participants, exchanges, clearing and settlement houses[7]. Tick rules allow relatively unrestricted short selling in a flat or advancing market, but prevent short selling at successively lower prices; thus, in a way, they mitigate the risk that short selling will be used to drive down share prices, and prevent short sellers from accelerating a declining market by exhausting all bids at one price level, which, in turn, could cause successively lower prices to be established by long sellers. In the US, short sales are not permitted on minus ticks or zero-minus ticks[8]. Proponents of tick rules see them as an important measure against manipulation and disorderly markets.

After a lengthy consultation with the general public, the FSA decided to adopt option (iii), i.e., the disclosure of data on securities lending as a proxy for short selling. There was a general recognition that such data would be useful to the market and, given that it was already being collated by Euroclear (previously known as CRESTCo), the data would not be very costly to

[6]There are two types of 'tick' rules. An uptick (or plus-tick) rule provides that the last sale must have been at a higher price than the sale preceding it before a share can be short sold. A zero-plus tick rule provides that if the last transaction price is unchanged but higher than the preceding different sale then the stock can be shorted (FSA Discussion Papers, dp09_01).

[7]http://www.fsa.gov.uk/pubs/discussion/dp09_01.pdf, p. 22

[8]US SEC Amendments to Exchange Act Rule 10a-1 and Rules 201 and 200(g) of Regulation SHO.

publish[9]. To most of the respondents involved in the discussions with the FSA, in the absence of full short sale disclosure, stock lending figures appeared to be a reasonable and practical proxy for short interest[10]. There were mixed views on the idea of requiring those holding large short positions in the securities of a company to disclose their positions. On the one hand, some respondents felt this would be useful information for companies and would provide parity with the existing Companies Act regime, which requires the disclosure of shareholdings above 3 percent. On the other hand, more respondents felt that, because the existing regime was intended to show who has control of a company, it would be inappropriate to disclose large short positions as short positions do not give voting rights. Many respondents also felt that publishing such information could be prejudicial to those holding large short positions as it could expose them to the risk of a 'short squeeze'[11].

The 'mild' anti-shorting measure in the form of the disclosure of data on securities lending as a proxy for short selling has been adopted well in the UK since 2003. In September 2008, the issue over whether short selling was the real culprit behind the instability in the financial markets around the world became an interesting issue. Financial markets were wobbling and market regulators as well as buy-side investors were feeling the effects. At midnight on 18th September 2008, the FSA announced a strong anti-shorting law – a short-selling ban in the form of the prohibition of the creation of new short-selling positions in certain financial stocks, in a move to restore investors' confidence in the stricken financial sector. When the

[9]Euroclear settles transactions in UK, Irish, Manx and Channel Island securities. It also provides other services: collateral facilities, securities borrowing and lending, tax assistance, stamp duty, corporate actions facilities, and transaction reporting to the UK and Irish regulators. Most equities traded on the London Stock Exchange are cleared by the London Clearing House, Clearnet, and subsequently settled in Euroclear. The Euroclear system provides a delivery versus payment settlement service in three currencies: Sterling, Euros and US Dollars.

[10]Stock lending as proxy is discussed by Thomas (2006), and employed by Au et al. (2009).

[11]'Short squeezes' or 'bear squeezes' occur during a period of sharply rising prices, caused by short sellers trying to cover their positions. As prices rise, short sellers are forced to cover their short positions and realize their losses.

ban was first announced, market participants reacted strongly. The supporters of the ban, mostly large, buy-side investors and long-term shareholders, were strongly supportive of the FSA's move. For instance, the chief executive officer of Liberty International plc, the UK's largest owner of shopping centres, called for a broader UK ban on short selling, citing that real estate investment trusts and other property companies are more exposed than other sectors to short selling[12]. The dissenters reacted against the decision and, in particular, the media and hedge funds commented strongly on the unfairness of the short-selling ban. Some hedge funds, in apparent retaliation, considered bringing legal proceedings against the FSA for losses sustained as a result of the ban, but did not in fact proceed with them in the end[13].

In a Discussion Paper in February 2009, the FSA claimed that short selling "*can be used abusively in conjunction with scaremongering tactics to push down the price of a stock being shorted*" (p. 11) and that the ban was needed in order to prevent contagion. The chief executive officer of the FSA, Hector Sants, explicitly stated that the decision to enact the short-selling ban was taken to protect fundamental integrity and market quality and to guard against further instability in the financial sector. The ban was lifted on 16th January 2009. While the FSA recognized that short selling is very controversial in times of falling markets, it regards the practice as a legitimate investment technique under normal market conditions. In addition, the FSA made it very clear that, even though they had allowed the ban on short selling to expire, they would be prepared to reintroduce it, if necessary without public consultation. It stated that the costs and risks of not intervening in the event of tumbling

[12]Bloomberg newswire (BN), "*Liberty's Fischel Calls For Broader Ban on U.K. Short Selling*", 26th September 2008, 12:32:14.
[13]The Telegraph news, "*Hedge funds plan to sue FSA over short-selling ban ",* 22nd September 2008, 11:57am.

markets would far outweigh the potential cost in terms of an adverse effect on market efficiency (FSA Discussion Paper DP09/1, p. 20).

2.5 The Stock-Lending Market in the UK

The current study focuses on short selling in the UK market, and in particular covered short selling, for which sellers need to borrow the stocks they are going to short. The most common reason for borrowing stocks is to finance a short sale, with the short seller borrowing the stocks to deliver to the buyer upon settlement. The lender's motivation for lending is to earn a fee from an otherwise idle asset. The borrower then collateralizes the transaction with cash or other securities of greater or equal value than the lent securities. Under English common law, the transaction in fact consists of the absolute transfer of title (sale) against the undertaking to return an equivalent amount of securities (Makinson Cowell, 2005). Once he/she has acquired the stocks, the new owner has certain rights to sell or lend them to another buyer and to vote at annual general meetings. However, borrowing securities for the specific purpose of influencing a shareholder vote is not regarded as acceptable market practice (Faulkner, 2007)[14,15]. Although the absolute title over lent securities is passed from lender to borrower, the lender is still exposed to price movements on the lent securities since the borrower is committed to returning them[16]. The borrower is entitled to

[14]According to Makinson Cowell (2005), at British Land's 2002 AGM, Laxey Partners tabled a motion to unseat the chairman, and voted with their 9% holding. The institution was unsuccessful, and later it transpired that Laxey only owned 1% of British Land and had borrowed 8% for the purpose of voting. Laxey had done nothing illegal but the actions resulted in an investigation by the Department of Trade and Industry and embarrassed both the lending institution and Laxey.

[15]Paul Myners wrote the following in the March 2005 Report to the Shareholder Voting Working Group, 'Review of the Impediments to voting UK shares': "*Borrowing shares for the purpose of acquiring the vote is inappropriate, as it gives a proportion of the vote to the borrower which has no relation to their economic stake in the company."*(Faulkner, 2007, p. 47)

[16]This does not mean the lender gets exactly the same securities back – the borrower's obligation is to return 'equivalent securities' i.e. from the same securities issue with the same International Securities Identification Number (ISIN) (Faulkner, 2007).

other economic benefits of owning the lent securities (e.g. dividends), but the agreement with the lender will oblige them to make equivalent manufactured payments back to the lender.

Before the securities can be borrowed for the purpose of shorting, they must first be located. The majority of lent securities are deposited with a central securities depository, to make them available for shorting. Euroclear UK and Ireland (Euroclear), as the UK's central securities depository, provides custodian services and operates a securities settlement system for at least 95.6 percent[17] of the UK securities market. Euroclear started publishing monthly and daily stock-lending data after the FSA decided to enhance the transparency of short selling (as explained in the previous section). Monthly stock-lending data is freely available but daily data is only available through subscription, and runs as far back as 1st September 2003.

2.6 Theoretical Framework and Empirical Evidence on Short Selling

This thesis focuses on the three strands of the extant literature relating to short selling. First, this study investigates the informational content of the level of short interest or changes in short interest. Secondly, it examines the effect of short sale constraints and prohibitions, on stock returns and market quality. Finally, the study explores the relationship between changes in ETF short interest and ETF returns. The informational content of ETF short interest is the most recent of these issues to emerge and the most unexplored, probably due to the opacity of short interest data on ETFs.

[17]Euroclear UK and Ireland newsletter statistics for January 2011.

2.6.1 Informational Content of Short Interest

Analytical work on the informational content of short interest was first presented by Diamond and Verrecchia (1987). They argue, under the rational expectations framework, that there are two types of short sale effects: the short sale prohibition effect and the short sale restriction effect. When short selling is prohibited altogether, this eliminates short selling by informed and uninformed traders alike. This type of prohibition reduces unconditional informational efficiency, especially with respect to private bad news. However, when short selling is only restricted or when additional costs are imposed, this only drives out uninformed traders from the pool of shorts. This actually improves informational efficiency with respect to private bad news. Only investors that have strong beliefs that a significant price decline will soon occur choose to short under these conditions. Any unexpected, unusually large increase in the announced short interest is thus bad news. This hypothesis is also known as the 'private information hypothesis'. On the one hand, this hypothesis implies that short sellers are sophisticated traders with superior information. On the other hand, one might see it as an outright contradiction of Fama's (1970, 1991) efficient market hypothesis. Even in 'weak form efficiency', using publicly-available market data investors should not be able to reliably predict the future performance of stock returns. So, according to Fama's argument, short interest data that are publicly available cannot be used to predict the future under- or over-performance of stocks.

Empirical Evidence

Empirical evidence on the informational content of short interest can therefore be seen as a direct test of Diamond and Verrecchia's (1987) hypothesis, with most of the prior studies investigating the predictability of long-term abnormal returns by examining the levels of

short interest and stock abnormal returns (e.g., Asquith and Meulbroek, 1995; Desai et al., 2002; Asquith et al., 2005; Au et al., 2009). These studies concentrate on the level of short interest and subsequent returns over monthly and weekly horizons. The first three study monthly short interest publication in the US, while Au et al. (2009) analyse 52-week returns following short interest publication in the UK. Fewer studies focus on the predictability of short-term abnormal returns by examining the effect of monthly changes in short interest and stock returns (two examples are Senchack and Starks, 1993; Choie and Hwang, 1994). These two studies analyse short-term daily stock returns following monthly short interest announcements in the US. In a later study using NYSE daily short-selling proprietary order flow data, Boehmer et al. (2008) compare abnormal returns, proxied by Fama-French alphas, across different types of accounts and degrees of shorting. Diether et al. (2009), on the other hand, study cross-sectional patterns among high-frequency short-selling activities in their dataset. Studies on the informational content of short interest are very scarce outside the US. Aitken et al. (1998), for example, investigate the informational content of short-selling orders in Australia using high-frequency tick data, while Au et al. (2009) investigate the relationship between the level of short interest and long-term, 52-week stock returns in the UK, using a three-year dataset.

On the expected relationship between short interest and stock returns, the extant literature provides three different perspectives. The first and most dominant view supports Diamond and Verrecchia's private information hypothesis, which states that short interest should have a negative relationship with stock returns. This view is supported by a number of empirical studies (e.g., Senchack and Starks, 1993; Choie and Hwang, 1994; Asquith and Meulbroek, 1995; Aitken et al., 1998; Desai et al., 2002; Asquith et al., 2005; Boehmer et al. 2008; Diether et al., 2009). In particular, Aitken et al. (1998) find that short sales are bad news as

short sellers tend to use market orders to execute selling orders, suggesting that they are informed traders. Asquith and Meulbroek (1995), Desai et al. (2002) and Asquith et al. (2005) all find that a high level of short interest in stocks is a bearish signal, indicating a negative relationship between the level of short interest and stock returns. Senchack and Starks (1993) and Choie and Hwang (1994) study the relationship between changes in short interest and stock returns and they too find large increases in short interest to be bearish signals. Thus, their study also supports Diamond and Verrecchia's (1987) prediction. Choie and Hwang's (1994) study is particularly interesting as they find that large simple increases and large percentage increases in short interest signal more about short returns than does a high level of short interest. Boehmer et al. (2008) document that heavily-shorted stocks on the NYSE significantly underperform lightly-shorted stocks, over 20 trading days, and that institutional non-program shorts are the most informed. Similarly, Diether et al. (2009) find that short sale strategies pay off in their dataset; portfolios of long slightly-shorted stocks and short heavily-shorted stocks yield positive abnormal returns over five trading days. Table 2.1 provides a summary of prior studies that find the informational role of short interest to be a bearish signal.

Table 2.1 Summary of Prior Studies on the Informational Content of Short Interest; Bearish Signal

Study / Objective	Sample Characteristics	Methodology	Informational Role of Short Interest (Signal) and Finding
Senchack and Starks (1993) • To analyse short-term daily abnormal returns following large increases in short interest.	• US monthly short interest in NYSE/AMEX covering the period from January 1980 to December 1986. • Short interest securities data (20th of every month) were published in the Wall Street Journal, Barrons, Financial Weekly and the New York Times from January 1980 to December 1986. Data sample filtered to include those stocks that experienced at least a 100% increase in short interest. • Daily return data for each security from CRSP Daily Return file.	• Event study. Event period is 15 trading days before (-15) and 15 trading days after (+15) the public announcement of short interest. Estimation period for model parameters from day -170 to -20. Days -20 to -16 were omitted from the period because, for a few months, there was an overlap with the previous month's short interest announcement.	• Bearish signal. Find stocks with 100% increase in announced short interest yield significant negative abnormal returns on event date and during post-event window. • Some significant negative reaction occurs in the extended period around the announcement date; this result is expected, given the potential for the leakage of this information.
Choie and Hwang (1994) • To analyse short-term daily abnormal returns following large increases in short interest.	• US monthly short interest in NYSE/AMEX covering 1989 to 1991.	• Test the price movements of stocks with large short positions relative to the market in the period prior to the monthly publication of short interest.	• Bearish signal. Find stocks with large short positions under-perform the market immediately following the short interest announcement. A strategy of shorting individual stocks with the largest increases in short interest and going long on the S&P 500 index yields an average monthly return of 1.07%.

Study / Objective	**Sample Characteristics**	**Methodology**	**Informational Role of Short Interest (Signal) and Finding**
Asquith and Meulbroek (1995) • To analyse long-term monthly abnormal returns for firms with a high level of short interest.	• US monthly short interest in NYSE/AMEX covering 1976 to 1993.	• Calculate excess returns using different methods: a) Scholes Williams excess returns from CRSP b) Net of market returns; firm return - equally-weighted market c) Market model return; firm return - b (market return) d) Size-adjusted excess return; firm return - return of the same sized decile portfolio	• Bearish signal. Heavily-shorted stocks under-perform the market on a risk-adjusted basis. High short interest appears to be a reliable indicator that the stock price will deteriorate in the future.
Aitken et al. (1998) • To analyse high-frequency abnormal returns following short selling of stocks.	• Australian short-selling tick data: 4,773 market short order trades and 10,548 limit short order trades occurring on the Australian Stock Exchange from January 1994 to December 1996.	• Measure abnormal returns for each interval by trade-to-trade, ask-to-ask, bid-to-bid and mid-point-to-mid-point. An abnormal return is the difference between the returns of short trades and those of matched non-short trades.	• Bearish signal. Find significant negative abnormal returns following short sales. Short sellers tend to use market orders for execution. This suggests that short sales are instantaneously bad news within a transparent market setting.
Desai et al. (2002) • To study the long-term relationship between the level of short interest and monthly stock returns of NASDAQ firms. • To determine the informational role of a high level of short interest: whether it is a bullish, bearish or neutral signal.	• US monthly short interest in the NASDAQ, covering June 1988 to December 1994. Monthly short interest data obtained directly from the NASDAQ, while data on stock returns, firm size, trading volume, share turnover, and delisting status are obtained from CRSP files.	• Follow Mitchell and Stafford's (2000) method of using a time series regression and a calendar time portfolio approach to measure performance over long horizons, to address the problem of cross-sectional dependence. • Regress the monthly portfolio excess returns on the three Fama and French (1993) factors as well as a fourth factor (momentum) suggested by Carhart (1997).	• Bearish signal. Find that firms with large short positions experience negative and significant abnormal returns when they are heavily shorted. Negative abnormal returns are increasing in the level of short interest.

Study / Objective	**Sample Characteristics**	**Methodology**	**Informational Role of Short Interest (Signal) and Finding**
Asquith et al. (2005) • To analyse long-term monthly abnormal returns for firms with a high level of short interest and institutional ownership.	• US monthly short interest in NYSE/AMEX from 1980 to 2002, and the NASDAQ from 1988 to 2002.	• Perform four-factor monthly time series regression model, based on Fama and French (1993) and Carhart (1997). Calculate abnormal returns on five different portfolios with high short interest.	• Bearish signal. Find that stocks with high short interest and low institutional ownership significantly under-perform the market on an equal-weighted basis.
Boehmer et al. (2008) • To analyse short-term daily abnormal returns on stocks, based on the level of short interest.	• US daily short order flow data in NYSE covering 2000 to 2004.	• Construct a long daily panel of short sales data, and perform Fama and French (1993) daily time series regressions based on different account types.	• Bearish signal. Find that heavily-shorted stocks significantly under-perform lightly-shorted ones over the following 20 trading days.
Diether et al. (2009) • To analyse short-term daily abnormal returns for shorted stocks.	• US short-selling daily data, aggregated from tick data in NYSE and the NASDAQ, covering 2005.	• Perform four-factor daily time series regression model, based on Fama and French (1993) and Carhart (1997), on five different portfolios.	• Bearish signal. Find that portfolios of long slightly-shorted stocks and short heavily-shorted stocks yield positive abnormal returns, over five trading days.

The second perspective, which is mostly shared by technical traders and analysts, argues for a positive relationship between a high level of short interest and stock returns. Although the literature on this is a bit dated, the view is well accepted among practitioners. According to this view, a high level of short interest represents a latent demand for shorted stocks. Short positions will need to be covered eventually and this will result in the eventual purchase of stocks, which will ensure that stock prices rise in the future. A high level of short interest is therefore a bullish signal (Epstein, 1995). Proponents of this perspective also suggest, from the 'contrarian opinion' point of view, that institutional investors do not sell short, so a high level of short interest indicates the increasing and misguided pessimism of the public and traders. They believe that the majority of those in these latter two groups are usually wrong, so a high level of short interest is a good buying indicator, hence a bullish signal (Biggs, 1966). To justify this view, Biggs (1966) quoted Joseph Granville's trading rule:

> "If the short interest is rising it means people are growing bearish on the issue. The further short interest rises, the more bearish is the public opinion on the stock. The market cannot accommodate that many people as being right and thus stock is destined to advance. A rising short interest is bullish, the longer it rises, the more bullish it is." (p. 111) [18]

However, despite its huge following among practitioners, there is no empirical evidence to support this view.

The final perspective offers no expected relationship between a high level of short interest and stock returns. Previous studies by Mayor (1968), Whitmarsh (1972) and Dyl (1977) suggest that shorting against the box is a good means to defer capital gains tax and is a major factor explaining the abnormal year-end trading volume anomaly in the US. Whitmarsh

[18]Joseph Granville was known as one of the top stock market gurus in the 1960s and 1970s.

(1972) defines 'shorting against the box' as a short sale against an existing long position. Brent et al. (1990) explain that the increasing trend in short interest in the US from 1974 to 1985 is mostly related to hedging and arbitrage motives, and also argue that short interest is less informative if it is motivated by arbitrage-related reasons. Using a UK dataset from 2003 to 2006, Au et al. (2009) also find no significant relationship between a high level of short interest and stock returns. They argue that short selling in the UK is dominated by arbitrage-related activities, hence lacks informational content, and thus using short interest as a selling signal may not be optimal. Table 2.2 presents a summary of the literature finding the informational role of short interest to be mixed or neutral.

Table 2.2 Summary of Prior Studies on the Informational Content of Short Interest; Mixed and Neutral Signals

Study / Objective	Sample Characteristics	Methodology	Informational Role of Short Interest (Signal) and Findings
Biggs (1966) • To analyse the validity of the view that a trend of rising short interest is bullish for the market action of a security, while declining short interest is bearish. The study focuses on long-term trends.	• A sample of 33 stocks is used. Sample criteria: (a) samples have a major price move during the period; (b) the short interest of the shares has to be significant relative to the trading volume; (c) the short interest is published in the Wall Street Journal.	• Studies the correlation between short interest and stock returns over a period of 16 months from January 1965 to April 1966.	• Mixed signal. Finds no meaningful correlation between the short interest trend and stocks' prices; mixed relationships found for the 33 stocks under study: 16 bearish, 14 bullish, 3 neutral.
Mayor (1968) • To investigate the relationship between the level of short interest and stock prices at firm and index levels.	• Weekly prices and short interest for a random sample of fourteen frequently shorted NYSE stocks and the S&P 500 index. The data are collected for a four-year period ending in early 1966.	• Applies a multivariate regression to weekly prices and short interest for the index and for individual stocks.	• Neutral signal. Finds no significant relationship between the level of short interest and the index prices. The short interest level is therefore not useful as a means of predicting future stock prices.
Whitmarsh (1972) • To explain the benefit of shorting against the box.	• Descriptive tax paper.	• No methodology.	• Neutral signal. Explains the benefit of shorting against the box. While profits from a long sale under the US Inland Revenue code are subject to capital gains tax, profits from a short sale are not. As a result, there is a motivation for long sellers to initiate short sales when they are in the money so as to defer the capital gains tax while keeping the original long position open.

Study / Objective	**Sample Characteristics**	**Methodology**	**Informational Role of Short Interest (Signal) and Findings**
Dyl (1978) • To evaluate the costs and benefits of realizing capital gains by selling short against the box in lieu of selling the stock outright.	• Theoretical paper.	• Presents a deterministic model for evaluating the aforementioned costs and benefits.	• Neutral signal. The decision over whether to sell outright or sell short depends on the relative magnitude of the capital gain to be realized, the investor's current and expected future tax rates, the interest rate and the length of time the short position will remain open.
Brent et al. (1990) • To explain why there is a general increase in short interest and why certain securities have a higher propensitiy to be held short.	• Aggregate market short interest on a monthly basis from the NYSE Fact Book from January 1974 to January 1986. A random sample of 200 stocks is drawn from the NYSE at the beginning of each year from 1981 to 1984. Security returns taken from CRSP tape.	• Compute the monthly characteristics of a percentage change in the proportion of shares held short in the NYSE, 1974-1985. • Perform cross-sectional tests of belief and arbitrage for each year, with a pooled sample. • Perform cross-sectional regressions explaining the percentage of shares held short.	• Neutral signal. Find that firms with high betas, options and convertible securities tend to have more shares held short. Conclude that the main purposes of shorting are hedging and arbitrage.
Au et al. (2009) • To analyse long-term 52-week abnormal returns on stocks, based on the level of short interest.	• UK weekly short interest data from 2003 to 2006.	• Perform Fama and French (1993) weekly time series regressions on five portfolios sorted according to the level of short interest.	• Neutral signal. Find that heavily-shorted stocks do not under-perform on a risk-adjusted basis over the following 52 weeks.

2.6.2 Short-Selling Constraints and Stock Returns

Fundamentally, there are two types of short-selling constraints. The first is in the form of an additional cost of engaging in short selling, with securities needing to be located and borrowed and fees paid for them. The second constraint takes the form of prohibition. For instance, in times of falling stock markets, financial regulators may impose a ban on short selling. With respect to the short-selling constraint, Miller (1977), for example, argues in favour of the overpricing hypothesis, where stocks under a short-selling constraint for which there is a wide divergence of opinion are likely to become overpriced due to the more optimistic investors being able to absorb the shares, and the less optimistic ones being constrained from participating in price discovery. In other words, short-selling constraints will prevent negative information from being incorporated into stock prices and this will result in the overpricing of these stocks. In the absence of such constrains, a sufficient amount of short selling would increase the volume of securities outstanding until the price was forced down to the average valuation of all investors. On the basis of Miller's theoretical framework on short-selling constraints, Figlewski (1981) hypothesizes that a high (low) level of short interest predicts overpricing (underpricing) in individual stocks, but finds mixed support for this hypothesis.

Jarrow (1980), on the other hand, disagrees with Miller's argument, claiming that the latter neglects changes in the aggregate demand of those investors for whom the short-selling constraint is not binding. Jarrow (1980) argues that the relative prices of risky assets could rise or fall, depending upon the underlying parameters in the economy, as long as investors disagree about the covariance matrix of the next period's asset price. This means that, depending on investors' expectations, the prices of stocks can either increase or decrease when a short-selling restriction is eliminated. For example, suppose we take a simplified

market, in which there are two stocks, A and B, that initially cannot be shorted. If the market rules are changed to allow short selling, investors cannot be sure that both stocks will fall in price. Investors who are bullish on stock A will short stock B and use the proceeds to buy more of stock A. The supply of stock B will increase and the price of stock B will decrease, as Miller (1977) predicts. Additional demand for stock A will increase the price of stock A. In short, Jarrow (1980) recognizes that optimists may use the short sale market to finance the purchase of assets about which they hold bullish views.

The focus of this thesis is the impact of a short-selling ban on stock prices and market quality. Early studies (Miller, 1977; Figlewski, 1981) note that pessimists wish to sell short. Constraining the ability of pessimists to trade without constraining optimists should produce an upward bias in stock prices. Diamond and Verrecchia (1987) challenge Miller's conclusions, using a rational expectations framework. While short-selling constraints eliminate some informative trades, such constraints should not produce an upward bias in prices, because rational investors and traders will recognize the constraints and adjust their valuations accordingly, before making their trading decisions. A distinction is drawn between short-selling restrictions, and a ban on short selling, as explained at the start of this section. Short-selling restrictions might include, for example, the imposition of an additional cost on borrowing, which makes short selling less attractive. In this situation, only those investors who are highly informed, and have a strong expectation of a significant price decline, will choose to short. Effectively, a restriction of this kind changes the proportion of traders who are informed, by driving the uninformed out of the pool of short sellers. This reasoning suggests that short-selling restrictions increase the informational content of short-sale transactions, thereby increasing informational efficiency. On the contrary, prohibition eliminates short selling by informed and uninformed traders alike, leaving the proportions of

informed and uninformed unchanged. Prohibition reduces informational efficiency, especially with respect to bad news, and thereby reduces market quality.

Hong and Stein (2003) suggest that short-selling constraints prevent bearish investors from participating in the market. When bearish investors' signals are concealed, only bullish investors' information is revealed in stock prices. If some bullish investors bail out, the original bearish group may become 'support buyers'. Bullish investors then become aware of the bearish group's previously concealed signals, resulting in a market decline or crash. Likewise, Bai, Chang and Wang (2006) suggest that short-selling constraints cause marginal investors, who are rational but risk-averse, to perceive a higher risk associated with constrained stocks. This perception causes risk-averse investors to reduce their demand for these stocks, reducing their price and increasing their volatility.

Empirical Evidence

Much of the empirical evidence supports Miller's (1977) overpricing hypothesis. Proxies used for short-selling constraints, however, are diverse, including the level of short interest and the short-interest ratio (Figlewski, 1981; Asquith and Meulbroek, 1995; Desai, Thiagarajan and Balachandran, 2002; Asquith, Pathak and Ritter, 2005), the introduction of option trading (Figlewski and Webb, 1993; Danielsen and Sorescu, 2001), the stock-lending supply (D'Avolio, 2002; Geczy, Musto and Reed, 2002; Jones and Lamont, 2002; Saffi and Sigurdsson, 2011), the percentage of institutional ownership (Chen, Hong and Stein, 2001; Asquith et al., 2005; Nagel, 2005), and a designated or 'allowed-to-short' list (Chang, Cheng and Yu, 2007). In a multi-country study, Charoenrook and Daouk (2005) investigate the effects of short-selling restrictions on market quality in each country. When short selling is

permitted subject to constraints, aggregate stock returns are less volatile, and liquidity is higher. Bris, Goetzmann and Zhu (2007) report that in jurisdictions where short selling is permitted, capital inflows are reduced and market efficiency is improved. Ali and Trombley (2006) argue that short-selling constraints, proxied by stock-lending fees, are important in preventing arbitrage of momentum in stock returns. Further, Thomas (2006) points out that short-selling constraints are difficult to calibrate, especially in the UK context, and suggests that more high-frequency analysis is needed to provide conclusive evidence on the role of short sales.

Several empirical studies offer direct tests of Miller's (1977) overpricing hypothesis and Diamond and Verrecchia's (1987) no overpricing hypothesis (or the lower market quality hypothesis). Frino et al. (2011) investigate the effect on stock prices and market quality by comparing eleven countries in which a short-selling ban was implemented, and three countries with no ban. There was a positive price effect in most of the eleven countries that were subject to prohibition, including the UK, and a reduction in market quality in all eleven of them. Beber and Pagano (2012) examine the impact of restrictions on short selling in 30 countries. There was a deterioration in market quality for stocks subject to a short-selling ban, but empirical support for Miller's overvaluation hypothesis is found in the US only. Boehmer et al. (2009), Boulton and Braga-Alves (2010) and Kolasinski et al. (2010) examine the impact of the short-selling ban in the US. Collectively, these studies identify a positive price effect and a reduction in market quality, evidenced by increasing volatility, deteriorating liquidity, and widening bid-ask spreads. Braga-Alves (2010) provides evidence in support of Miller's overvaluation hypothesis but Boehmer et al. (2009) suggest that evidence of a positive price effect following the short-selling ban might be confounded by the US government bail-out packages that were announced at the same time.

In addition to Beber and Pagano's (2012) and Frino et al.'s (2011) multi-country studies, both of which include the UK, Clifton and Snape (2008), Marsh and Niemer (2008) and Hansson and Fors (2009) report evidence that the UK short-selling ban reduced market quality. Results concerning any price effect are mixed, however. Hannson and Fors (2009) and Beber and Pagano (2012) find that the price effect is neutral, while Frino et al. (2011) report a positive price effect consistent with the overvaluation hypothesis. We believe the conflicting results concerning the price effect may be explained by sample selection effects. Only Hansson and Fors (2009) compare stocks that were subject to the ban with a control group; however, they only consider an incomplete list of stocks that were subject to the ban. Meanwhile, both Beber and Pagano (2012) and Frino et al. (2011) draw comparisons at a country level, rather than at the level of individual stocks. A summary of prior studies on short-selling bans is shown in Table 2.3.

Table 2.3 Summary of Prior Studies on Short-Selling Bans

Study / Level of Comparison	**Sample Characteristics**	**Methodology**	**Findings**
Clifton and Snape (2008) • Firm-level comparison	• 15 stocks subject to a short-selling ban vis-à-vis a matched sample of 78 FTSE100 stocks.	• Panel regression	• Find evidence that, for the banned stocks, bid-ask spreads increase significantly and depth, trades, volumes and liquidity decline significantly following the ban.
Marsh and Niemer (2008) • Firm-level comparison	• 23 stocks subject to a short-selling ban vis-à-vis a matched sample of 335 FTSE350 stocks.	• Bootstrapping and panel regression	• Find no strong evidence that the imposition of restrictions on short selling in the UK changed the behaviour of stock returns. Restricted stocks behave in the same way as unrestricted stocks before and after the restriction.
Hansson and Fors (2009) • Firm-level comparison	• 23 stocks subject to a short-selling ban vis-à-vis a matched sample of 321 FTSE350 stocks.	• Event study and panel regression	• Find no evidence of any effects of the ban on abnormal returns or volatilities, largely due to the extreme level of noise during the financial crisis. However, there is evidence of widening bid-ask spreads and decreasing activity in the affected stocks during the ban.

Study / Level of Comparison	**Sample Characteristics**	**Methodology**	**Findings**
Beber and Pagano (2012) • Country-level comparison	• 33 stocks subject to short-selling bans vis-à-vis a matched sample of an unstated number of stocks. • Employ panel data in 30 countries to identify the effect of short-selling bans. Sample countries that imposed a short-selling ban (20 countries) were Australia, Austria, Belgium, Canada, Denmark, France, Germany, Greece, Ireland, Italy, Japan, Luxembourg, the Netherlands, Norway, Portugal, South Korea, Spain, Switzerland, the UK and the US. • Sample countries that did not impose a short-selling ban (10 countries) were the Czech Republic, Finland, Hong Kong, Hungary, Israel, New Zealand, Poland, Singapore, Slovenia and Sweden.	• Cumulative excess returns and panel regression	• Find that bans on short sales appear to have failed to support the market prices of a group of countries including the UK, thereby failing to meet the prime objective of the regulators. However, the authors find that the ban does support market prices in the US. • Overall, a ban is found to be detrimental for market liquidity, especially for stocks with small market capitalization, high volatility and no listed options.
Frino et al. (2011) • Country-level comparison	• Unstated number of stocks subject to short-selling bans vis-à-vis 100 largest stocks in FTSE100. • Sample countries that imposed a short-selling ban (11 countries): the US, the UK, Canada, Europe, Norway, the Netherlands, Belgium, France, Germany, Italy and Portugal. • Sample countries that did not impose a short-selling ban (3 countries): Japan, Sweden and Hong Kong.	• Event study and panel regression	• Find positive abnormal returns on the event day, indicating that a restriction on short selling leads to artificially inflated but reduced market quality, i.e., wider bid-ask spreads, increased price volatility, and reduced trading activity.

Impact of Short-Selling Bans on Contagion

While most studies cite two of the FSA's objectives in implementing the short-selling ban, namely providing stability and protecting market quality, a third key objective, preventing contagion from the financial sector to non-financial sectors, is rarely cited. The impact of the ban on short selling on cross-sectoral contagion is a largely neglected topic. Forbes and Rigobon (2002) define contagion as a significant increase in cross-market linkages following a shock in one market. Cross-market correlations between returns, used to measure contagion during a stable period and immediately after a shock or crisis, are sensitive to market volatility. The authors adjust for heteroskedasticity bias by estimating the unconditional correlation. After this adjustment, they find virtually no increase in unconditional correlation, and therefore no evidence of contagion, during either the 1997 Asian crisis, the 1994 Mexican devaluation or the 1987 US stock market crash. A high level of market co-movement during these periods is attributed to interdependence rather than contagion.

One of the objectives of the present study is to empirically assess the impact of the imposition and subsequent removal of the ban on short selling in the UK. The assessment will use measures of abnormal returns and market quality for all stocks that were subject to the ban, and for a matched sample of stocks that were outside its scope. This study also searches for evidence of cross-sectoral contagion from the financial sector to non-financial sectors. The empirical investigation is expected to provide evidence relevant to the evaluation of the theories developed by Miller (1977), Diamond and Verrecchia (1987), Hong and Stein (2003) and Bai et al. (2006).

2.6.3 Informational Content of ETF Short Interest

As far as the short selling of ETFs is concerned, no empirical exercise has been undertaken as yet to study the impact it has on price, perhaps mainly due to the opacity of the ETF short interest data. This thesis is the first to study the informational content of ETF short interest and is motivated by Gastineau's (2004) lengthy discussion of the benefits of the ETF as a risk management tool, in which the author draws comparisons with stocks and futures within the US context. According to Gastineau (2004), the trading flexibility and open-endedness of ETFs offer unusual protection to short sellers in several ways. First, it is essentially impossible to suffer a short squeeze in ETFs due to their open-ended capitalization and diversification requirement, while in practical terms, 'cornering' or taking control of a sufficient portion of an ETF market to be able to engage in manipulation is unimaginable. Second, most ETF short sales are made to reduce or offset the risk of a related financial position. In other words, risk managers sell ETFs short to reduce the total risk in a portfolio. Third, short sales in ETFs can be executed without a price uptick; requiring upticks for short sales is unnecessary for ETFs that compete in risk management applications with sales of futures, swaps and options. This is due to the fact that risk management instruments have never had uptick rules. Finally, a disadvantage of using derivative contracts as a risk management tool is their limited lifespans. While risk managers can take futures positions with more distant settlements, liquidity is usually concentrated in near month contracts, thus they would typically use such a contract and roll the position forward as it approaches expiration. With this practice, risk managers face a considerable roll risk, that is, there is a risk of an adverse market impact from rolling the hedge forward to the next expiration date. A huge advantage with ETFs is that the hedger, having shorted the ETF, can hold the hedging position indefinitely without having to face roll risk.

On the basis of these arguments, Gastineau (2004) maintains that large short positions in ETFs may be motivated by hedging and tax-related reasons. Thus, they may lack informational content, in that a large level of short interest will not necessarily indicate that short sellers expect the ETF portfolio to under-perform other ETFs in the same sector. A similar view is held by Brent et al. (1990), who contend that short interest is less informative if it is motivated by tax and arbitrage-related reasons. However, this view runs counter to Diamond and Verrecchia's (1987) private information hypothesis and the popular Wall Street bullish signal view discussed earlier.

2.7 Summary and Conclusion

This chapter provides a review of the literature on short selling. The three major themes described in this chapter are (a) the informational content of short interest, (b) the effect of a short-selling constraint on stock returns and contagion and (c) the informational content of short interest in relation to ETFs.

On the basis of these themes, this thesis undertakes empirical exercises to address the current gap and thus contribute to the growing literature on short selling. First, the next chapter, "Short selling and stock returns" examines the informational content of short interest in the UK market. In particular, studies on informational content in the UK context are scarce; the study reported in this thesis is made possible by the greater availability of high-quality and high-frequency, daily data, that has only emerged recently. The chapter after that, "Short-selling bans and cross-sectoral contagion", deliberates on the effect of the enactment of the FSA's ban on short selling, on stock returns and market quality. In addition, the chapter investigate the cross-sectoral contagion between financial and non-financial sectors, before

and while the ban was in force. This part of the study is particularly interesting since the FSA's short-selling ban has been the subject of debate by many market participants during the recent financial crisis of 2008/2009. Finally, Chapter 6, "Is the shorting of ETFs a dangerous financial sport?" extends Gastineau's (2004) argument that ETFs, being effective risk management tools, do not carry informational content in their announced short interest information. Prior analytical work by Diamond and Verrecchhia (1987), however, provides a framework suggesting that unusually large increases in short interest provide a bearish signal. In answer to these competing theories, this study attempts to provide empirical evidence and add a fresh new brick to the block of short-selling literature.

Chapter 3

Short Selling and Stock Returns

3.1 Introduction

A fundamental question for investors, researchers and policymakers is whether short selling leads to predictable changes in stock prices. An increase in the short interest in a stock is often viewed as a signal that the stock price is going to fall, since market participants may believe that short sellers possess significant private information. In general, a short sale is costlier to execute than a long sale. To short, sellers first have to locate stocks they want to short and they then have to pay the borrowing costs. As a result of this constraint, Diamond and Verrecchia (1987) predict that only investors who have strong expectations of a considerable price decline will choose to short, hence large increases in short interest should be followed by negative abnormal returns. This price adjustment to short sellers' information may be far from instantaneous (Boehmer, Jones, & Zhang, 2008), and this can be regarded as consistent with a limit-to-arbitrage setting in which rational arbitrageurs are unable to costlessly borrow and arbitrarily short a sufficient quantity of stock to force rapid price adjustment.

Our study is motivated by Diamond and Verrecchia's (1987) rational expectation framework which argues that short sellers are not liquidity driven traders, instead they are sophisticated traders with private information. That is, when short sellers short the stocks they expect the stock price to drop, hence large increases in short interest are regarded as bad news. Thus, the main aim of this paper is to provide empirical exercise of Diamond and Verrecchia's (1987) prediction. In particular, this paper examines whether firms that experience large increases in short interest subsequently experience negative abnormal returns. Here, we define large increases in short interest as the top one percentile of changes in short interest. We also carefully separate the sample into dividend arbitrage shorts and those involving pure bets on price falls, i.e., valuation shorts in order to assess the informational content of both types of short position. Previous UK studies of short interest utilised weekly data, we, however, focus on short-term abnormal returns, and thus utilise daily short interest data. To our knowledge, no previous study has examined the informational content of large daily increases in short interest in the UK stock market. This non-occurrence may be due to several reasons. The lack of suitable data might have previously restricted research in this area. Monthly short interest data have been publicly available in the US, for example, since the 1980s, whereas stock lending data in the UK (a proxy for short interest) has only been available since September 2003. Furthermore, the necessity of using stock lending data as a proxy for short interest in the UK market may have deterred prior research in this area.

The empirical results show that for the overall period of 2003 to 2010, when short selling data are separated into valuation short and dividend arbitrage short subsamples, large increases in valuation shorts have greater informational value than large increases in dividend arbitrage shorts. Valuation shorts yield significant negative cumulative

abnormal returns of 0.28% and 1.48% for the first two days and 15 days post-publication of short interest, respectively. This finding is generally consistent with Senchack and Starks (1993), Boehmer et al. (2008) and Diether et al. (2009) for US datasets. As a robustness test, we examine the informational content of short interest in the periods before and after September 2008 in order to assess the impact of the financial crisis. We also consider abnormal returns before and after the September 2008 - January 2009 short selling ban. We find no significant difference in the mean abnormal returns of valuation shorts between the sub-periods, suggesting a consistent informational content of short interest throughout the period of the data sample. For dividend arbitrage shorts however, there are differences in mean abnormal returns between the sub-periods in certain event windows.

We contribute to the growing short selling literature in several ways. First, this is the first study to use high frequency data to examine the effect of large increases in short interest on stock returns in the UK stock market as a direct test of Diamond and Verrecchia's (1987) 'Private Information Hypothesis'. Indeed, there are a limited number of studies on short selling in the UK. The only prior UK study on short selling by Au, Doukas and Onayev (2009) uses a low frequency of weekly horizon data. The main methodological advantages of a daily data set include the ability to control for contaminating events and to employ an event-study methodology for a more detailed investigation of the informational content of short interest (Thomas, 2006). Previous studies on changes or increases in short interest and subsequent stock returns (e.g. Senchack & Starks, 1993; Choie & Hwang, 1994) concentrate on the US market, where the unavailability of daily data until more recently dictated the use of monthly changes in short interest as a predictor of future stock returns. For US studies, Boehmer et al. (2008) and Diether, Lee

and Werner (2009) are among the first authors to use high frequency daily and tick data, respectively, to investigate the informational content of short interest. Boehmer et al. (2008) use proprietary daily short selling order flow data, whereas Diether et al. (2009) use tick data on all short sales executed in the US in 2005. Secondly, the previous UK study on the level of short interest (Au et al., 2009) uses stock lending data as a proxy, but does not separate the sample into stock lending data associated with dividend arbitrage (dividend arbitrage shorts) and those involving pure bets on price falls (valuation shorts). The separation of dividend arbitrage shorts and valuation shorts in the current study allows us to compare the informational content of both types of short position. Thirdly, this paper also considers whether large increases in short interest convey the same information during different states of the economy. Finally, the event-study methodology used in the current paper enables us to examine the market reaction to the disclosure of large increases in short interest.

The remainder of this paper is organised as follows. In the next section, we provide a brief description of the UK short selling and stock lending mechanism. We review the related literature on the informational content of short interest in Section 3.3. Section 3.4 describes our data and research methodology. Section 3.5 reports our results and finally Section 3.6 offers some concluding remarks.

3.2 The Mechanism for Short Selling in the UK

The short selling mechanism in the UK is very different from that in the US. Unlike in the US, a short sale trade in the UK is not specifically marked as such; therefore it is not possible to differentiate between a short sale and a long sale in transaction data. One

result of this limitation is that there are no tick rules in the UK market. Tick rules allow relatively unrestricted short selling in a flat or advancing market, but prevent short selling at successively lower prices and hence help to mitigate the risk of short selling accelerating a downward move in share prices. An up-tick (or plus-tick) rule provides that the last sale must have been at a higher price than the sale preceding it before a share can be short sold. A zero-plus tick rule provides that if the last transaction price is unchanged but higher than the preceding different sale then the stock can be shorted. In the US, short sales are not permitted on minus ticks or zero-minus ticks. The lack of such rules in the UK may enable short interest in a stock to build up relatively quickly, and the returns following such large increases in (relatively unconstrained) short interest are of particular interest from a research and policy perspective.

The most common reason to borrow stocks is to cover a short sale, with the short seller borrowing the stock to deliver to the buyer on settlement. Some transactions captured in the stock lending data may reflect other motives. Given that under English Common Law a stock borrowing transaction involves absolute transfer of title (sale) against the undertaking to return equivalent securities in the future, the borrower obtains other rights that might provide a rationale for the stock borrowing transaction, including the rights to sell or lend the stock to another buyer and the right to vote at Annual General Meetings. Borrowing securities for the specific purpose of influencing a shareholder vote is not, however, regarded as acceptable market practice in the UK (Faulkner, 2007), with the result that most stock lending is likely to be associated with genuine short positions in a stock, and stock lending data can be regarded as a reasonable proxy for the outstanding level of short interest. Euroclear UK and Ireland (Euroclear), as the UK's central securities depository, provides custodian services and operates the securities settlement

system for at least 95.6%[19] of the UK securities market. Euroclear has published monthly and daily stock lending data since 01 September 2003.

The lender's motivation in a stock lending transaction is to earn a fee. According to the capital markets advisory firm Makinson Cowell (2005), stock lending fees in the UK can be as low as 5 basis point per annum (of the total value of the loan), or as high as 400 basis point or more in extreme circumstances. The great majority of transactions are at the lower end of this range, and the average fee in the UK market is around 14 basis points per annum. Small capitalisation stocks typically require much higher short selling fees than large capitalisation stocks. In the US, average stock lending fees for majority of stock are around 17 basis points per annum (D'Avolio, 2002). In a similar vein, Ali and Trombley (2006) also use stock lending fees as a proxy for short sale constraint. They all find high stock lending fees are important in preventing arbitrage of momentum in stock returns. Nagel (2005) and Asquith et al. (2005) on the other hand, use institutional ownership as a proxy for short sale constraint. Generally, these literatures argue that low institutional ownership makes stock lending fees expensive, hence explaining cross-sectional stock returns anomalies.

Within the short interest proxied by the stock lending data, short positions in a stock may reflect dividend arbitrage (dividend arbitrage shorts) or more general short selling (valuation shorts). Makinson Cowell (2005) states that stock lending levels among its FTSE 100 clients regularly rise to 10% and above around dividend record dates, as compared to an average level of 0.5% over the period 2003 to 2005, signifying high

[19]Euroclear UK and Ireland Newsletter Statistics for January 2011.

levels of stock lending associated with dividend arbitrage activity. Asimakopoulos and Hodgkinson (2001) document that share prices drop significantly following ex-dividend and the amount of drop is indifferent from the value of dividend paid. Even though short sellers or stock borrowers are obliged to make equivalent manufactured payments back to the lender (owner), we believe investors may still be motivated to borrow and short for two reasons. First, if investors foresee share prices to fall by more than the ex-dividend amount and if there is a time value to the ex-dividend amount paid. Secondly, if investors receive tax benefits, for example,

> "French tax rules provide French investors with a 10% tax credit on dividend income that is not available to UK shareholders. Therefore a number of institutions, led by French banks such as BNP Paribas and Credit Lyonnais, enter into agreements to borrow UK equities ahead of the dividend record date in order to receive the dividend payment. As the borrower can derive a greater net dividend return from the equity than the lender, the former can compensate the latter for the lost dividend and still profit" (Makinson Cowell, 2005, p.5).

Hence, an increase in short interest may be attributable to dividend arbitrage. Since the informational implications of dividend shorts may be different from those of short selling motivated by non-dividend information, it is important that research methodologies address these two key components of the stock lending data[20].

3.3 Related Literature

Three main theoretical hypotheses can be identified in the literature relating to the relationship between the level of short interest and subsequent stock returns. Diamond and Verrecchia (1987) argue in their 'Private Information Hypothesis' that, in a rational

[20] In doing so, we extract all ex-dividend dates of the stocks that experience largest increases (top one percentile) in short interest from Bloomberg and we manually match the date of largest increases in short interest with the nearest ex-dividend dates. If the largest increases in short interest occur within 30 days before ex-dividend dates, we classify the samples as dividend arbitrage shorts.

expectations framework, there are two types of short sale effects: short sale prohibition effects and short sale restriction effects. When short selling is completely prohibited, the impact on informed and uninformed traders is equal and informational efficiency is reduced, especially with respect to private bad news. When short selling is restricted, either directly or through the imposition of additional costs, however, uninformed traders tend to be driven out of the pool of shorts and informational efficiency may be improved. In this scenario, only well-informed traders (those with very strong expectations of a price decline) will choose to bear the cost of shorting stock, and unexpected, unusually large increases in short interest tend to signal poor subsequent returns.

The second approach hypothesises a positive relationship between high levels of short interest and subsequent stock returns (Epstein, 1995). A high level of short interest represents a latent demand for shorted stocks since short positions will ultimately need to be covered through a buy transaction. Finally, there may be no significant relationship between a high level of short interest and stock returns. Brent, Morse and Stice (1990) argue that increasing levels of short interest in the US between 1974 and 1985 are mainly driven by hedging and arbitrage, with short interest due to arbitrage being less informative and hence unlikely to have a significant impact on future returns.

The majority of prior empirical studies of the informational content of short interest consider the predictability of long-term abnormal returns based on the level of short interest in the stock (e.g. Asquith & Meulbroek, 1995; Desai, Ramesh, Thiagarajan & Balachandran, 2002; Asquith, Pathak & Ritter, 2005; Au et al., 2009). A smaller number of studies focus on the predictability of short-term abnormal returns by examining the

effect of monthly changes in short interest on stock returns (e.g. Senchack & Starks, 1993; Choie & Hwang, 1994). In a later study using NYSE daily short selling proprietary order flow data, Boehmer et al. (2008) compare abnormal stock returns across different types of accounts and degrees of shorting. Diether et al. (2009) use high-frequency data to assess the cross-sectional pattern of short selling. Most of the prior empirical literature is based on US data. Exceptions include Aitken, Frino, McCorry and Swan (1998), who investigate the informational content of short selling orders in Australia using high frequency data, and Au et al. (2009), who consider the relationship between the level of short interest and medium-term (52-week) stock returns in the UK.

The Diamond and Verrecchia 'Private Information Hypothesis' view of short interest is supported by a number of prior empirical studies (e.g. Asquith & Meulbroek, 1995; Aitken et al., 1998; Desai et al., 2002; Asquith et al., 2005; Boehmer et al., 2008; Diether et al.,2009). Asquith and Meulbroek (1995), Desai et al. (2002) and Asquith et al. (2005) all find a negative relationship between high levels of short interest and subsequent stock returns. Senchack and Starks (1993) and Choie and Hwang (1994) study the relationship between changes in short interest (rather than level of short interest) and stock returns and similarly find a negative relationship between short interest and returns. Boehmer et al. (2008) find that heavily shorted stocks in NYSE significantly underperform lightly shorted stocksover periods of 20 trading days. Diether et al. (2009) similarly find that portfolios combining long positions in lightly shorted stocks and short positions in heavily shorted stocks yield positive returns over periods of five trading days. Choie and Hwang (1994) find a stronger relationship between large increases in short interest (both in simple and percentage terms) and subsequent returns than between the level of short interest and returns. Blau, Van Ness, Van Ness and Wood (2010) find that short selling

of NYSE stocks increases (decreases) during large down (up) days suggesting short sellers tend to follow the crowd during extreme market movements.

The results of these prior studies inform the methodology of the current paper, which examines the relationship between particularly large increases in short interest and subsequent abnormal returns over periods up to 15 trading days. This differs from the approach taken by Au et al. (2009) in the main prior study using UK data, who find no significant relationship between high levels of short interest and 52-week stock returns. It is argued that these results show that short selling in the UK is dominated by arbitrage, consistent with Brent et al.'s (1990) hypothesis, and hence lacks informational content. Given the results of prior studies using US data however, large changes in the level of short interest may have informational content in the short term, and this is the focus of the current study. Furthermore, results from the UK market are of broader interest due to the lack of tick rules in the UK, which may impact on the informational value of short interest. Finally, the current study is one of the first to explicitly consider the different informational value of valuation shorts and dividend arbitrage shorts in the UK market. To the extent that short interest has informational value for future returns, this is expected to be concentrated in valuation short stocks rather than arbitrage short stocks.

3.4 Research Methodology

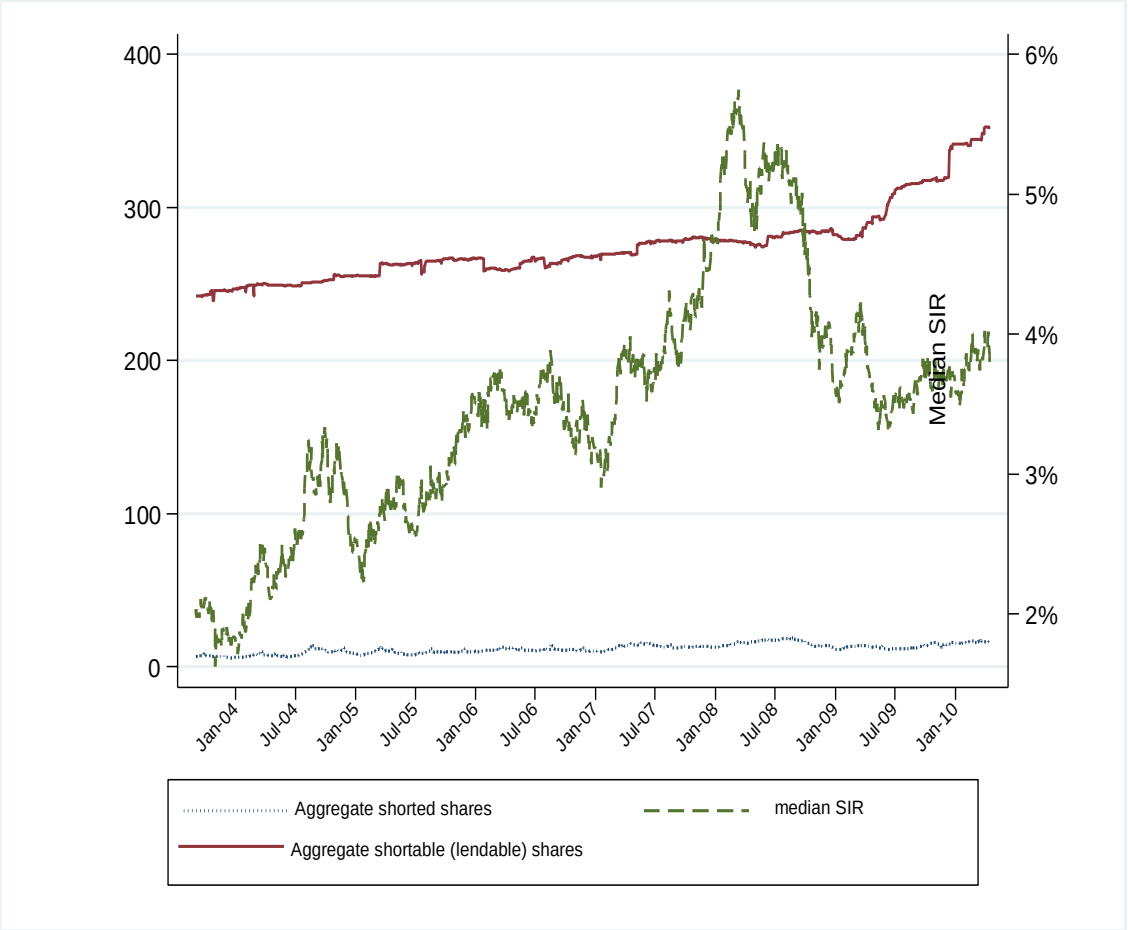
3.4.1 Sample Selection

The dataset for daily shares on loan for all FTSE 350 stocks are obtained from Euroclear UK and Ireland for the period September 2003 to April 2010 and used as a proxy for the level of short interest. Daily stock price, market value and dividend yield data, together

with ex-dividend dates, listed option status and convertible bond information are sourced from the Datastream and Bloomberg databases. The population consists of 463,811 observations.

Figure 3.1 illustrates the growing importance of short selling in UK equity markets across the period covered by the data sample. We present three measures: the aggregate quantity of shorted stock, the aggregate supply of shortable stocks in Euroclear and the median of the short interest ratio (SIR), which expresses short interest as a percentage of the available supply of shortable stocks. We observe an upward trend in the aggregate supply of shortable stocks over the sample period. Short selling, however, appears to become less prevalent, both in terms of stock volume and as a percentage of the available supply of shortable stocks following the short selling ban on financial stocks in September 2008.

Figure 3.1 Time Series of Three Short Selling Measures.



Notes: This figure shows market aggregate shorted, shortable and median short interest ratio (SIR) for FTSE 350 stocks from September 2003 to April 2010. The SIR is the percentage of available (lendable) supply of shares sold short. The aggregate shortable (lendable) share is the total number of shares that can be borrowed and shorted. The aggregate shorted share is the total number of shares shorted by investors.

We are particularly interested in stocks that experience significant large increases in short interest. Euroclear publishes daily stock lending data on the third trading day so, for example, data relating to stock lending positions on Monday will be made available on Thursday. We define the short interest ratio as the number of stocks on loan divided by the number of stocks available to be loaned through Euroclear. The change in short interest is the simple arithmetic change in this ratio from one day to the next. As discussed in Section 3.3, the focus of the current paper is the relationship between particularly large increases in short interest and subsequent returns, hence the top one

percentile of daily changes in short interest (i.e., 4639 stock-day observations) is identified as the initial sample. In order to apply the event-study methodology, we require complete data covering a 115 trading day estimation window prior to the large increase in short interest. That is, we consider only the first large increase in short interest as a sample if more than one occur in the 115 trading day period to ensure no confounding effects. Further criteria as reported in Table 3.1 below are applied which further reduce the size of the sample.

Thomas (2006) and Makinson Cowell (2005) argue that large increases in stock lending may reflect scrip dividend arbitrage. Therefore, to segregate the possibly confounding effect of ex-dividend trading, we split the sample into dividend arbitrage shorts (where the large increase in short interest occurs within 30 days of the stock going ex-dividend) and valuation shorts (all other large increases in short interest). In general, arbitrage shorts are not expected to have informational value, hence we exclude stocks of companies that are involved in acquisition activity (acquirer[21] stocks) and stocks of companies that have convertible bonds and where the short interest may therefore be related to convertible[22] bond arbitrage. The application of these filtering criteria further reduces the sample to 955 observations. The final dividend arbitrage shorts subsample contains 500 observations and the valuation shorts subsample 455 observations. Table 3.1 shows the sampling process relating to our sample selection.

[21]To eliminate acquirer stocks from the sample, we specify that a) the acquirers acquire a listed company, b) the large change in short interest occurs between the acquisition's announcement dates and completion dates. According to Asquith et al. (2005), in a typical merger arbitrage (stock-for-stock exchange), investors go short in acquiring firms' stocks and go long in target firms' stocks.

[22]We do not report the analysis of acquisition (13 samples) and convertible bond shorts (71 samples) as the sample size is very small.

Table 3.1 Population of Changes in Short Interest and Sampling Process

Panel A: Descriptive statistics of the population of changes in short interest

N	Minimum	1st pctile	25th pctile	Median	Mean	75th pctile	99th pctile	Maximum	Std Dev
463,811	-27.14%	-1.17%	-0.05%	0.00%	0.00%	0.05%	1.18%	23.99%	0.52

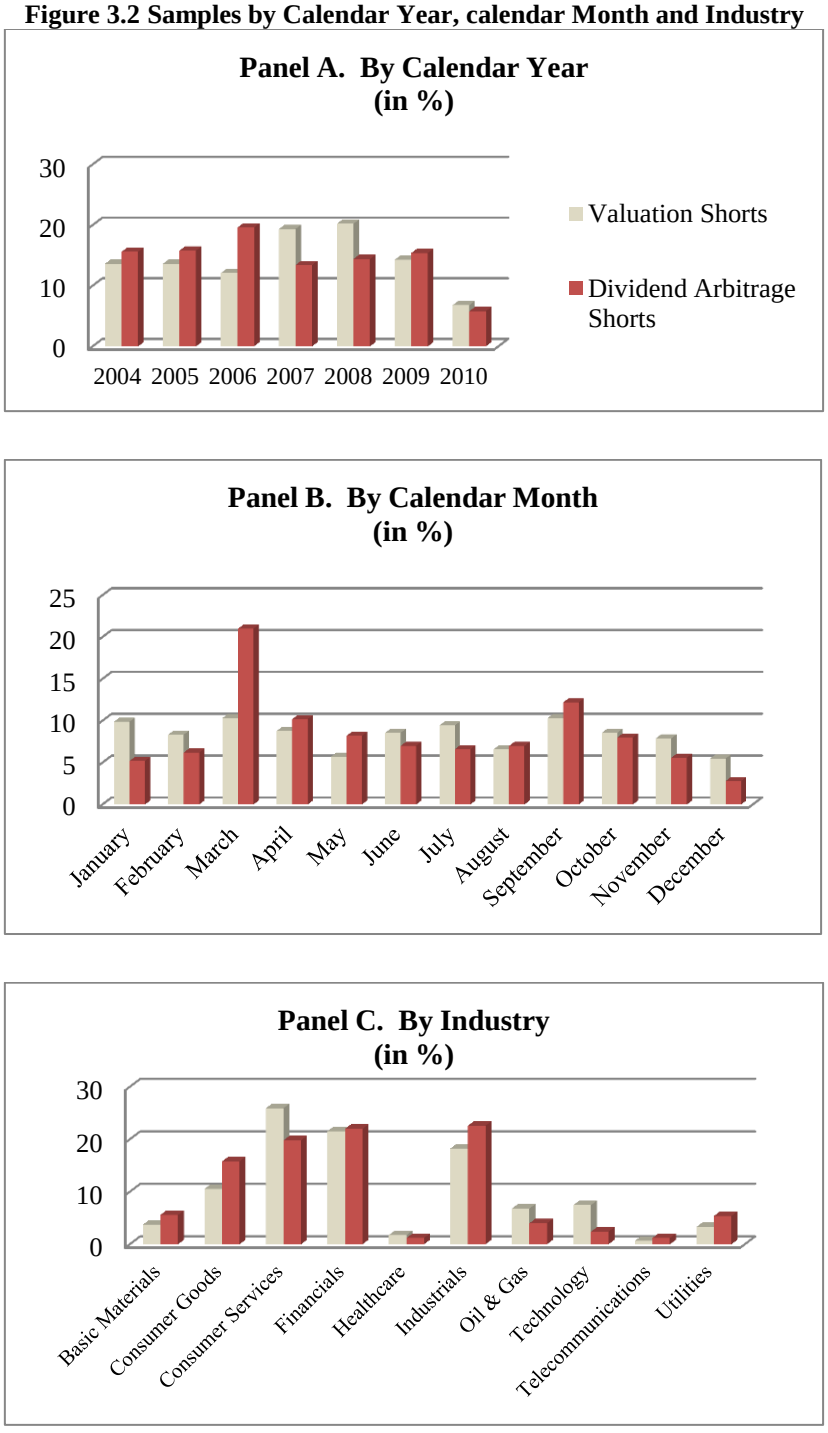
Panel B: Sampling Process	***N***
Take the top one percentile of largest changes (increases) in short interest	4639
Filter for 115 days estimation period prior to event of largest increases in short interest	(3600)
Separate merger and arbitrage samples	(13)
Separate convertibles arbitrage samples	(71)
Final samples	955
Dividend arbitrage shorts	500
Valuation shorts	455

Notes: Panel A provides descriptive statistics of the population of changes in short interest. Changes in short interest are defined as simple arithmetic changes in short interest ratio from one day to the next. We define largest increases in short interest as the top one percentile of changes in short interest, hence the cut-off for the largest increases in short interest is defined from 1.18% (99th percentile) to 23.99% (Maximum). Panel B describes the sample selection process. The short interest ratio is the percentage of available (lendable) supply of shares sold short. The initial sample is taken from the top one percentile of largest changes in short interest of the total population of 463,811 that gives an initial sample (*N*) of 4,639. The event-study estimation window is defined as 100 days from day-115 to day -16, thus we consider only the first largest increase in short interest as a sample if more than one occur in the 115 trading day period to ensure no confounding effects. A sample is deemed merger and arbitrage related if the increase in short interest occurs between announced and completion date. Convertibles arbitrage samples are defined if the stocks have convertible bonds in their balance sheet. We categorize samples as dividend arbitrage samples if the increase in short interest occurs within 30 days of the stocks going ex-dividend.

Figure 3.2 reports the characteristics of the resulting data sample by year, month of the year and by industry classification. In Panel B, we observe a different pattern in March and September particularly for dividend arbitrage shorts subsample. It is plausible that this is due to a seasonal effect, with more large increases in short interest in dividend arbitrage shorts in March and September than in other months coinciding with end-of-year dividend payments. Makinson Cowell (2005) also reports that stock lending levels for UK FTSE100 firms rise dramatically around March and September due to these firms going ex-dividend. Senchack and Starks (1993) on the other hand find a seasonality pattern from December to February in their US dataset and attribute the effect to tax selling. Panel C shows that consumer services, financials and industrials sectors represent

65.6% and 64.4% of the total samples of valuation shorts and dividend arbitrage shorts, respectively.

Figure 3.2 Samples by Calendar Year, calendar Month and Industry



Notes: These figures report the distribution of the top one percentile of stocks reporting largest changes (increases) in short interest day-over-day from September 2003 to April 2010, for valuation shorts and dividend arbitrage shorts subsamples, after separating for merger and acquisition as well as convertibles arbitrage samples. The total number of observations (*N*) for valuation shorts and dividend arbitrage shorts are 455 and 500, respectively. These samples are distributed by calendar year, calendar month and industry classification.

3.4.2 Research Design

Event-study methodology

To test for a relationship between the large increases in short interest and the subsequent abnormal returns, we calculate the abnormal returns by employing Fama and French (FF, 1993) three-factor model. We let R_{it} denote the daily logarithmic return for stock *i* on day *t*, R_{mt} denote the daily logarithmic return on the FTSE350 index and R_{ft} denote average daily return on three-month UK Treasury-Bill[23]. The daily size factor (SMB_t) and value factor (HML_t) are calculated for the UK market following the standard approach described by FF, using data on all listed UK stocks[24]. We estimate the following three-factor model over the estimation period (days *s*= –115 to *s*= –16, defined relative to the event date):

$$R_{is} = \hat{a}_i + \hat{b}_i \left(R_{ms} - R_{fs}\right) + \hat{s}_i SMB_s + \hat{h}_i HML_s) + \varepsilon_{is} \qquad (3.1)$$

The coefficients $\hat{a}_i, \hat{b}_i, \hat{s}_i, \hat{h}_i$ are obtained using ordinary least squares (OLS) estimation. We let AR_{it} denote the daily abnormal return of stock *i* on day *t* during the event window (days *t*= –15 to *t*= +30, defined again relative to the event date):

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i \left(R_{mt} - R_{ft}\right) - \hat{s}_i SMB_t - \hat{h}_i HML_t) \qquad (3.2)$$

[23]For example, on 1st September 2003, where annual rate for the three-month UK Treasury-Bill is 3.3281%, the average daily return is 3.3281%/365 = 0.0091%.

[24]Our sample for the construction of FF factors (SMB and HML) uses daily returns data for all UK listed firms, live and dead, over the period July 2003 to June 2010. The both factors are constructed by Dr Jo Wells.

We let AAR_t denote the average daily abnormal return (calculated over all stocks in each sample) on day *t,* and $CAAR_t$ denote the cumulative average daily abnormal return on day *t* during the event window:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \qquad (3.3)$$

$$CAAR_t = \sum_{\tau=-15}^{t} AAR_\tau \qquad (3.4)$$

To assess whether each average daily abnormal return is significantly different from zero, we use the test procedure suggested by Boehmer, Musumeci and Poulsen (BMP, 1991) to adjust for event-induced variance[25]. We let SAR_{it} denote Brown and Warner's (1985) standardized abnormal return for stock *i* on day *t* during the event window, and $\hat{S}(SAR_t)$ denote the cross-sectional standard deviation of standardised abnormal returns on day *t*. The BMP t-statistic is:

$$t = \frac{1}{\sqrt{N}}\sum_{i=1}^{N} SAR_{it}/\hat{S}(SAR_t) \qquad (3.5)$$

where $\hat{S}(SAR_t) = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(SAR_{it} - \overline{SAR_t})^2}$; $\overline{SAR_t} = \frac{1}{N}\sum_{i=1}^{N} SAR_{it}$

For tests over the multi-day intervals, the test statistic is the ratio of cumulative average abnormal returns to its estimated standard deviation, and is given by:

[25] Harrington and Shrider (2007) emphasise the importance of using a test that is robust to cross-sectional variation in abnormal returns in the presence of event-induced variance.

$$\sum_{t=t_1}^{t_2} CAAR_t \Big/ \sqrt{\sum_{t=t_1}^{t_2} \hat{S}^2(CAAR_t)} \qquad (3.6)$$

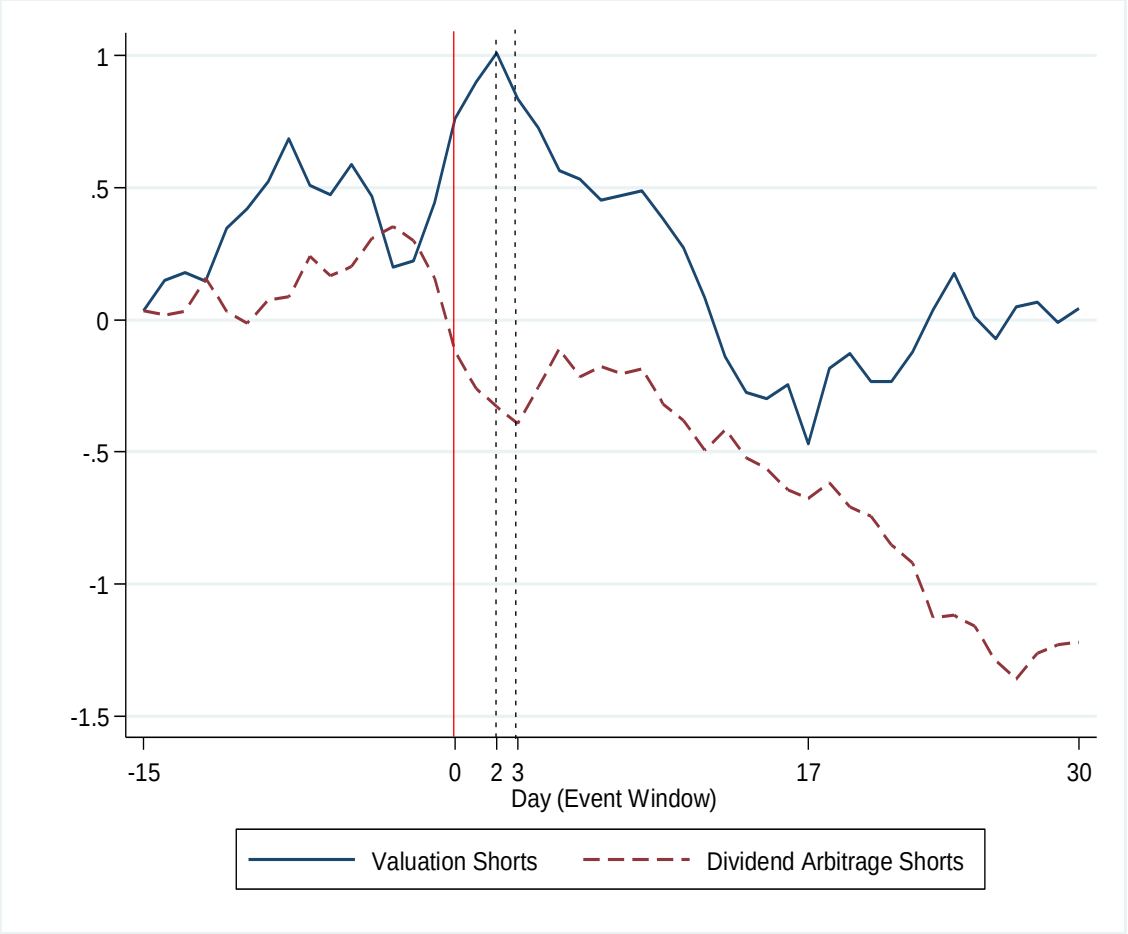
where $\hat{S}(CAAR_t) = \frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - CAAR_t)^2$

3.5 Empirical Results

3.5.1 Event-Study Results for Overall Period (September 2003 – April 2010)

Figure 3.3 shows the cumulative average abnormal returns for the 46-day period from 15 days prior to 30 days following the top one percentile of largest increases in short interest for both valuation shorts and dividend arbitrage shorts subsamples. Day0 is the day on which the large increase in short interest occurs (the event day). Day+3 (between the two dashed lines) is the time when the large increase in short interest becomes public knowledge through the publication of stock lending data by Euroclear. Cumulative average abnormal returns for the valuation shorts subsample are generally increasing from day-15 to day+2, then falling rapidly from day+3 to day+17. The graph suggests an abnormal run up in stock prices prior to, and an abnormal fall in the days following the disclosure of large increases in short interest. The dividend arbitrage short subsample shows low positive abnormal returns prior to the event and negative abnormal returns around the event date and throughout the subsequent event window.

Figure 3.3 Event study cumulative abnormal returns for overall period based on Fama-French three-factor model.



Notes: This figure presents the comparison of cumulative average abnormal returns during event window of 46 trading days (15 trading days before through 30 trading days after) of events representing the top one percentile of largest increases in short interest between valuation shorts and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. Day3 is the event day when the data of largest increases in short interest in Day0 is made available to public. Valuation shorts (*N*) = 455 stocks. Dividend arbitrage shorts (*N*) = 500 stocks. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model.

Table 3.2 shows the average abnormal returns on each day in the event window for both valuation and dividend arbitrage shorts subsamples. The BMP test for valuation shorts subsample indicates significance at the 1% level for day0, reflecting strong positive returns on the day on which the particularly large increase in short interest (the event) takes place. For the dividend arbitrage shorts subsample, the return is also significant at the 1% level for day0, but in this case the abnormal return is negative, suggesting that

dividend arbitrage shorts are selling into a weak rather than a strong market for the stock in question.

Table 3.2 Event-study Cumulative Abnormal Returns

	Panel A. Valuation Shorts				Panel B. Dividend Arbitrage Shorts			
Day	Average Abnormal Return (%)	Cumulative Average Abnormal Return (%)	Average Standardised Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics	Average Abnormal Return (%)	Cumulative Average Abnormal Return (%)	Average Standardised Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics
-15	0.034	0.034	2.127	0.449	0.035	0.035	-2.673	-0.525
-14	0.115	0.149	5.380	0.934	-0.017	0.017	-1.984	-0.393
-13	0.029	0.178	1.241	0.178	0.016	0.033	-1.837	-0.361
-12	-0.033	0.145	-5.215	-0.844	0.124	0.157	5.686	1.182
-11	0.202	0.347	7.368	1.393	-0.125	0.032	-4.058	-0.793
-10	0.074	0.421	-2.318	-0.404	-0.044	-0.012	-1.414	-0.276
-9	0.101	0.522	8.508	1.178	0.087	0.075	9.470	1.675 *
-8	0.163	0.685	2.380	0.422	0.012	0.087	3.740	0.676
-7	-0.177	0.508	-12.439	-1.895 *	0.153	0.240	9.893	1.978 **
-6	-0.034	0.474	-7.799	-1.180	-0.072	0.167	0.622	0.110
-5	0.113	0.587	10.889	1.386	0.034	0.201	5.113	0.906
-4	-0.119	0.468	-3.678	-0.417	0.106	0.307	2.529	0.377
-3	-0.270	0.198	-19.751	-1.699 *	0.046	0.353	3.300	0.422
-2	0.026	0.224	-0.558	-0.086	-0.053	0.300	-0.748	-0.105
-1	0.220	0.444	8.867	1.356	-0.141	0.159	-9.342	-1.772 **
0	0.317	0.761	15.179	3.079 ***	-0.281	-0.122	-23.399	-3.945 ***
1	0.138	0.899	1.328	0.259	-0.140	-0.262	-11.661	-2.113 **
2	0.108	1.007	1.004	0.190	-0.067	-0.329	-6.981	-1.312
3	-0.174	0.834	-7.890	-1.243	-0.064	-0.392	-4.936	-0.964
4	-0.107	0.727	-5.398	-0.990	0.138	-0.254	7.978	1.393
5	-0.161	0.565	-7.242	-1.419	0.145	-0.109	7.573	1.354
6	-0.033	0.533	-5.507	-1.234	-0.108	-0.217	-6.894	-1.314
7	-0.079	0.453	-1.627	-0.256	0.039	-0.178	-0.229	-0.046
8	0.016	0.470	4.813	0.872	-0.027	-0.205	-1.991	-0.276
9	0.017	0.487	-4.983	-0.958	0.019	-0.186	-0.717	-0.105
10	-0.106	0.381	-5.439	-0.991	-0.132	-0.318	-10.084	-2.076 **
11	-0.107	0.274	-9.205	-1.696 *	-0.064	-0.382	-0.769	-0.157
12	-0.189	0.084	-11.983	-2.134	-0.111	-0.493	-5.414	-1.063
13	-0.224	-0.140	-11.862	-2.261 **	0.078	-0.416	2.430	0.477
14	-0.134	-0.274	-4.268	-0.713	-0.105	-0.521	-6.660	-1.387
15	-0.024	-0.298	-3.738	-0.626	-0.042	-0.564	-2.691	-0.503
16	0.052	-0.247	2.626	0.462	-0.079	-0.643	-3.832	-0.714
17	-0.223	-0.469	-12.462	-2.260 **	-0.033	-0.676	-6.088	-1.205
18	0.286	-0.184	17.614	1.990 **	0.060	-0.616	5.095	0.898
19	0.056	-0.128	2.363	0.503	-0.091	-0.707	-5.836	-1.093
20	-0.105	-0.233	-7.014	-1.458	-0.036	-0.743	-4.139	-0.834
21	0.000	-0.232	0.672	0.117	-0.108	-0.851	-8.931	-1.727 *
22	0.110	-0.122	6.081	1.264	-0.068	-0.919	-2.195	-0.484
23	0.160	0.038	6.288	1.244	-0.205	-1.124	-10.844	-2.425 **
24	0.137	0.175	8.488	1.531	0.006	-1.118	-0.242	-0.046
25	-0.165	0.010	-18.468	-2.549 **	-0.041	-1.158	-2.943	-0.583
26	-0.081	-0.071	-4.544	-0.828	-0.129	-1.288	-5.384	-1.057
27	0.120	0.049	3.864	0.709	-0.071	-1.359	-7.353	-1.627
28	0.017	0.066	-3.446	-0.649	0.098	-1.261	3.849	0.809
29	-0.077	-0.010	-1.799	-0.355	0.032	-1.229	2.861	0.596
30	0.054	0.044	1.740	0.317	0.009	-1.220	-2.687	-0.481

Notes: This table reports the results of an event study analysis of abnormal returns during an event window of 46 trading days (15 trading days before through 30 trading days after) of events of the top one percentile of largest increases in short interest of valuation shorts and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. The total number of observations (N) for valuation shorts and dividend arbitrage shorts are 455 and 500, respectively. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model. Following Brown and Warner (1985), we standardise the abnormal returns and following Boehmer, Musumuci and Poulsen (1991), we construct standardised cross-sectional test statistics to account for event induced variance. *, **, *** denote statistical significance at 10, 5 and 1%, respectively.

Table 3.3 presents cumulative average abnormal returns for multi-day intervals. We cumulate returns over five intervals: overall (-15 to +30), pre-event (-15 to 0), post-event (0 to +30), immediate post-publication (+3 to +4) and extended post-publication (+3 to +17). Following Brown and Warner (1985), we compute test statistics to assess the significance of the cumulative average abnormal returns over different intervals. For the valuation shorts subsample, we find that cumulative abnormal returns are significantly different from zero at the 1% significance level for the pre-event, post-event, immediate post-publication and extended post-publication intervals. Average abnormal returns for the dividend arbitrage shorts subsample on the other hand are significantly different from zero for the overall event window (negative) as well as the post-event (negative) and extended post-publication (negative) periods. Over 15 trading days following large increases in short interest, valuation shorts yield an average cumulative abnormal return of 1.48%, suggesting possible profit from a strategy of short selling following the publication of large increases in short interest for valuation short stocks. With an average of UK stock lending fees of 14 basis points per annum, valuation shorting appears to be highly profitable[26].

[26] For the UK small capitalization stocks however, the lending fees can go as high as 400 basis points (Thomas, 2006), then the valuation shorts may not be profitable.

Table 3.3 Event-study Multi-day Cumulative Abnormal Returns

Event Window	Panel A. Valuation Shorts		Panel B. Dividend Arbitrage Shorts	
	CAARs	Brown-Warner t-statistics	CAARs	Brown-Warner t-statistics
(-15,+30) Overall	0.04% (0.14%)	0.315	-1.22% (0.09%)	-12.894 ***
(-15,0) Pre-event	0.76% (0.15%)	5.020 ***	-0.12% (0.11%)	-1.092
(0,+30) Post-event	-0.40% (0.14%)	-2.849 ***	-1.38% (0.09%)	-14.652 ***
(+3,+4) Immediate post-publication	-0.28% (0.09%)	-5.940 ***	0.07% (0.14%)	0.522
(+3,+17) Extended post-publication	-1.48% (0.05%)	-16.667 ***	-0.35% (0.09%)	-3.907 ***

Notes: This table reports the results of a multi-day event study analysis of cumulative abnormal returns (CAARs) for different event windows and provides comparison between valuation shorts and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. The total number of observations (*N*) for valuation shorts and dividend arbitrage shorts are 455 and 500, respectively. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model. Following Brown and Warner (1985), we construct a multi-day test statistics to show significance. We report standard error of the cumulative abnormal returns in parentheses. *, **, *** denote statistical significance at 10, 5 and 1%, respectively.

Taken together, the results presented in Figure 3.3, Table 3.2 and Table 3.3 point to several tentative findings. First, it seems that investors do react to the disclosure of a large increase in short interest. Since the information is only disclosed on the third day after the occurrence of a large increase in short interest, investors may be able to exploit the information by shorting the reported stocks when the news come out at day+3 and buying the stocks back at a later date. Secondly, significant positive abnormal returns on the date of the large increase in short interest, together with positive average abnormal returns over the previous 15 trading days, suggest that short sellers (valuation shorts) are selling into a strong market and may therefore tend to be acting on private information

rather than chasing an extant downward trend. Thirdly, the prices of stocks that report large increases in short interest seem to adjust rapidly, but not instantaneously to the arrival of the short interest information, consistent with Boehmer et al. (2008).

3.5.2 Comparison of Mean Abnormal Returns between Valuation Shorts and Dividend Arbitrage Shorts

The average negative abnormal returns over the extended and immediate post-publication windows are much greater for the valuation shorts than for the dividend arbitrage shorts subsample, suggesting a greater informational value of valuation shorts. These findings are generally consistent with Asquith et al. (2005), who find smaller negative abnormal returns for arbitrage shorts rather than valuation shorts using a US data sample.

Table 3.4 Comparison of Mean Abnormal Returns between Valuation and Dividend Arbitrage Shorts over Different Event Windows.

Event Window	Valuation Shorts	Dividend Arbitrage Shorts	Difference	t-statistics
(-15,+30)	0.10%	-2.65%	2.75%	1.28
Overall	(1.79%)	(1.26%)	(2.15%)	
(-15,0)	4.76%	-0.76%	5.52%	1.42
Pre-event	(3.21%)	(2.28%)	(3.89%)	
(0,+30)	-4.64%	-4.52%	-0.12%	-0.03
Post-event	(2.96%)	(2.14%)	(3.61%)	
(+3,+4)	-14.03%	3.73%	-17.76%	-1.68*
Immediate post-publication	(9.05%)	(5.87%)	(10.60%)	
(+3,+17)	-9.84%	-2.32%	-7.53%	-2.03**
Extended post-publication	(3.09%)	(2.15%)	(3.71%)	

Notes: This table reports the differences in mean abnormal returns over different event windows between valuation and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. The total number of observations (*N*) for valuation shorts and dividend arbitrage shorts are 455 and 500, respectively. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model. We construct a two sample t-test to show significance in difference. We report standard error of the mean abnormal returns in parentheses. *, **, *** denote statistical significance at 10, 5 and 1%, respectively.

Table 3.4 compares the mean abnormal returns of the valuation and dividend arbitrage shorts subsamples using a two sample t-test. For the (+3,+4) and (+3,+17) multi-day event windows, valuation shorts experience lower average abnormal returns than dividend arbitrage shorts, with the differences significant at the 10% and 5% levels, respectively.

3.5.3 Robustness Check

The results documented so far suggest that unusually large increases in short interest convey negative signals based on the Fama-French three-factor specification. As event-study results may be sensitive to the model of expected returns, we test the robustness of the analysis by using two additional benchmarks, i.e., Brown and Warner (1985) market model and Capital Asset Pricing model (CAPM). We estimate the following model over the estimation period (days s= –115 to s= –16, defined relative to the event date). We let AR_{it} denote the daily abnormal return of stock i on day t during the event window (days t= –15 to t= +30, defined again relative to the event date). For Brown and Warner (1985) market model:

$$R_{is} = \hat{a}_i + \hat{b}_i \, R_{ms} + \varepsilon_{is} \tag{3.7}$$

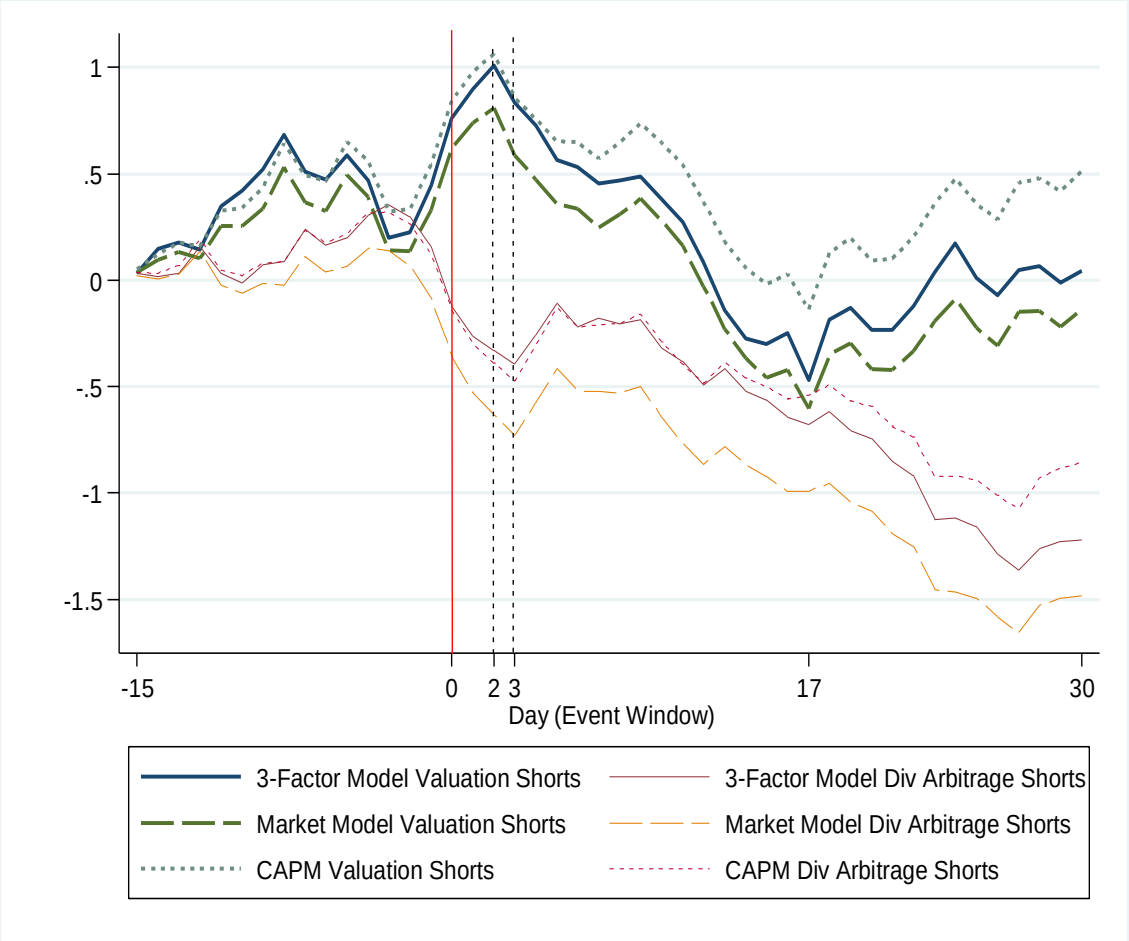
$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i \, R_{mt} \tag{3.8}$$

and for CAPM:

$$R_{is} = \hat{a}_i + \hat{b}_i \left(R_{ms} - R_{fs}\right) + \varepsilon_{is} \tag{3.9}$$

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i \left(R_{mt} - R_{ft}\right) \tag{3.10}$$

Figure 3.4 Event study cumulative abnormal returns for overall period based on three different benchmarks.



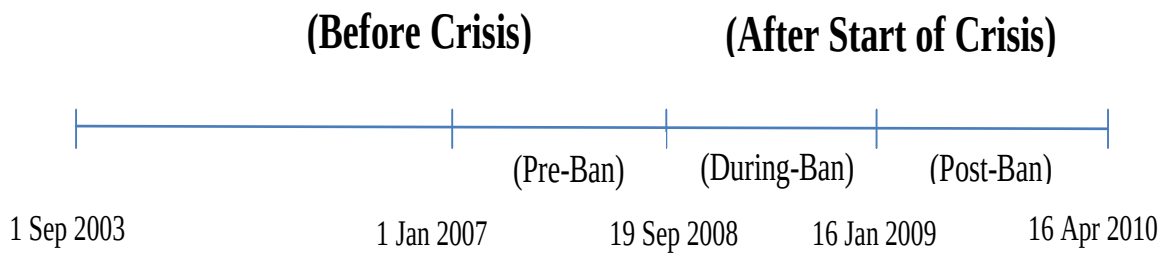
Notes: This figure shows the comparison of cumulative average abnormal returns during event window of 46 trading days (15 trading days before through 30 trading days after) of events of the top one percentile of largest increases in short interest between valuation shorts and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. Day3 is the event day when the data of largest increases in short interest in Day0 is made available to public. Valuation shorts *(N)* = 455 stocks. Dividend arbitrage shorts *(N)* = 500 stocks. Abnormal returns are measured relative to: a) UK Fama-French (1993) three-factor model, b) Market Model, and c) Capital asset pricing model (CAPM).

Figure 3.4 shows cumulative average abnormal returns for the 46-day period from 15 days prior to 30 days following the large increase in short interest for both valuation and dividend arbitrage shorts subsamples as well as for all three benchmarks: Three-factor model, Market model and CAPM. All models share an almost similar pattern. For valuation shorts, cumulative abnormal returns for all models are increasing from day-15 to day+2, falling rapidly from day+3 to day+17. The graph suggests for all models an

abnormal run up in stock prices prior to, and an abnormal fall in the days following the disclosure of large increases in short interest.[27] For the dividend arbitrage shorts, again all models follow similar pattern. The graph shows low positive abnormal returns prior to the event and negative abnormal returns around the event date and throughout the subsequent event window. These findings are in line with Thompson (1988) and MacKinlay (1997) who argue that marginal explanatory power of factors other than the market factor in is very small, in that, the usual market model is sufficient to provide evidence of a non-zero abnormal return in event-study.

3.5.4 Event-Study Results around the Period of 2008/09 Financial Crisis

Figure 3.5 This time line shows the period of before and after the start of the 2008/09 financial crisis, as well as the period of before, during and after the short selling ban.



As shown in Figure 3.5 above, we compare informational contents in valuation and dividend arbitrage shorts for sub-periods: (i) before and after the start of the financial crisis, and (ii) before and after the short selling ban. We define the period before the financial crisis to run from 1 September 2003 to 19 September 2008 whilst the period after the start of the financial crisis runs from 20 September 2008 to 16 April 2010. The ban refers to the short selling ban period from 20 September 2008 to 16 January 2009.

[27] The cumulative abnormal returns for multi-day intervals for all benchmarks are provided in the Appendix.

The pre-ban period is defined as 1 January 2007 to 19 September 2008 whilst the post-ban period is defined 17 January 2009 to 16 April 2010. In Table 3.5, we find no significant difference in mean abnormal returns in valuation shorts for either the pre/post financial crisis or pre/post short selling ban subsamples. In the case of dividend arbitrage shorts however, we find significant differences in mean abnormal returns in the overall and pre-event windows for the pre/post financial crisis subsamples, and overall and post-event windows for the pre/post ban subsamples. Taken together, the main empirical results for the full data sample for valuation shorts appear to hold when we carry out robustness checks on different states of economy, suggesting similar informational contents for valuation shorts throughout the period under study. The informational contents of dividend arbitrage shorts however appear to be dependent on different sub-periods.

Table 3.5 Comparison of Mean Abnormal Returns over Valuation and Dividend Arbitrage Shorts, and between Before vs. After the Start of Financial Crisis Period and Pre- vs. Post-Ban Period

	Panel A. Before vs. After the Start of Crisis		Panel B. Pre-Ban vs. Post-Ban	
	Difference in Mean Abnormal Returns		Difference in Mean Abnormal Returns	
Event Window	Valuation Shorts	Dividend Arbitrage Shorts	Valuation Shorts	Dividend Arbitrage Shorts
(-15,+30)	0.04%	-0.06%**	-0.07%	0.09%**
Overall	(1.21)	(-2.45)	(-1.36)	(2.20)
(-15,0)	0.05%	-0.10%**	-0.12%	0.11%
Pre-event	(0.81)	(-2.29)	(-1.22)	(1.45)
(0,+30)	0.04%	-0.03%	-0.06%	0.10%**
Post-event	(0.96)	(-1.09)	(-0.90)	(2.04)
(+3,+4)	0.12%	0.05%	-0.31%	-0.07%
Immediate post-publication	(0.64)	(0.46)	(-1.07)	(-0.40)
(+3,+17)	0.04%	-0.04%	-0.05%	0.06%
Extended post-publication	(0.60)	(-0.83)	(-0.52)	(0.93)

Notes: This table reports the differences in mean abnormal returns over different event windows, over valuation and dividend arbitrage shorts between before vs. after the start of financial crisis, and pre- vs. post-ban period subsamples for the period of September 2003 to April 2010. The period of before financial crisis is from 1 September 2003 to 19 September 2008 whilst the period of after the start of financial crisis is from 20 September 2008 to 16 April 2010. The ban refers to the short selling ban period from 20 September 2008 to 16 January 2009. The post-ban period is defined as from 17 January 2009 to 16 April 2010 whilst the pre-ban period is defined as from 1 January 2007 to 19 September 2008. The total numbers of observations (*N*) for valuation shorts before crisis, after crisis and dividend arbitrage shorts before crisis and after crisis are 179, 276, 255 and 245, whilst the *N* for valuation shorts for pre-ban and post-ban and dividend arbitrage shorts for pre-ban and post-ban periods are 157, 91, 132 and 105 respectively. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model. We construct a two sample t-test and report t-statistics of the difference in mean abnormal returns in parentheses. *, **, *** denote statistical significance at 10, 5 and 1%, respectively.

3.6 Conclusion

We contribute to the existing short selling literature regarding the informational content of short interest in the UK stock market. Using high frequency daily data from September 2003 to April 2010, we examine the informational content of the top one percentile of increases in short interest. Employing an event-study methodology, we find that large increases in short interest are followed by periods of strong abnormal returns for valuation shorts, but this does not appear to be the case for dividend arbitrage shorts. Secondly, for valuation shorts, the market seems to adjust rapidly, but not instantaneously to the arrival of the short interest information. Valuation shorts yield cumulative abnormal returns of 1.48% on average over 15 trading days following large increases in short interest, suggesting possible profit from a strategy of short selling following the disclosure of large increases in short interest for valuation short stocks. Thirdly, dividend arbitrage shorts appear to be less informative. We also examine the impact of 2008/09 financial crisis on the informational content of short interest. We find a similar informational content of short interest for valuation shorts throughout the period of the data sample. With respect to dividend arbitrage shorts however, the informational content of short interest is dependent on the states of economy.

Overall, our empirical results provide support for the conjecture by Diamond and Verrecchia (1987): unusually large increases in short interest are followed by a period of negative abnormal returns. These results are broadly consistent with prior studies (e.g. Senchack and Starks, 1993; Desai et al., 2002; Asquith et al., 2005), suggesting an informational content is associated with short interest. Our findings have several important implications. First, it appears that investors do react to the disclosure of large increases in short interest and the fact that valuation short sellers are shorting into a strong

market rather than chasing a downward trend may suggest that the short sellers are acting on private information. Second, we observe a different degree of informativeness of short interest disclosure between valuation and dividend arbitrage shorts, and this may infer these two different shorts may have been executed by two different sets of traders who are scrutinizing two different sets of information. Future research may be undertaken to explore the decision making process of valuation short sellers that trigger them into shorting a strong market, and unravel the mystery surrounding the so-called sophisticated traders or short sellers.

Chapter 4

Seeking Negative Alpha through Shorting

4.1 Introduction

The most important purpose that drives short sellers to short stocks is perhaps to earn a negative alpha or an abnormal return. Throughout the short-selling literature, researchers use event studies and calendar time portfolio approaches to show that a negative alpha or abnormal return follows shorting. As shorting is costly, only rational investors with a strong expectation that the stock price will drop will choose to short (Diamond and Verrecchia, 1987). This model argues that short sellers possess significant private information about the stock in question. At a glance, accepting this model is equivalent to admitting that negative alphas or abnormal returns are a persistent anomaly, hence rejecting the market efficiency hypothesis. Fama (1998) however, contends that generally apparent anomalies are due to the methodology used and tend to disappear with reasonable changes in technique.

This paper is therefore motivated by Fama's (1998) strong rebuttal of the idea that there are anomalies to market efficiency. Our central research question is to examine whether short-term, daily negative abnormal returns or alphas are sensitive to the methodology or assumed model for expected returns. In this paper, we study a number of models that have been used in the extant literature to detect a negative abnormal return or alpha on top and bottom percentile portfolios of stocks that experience positive increases in short interest. The main methodologies considered are the event study and calendar time portfolio approaches. Within the event study methodology, we consider the Market Model (MM), Capital Asset Pricing Model (CAPM) and Fama and French Three Factors Model (FF3F), while, as calendar time portfolio approaches, we study Jensen and Fama-French alpha.[28] Further, for the event studies we consider two different estimation windows, 60 and 120 days, while for the calendar time portfolios, we consider both equal and value weights.

Previous empirical studies on the information content of short interest are framed with reference to Diamond and Verrecchia's (1987) private information hypothesis and use either the change or the level of short interest in stocks as a proxy for short-selling activities. Either event studies (Blau et al., 2010; Senchack and Starks, 1993) or the calendar time portfolio approach (Asquith et al., 2005; Desai et al., 2002) are used to show the information content of short interest.

To our knowledge, this is the first study to test for information content and compare the mean abnormal returns and alphas produced by alternative models, with respect to

[28] Abbreviations used in this chapter: Market Model (MM), Capital Asset Pricing Model (CAPM), Fama-French Three-Factor Model (FF3F), ordinary least squares (OLS).

methodology (and estimation window and weight), using the largest daily increases in short interest as a laboratory. For the first time, using short interest data, we test Fama's (1998) argument that anomalies are generally illusions and tend to disappear with reasonable changes in the way they are measured. We also test MacKinlay's (1997) proposition that the gain from employing multi-factor models in event studies are limited as the marginal explanatory power of any additional factors other than the market factor is very small.

Our empirical results from all ten of our models are consistent with the analytical work of Diamond and Verrecchia (1987), which predicts negative alphas (and abnormal returns) following the largest increases in short interest in stocks. These anomalies or under-performance of stocks appear to persist for up to thirty days after the event period, for the top percentile of increases in the short interest portfolio. We find significant differences in mean abnormal returns when we compare the top and bottom percentiles of increases in the short interest ratio, suggesting that stronger information content is associated with the largest increases in short interest. When we compare models, estimation windows and weights for the top percentile portfolio, we do not find any significant differences in the mean abnormal returns and alphas, suggesting that short-term anomalies in negative alphas and abnormal returns are not due to the assumed methodology. However, for the portfolio with the smallest increases in short interest, proxied by the bottom percentile portfolio, as suggested by Fama (1998), we do find the choice over whether to use equal or value weights to be an important and relevant issue, as they present conflicting results.

Taken together, the short-term persistent negative alphas or abnormal returns derived from different methodologies for the portfolio with the largest increases in short interest

may be considered as evidence against the efficient market hypothesis. Investors seeking alpha should find a negative alpha from shorting, in the short term, that is, for up to thirty days following the largest increases in short interest.

The remainder of the paper is organized as follows. In Section 4.2 we provide justifications for measuring alphas and abnormal returns following increases in short interest. In Section 4.3, we provide some motivation for examining increases in short interest. In Section 4.4, we describe the sample selection and methodological considerations. In Section 4.5, we report the empirical results. In Section 4.6, we offer some concluding remarks.

4.2 Measuring alphas and abnormal returns following increases in short interest

Fama (1998) argues that stock return anomalies, particularly long-term ones, are difficult to classify as they are plagued by ambiguities and chance. Given that market efficiency must be tested jointly with a model of expected returns, and all models for expected returns are incomplete descriptions of the systematic patterns in average returns during a sample period, tests of market efficiency, arguably, are always contaminated by bad model problems. In addition to the assumed model, the expected returns can be sensitive to the way in which the tests are carried out. Further, equally-weighted returns may produce different results to value-weighted returns, and since equal weight portfolio returns give more weight to small stocks, bad model problems can be more severe when inferences are drawn from equally-weighted returns.

Empirically, the event study methodology has become the standard method of measuring stock returns and providing evidence of stock return anomalies or non-anomalies. A key

event study paper by Fama et al. (1969), for example, has become a classic paper, having been cited on average about 21 times per year over a 25-year period. Generally, event studies have been widely used for two major reasons: (i) to test the null hypothesis that the market efficiently incorporates information, and (ii) to examine the impact of some event on the wealth of a firm's security holders, under the maintained hypothesis that all publicly available information is incorporated in current prices under market efficiency (Binder, 1998).

With respect to event studies, different lengths of estimation windows may yield different sample sizes, in that, the longer is the estimation window, the smaller would be the sample size. The estimation and event windows for the samples must not overlap, so as to prevent potential confounding effects from the events on the samples' abnormal returns. In other words, inferences drawn from the event studies may be largely dependent on the sample sizes which in turn dependent on the choice of length of the estimation windows. We address this issue in Section 4.4.3 and Section 4.5.4 of the current paper. Another problem that may affect inferences is cross-sectional dependence in the stock returns sample data. This would be the case in all studies of the reaction of stock prices to a regulatory event. In such circumstances, procedures based on the assumption of independence can yield biased estimates of standard errors and incorrect inferences (Bernard, 1987). The cross-sectional dependency problems may be more likely when the return interval is long, that is when using quarterly or yearly data. There are several ways to overcome the bias arising from residual cross-correlation. First, researchers can carry out cross-sectional aggregation of the data, which is also known as the calendar time portfolio or Jensen alpha approach. Secondly, researchers can use a multi-factor version of the MM to measure the dependent variable, as the extra factors incorporated may

reduce residual cross-correlation. Previous short-selling studies that opt for cross-sectional aggregation and use a multi-factor model include Asquith et al. (2005), Au et al. (2009), Boehmer et al. (2008), Boehmer et al. (2010), Desai et al. (2002) and Diether et al. (2009).

On the basis of these issues and concerns, we choose to run a series of event study methodologies and calendar time portfolio approaches and compare the differences in mean abnormal returns between categories so as to ascertain whether the resulting non-zero abnormal returns or alphas are due to chance. In our sample, we assume cross-sectional independence in the residuals of the data since increases in short interest are expected to occur randomly.

4.3 Measuring short-selling activity through increases in short interest

Most studies predicting long-term returns with short interest in the US focus on the level of short interest and define aggregate short interest in a stock as a percentage of the firm's total shares outstanding. Short interest data in the US are published on the 20th of every month in the financial press, that is, in the Wall Street Journal, Barron's Financial Weekly and the New York Times. Early studies of the information content of short interest in the US (e.g.,Asquith and Meulbroek, 1995; Asquith et al., 2005; Desai et al., 2002; Senchack and Starks, 1993) use these market data for their research. Most early studies, with the exception of Senchack and Starks (1993), examine the information content of short interest when the level of short interest hits a certain threshold and use negative monthly Fama-French alphas to indicate the under-performance of the shorted portfolio. Senchack and Starks (1993), however, employ an event study methodology to show negative abnormal returns following a minimum 100 percent increase (i.e., at least a doubling) in

monthly short interest over the previous month. The recent US studies by Boehmer et al. (2008) and Diether et al. (2009), based on daily short sales order flow data, employ Fama-French alphas to show the under-performance of shorted stocks. Blau et al. (2010) on the other hand use an event study to make inferences about the shorting of stocks, using daily data.

In the UK, short interest data has been made available to the public by Euroclear UK and Ireland, the UK's central securities depository, since September 2003, ever since the Financial Services Authority decided to enhance the transparency of short-selling activities. Here, short interest is defined as a percentage of the lendable supply. However, UK studies on short interest are very limited. The only UK study was conducted by Au et al. (2009). They use weekly horizon data and employ Fama-French alphas to make inferences about shorting activities in the UK market.

Given that previous studies employ either event studies or the calendar time portfolio approach, in this paper we use both methodologies and, as stated earlier, we consider a total of ten different models of expected returns. We focus on the largest daily increases and compare them against the smallest daily increases in a short interest portfolio. Here, we define an increase in short interest as a simple increase from one day to the next. We then sort the increases in short interest into percentiles and compare the top and bottom percentiles. We choose simple increases in short interest as a measure of shorting activity for practical reasons. We cannot limit our sample to those that have seen a 100 percent increase because, unlike Senchack and Starks (1993), we are dealing with high-frequency, daily data. Moreover, it is easier for investors or short sellers to calculate simple

increases in short interest from one day to the next, and decide based on that whether to take a risk by shorting the stock.

4.4 Research methodology

4.4.1 Sample selection

Daily data on short interest is obtained from Euroclear UK and Ireland, while daily data on stock prices, the FTSE350 index prices, market capitalization, dividend yields, market-to-book and price-earnings ratios are sourced from Datastream. As we seek negative alphas through shorting, we confine our sample to stocks that experience positive increases in short interest. We define increases in short interest as simple increases in short interest from one day to the next, thus we begin with 292,623 stocks with daily increases in short interest in our initial sample. We then sort the daily increases into percentiles and take only the top and bottom percentiles as our sample. Naturally, this screening process yields 2,926 observations for each percentile but, after sourcing available market data from Datastream, the number of observations is reduced to 2,255 for the top and 1,777 for the bottom percentile. In Table 4.1, we report the characteristics of the top and bottom percentile samples. It is worth noting that, for the top percentile portfolio that contains the largest increases in short interest, the increases in short interest range from 1.91 percent upwards. Meanwhile, for the bottom percentile, the increases in short interest are close to zero. The means and Wilcoxon rank sum tests shown in Panel C indicate that there is a significant difference between the top and bottom percentiles in terms of market capitalization, market-to-book, price-earnings ratios and dividend yields.

Table 4.1 Sample descriptive statistics

Panel A: Top Percentile (*N*=2255)	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Increase in Short Interest (in %)	3.87	2.92	2.47	1.91	28.31
Market Capitalization (in £ million)	6,906.99	1,951.19	17,297.15	63.13	127,526.70
Market to Book Ratio	3.41	1.98	8.64	0.07	204.19
Price Earnings Ratio	34.24	13.80	445.16	0.40	13197.60
Dividend Yield (in %)	3.54	3.11	5.09	0.00	163.42
Panel B: Bottom Percentile (*N*=1777)	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Increase in Short Interest (in %)	0.00000512	0.000005	0.00000327	0.0000001	0.0000116
Market Capitalization (in £ million)	1,391.92	551.58	4,262.06	56.97	80,162.88
Market to Book Ratio	2.43	1.50	5.12	0.11	178.73
Price Earnings Ratio	56.76	15.50	334.73	2.00	9869.50
Dividend Yield (in %)	2.85	2.57	2.28	0.00	26.41
Panel C: Difference between Top and Bottom Percentile	**Mean**	***p*-value**		**Median**	***p*-value**
Increase in Short Interest (in %)	3.87	0.00		2.92	0.00
Market Capitalization (in £ million)	5,515.07	0.00		1,399.61	0.00
Market to Book Ratio	0.98	0.00		0	0.00
Price Earnings Ratio	-22.52	0.09		-1.70	0.00
Dividend Yield (in %)	0.69	0.00		0.54	0.00

Notes: This table reports descriptive statistics for both the top and bottom percentile portfolios. The top percentile refers to the largest one percent of daily increases in short interest while the bottom percentile refers to the smallest one percent of daily increases in short interest. An increase in short interest is a simple daily increase from one day to the next. Short interest is expressed as the percentage of the lendable supply of shares that is sold short. Market capitalization is the aggregate value of total outstanding shares in GB pounds (£). Market-to-book is the ratio of the current market value of the shares to the historical book value. Price-earnings is the ratio of the stock price to its per-share earnings. Dividend yield is the current dividend as a percentage of the stock price. *N* is the number of observations in each portfolio. *p*-values are for t-tests of the difference in means and the Wilcoxon rank sum test for the difference in medians.

4.4.2 Methodological considerations

In this section, we consider several methodologies that can be used to show abnormal performance or alphas following an increase in short interest. The approaches that can be used are event studies and the calendar time portfolio approach.

Event study methodology: MM, estimation period (a) 120 days, from day -120 to day -1; (b) 60 days, from day -60 to day -1.

The MM, developed by Fama et al. (1969) and later refined by Brown and Warner (1985) for the use of daily data, is a statistical model that relates the return of any given security to the return of the market portfolio. Brown and Warner (1985) find that simple estimation techniques based on ordinary least squares (OLS), with a market index using parametric statistical tests, are well-specified under non-normally distributed daily data and in the presence of non-synchronous trading. We estimate the following model over the estimation period: (a) days *s*= –120 to *s*= –1; and (b) days *s*= –60 to *s*= –1, defined relative to the event date.

$$R_{is} = \hat{a}_i + \hat{b}_i R_{ms} + \varepsilon_{is} \quad (4.1)$$

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i R_{mt} \quad (4.2)$$

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \quad (4.3)$$

$$CAAR_t = \sum_{t=0}^{t=30} AAR_t \quad (4.4)$$

where R_{it} denotes the daily logarithmic return for stock *i* on day *t*, R_{mt} denotes the daily logarithmic return on the FTSE350 index, AR_{it} denotes the daily abnormal return of stock *i* on day *t* during the event window (days *t*= 0 to *t*= +30, defined again relative to the event date), AAR_t denotes the average daily abnormal return (calculated over all stocks in each sample) on day *t*, and $CAAR_t$ denotes the cumulative average daily abnormal return on day *t* during the event window. The coefficients $\hat{a}_i$ and $\hat{b}_i$ are obtained using the OLS estimation.

Event-study methodology: CAPM, estimation period (a) 120 days, from day -120 to day -1; (b) 60 days, from day -60 to day -1.

The CAPM was established by Sharpe (1964) and Lintner (1965). In this model, the expected returns of a given security are determined by its covariance with the market portfolio. Banz (1981) however, finds that returns on small stocks, given their beta, is too high and argues that the CAPM predicts returns that are too low for small firms. We estimate the following model over the estimation period: (a) days *s*= –120 to *s*= –1; and (b) days *s*= –60 to *s*= –1, defined relative to the event date.

$$R_{is} = \hat{a}_i + \hat{b}_i \left(R_{ms} - R_{fs}\right) + \varepsilon_{is} \qquad (4.5)$$

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i \left(R_{mt} - R_{ft}\right) \qquad (4.6)$$

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \qquad (4.7)$$

$$CAAR_t = \sum_{t=0}^{t=30} AAR_t \qquad (4.8)$$

where R_{it} denotes the daily logarithmic return for stock *i* on day *t*, R_{mt} denotes the daily logarithmic return on the FTSE350 index, R_{ft} denote average daily return on three-month UK Treasury-Bill[29], AR_{it} denotes the daily abnormal return of stock *i* on day *t* during the event window (days *t*= 0 to *t*= +30, defined again relative to the event date), AAR_t denotes the average daily abnormal return (calculated over all stocks in each sample) on day *t*, and $CAAR_t$ denotes the cumulative average daily abnormal return on day *t* during the event window. The coefficients $\hat{a}_i$ and $\hat{b}_i$ are obtained using the OLS estimation.

[29]For example, on 1st September 2003, where the annualised rate for the UK three-month Treasury-Bill is 3.3281%, the average daily return is 3.3281%/365 = 0.0091%.

Event study methodology: FF3F, estimation period (a) 120 days, from day -120 to day -1; (b) 60 days, from day -60 to day -1.

In their model, Fama and French (1993) use a three-factor model including a market index, size index, and book-to-market index to explain stock returns. The model specifications are as follows:

$$R_{is} = \hat{a}_i + \hat{b}_i \left(R_{ms} - R_{fs}\right) + \hat{s}_i SMB_s + \hat{h}_i HML_s) + \varepsilon_{is} \quad (4.9)$$

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i \left(R_{mt} - R_{ft}\right) - \hat{s}_i SMB_t - \hat{h}_i HML_t) \quad (4.10)$$

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \quad (4.11)$$

$$CAAR_t = \sum_{t=0}^{t=30} AAR_t \quad (4.12)$$

We let R_{it} denote the daily logarithmic return for stock i on day t, R_{mt} denote the daily logarithmic return on the FTSE350 index and R_{ft} denote average daily return on three-month UK Treasury-Bill. The daily size factor (SMB_t) and value factor (HML_t) are calculated for the UK market following the standard approach described by Fama and French (1993), using data on all listed UK stocks[30]. We estimate the following model over the estimation period: (a) days s= –120 to s= –1; and (b) days s= –60 to s= –1, defined relative to the event date. The coefficients $\hat{a}_i, \hat{b}_i, \hat{s}_i, and\ \hat{h}_i$ are obtained using ordinary least squares (OLS) estimation. We let AR_{it} denote the daily abnormal return of stock i on day t during the event window (days t= 0 to t= +30, defined again relative to the event date). We let AAR_t denote the average daily abnormal return (calculated over

[30]Our sample for the construction of Fama and French (1993) factors (SMB and HML) uses daily returns data for all UK listed firms, live and dead, over the period July 2003 to June 2010.

all stocks in each sample) on day *t*, and $CAAR_t$ denote the cumulative average daily abnormal return on day *t* during the event window.

Jensen alpha: equal and value-weighted portfolios

Jensen (1968) examines the performance of mutual fund managers in light of the emerging efficient market hypothesis. The CAPM formula prevailing in 1968 did not permit an evaluation of the fund manager's performance, so Jensen added a coefficient, known as alpha. A positive alpha or intercept signifies over-performance while a negative alpha denotes under-performance of a portfolio compared to a benchmark index. This approach is known as the Jensen alpha approach or the calendar time portfolio approach. The approach was further refined by Jaffe (1974) and Mandelker (1974) and is strongly advocated by Fama (1998). The model specification is as follows:

$$R_{pt} - R_{ft} = \alpha_p + \beta_p \left(R_{mt} - R_{ft}\right) + \epsilon_{pt} \qquad (4.13)$$

where R_{pt} is the daily calendar time portfolio return on day *t*, R_{mt} is the daily return on the FTSE350 index on day *t*, R_{ft} is the average risk-free rate, proxied by the UK Treasury Bill rate on day t, α_p, β_p are regression parameters, and ϵ_{pt} is the error term. The intercept, α_p (Jensen alpha) measures the abnormal performance in the daily return with respect to the CAPM benchmark. In the Jensen alpha method, the alpha is computed using both equal and value weighting of the stocks in the portfolio. Here, we have only two portfolios: the top percentile and the bottom percentile. So, for the Jensen alpha approach, we obtain daily portfolio return series for four calendar time portfolios: (i) equally-weighted top percentile portfolio, (ii) value-weighted top percentile portfolio, (iii) equally-weighted bottom percentile portfolio and (iv) value-weighted bottom percentile portfolio. Then, the regression is run for all portfolios to find the intercept, α_p (Jensen

alpha), for day 0, day 1, day 2, etc. until day 30, following the event. The advantage of the calendar time portfolio approach over the event study methodology is that cross-sectional and serial correlations are not a problem.

Fama-French alpha: equal and value-weighted portfolios

The Jensen alpha approach can be further enhanced by incorporating Fama-French factors, in which case the method takes a new name, the Fama-French alpha. The model specification is as follows:

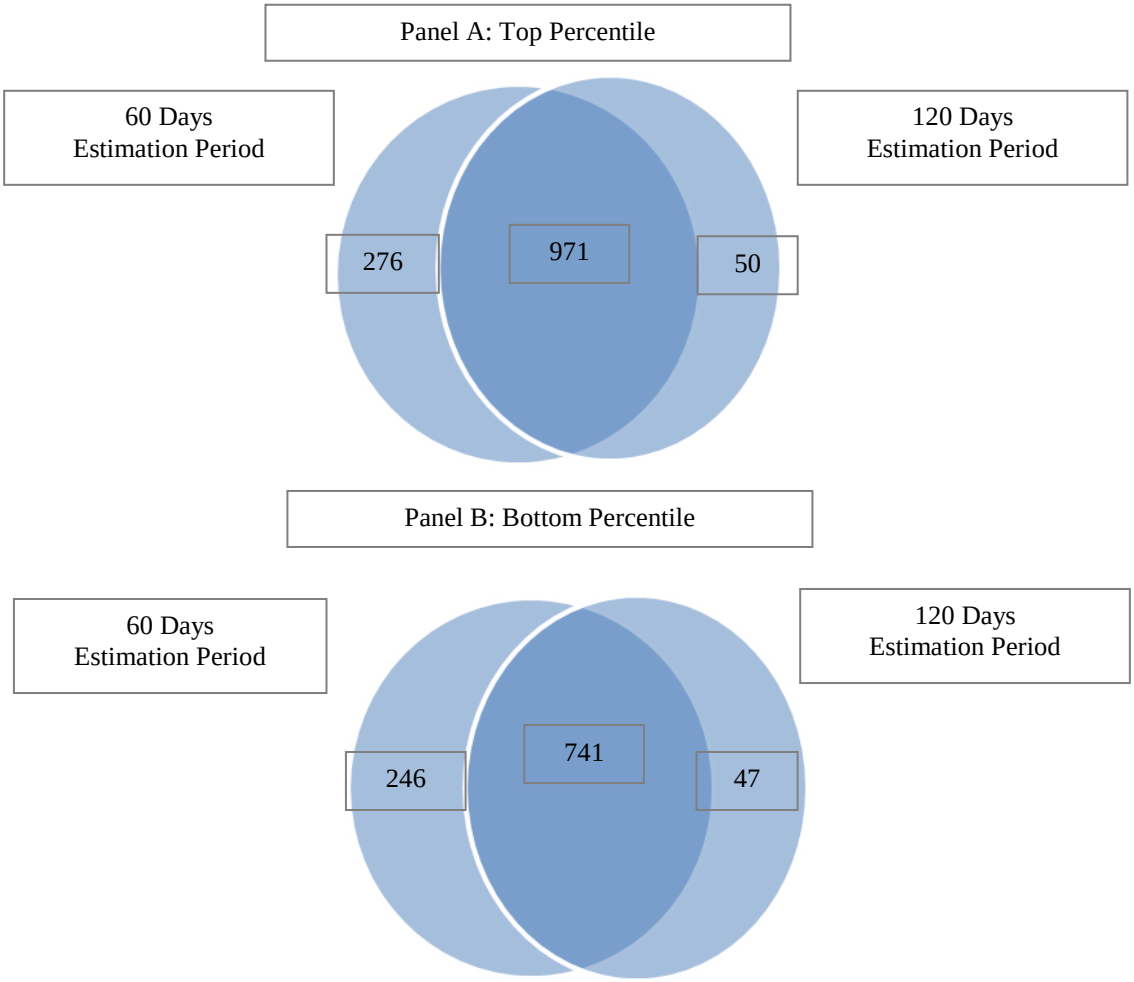
$$R_{pt} - R_{ft} = \alpha_p + \beta_p \left(R_{mt} - R_{ft}\right) + S_p SMB_t + H_p HML_t + \epsilon_{pt} \qquad (4.14)$$

The regression parameters for the Fama-French model are α_p, β_p, S_p and H_p. The three factors β_p, S_p and H_p are zero investment portfolios, representing the excess return of the market $\left(R_m - R_f\right)$, the difference between a portfolio of small stocks and a portfolio of big stocks (SMB) and the difference between a portfolio of high book-to-market stocks and a portfolio of low book-to-market stocks, respectively. The intercept, α_p, (Fama-French alpha) measures the abnormal performance in the daily return with respect to the three-factor benchmark. In the Fama-French alpha method we again compute alpha using both equal and value weighting of the stocks in the portfolio. Here, again, we have just two portfolios: the top percentile and the bottom percentile. So, as with the Jensen alpha approach, we obtain daily portfolio return series for four calendar time portfolios, and run the regression for each portfolio to find the intercept α_p, for day 0, to day 30, following the event.

4.4.3 Sample selection due to different estimation periods in the event study

In the event study, the analysis of aggregated abnormal returns requires an assumption that the event windows of the included securities do not overlap in calendar time. This assumption specifically allows the calculation of the variance of the aggregated sample of cumulative abnormal returns, without concern about covariances across securities, as they are zero (MacKinlay, 1997). As mentioned earlier, the estimation and event windows for the included securities are also assumed not to overlap, in order to prevent potential confounding effects from the events on stocks returns. There is no clear-cut rule as to what is the best length of estimation window in an event study. The trade-off is that the longer is the estimation window, the fewer samples can be included and this may result in a test with less power to show non-zero abnormal returns.

Figure 4.1 Event study sampling size with respect to different estimation windows



Notes: This figure presents the number of obervations when using 120 day and 60 day estimation periods in the event study procedure. The top percentile is the percentile with the largest increases in short interest while the bottom percentile is the percentile with the smallest increases in short interest. The data for daily increases in short interest span from September 2003 to April 2010.

In Figure 4.1, we find that when the estimation period is lengthened from 60 to 120 days, the number of observations in the top percentile portfolio reduces considerably from 1,247 to 1,021, while the number in the bottom percentile portfolio falls from 987 to 788. The venn diagrams show that the numbers of observations common to both sizes of estimation window are 971 and 741 for the top and bottom percentile portfolios respectively. The number of observations that only appear under one or the other of the estimation windows is 326 (276 + 50) and 293 (246 + 47) for the top and bottom percentile portfolios respectively. The aim here is to test whether the difference in the

number of observations, as a result of the difference in estimation periods, will result in a significant difference in the mean abnormal return.

4.5 Empirical results

4.5.1 Cumulative abnormal returns and alphas for all models

In Table 4.2, we report the abnormal returns and alphas for day 0 and day 1, as well as cumulative abnormal returns and cumulative alphas for day 0, 1, (0,10), (0,20) and (0,30), for all models, for the top percentile portfolio. The models are the MM with 120-day estimation window (MM 120), the MM with 60-day estimation window (MM 60), CAPM with 120-day estimation window (CAPM 120), CAPM with 60-day estimation window (CAPM 60), FF3F with 120-day estimation window (FF3F 120), FF3F with 60-day estimation window (FF3F 60), Jensen alpha equal weighted (Jensen alpha EW), Jensen alpha value weighted (Jensen alpha VW), Fama-French alpha equal weighted (FF alpha EW) and Fama-French alpha value weighted (FF alpha VW).

Table 4.2 Cumulative abnormal returns and alphas for top percentile portfolio

	Model	*N*	$AR_{(0)}$	$AR_{(1)}$	$CAR_{(0,10)}$	$CAR_{(0,20)}$	$CAR_{(0,30)}$
1	MM 120	1021	-0.13% ***	-0.13% ***	-0.78% ***	-1.20% ***	-1.12% ***
			(-2.99)	(-2.72)	(-8.03)	(-11.65)	(-10.94)
2	MM 60	1247	-0.08% **	-0.08% **	-0.60% ***	-0.98% ***	-0.91% ***
			(-2.35)	(-2.25)	(-7.21)	(-10.48)	(-9.98)
3	CAPM 120	1021	-0.12% ***	-0.12% **	-0.63% ***	-0.91% ***	-0.69% ***
			(-2.74)	(-2.45)	(-6.45)	(-8.82)	(-6.71)
4	CAPM 60	1247	-0.07% **	-0.07% *	-0.44% ***	-0.69% ***	-0.47% ***
			(-2.08)	(-1.95)	(-5.36)	(-7.35)	(-5.22)
5	FF3F 120	1021	-0.10% **	-0.09% *	-0.54% ***	-1.01% ***	-0.93% ***
			(-2.24)	(-1.95)	(-5.66)	(-10.05)	(-9.28)
6	FF3F 60	1247	-0.05%	-0.07% *	-0.34% ***	-0.68% ***	-0.51% ***
			(-1.47)	(-1.65)	(-3.78)	(-7.11)	(-5.32)

		N	$Alpha_{(0)}$	$Alpha_{(1)}$	$Cum\ Alphas_{(0,10)}$	$Cum\ Alphas_{(0,20)}$	$Cum\ Alphas_{(0,30)}$
7	Jensen Alpha EW	2255	-0.17% ***	-0.07%	-0.49% ***	-0.96% ***	-1.22% ***
			(-3.20)	(-1.41)	(-7.21)	(-12.37)	(-16.54)
8	Jensen Alpha VW	2255	-0.27% ***	-0.12% ***	-0.69% ***	-0.90% ***	-1.19% ***
			(-8.02)	(-3.71)	(-8.28)	(-12.07)	(-16.72)
9	FF Alpha EW	2255	-0.17% ***	-0.08%	-0.41% ***	-0.84% ***	-1.04% ***
			(-3.14)	(-1.57)	(-6.03)	(-10.73)	(-14.13)
10	FF Alpha VW	2255	-0.27% ***	-0.11% ***	-0.59% ***	-0.72% ***	-0.97% ***
			(-8.09)	(-3.58)	(-6.61)	(-9.54)	(-13.70)

Notes: This table reports the results of a multi-day analysis of the event study and calendar time portfolio approaches for the top percentile of increases in the short interest, for the period from September 2003 to April 2010. Abnormal returns and alphas are measured for the models given below, and cumulated for 10, 20 and 30 days following the largest increases in short interest. 120 and 60 refer to 120- and 60-day estimation periods, EW and VW refer to equal and value weightings, FF refers to Fama-French, and *N* is the number of observations. Following Brown and Warner (1985), we construct multi-day test statistics to show significance. *, **, *** denote statistical significance at 10, 5 and 1% respectively. We report the t-statistics in parentheses.

Generally speaking, all models show under-performance following the largest increases in short interest, proxied by top percentile increases in short interest. When abnormal returns and alphas are cumulated over multi-day intervals, all models show significant

under-performance, with the Jensen alpha equally-weighted portfolio showing the biggest under-performance of 1.22 percent for the 30 trading days following the largest increases in short interest. However, for the 20 and 10 trading day intervals, (0,20) and (0,10), MM 120 yields the greatest under-performance of 1.20 percent and 0.78 percent respectively. The test statistic for multi-day interval cumulative abnormal returns or alphas is the ratio of cumulative abnormal returns or alphas to their estimated standard deviation, and is given by:

$$\sum_{t=0}^{T} CAAR_T \Big/ \sqrt{\sum_{t=0}^{T} \hat{S}^2(CAAR_T)} \qquad (4.15)$$

where $\hat{S}(CAAR_t) = \frac{1}{N-1}\sum_{i=1}^{N}(CAR_i - CAAR_t)^2$

In Table 4.3, we present the cumulative abnormal returns and alphas for all models, for the bottom percentile portfolio. Unlike the top percentile, the bottom percentile yields some conflicting results. For multi-day intervals, CAPM 60 with a (0,30) interval shows the biggest over-performance of 1.56 percent, whereas cumulative Jensen alphas on value-weighted portfolios for the (0,20) interval yields the biggest under-performance of 0.45 percent.

Table 4.3 Cumulative abnormal returns and alphas for bottom percentile portfolio

	Model	*N*	$AR_{(0)}$	$AR_{(1)}$	$CAR_{(0,10)}$	$CAR_{(0,20)}$	$CAR_{(0,30)}$
1	MM 120	788	0.05%	-0.01%	-0.06%	0.20% ***	0.66% ***
			(-0.10)	(-0.30)	(-0.98)	(3.11)	(9.24)
2	MM 60	987	0.00%	-0.05%	0.14% ***	0.48% ***	1.14% ***
			(-0.80)	(-0.47)	(3.22)	(10.20)	(21.54)
3	CAPM 120	788	0.07%	0.00%	0.09%	0.49% ***	1.08% ***
			(0.18)	(-0.04)	(1.38)	(7.48)	(15.08)
4	CAPM 60	987	0.01%	-0.04%	0.29% ***	0.77% ***	1.56% ***
			(-0.50)	(-0.17)	(6.57)	(16.16)	(29.43)
5	FF3F 120	788	0.06%	0.00%	0.01%	0.34% ***	0.79% ***
			(0.21)	(-0.02)	(0.21)	(5.37)	(11.13)
6	FF3F 60	987	-0.01%	-0.04%	0.22% ***	0.60% ***	1.14% ***
			(-0.59)	(-0.02)	(5.12)	(12.61)	(22.36)

		N	$Alpha_{(0)}$	$Alpha_{(1)}$	$Cum\ Alphas_{(0,10)}$	$Cum\ Alphas_{(0,20)}$	$Cum\ Alphas_{(0,30)}$
7	Jensen Alpha EW	1777	-0.01%	0.02%	0.11% **	0.24% ***	0.60% ***
			(-0.10)	(0.38)	(1.97)	(4.87)	(12.78)
8	Jensen Alpha VW	1777	0.05%	-0.18% ***	-0.02%	-0.45% ***	-0.30% ***
			(1.49)	(-5.12)	(-0.18)	(-5.02)	(-3.24)
9	FF Alpha EW	1777	0.01%	0.04%	0.27% ***	0.52% ***	0.92% ***
			(0.17)	(0.80)	(5.31)	(10.84)	(20.81)
10	FF Alpha VW	1777	0.04%	-0.18% ***	0.02%	-0.38% ***	-0.23% ***
			(1.26)	(-4.96)	(0.23)	(-4.50)	(-2.66)

Notes: This table reports the results of a multi-day analysis of the event-study and calendar time portfolio approaches for the portfolio made up of the bottom percentile of increases in short interest, for the period from September 2003 to April 2010. Abnormal returns and alphas are measured for the various models, and cumulated for 10, 20 and 30 days following the smallest increases in short interest. Following Brown and Warner (1985), we construct multi-day test statistics to show significance. *, **, *** denote statistical significance at 10, 5 and 1% respectively. We report the t-statistics in parentheses.

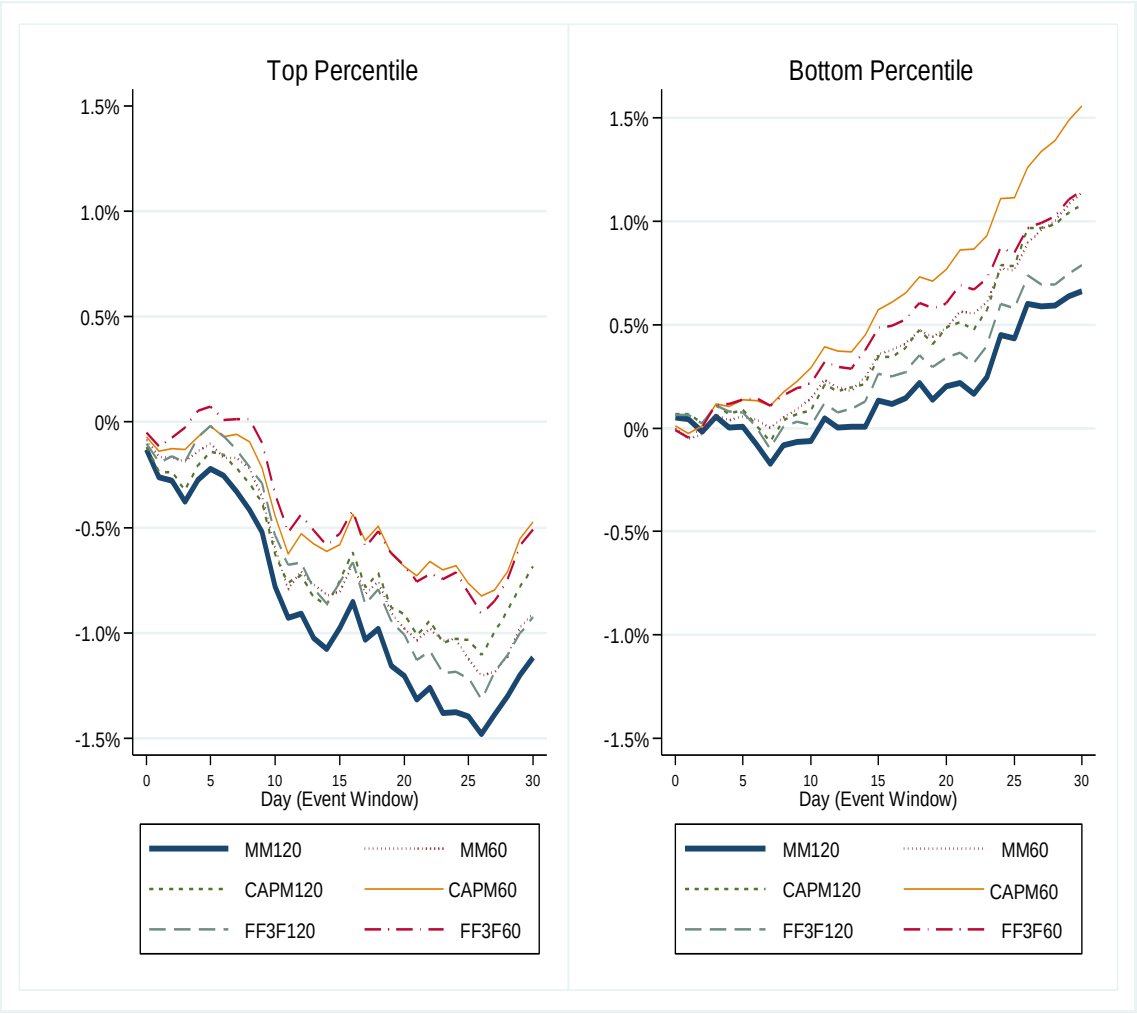
By and large, here, all event study models show very similar results but, for the calendar time portfolio approach, the results of the equally-weighted method appear to contradict those of the value-weighted method. The equally-weighted portfolios tend to show positive cumulative alphas, while the value-weighted portfolios tend to show negative

cumulative alphas. It appears that the bottom percentile portfolio is dominated by large capitalization stocks, which explains the negative cumulative alphas obtained using value-weighted portfolios.

4.5.2 Cumulative abnormal returns: top versus bottom percentile portfolio

In Figure 4.2, we chart the cumulative abnormal returns for all event study models, for both top and bottom percentile portfolios, and compare them side by side. We find a striking difference between the two portfolios. For the top percentile portfolio, we find positive cumulative abnormal returns for all models, but for the bottom percentile portfolio, we find negative cumulative abnormal returns for all models. Secondly, over a period of 30 days following the largest increases in short interest, the MM 120 model shows the greatest under-performance while the CAPM 60 model shows the least under-performance. Thirdly, over a period of 30 days following the smallest increases in short interest, the MM 120 shows the least over-performance while the CAPM 60 shows the greatest over-performance.

Figure 4.2 Event study cumulative abnormal returns



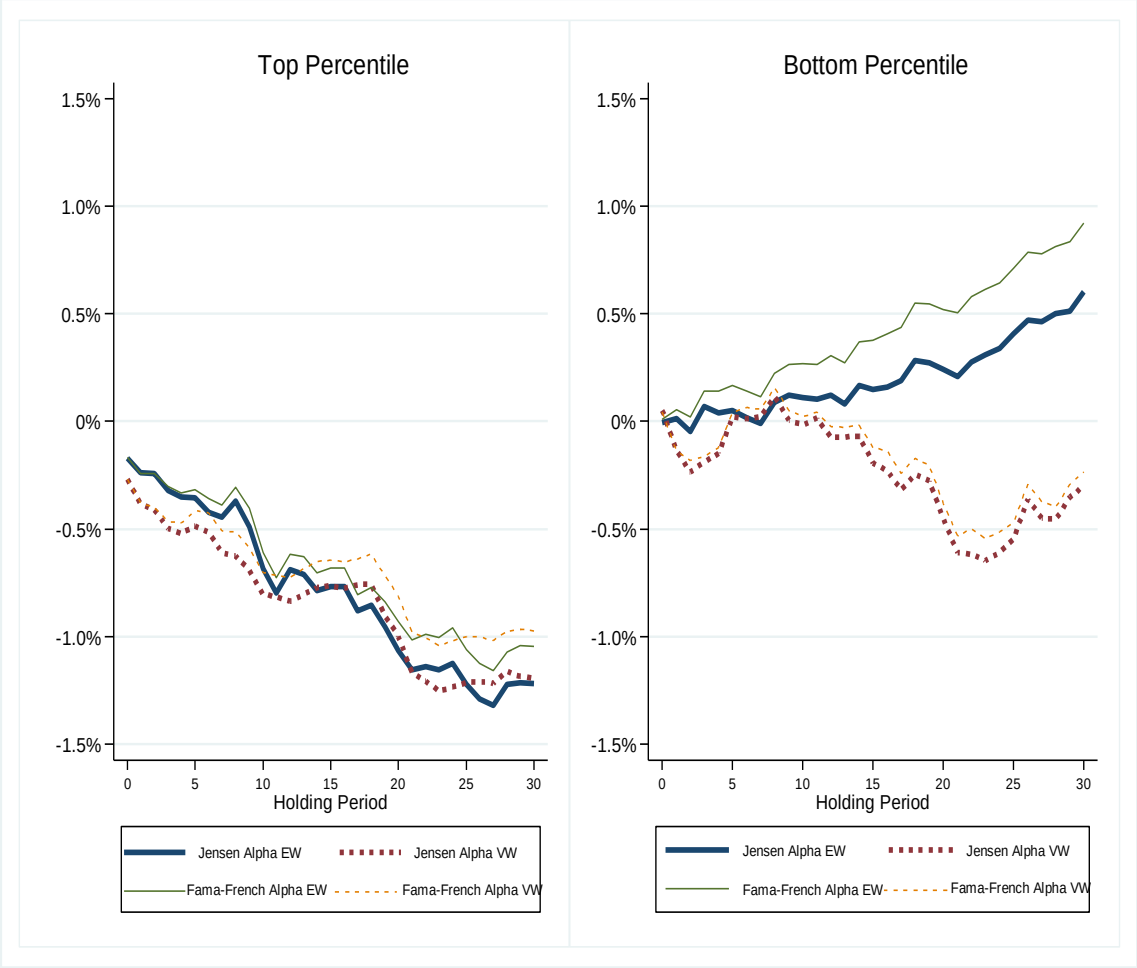
Notes: This figure presents cumulative abnormal returns following the largest (for the top percentile portfolio) and smallest (for the bottom percentile portfolio) increases in short interest, for the period from September 2003 to April 2010. Abnormal returns are measured according to the three models: MM, CAPM and FF3F. 120 and 60 refer to the number of days in the estimation window. The number of observations (*N*) for the 120 and 60-day estimation periods, and top and bottom percentiles are 1021, 1247, 788 and 987 respectively.

4.5.3 Cumulative alphas: top versus bottom percentile portfolio

We present the cumulative alphas for the top and bottom percentile portfolios in Figure 4.3. For the top percentile portfolio, all models – Jensen alpha EW, Jensen alpha VW, FF alpha EW and FF alpha VW – show a very similar pattern of under-performance, with Jensen alpha EW showing the greatest under-performance. In the bottom percentile portfolio, the pattern is not consistent, however. While the equally-weighted portfolios

for both Jensen and Fama-French alpha show over-performance, the value-weighted portfolios show the opposite: underperformance. Again, these negative cumulative alphas in the value-weighted portfolios may suggest that large capitalization stocks dominate the bottom percentile portfolio.

Figure 4.3 Calendar time portfolio cumulative alphas



Notes: This figure presents cumulative alphas following the largest (top percentile portfolio) and smallest (bottom percentile portfolio) increases in short interest for the period September 2003 to April 2010. EW and VW refer to equal weights and value weights respectively. The number of observations (*N*) for the top and bottom percentiles are 2,255 and 1,777 respectively.

4.5.4 Comparison of mean abnormal returns between categories

We compare mean abnormal returns between categories over several event windows in Table 4.4 and report the differences in mean abnormal returns in the upper row and the t-statistics of the differences in parentheses.

Table 4.4 Comparison of mean abnormal returns

Panel A (Top Percentile vs Bottom Percentile)						
Event Window	MM120 Top vs MM120 Bottom	CAPM120 Top vs CAPM120 Bottom	FF3F120 Top vs FF3F120 Bottom	MM60 Top vs MM60 Bottom	CAPM60 Top vs CAPM60 Bottom	FF3F60 Top vs FF3F60 Bottom
(0, +1)	-0.15%**	-0.15%**	-0.13%*	-0.06%	-0.06%	-0.03%
	(-1.99)	(-1.99)	(-1.65)	(-0.81)	(-0.80)	(-0.49)
(0, +10)	-0.07%**	-0.06%**	-0.05%	-0.07%**	-0.07%**	-0.05%*
	(-2.07)	(-2.06)	(-1.59)	(-2.35)	(-2.33)	(-1.78)
(0, +20)	-0.07%***	-0.07%***	-0.06%***	-0.07%***	-0.07%***	-0.06%***
	(-2.78)	(-2.76)	(-2.69)	(-3.19)	(-3.17)	(-2.82)
(0, +30)	-0.06%***	-0.06%***	-0.06%***	-0.07%***	-0.07%***	-0.05%***
	(-2.95)	(-2.92)	(-2.85)	(-3.71)	(-3.68)	(-3.00)
Panel B (120 vs 60 Days Estimation Period)						
Event Window	MM120 Top vs MM60 Top	CAPM120 Top vs CAPM60 Top	FF3F120 Top vs FF3F60 Top	MM120 Bottom vs MM60 Bottom	CAPM120 Bottom vs CAPM60 Bottom	FF3F120 Bottom vs FF3F60 Bottom
(0, +1)	-0.05%	-0.05%	-0.04%	0.05%	0.05%	0.06%
	(-0.69)	(-0.69)	(-0.52)	(0.65)	(0.65)	(0.74)
(0, +10)	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%	-0.02%
	(-0.56)	(-0.56)	(-0.61)	(-0.61)	(-0.61)	(-0.61)
(0, +20)	-0.01%	-0.01%	-0.02%	-0.01%	-0.01%	-0.01%
	(-0.45)	(-0.45)	(-0.66)	(-0.64)	(-0.64)	(-0.59)
(0, +30)	-0.01%	-0.01%	-0.01%	-0.02%	-0.02%	-0.01%
	(-0.35)	(-0.35)	(-0.70)	(-0.93)	(-0.93)	(-0.69)
Panel C (Comparison between Methodologies for Top Percentile)						
Event Window	MM120 Top vs CAPM120 Top	MM120 Top vs FF3F120 Top	CAPM120 Top vs FF3F120 Top	MM60 Top vs CAPM60 Top	MM60 Top vs FF3F60 Top	CAPM60 Top vs FF3F60 Top
(0, +1)	-0.01%	-0.04%	-0.02%	-0.01%	-0.02%	-0.01%
	(-0.19)	(-0.49)	(-0.30)	(-0.20)	(-0.36)	(-0.15)
(0, +10)	-0.01%	-0.02%	-0.01%	-0.01%	-0.02%	-0.01%
	(-0.46)	(-0.73)	(-0.27)	(-0.49)	(-0.83)	(-0.33)
(0, +20)	-0.01%	-0.01%	0.00%	-0.01%	-0.01%	0.00%
	(-0.56)	(-0.38)	(0.19)	(-0.61)	(-0.63)	(-0.01)
(0, +30)	-0.01%	-0.01%	0.01%	-0.01%	-0.01%	0.00%
	(-0.69)	(-0.31)	(0.39)	(-0.75)	(-0.69)	(0.06)

Notes: This table reports the differences in mean abnormal returns between categories over several event windows for the period from September 2003 to April 2010. Abnormal returns are measured according to each model below. The number of observations (*N*) for the 120- and 60-day estimation periods, and top and bottom percentiles are 1021, 1247, 788 and 987 respectively. We construct a two-sample t-test to show the significances of the differences and report the t-statistics in parentheses. *, **, *** denote statistical significance at 10, 5 and 1% respectively.

Top versus bottom percentile (largest versus smallest increases in short interest)

In Panel A of Table 4.4, we compare and report the differences in mean abnormal returns between the top and bottom percentiles, while holding methodology and number of estimation days constant. We find that, by and large, mean abnormal returns between the top and bottom percentiles are significantly different, particularly for long event windows, that is, (0,20) and (0,30). This result specifically shows that the mean abnormal returns for stocks that experience the largest increases in short interest are significantly more negative than those for stocks that experience the smallest increases in short interest, thus providing empirical evidence to support Diamond and Verrecchia's (1987) hypothesis that an unusually large increase in short interest is bad news.

120 versus 60-day estimation period

In Panel B of Table 4.4, we present the differences in mean abnormal returns between the 120 and 60-day estimation windows, while holding methodology and top or bottom portfolio constant. We do not find any significant differences in the mean abnormal returns between the two estimation windows, for any model or event window. Recall that earlier, in Figure 1, we presented the sample sizes for 120 and 60-day estimation windows. The number of common observations are 971 and 741, while the unique observations are 326 (276+50) and 293 (246+47) for the top and bottom percentile portfolios, respectively. It appears that the differences in mean abnormal returns in the unique observations resulting from different estimation windows are not large enough to influence the common samples. This finding may imply that the choice of estimation window, at least between 120 and 60 days, will not significantly influence the results, and that it cannot be used to 'create' a desired result.

Comparison between event study methodologies

In Panel C of Table 4.4, we show the differences in mean abnormal returns between the event study methodologies, while holding the estimation window and top or bottom percentile portfolio constant. Here, we compare the MM with the CAPM, the MM with the FF3F, and the CAPM with the FF3F. Surprisingly, we do not find any significant differences in the mean abnormal returns between methodologies for any of these models and using any event windows. Our finding is in line with MacKinlay (1997), who argues that the gain from employing multi-factor models for event studies are limited because the marginal explanatory power of additional factors other than the market factor is small. A multi-factor model, according to MacKinlay (1997), can be considered if the sample firms have common characteristics, hence the variance reduction in the abnormal returns will be the greatest.

4.5.5 Comparison of alphas between categories

We compare alphas between categories over several event windows in Table 4.5, reporting the differences in the mean alphas in the upper row and the t-statistics of the differences in parentheses.

Table 4.5 Comparison of alphas

Panel A (Equal vs Value Weighted)				
Holding Period	Jensen Alpha Top EW vs Jensen Alpha Top VW	Fama-French Alpha Top EW vs Fama-French Alpha Top VW	Jensen Alpha Bottom EW vs Jensen Alpha Bottom VW	Fama-French Alpha Bottom EW vs Fama-French Alpha Bottom VW
(0, +1)	0.07%	0.07%	0.07%	0.09%
	(0.80)	(0.76)	(0.62)	(0.84)
(0, +10)	0.01%	0.01%	0.01%	0.02%
	(0.31)	(0.24)	(0.33)	(0.70)
(0, +20)	0.00%	-0.01%	0.03%	0.04%*
	(-0.13)	(-0.24)	(1.47)	(2.02)
(0, +30)	0.00%	0.00%	0.03%	0.04%**
	(-0.05)	(-0.13)	(1.56)	(2.11)

Panel B (Comparison between Methodologies holding Weight Constant)				
Holding Period	Jensen Alpha Top EW vs Fama-French Alpha Top EW	Jensen Alpha Top VW vs Fama-French Alpha Top VW	Jensen Alpha Bottom EW vs Fama-French Alpha Bottom EW	Jensen Alpha Bottom VW vs Fama-French Alpha Bottom VW
(0, +1)	0.00%	0.00%	-0.02%	0.00%
	(0.03)	(-0.02)	(-0.96)	(0.01)
(0, +10)	-0.01%	-0.01%	-0.01%	0.00%
	(-0.21)	(-0.25)	(-0.64)	(-0.09)
(0, +20)	-0.01%	-0.01%	-0.01%	0.00%
	(-0.27)	(-0.39)	(-0.88)	(-0.13)
(0, +30)	-0.01%	-0.01%	-0.01%	0.00%
	(-0.30)	(-0.40)	(-0.88)	(-0.09)

Notes: This table reports the difference in mean alphas between categories over several holding periods for the period from September 2003 to April 2010. Alphas are measured using either the Jensen or Fama-French alpha method. The number of observations (*N*) in the top and bottom percentiles are 2255 and 1777 respectively. We construct a two-sample t-test to show the significance of the differences and report the t-statistics in parentheses. *, **, *** denote statistical significance at 10, 5 and 1% respectively.

Equal versus value weighted

In Panel A of Table 4.5, we compare and report the differences in mean alphas between equal and value-weighted portfolios, while holding methodology constant for several holding periods. Generally, for the top percentile portfolio, there is no difference in alphas regardless of whether we use equal or value weighting. The difference does become apparent for the bottom percentile portfolio, though, particularly for the Fama-French alpha in the longer holding periods: (0,20) and (0,30). This result is not surprising, as we stated earlier that the composition of the bottom percentile portfolio may be

dominated by large capitalization stocks. Boehmer et al. (2010) argue that, although value weighting is preferable as it reflects the average investor, it does not reflect the investor's net short position, which is zero in all stocks at all times. It is therefore not clear that the value weighting method is superior to equal weights in examining the performance of shorted stocks.

Comparison between calendar time portfolio approaches

In Panel B of Table 4.5, we present the differences in the mean alphas of the calendar time portfolio approaches, while holding weights and top or bottom percentile portfolios constant. In this table, we compare the Jensen and Fama-French alpha approaches over several holding periods. Holding the weights constant, we do not find any significant difference in the mean alphas of the Jensen and Fama-French approaches in any of the holding periods. This result may suggest that the gain from employing a multi-factor model for the calendar time portfolio approach may be limited, due to the very small marginal explanatory power of factors other than the market factor.

4.6 Conclusion

In this paper, we compare the abnormal returns and alphas of several portfolios following the shorting of stocks. Specifically, we compare across different categories: (i) top and bottom percentile portfolios, (ii) 120 and 60-day estimation windows, (iii) different models of event studies, (iv) equal and value weightings and (v) different models of the calendar time portfolio approach. In all categories, we test for differences in mean abnormal returns and alphas for all models in several event windows and holding periods. For the event study methodology, the difference between the top and bottom percentiles is extremely significant. However, the differences between different estimation windows

and choices of model for the event study approach are very marginal and insignificant. Similarly, for the calendar time portfolio approach, we find significant differences between the results of using equal and value weightings over long holding periods, but no significant differences resulting from the choice of model, that is, between the Jensen and Fama-French alpha approaches.

Our evidence is in line with MacKinlay's (1997) argument that the gains from employing multi-factor models in event studies are limited as the marginal explanatory power of factors other than the market factor is very small. For event studies, the choices of methodology and estimation window appear to be immaterial. For the calendar time portfolio approach, however, the choice of weighting approach appears very important, as equal and value weightings can yield opposing results. We agree with Boehmer et al. (2010) that, while value weightings may not be superior to equal weightings when studying the performance of shorted stocks, the potentially conflicting results may require disclosure of the results of both.

Our findings have several important implications. First, despite Fama's (1998) strong rebuttal, claiming apparent anomalies are methodological illusions, we find that shorting anomalies persist in all the models under study, particularly with respect to the top percentile with the largest increases in short interest. Secondly, from an empirical point of view, this exercise provides supporting evidence for Diamond and Verrecchia's (1987) hypothesis that unusually large increases in short interest are associated with periods of negative alphas or abnormal returns. Thirdly, our evidence shows that UK short sellers may have the chance to strike negative alphas if the increases in short interest are 1.91 percent or more. Investors seeking negative alphas can find them through shorting.

Chapter 5

Short-Selling Ban and Cross-Sectoral Contagion

5.1 Introduction

At the height of the recent crisis in global financial markets, the UK Financial Services Authority (FSA) announced a ban on the short selling of certain financial-sector stocks at midnight on 18th September 2008. An immediate prohibition on the creation of new short-selling positions was intended to restore investor confidence in the stricken financial sector. When the ban was announced, the reaction of many market participants was highly vocal. Many large buy-side investors and long-term shareholders were strongly supportive. David Fischel, chief executive officer (CEO) of Liberty International Plc, the largest owner of shopping centres in the UK, called for a broader ban on short selling, claiming that real-estate investment trusts and other property companies were more heavily exposed than other sectors to short selling.[31] Opponents of the ban, including many hedge funds and some sections of

[31] Bloomberg newswire (BN), "*Liberty's Fischel Calls For Broader Ban on U.K. Short Selling*", Sep 26 2008, 12:32:14

the media, objected vehemently. Several hedge funds discussed initiating legal proceedings against the FSA in respect of losses they claimed to have sustained as the result of the ban, but eventually did not proceed.[32] In a February 2009 Discussion Paper, the FSA claimed that short selling "*can be used abusively in conjunction with 'scaremongering' tactics to push down the price of a stock being shorted*", and that the ban was necessary to prevent contagion. Hector Sants, CEO of the FSA, stated that the ban protected the fundamental integrity and quality of the financial sector, and guarded against further financial instability. The ban was lifted on 16th January 2009.

Several previous empirical studies on the effect of constraints on short selling are framed with reference to either or both of Miller's (1977) overpricing hypothesis, and Diamond and Verrecchia's (1987) no overpricing hypothesis (Clifton and Snape, 2008; Marsh and Niemer, 2008; Beber and Pagano, 2012; Boehmer, Jones and Zhang, 2009; Boulton and Braga-Alves, 2010; Kolasinski, Reed and Thornock, 2010; Hansson and Fors, 2009; Frino, Lecce and Lepone, 2011). Diamond and Verrecchia (1987) suggest a ban on short selling leads to a reduction in both informational efficiency and market quality. In this study we investigate the impact of the imposition and removal of the short-selling ban on abnormal returns and market quality. We also investigate a possible cross-sectoral contagion effect, from the financial sector to other non-financial sectors that may have motivated the imposition of the ban. For the stocks that were subject to the ban we create a matched sample of stocks for which short selling was permitted, using the short interest ratio and market capitalization as matching criteria. Using Brown and Warner's (1985) event-study methodology, we examine the differences between the two samples. Following Forbes and Rigobon (2002), we estimate a

[32]The Telegraph news, "*Hedge funds plan to sue FSA over short-selling ban ",* 22 Sep 2008, 11:57 bst.

heteroskedasticity-adjusted correlation coefficient between financial sector and non-financial sector abnormal returns, in order to identify a contagion effect.

Our empirical results are consistent with the theoretical analysis of Diamond and Verrecchia (1987), which predicts no overpricing effect, and lower market quality, as a consequence of a ban on short selling. We report evidence consistent with Miller's (1977) overpricing (underpricing) effect when the ban was first imposed (lifted); but any such effect appears to have been short-lived. After 30 days following the imposition (removal) of the ban, the overpricing (underpricing) effect disappears, and the difference between the two matched samples is insignificant. Our results are consistent with those of Hansson and Fors (2009), but inconsistent with those of Frino et al. (2011) for the UK. Stocks that were subject to the ban registered an insignificant average increase in abnormal returns, higher volatility, lower standardized volume, and a wider bid-ask spread, following the imposition of the ban. The average difference in abnormal returns following the removal of the ban is also insignificant. In respect of the FSA's claim that the ban was intended to mitigate cross-sectoral contagion, we find evidence of a significant increase in the correlation between the daily returns in the financial sector and the telecommunication sector, during a six-week period immediately prior to the imposition of the short-selling ban. To some extent, the FSA's concerns over contagion are substantiated by this finding; although there is no evidence of any significant contagion effect in respect of seven other non-financial sectors during the weeks preceding the imposition of the ban. There is no evidence of contagion while the ban was in force.

Our contribution to the literature on short selling is threefold. First, using a complete list of 35 stocks that were subject to the ban on short selling, we create a matched sample of stocks

for which short selling was permitted, using the short interest ratio and market capitalization as matching criteria. We analyse the price effects of the imposition and removal of the ban, by examining the differences between the two matched samples on a daily basis throughout the duration of the ban. It would not be appropriate to compare a lightly shorted stock that was subject to the ban with a heavily shorted one that was not subject to any restriction on short selling. Superficial comparisons are likely to obscure true differences and give rise to misleading conclusions. To the best of our knowledge, this is the first UK study to use matched samples to evaluate the impact of the short-selling ban on market quality.

Second, this is the first UK study to use complete data. By tracking the sequence of daily news announcements on Bloomberg and cross-checking against the FSA's website, we compile a complete list of the stocks that were subject to the short-selling ban. Previous studies (Marsh and Niemer, 2008; Hansson and Fors, 2009) examine smaller, incomplete samples. Third, our study is the first to investigate cross-sectoral contagion from the financial sector to other non-financial sectors. Concern over cross-sectoral contagion was cited by the FSA as a motivating factor for the imposition of the ban. In general, our findings suggest that while this measure did not contribute effectively towards the regulatory aims of protecting market quality, it was successful in mitigating contagion, thereby promoting capital market stability.

The remainder of the paper is organised as follows. In Section 5.2 we provide background information about the short-selling ban in the UK. In Section 5.3 we review the literature on the effects of constraints on short selling, including prohibition. In Section 5.4 we describe the matched samples of stocks that were subject to the ban and stocks for which short selling

was permitted, and we describe our empirical approach. In Section 5.5 we report the empirical results. In Section 5.6 we offer some concluding remarks.

5.2 The short-selling ban in the UK

> *"If short selling precipitates the collapse of an issuer, this may have implications for market confidence, leading to contagion for related stocks. Share prices of certain financial sectors companies can plummet to a systemic level, and banks targeted this way might ultimately experience a depositor run" (FSA Discussion Paper, February 2009, p.12)*

The ban on the short selling of financial stocks in the UK was implemented by the FSA, in an effort to stabilize and restore investor confidence in exceptionally volatile financial markets. The first steps towards the ban can be traced back to 20th June 2008, when the FSA announced a requirement for the disclosure of short positions in the securities of a company that was conducting a rights offering. At midnight on 18th September 2008, the FSA announced a ban on the short selling of stock in 29 banks and insurance companies.[33] Disclosure of existing short positions in excess of 0.25 percent of the issued share capital of the same stocks was required, and the creation of new short positions was prohibited. Market makers, however, were exempted from this rule.[34]

During trading hours on 19th September 2008, the FSA extended the ban to the stock of four further companies. On 23rd and 30th September 2008, two and one further companies, respectively, were added to the list, which ultimately covered the stocks of 35 companies. The FSA lifted the ban on 16th January 2009, but the requirement for disclosure of short

[33]The number of securities originally listed as subject to the ban was 29, but the list included Resolution Plc, which was delisted in early 2008. Hence the correct number was 28.
[34]FSA defines a market maker as an entity that, ordinarily as part of their business, provides liquidity on a regular basis on both the bid and offer sides of the market, in comparable size.

positions in financial stocks continued. Table 5.1 provides further detail on the list of stocks that were subject to the ban. Several previous studies examine the effects of constraints on short selling that were enacted from a single date, or were applied to a considerably shorter list of stocks (i.e., Clifton and Snape, 2008; Marsh and Niemer, 2008; Beber and Pagano, 2012; Hansson and Fors, 2009; Frino, Lecce and Lepone, 2011).

Table 5.1 List of stocks subject to the FSA short-selling ban

Stocks	Date Ban Announced	Date Ban Effective	Status	Survive through Removal of Ban?	
Admiral Group	18/09/2008	19/09/2008		Yes	
Alliance & Leicester	18/09/2008	19/09/2008	Acquired by Banco Santander SA on 13 Oct 2008		No
Alliance Trust	18/09/2008	19/09/2008		Yes	
Arbuthnot Banking Group	18/09/2008	19/09/2008		Yes	
Aviva	18/09/2008	19/09/2008		Yes	
Barclays	18/09/2008	19/09/2008		Yes	
Bradford & Bingley	18/09/2008	19/09/2008	Nationalised by UK govt on 29 Sep 2008		No
British Insurance Holdings	18/09/2008	19/09/2008	Acquired on 7 Apr 2011 by multiple acquirer	Yes	
Chesnara	18/09/2008	19/09/2008		Yes	
European Islamic Inv Bank	18/09/2008	19/09/2008		Yes	
Friends Provident Group	18/09/2008	19/09/2008	Acquired by Resolution in Nov 2009	Yes	
Hbos	18/09/2008	19/09/2008	Acquired by Lloyds Tsb on 19 Jan 2009		No
Highway Insurance Group	18/09/2008	19/09/2008	Acquired by Liverpool Victoria Insurance on 6 Nov 2008		No
Hsbc Holdings	18/09/2008	19/09/2008		Yes	
Islamic Bank of Britain	18/09/2008	19/09/2008	Acquired by Qatar International Islamic Bank 27 Apr 2011	Yes	
Just Retirement Holdings	18/09/2008	19/09/2008	Acquired by Permira Advisers LLP on 26 Nov 2009	Yes	
Legal & General	18/09/2008	19/09/2008		Yes	
Lloyds Banking Group	18/09/2008	19/09/2008		Yes	
London Scottish Bank	18/09/2008	19/09/2008	Delisted on 28 Nov 2008		No
Novae Group	18/09/2008	19/09/2008		Yes	
Old Mutual	18/09/2008	19/09/2008		Yes	
Prudential	18/09/2008	19/09/2008		Yes	
Resolution *					
Royal Bank of Scotland	18/09/2008	19/09/2008		Yes	
RSA Insurance Group	18/09/2008	19/09/2008		Yes	
St James Place	18/09/2008	19/09/2008		Yes	
Standard Chartered	18/09/2008	19/09/2008		Yes	
Standard Life	18/09/2008	19/09/2008		Yes	
Tawa	18/09/2008	19/09/2008		Yes	
Close Brothers Group	19/09/2008	22/09/2008		Yes	
Investec	19/09/2008	22/09/2008		Yes	
Rathbone Brothers	19/09/2008	22/09/2008		Yes	
Schroders	19/09/2008	22/09/2008		Yes	
Aberdeen Asset Mgt	23/09/2008	24/09/2008		Yes	
F&C Asset Mgt	23/09/2008	24/09/2008		Yes	
Provident Financial	30/09/2008	01/10/2008		Yes	

Notes: This table lists the stocks that were subject to the short-selling ban, together with the dates for which the ban was applicable to each stock, and any changes of status (acquisition or de-listing) that have occurred since the ban was imposed. Despite having been delisted in 2008, Resolution Plc was included erroneously on the original list, but was removed from subsequent versions. The data are sourced from Bloomberg.

The ban on short selling sparked emotive debates among supporters and critics. During an after-dinner speech to London bankers, the Archbishop of York spoke of his outrage at those

responsible for shorting shares in HBOS, labelling those responsible as bank robbers and asset strippers, and noting that the value of a bank was dependent not on the strength of its performance, but on the willingness of government to bail it out.[35] By contrast, the Financial Services Lawyer Association regarded the ban as regulation by mirror and smoke, and questioned whether the intended effect on financial markets would materialise.[36] The FSA claimed to have enacted the ban to restore investor confidence, stabilize financial markets, protect market quality, and prevent contagion. The episode of the short-selling ban represents a natural experiment in regulatory intervention, and provides an opportunity to assess the effectiveness of such a measure in achieving its broad and specific objectives.

5.3 Related Literature

The impact of short-selling constraints on stock prices and market quality has been the subject of theoretical debate, focused primarily on price effects. Early studies (Miller, 1977; Figlewski, 1981) note that pessimists wish to sell short. Constraining the ability of pessimists to trade without constraining optimists should produce an upward bias in stock prices. Miller's overvaluation hypothesis is that stocks subject to short-selling constraints should yield lower future returns.

Diamond and Verrecchia (1987) challenge Miller's conclusions, using a rational expectations framework. While short-selling constraints eliminate some informative trades, such constraints should not produce an upward bias in prices, because rational investors and traders recognize the constraints and adjust their valuations accordingly, before making their

[35] See Bloomberg Newswire (BN), "Short-Sellers Clearly Bank Robbers, Says Archbishop", Sep 25 2008, 12:25:23

[36] See http://www.blplaw.com/media/pdfs/FSA%20Documents/FSA_ban_on_short_selling.pdf

trading decisions. A distinction is drawn between short-selling restrictions, and a ban on short selling. Short-selling restrictions might include, for example, the imposition of an additional cost on borrowing, which makes short selling less attractive. Only those investors who are highly informed, and have a strong expectation of a significant price decline, will choose to short. Effectively, a restriction of this kind changes the proportion of informed traders, by driving out the uninformed from the pool of short sellers. This reasoning suggests that short-selling restrictions increase the information content of short-sale transactions, thereby increasing informational efficiency. On the contrary, prohibition eliminates short selling by informed and uninformed traders alike, leaving unchanged the proportions of informed and uninformed. Prohibition reduces informational efficiency, especially with respect to bad news, and thereby reduces market quality.

Hong and Stein (2003) suggest that short-selling constraints prevent bearish investors from participating in the market. When bearish investors' signals are concealed, only bullish investors' information is revealed in the stock price. If some bullish investors bail out, the original bearish group may become "support buyers". Bullish investors then become aware of the bearish group's earlier concealed signals, resulting in a market decline or crash. Likewise, Bai, Chang and Wang (2006) suggest short-selling constraints cause marginal investors, who are rational but risk-averse, to perceive higher risk associated with constrained stocks. This perception causes risk-averse investors to reduce their demand for these stocks, reducing price and increasing volatility.

Much of the empirical evidence supports Miller's (1977) overpricing hypothesis. Proxies used for short-selling constraints, however, are diverse, including the level of short interest or

short-interest ratio (Figlewski, 1981; Asquith and Meulbroek, 1995; Desai, Thiagarajan and Balachandran, 2002; Asquith, Pathak and Ritter, 2005), introduction of options trading (Figlewski and Webb, 1993; Danielsen and Sorescu, 2001), stock-lending supply (D'Avolio, 2002; Geczy, Musto and Reed, 2002; Jones and Lamont, 2002; Saffi and Sigurdsson, 2011), percentage of institutional ownership (Chen, Hong and Stein, 2001; Asquith et al., 2005; Nagel, 2005), and a designated or "allowed-to-short" list (Chang, Cheng and Yu, 2007). In a multi-country study, Charoenrook and Daouk (2005) investigate the effects of short-selling restrictions on market quality in each country. When short selling is permitted subject to constraints, aggregate stock returns are less volatile, and liquidity is higher. Bris, Goetzmann and Zhu (2007) report that in jurisdictions where short selling is permitted, capital inflows are reduced and market efficiency is improved. Ali and Trombley (2006) argue that short selling constraints, proxied by stock lending fees are important in preventing arbitrage of momentum in stock returns. Further, Thomas (2006) points out that short selling constraints are difficult to calibrate especially in the UK context, and suggests more high-frequency analysis to provide conclusive evidence on the role of short sales.

Several empirical studies offer direct tests of Miller's (1977) overpricing hypothesis and Diamond and Verrecchia's (1987) no overpricing hypothesis, or the lower market quality hypothesis. Frino et al. (2011) investigate the effect on stock prices and market quality, by comparing eleven countries in which a short-selling ban was implemented, and three countries with no ban. There was a positive price effect in most of the countries that were subject to prohibition, including the UK, and a reduction in market quality in all eleven countries. Beber and Pagano (2012) examine the impact of restrictions on short selling in 30 countries. There was a deterioration in market quality for stocks subject to a short-selling ban, but empirical support for Miller's overvaluation hypothesis is found for the US only.

Boehmer et al. (2009), Boulton and Braga-Alves (2010) and Kolasinski et al. (2010) examine the impact of the short-selling ban in the US. Collectively, these studies identify a positive price effect and a reduction in market quality, evidenced by increasing volatility, deteriorating liquidity, and widening bid-ask spreads. Boulton and Braga-Alves (2010) provides evidence in support of Miller's overvaluation hypothesis; but Boehmer et al. (2009) suggest a positive price effect following the short-selling ban might be confounded by US government bail-out packages that were announced at the same time.

In addition to the Beber and Pagano (2012) and Frino et al. (2011) multi-country studies, both of which include the UK, Clifton and Snape (2008), Marsh and Niemer (2008) and Hansson and Fors (2009) report evidence that the UK short-selling ban reduced market quality. Results concerning any price effect are mixed, however. Hannson and Fors (2009) and Beber and Pagano (2012) find that the price effect is neutral, while Frino et al. (2011) report a positive price effect consistent with the overvaluation hypothesis. We believe the conflicting results concerning the price effect may be explained by sample selection effects. Only Hansson and Fors (2009) compare stocks that were subject to the ban with a control group; however, only an incomplete list of stocks that were subject to the ban is considered. Both Beber and Pagano (2012) and Frino et al. (2011) draw comparisons at country level, rather than at the level of individual stocks.

While most studies cite two of the FSA's objectives in implementing the short-selling ban, namely providing stability and protecting market quality, a third key objective, preventing contagion from the financial sector to other non-financial sectors, is rarely cited. The impact of the ban on short selling on cross-sectoral contagion is a largely neglected topic. Forbes

and Rigobon (2002) define contagion as a significant increase in cross-market linkages following a shock in one market. Cross-market correlations between returns, used to measure contagion during a stable period and immediately after a shock or crisis, are sensitive to market volatility. An adjustment for heteroskedasticity bias is obtained by estimating the unconditional correlation. After adjustment there is virtually no increase in unconditional correlation, and therefore no evidence of contagion, during the 1997 Asian crisis, the 1994 Mexican devaluation and the 1987 US stock market crash. A high level of market co-movement during those periods is attributed to interdependence, rather than contagion.

In this paper, our objective is to assess empirically the impact of the imposition and removal of the ban on short selling in the UK, using measures of abnormal returns and market quality for all stocks that were subject to the ban, and for a matched sample of stocks that were outside the scope of the ban. We also search for evidence of cross-sectoral contagion from the financial sector to other non-financial sectors. The empirical investigation is expected to provide evidence relevant to the evaluation of the theories developed by Miller (1977), Diamond and Verrecchia (1987), Hong and Stein (2003) and Bai et al. (2006).

5.4 Research Methodology

5.4.1 Sample and Matching Procedure

The list of stocks that were subject to the ban on short selling in the UK is compiled from Bloomberg, by carefully following the sequence of newswires. The FSA issued the first list on 18th September 2009 and extended the list on three subsequent occasions. By end of September 2009, the ban applied to 35 stocks. We create a matched sample of 35 stocks that were not subject to the ban, using the closest short interest ratio and market capitalization at

end of September 2009 as matching criteria. Short interest ratio is the percentage of available (lendable) supply of shares sold short. In our view, comparing a group of stocks that were subject to the ban, which might have been either heavily or lightly shorted, with an unmatched group of stocks that were not subject to the ban, as in several previous studies (Clifton and Snape, 2008; Marsh and Niemer, 2008; Beber and Pagano, 2012; Hansson and Fors, 2009; Frino, Lecce and Lepone, 2011) might misrepresent the effect of the short-selling ban. Several of the companies on the list were small in terms of market capitalization. Neglecting a control for capitalization is likely to result in misleading comparisons of bid-ask spreads and other market quality measures between, for example, a small-capitalization stock that was on the list and a large-capitalization stock that was not subject to the ban.

Daily data on the short interest ratio are sourced from Euroclear UK and Ireland. Daily data on stock prices (daily close, high and low), market capitalization, volume traded, and number of shares outstanding are sourced from Datastream. Table 5.2 reports summary descriptive statistics for the stocks on the list and the matched samples on the announcement date. The Means and Wilcoxon rank sum tests reported in Panel C indicate that there is no significant difference between the two samples with regard to the matching criteria.

Table 5.2 Samples' descriptive statistics

Panel A: Stocks Subject to Short-Selling Ban (*N*=35)	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Short Interest Ratio (in %)	7.60	6.91	4.62	0.00	19.97
Market Capitalization (in £ million)	7,158	1,120	16,959	7	95,934
No of Shares Outstanding (in millions of shares)	2,348	492	3,674	14	16,500
Bid-Ask Spread (in %)	1.42	0.26	2.46	0.03	10.48
Panel B: Matched Samples (*N*=35)	**Mean**	**Median**	**Std. Dev.**	**Min**	**Max**
Short Interest Ratio (in %)	7.02	5.86	4.22	0.00	17.59
Market Capitalization (in £ million)	6,907	1,220	15,682	21	87,115
No of Shares Outstanding (in millions of shares)	1,503	474	3,373	25	18,800
Bid-Ask Spread (in %)	1.36	0.42	2.30	0.05	11.24

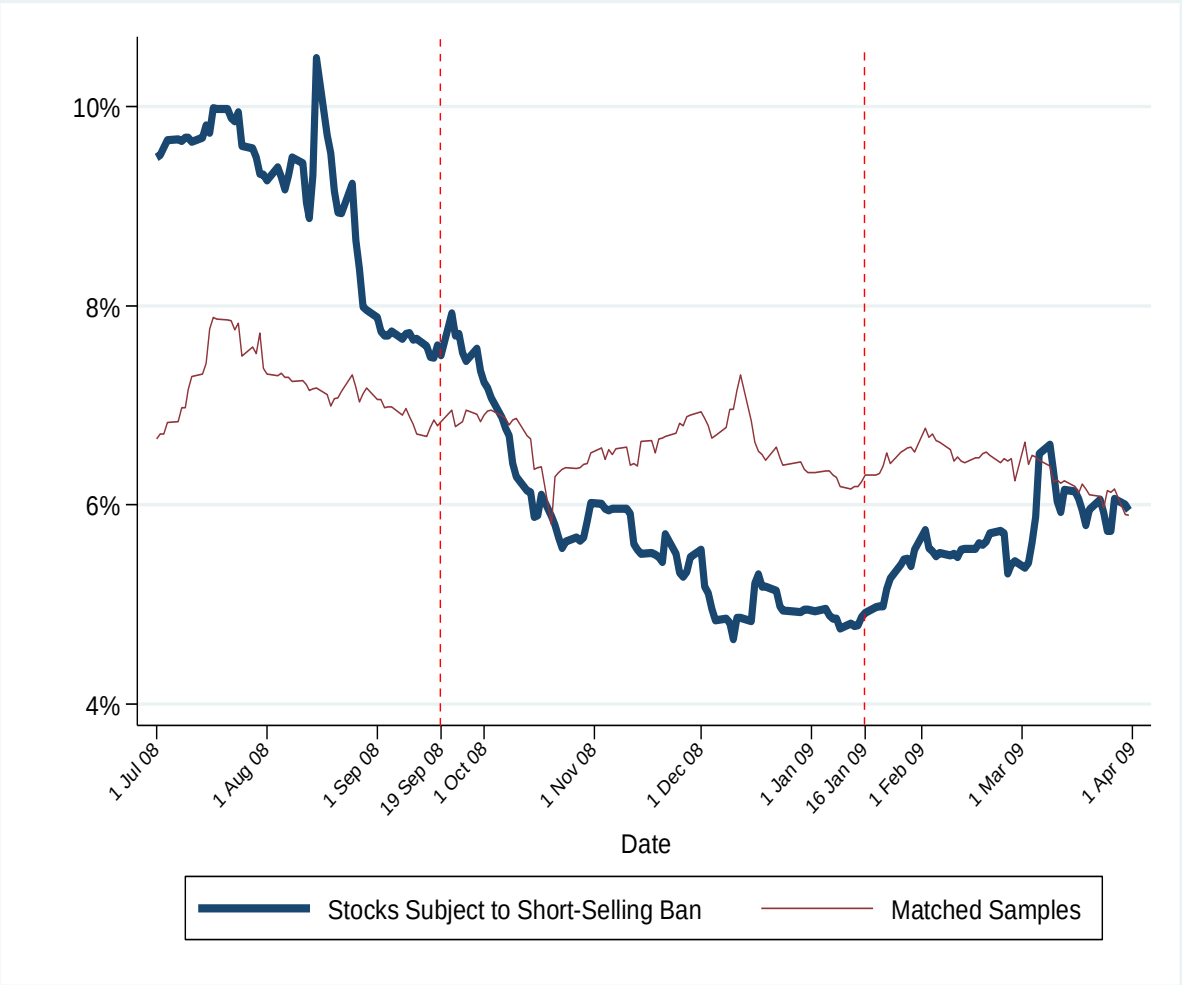
Panel C: Difference between Samples	**Mean**	***p*-value**	**Median**	***p*-value**
Short Interest Ratio (in %)	0.58	0.65	1.05	0.58
Market Capitalization (in £ million)	251	0.95	-100	0.88
No of Shares Outstanding (in millions of shares)	845	0.32	18	0.15
Bid-Ask Spread (in %)	0.06	0.91	-0.16	0.81

Notes: This table reports descriptive statistics for the stocks that were subject to the short-selling ban and the matched samples, with reference to the date on which the ban was imposed for each stock in the former group. The matched samples are constructed using the short interest ratio and market capitalization as matching criteria. Short interest ratio is the percentage of available (lendable) supply of shares sold short. Market capitalization is the aggregate value of the total outstanding shares. Number of shares outstanding is the total number of shares held by investors. Bid-ask spread is the difference in daily closing bid and ask price over ask price. *p*-values are for *t*-tests of differences in means and Wilcoxon rank sum tests for difference in medians

Figure 5.1 compares the mean short interest ratio for the two matched samples. For the duration of the short-selling ban (between the two dashed lines), market makers were exempt from the ban. While ordinary investors were prevented from increasing their short positions in the stocks concerned, they were permitted to maintain their established short positions. Intuitively, if market makers are major players in the short market, the reduction in the mean short interest should be small. In practice, however, the short interest for the stocks that were subject to the ban fell by almost 3% relative to the control group, for which short interest was

stable throughout the period of the ban. After the ban was lifted, the short interest of the stocks that had been subject to ban increased, and the difference between the two samples disappeared quickly. These patterns may suggest that ordinary investors are the principal short sellers in UK equities.

Figure 5.1 Time series plot of mean short-interest ratio for the stocks subject to the short-selling ban, and the matched samples



Notes: The short-interest ratio is the percentage of available (lendable) supply of shares sold short. The number of stocks subject to the short-selling ban, and the number of stocks in the matched samples, is 35. The short-selling ban was in force between 19th September 2008 and 16th January 2009.

Of the 35 companies whose stocks were originally subject to the ban, four were acquired while the ban was in force, and one was delisted (see Table 5.1). We are therefore able to examine the effect of the removal of the ban using data for 30 stocks (and their matched counterparts). We obtain daily returns data for sectoral indices from Datastream for the

period 1st January 2008 to 16th January 2009 in order to investigate whether there is any evidence of cross-sectoral contagion. This period includes periods of eight-and-a-half months prior to the announcement of the ban, and four months while the ban was in force. The list of indices comprises financials, industrials, technology, telecommunication, utilities, basic materials, consumer goods, consumer services, and oil and gas.

5.4.2 Research Design

Event-study methodology

To compare the abnormal returns for the stocks subject to the short-selling ban and the matched sample, we use the Brown and Warner (1985) market model. We let R_{it} denote the daily logarithmic return for stock *i* on day *t*, and R_{mt} denote the daily logarithmic return on the FTSE350 index. We estimate the following market model over the estimation period (days *s*= –70 to *s*= –11, defined relative to the event date):

$$R_{is} = \hat{a}_i + \hat{b}_i R_{ms} + \varepsilon_{is} \qquad (5.1)$$

The coefficients $\hat{a}_i, \hat{b}_i$ are obtained using ordinary least squares (OLS) estimation. We let $\mathrm{AR_{it}}$ denote the daily abnormal return of stock *i* on day *t* during the event window (days *t*= –10 to *t*= +30, defined again relative to the event date):

$$AR_{it} = R_{it} - \hat{a}_i - \hat{b}_i R_{mt} \qquad (5.2)$$

We let AAR_t denote the average daily abnormal return (calculated over all stocks in each sample) on day *t*, and $CAAR_t$ denote the cumulative average daily abnormal return on day *t* during the event window:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{it} \qquad (5.3)$$

$$CAAR_t = \sum_{\tau=-10}^{t} AAR_\tau \qquad (5.4)$$

To assess whether each average daily abnormal return is significantly different from zero, we use the test procedure suggested by Boehmer, Musumeci and Poulsen (BMP, 1991) to adjust for event-induced variance.[37] We let SAR_{it} denote Brown and Warner's (1985) standardized abnormal return for stock *i* on day *t* during the event window, and $\hat{S}(SAR_t)$ denote the cross-sectional standard deviation of standardised abnormal returns on day *t*. The BMP t-statistic is:

$$t = \frac{1}{\sqrt{N}} \sum_{i=1}^{N} SAR_{it} / \hat{S}(SAR_t) \qquad (5.5)$$

where $\hat{S}(SAR_t) = \sqrt{\frac{1}{N-1}\sum_{i=1}^{N}(SAR_{it} - \overline{SAR_t})^2}$; $\overline{SAR_t} = \frac{1}{N}\sum_{i=1}^{N} SAR_{it}$

Volatility

The FSA took the view that the ban would tend to reduce volatility in the prices of financial-sector stocks. On the contrary, Scheinkman and Xiong (2003) and Bai et al. (2006) suggest stock prices may become more volatile under constraints on short selling. Parkinson (1980) develops a range-based estimator based on the highest and lowest prices over a one-day interval, which contains more information about the returns-generating process, and therefore provides a more accurate volatility measure, than any measure based on opening and closing prices only.

[37]Harrington and Shrider (2007) emphasise the importance of using a test that is robust to cross-sectional variation in abnormal returns in the presence of event-induced variance.

$$Volatility_{\ it} = ln\left(\frac{HIGH}{LOW}\right)_{it} \tag{5.6}$$

Liquidity

Our first liquidity measure, which allows for comparisons between stocks, is standardized trading volume, defined by Foster and Viswanathan (1993) as the ratio of trading volume to number of shares outstanding:

$$Volume_{\ it} = \left(\frac{VOLUME}{NOSH}\right)_{it} \tag{5.7}$$

Our second liquidity measure, which reflects trade execution costs, is the bid-ask spread. This key determinant of traders' investment performance can be interpreted as an indicator of market quality (Bessembinder and Venkataraman, 2010). Diamond and Verrecchia (1987) suggest that short-selling constraints result in wider bid-ask spreads, because they reduce informational efficiency. The bid-ask spread is defined as the difference between daily closing ask and bid prices over ask price:

$$Bid\ Ask\ Spread_{\ it} = \left(\frac{ASK - BID}{ASK}\right)_{it} \tag{5.8}$$

5.4.3 Cross-sectoral Contagion

Forbes and Rigobon (FR, 2002) define contagion as a significant increase in the cross-sectoral correlation between the returns for two sectors between a low-volatility period and a high-volatility period, after adjusting for heteroskedasticity bias in the estimated correlation for the high-volatility period. Suppose the linkage between the returns in the financial sector, denoted *x*, and a non-financial sector, denoted *y*, is described by the equation $y = \beta x + \varepsilon$, and assume β and $\sigma_{\varepsilon\varepsilon}$ (the variance of the disturbance, ε) remain unchanged between a benchmark

period of low volatility in the financial sector, denoted *l*, and a period of high volatility, denoted *h*. Financial-sector volatility in period *j* is measured by σ_{xx}^{j} (the variance of *x* in period *j*), and by definition $\sigma_{xx}^{h} > \sigma_{xx}^{l}$. Let ρ^{h} and ρ^{l} denote the correlations between *x* and *y* during *h* and *l*, respectively. FR demonstrate that $\rho^{h} > \rho^{l}$ despite the constancy of β and $\sigma_{\varepsilon\varepsilon}$, owing to the increase in the variance of *x*. FR propose the following heteroskedasticity-adjusted correlation as a measure of the linkage between *x* and *y* during *h*:

$$\rho_{adj}^{h} = \rho^{h}\{1 + \delta[1 - (\rho^{h})^{2}]\}^{-1/2} \qquad (5.9)$$

where

$$\delta = \left(\frac{\sigma_{xx}^{h}}{\sigma_{xx}^{l}}\right) - 1$$

The estimated ρ_{adj}^{h} can be compared directly with the estimated ρ^{l}, in order to test for contagion. Using the low-volatility period 1st January to 31st July 2008 as a benchmark, we investigate whether the estimated ρ_{adj}^{h} is significantly higher than ρ^{l} in respect of two high-volatility periods: (i) 1st August 2008 to 18th September 2008, immediately before the imposition of the short-selling ban; and (ii) 19th September 2008 to 16th January 2009, while the ban was in force.

5.5 Empirical Results

5.5.1 Impact of the imposition of the short-selling ban on abnormal returns and market quality

Table 5.3 Event-study cumulative abnormal returns around the imposition of the short-selling ban

	Panel A: Stocks Subject to Short-Selling Ban			Panel B: Matched Samples			
Day	Cumulative Average Abnormal Return (%)	Average Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics	Cumulative Average Abnormal Return (%)	Average Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics	Difference in Average Abnormal Return (%)
-10	1.47	1.47	4.12 ***	-0.03	-0.03	-0.89	1.50 ***
-9	1.45	-0.02	0.17	0.24	0.28	1.33	-0.30
-8	2.35	0.90	2.09 **	-0.27	-0.51	-0.85	1.41 *
-7	2.10	-0.25	-0.36	-0.41	-0.14	-0.66	-0.11
-6	1.11	-0.99	-2.85 ***	-0.92	-0.50	-2.08 **	-0.48
-5	-0.86	-1.97	-3.77 ***	-1.02	-0.11	-0.26	-1.86 ***
-4	-1.48	-0.62	-0.23	-0.63	0.39	1.05	-1.01
-3	-1.29	0.19	0.28	-1.17	-0.53	-1.13	0.73
-2	-1.10	0.19	0.85	-1.76	-0.59	-1.31	0.78
-1	-0.91	0.19	0.05	-2.37	-0.61	-1.29	0.80
0	0.71	1.62	2.42 **	-3.00	-0.63	-1.13	2.25 *
1	0.74	0.03	-0.34	-3.12	-0.13	-0.26	0.16
2	-0.25	-0.99	-1.43	-3.25	-0.12	0.48	-0.87
3	0.62	0.87	1.00	-3.31	-0.06	0.67	0.93
4	0.30	-0.33	-0.26	-3.65	-0.35	-1.19	0.02
5	-0.46	-0.75	-1.38	-2.80	0.85	0.89	-1.60 **
6	-0.16	0.29	-0.41	-2.70	0.10	0.16	0.19
7	-1.40	-1.24	-0.69	-2.46	0.24	-1.31	-1.48
8	0.37	1.78	1.51	-2.86	-0.40	0.50	2.17 **
9	0.58	0.20	-0.16	-2.38	0.47	0.15	-0.27
10	1.07	0.49	0.71	-2.33	0.06	0.08	0.43

Notes: Panel A and B report the results of an event-study analysis of abnormal returns from 10 trading days before through 10 days after the imposition of the short-selling ban. The analysis is based on 35 stocks that were subject to the ban, and a matched sample of 35 other stocks. Abnormal returns are measured using Brown and Warner's (1985) market model. Standardised cross-sectional test statistics account for event-induced variance, following Boehmer, Musumeci and Poulsen (1991). *, **, *** denote significance at the 10, 5 and 1% levels, respectively using a two-tail test.

Panels A and B in Table 5.3 report the average abnormal returns for the stocks subject to the ban and the matched samples, as well as the average difference between the two samples, on

each day in the event window. The average abnormal return for the day on which the ban was imposed for each stock is 1.62%. The Boehmer, Musumeci and Poulsen test indicates that the average abnormal return is significantly different from zero at the 5% level. For the same day, the average difference between the two matched samples is 2.25%. This difference is significant at the 10% level. While there was strong buying pressure for the stocks that were subject to the ban, the matched sample stocks were subject to a slight selling pressure.

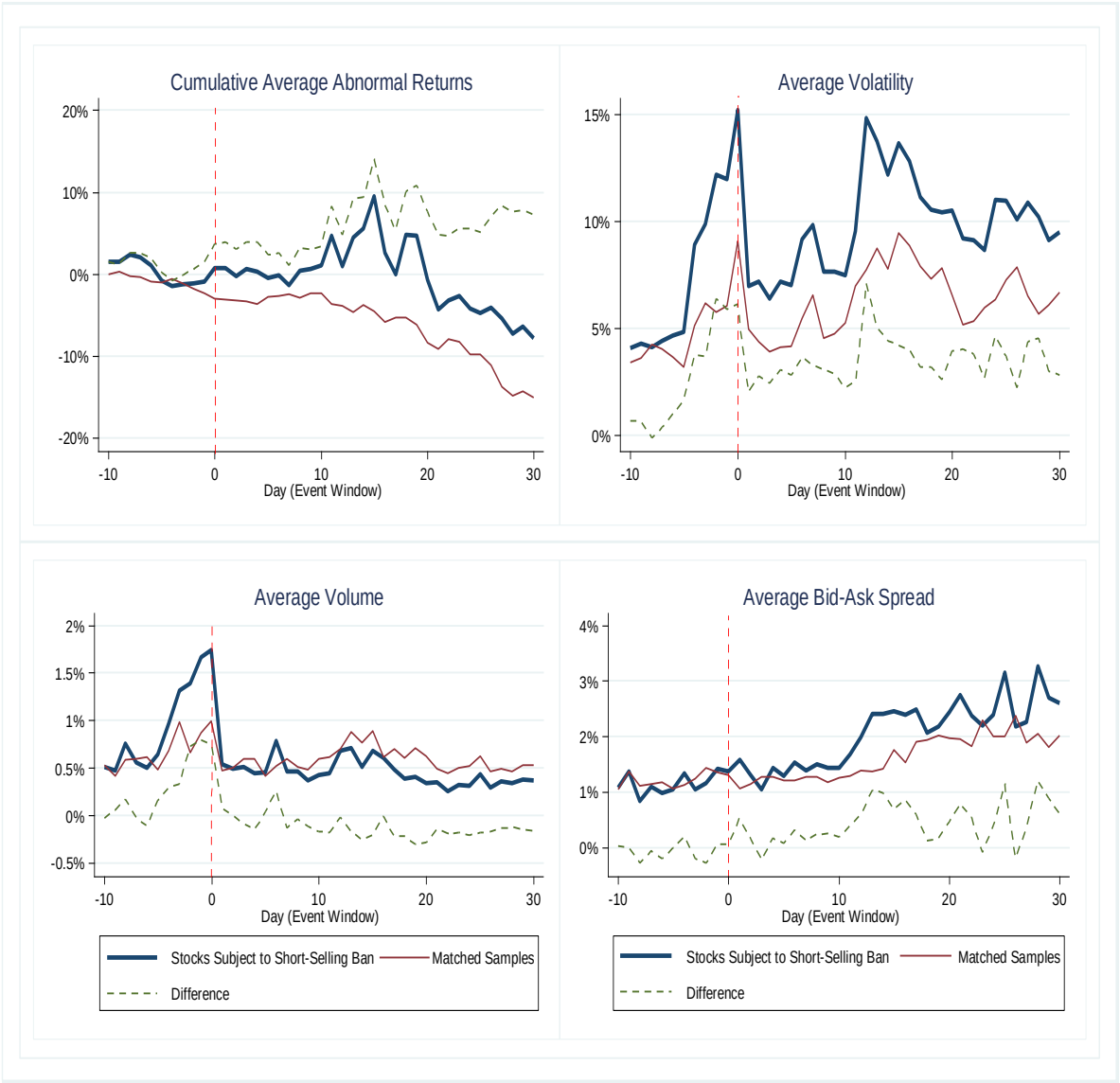
With reference to the average abnormal return calculated over a longer period of 30 days, reported in Panel A of Table 5.5, the difference between the two samples virtually disappears, suggesting that the effect of the ban was temporary and short-lived. Even though short sellers were prohibited from shorting the stocks, long sellers were still able to liquidate their holdings. While there is some support for Miller's (1977) overpricing theory around the event day, this hypothesis is not sustained over a longer period. Over 30 days, the lack of any difference between the average abnormal returns for the two samples is consistent with Diamond and Verrecchia's (1987) no overpricing hypothesis. Our findings on the price effect of the ban are in line with Hansson and Fors (2009) but at odds with Frino et al. (2011). The latter study compares the UK, where a short-selling ban was imposed, with Japan, Sweden and Hong Kong, where short selling was permitted. We argue that a more informative comparison is achieved using a matched sample of UK stocks that were not subject to the ban.

The results in Panel A of Table 5.5 suggest a deterioration in market quality following the imposition of the short-selling ban, evidenced by increases in volatility and the bid-ask spread, and a decrease in volume. These findings are consistent with Diamond and Verrecchia's (1987) lower informational efficiency hypothesis and Bai et al.'s (2006) increasing volatility

hypothesis; and with several previous empirical studies for the UK (Clifton and Snape, 2008; Marsh and Niemer, 2008; Beber and Pagano, 2012; Hansson and Fors, 2009; Frino et al., 2011).

Figure 5.2 plots the cumulative average abnormal returns, average volatility, volume and bid-ask spread for the stocks subject to the ban and the matched samples, as well as the difference between the two samples, from 10 days before to 30 days after the imposition of the ban in September 2008. Although the movement in the market quality measures appears to be similar for both samples, a careful check of Panel C of Table 5.3 reveals that while the difference between the cumulative average abnormal returns of the two samples is immaterial, the differences between the other three market quality measures are highly significant. Compared to the matched samples, the stocks that were subject to the ban were more volatile, less liquid and had larger bid-ask spreads following the imposition of the ban. The deterioration in these market quality measures suggests that the FSA's objective of protecting market quality was not achieved.

Figure 5.2 Event study cumulative average abnormal returns, average volatility, volume and bid-ask spread around the imposition of the short-selling ban



Notes: This figure compares the average cumulative abnormal returns, volatility, volume and bid-ask spread for the stocks subject to the short-selling ban and the matched samples, over an event window of 41 trading days (10 trading days before through 30 trading days after) around the imposition of the short-selling ban for each stock. The number of stocks subject to the short-selling ban, and the number of stocks in the matched samples is 35. The dates on which the ban was applied to individual stocks were 19th, 22nd, 24th September and 1st October 2008.

5.5.2 Impact of the removal of the ban on abnormal returns and market quality

Table 5.4 Event-study cumulative abnormal returns around the removal of the short-selling ban

	Panel A: Stocks Subject to Short-Selling Ban			Panel B: Matched Samples			
Day	Cumulative Average Abnormal Return (%)	Average Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics	Cumulative Average Abnormal Return (%)	Average Abnormal Return (%)	Boehmer Mesumeci Paulsen Statistics	Difference in Average Abnormal Return (%)
-10	-0.65	-0.65	-1.45	0.99	0.99	1.86 *	-1.64 **
-9	-1.66	-1.01	-1.79 *	2.47	1.48	2.62 **	-3.13 ***
-8	-0.24	1.42	1.68	3.39	0.92	0.86	-1.16
-7	1.38	1.62	2.73 **	3.92	0.53	0.62	0.85
-6	0.83	-0.55	-0.72	3.85	-0.07	-0.70	0.90
-5	1.99	1.16	2.40 **	4.59	0.74	1.08	1.25
-4	3.63	1.64	3.88 ***	5.41	0.82	1.50	2.82
-3	1.19	-2.44	-3.79 ***	4.88	-0.53	-1.72 *	1.72 *
-2	0.75	-0.44	0.00	5.24	0.36	0.78	0.38
-1	0.30	-0.45	-0.42	4.93	-0.31	-0.39	0.61
0	-1.73	-2.03	-1.34	4.01	-0.92	-0.68	-0.80
1	-10.20	-8.48	-2.90 ***	1.33	-2.68	-0.56	-7.52
2	-13.65	-3.44	-2.49 **	0.31	-1.01	-0.84	-12.63
3	-11.68	1.97	1.48	1.37	1.06	0.57	-12.74
4	-10.68	1.00	1.00	1.17	-0.20	-0.47	-10.48
5	-11.97	-1.29	-0.72	1.47	0.30	-0.20	-12.27
6	-7.63	4.33	2.24 **	1.93	0.46	-0.26	-8.09 *
7	-6.66	0.97	0.98	1.57	-0.37	-0.57	-6.30
8	-1.86	4.81	3.33 ***	2.70	1.14	0.57	-2.99 *
9	-3.74	-1.88	-2.90 ***	2.14	-0.56	-0.25	-3.18
10	-1.72	2.01	2.82 ***	2.73	0.59	0.81	-2.31

Notes: Panel A and B report the results of an event-study analysis of abnormal returns from 10 trading days before through 10 days after the removal of the short-selling ban. The analysis is based on 30 stocks that were subject to the ban, and a matched sample of 30 other stocks. Abnormal returns are measured using Brown and Warner's (1985) market model. Standardised cross-sectional test statistics account for event-induced variance, following Boehmer, Musumeci and Poulsen (1991). *, **, *** denote significance at the 10, 5 and 1% levels, respectively using a two-tail test.

Panels A and B of Table 5.4 compare the average abnormal returns and market quality measures for the stocks that were subject to the short-selling ban and the matched samples, following the removal of the ban on 16th January 2009. The average abnormal return on 16th January for stocks that were subject to the ban is negative but not significantly different from zero. There may have been some confusion over the precise timing of the removal of the ban:

an FSA press statement on 18th September 2008 states that *"provisions will remain in force until 16th January 2009"*, while the FSA handbook notice 84 states that the measure would lapse and short selling would be permitted on 16th January. The Boehmer, Poulsen and Musumeci test indicates that the negative average abnormal returns on the following two days, 17th and 18th January (-8.48% and -3.44%, respectively) for stocks that were subject to the ban, are significant. The cumulative average abnormal return for event days 0, +1 and +2 is -13.95%. The cumulative difference between the two samples over the same three days is -9.33%. As before, these initial price changes are consistent with Miller's (1977) overpricing hypothesis. Over a longer period of 30 days, however, the difference between the average abnormal returns of the two samples becomes insignificant, as reported in Panel B of Table 5.5. Figure 5.3 indicates that the difference between the cumulative average abnormal returns of the two samples achieves its maximum two days after the removal of the ban. As before, any overpricing effect is transitory, and the results for the 30-day period are consistent with Diamond and Verrecchia's (1987) no overpricing hypothesis.

Table 5.5 Differences in average abnormal returns and market quality between stocks subject to short selling ban and the matched samples

Panel A. Following Imposition of Short-Selling Ban	Stocks Subject to Short-Selling Ban	Matched Samples	Difference	T-Statistics
Average				
Abnormal Returns (in %)	-0.22	-0.41	0.19	0.70
	(0.23)	(0.14)	(0.27)	
Volatility (in %)	10.00	6.43	3.56	12.45***
	(0.24)	(0.15)	(0.29)	
Volume (in %)	0.50	0.60	-0.10	-3.17***
	(0.02)	(0.02)	(0.03)	
Bid-Ask Spread (in %)	2.05	1.62	0.42	2.72***
	(0.11)	(0.11)	(0.16)	

Panel B. Following Removal of Short-Selling Ban	Stocks Subject to Short-Selling Ban	Matched Samples	Difference	T-Statistics
Average				
Abnormal Returns (in %)	0.04	-0.01	0.05	0.18
	(0.22)	(0.16)	(0.28)	
Volatility (in %)	6.95	4.66	2.28	6.70***
	(0.25)	(0.23)	(0.34)	
Volume (in %)	0.37	0.52	-0.15	-3.99***
	(0.01)	(0.03)	(0.04)	
Bid-Ask Spread (in %)	2.51	1.38	1.13	5.97***
	(0.17)	(0.08)	(0.19)	

Notes: Panel A and B shows the differences in average abnormal returns, volatility, volume and bid-ask spread between the two samples, over a period of 30 days following the imposition and removal of the short-selling ban. Abnormal returns are measured using Brown and Warner's (1985) market model. Volatility is daily logarithmic return based on high and low prices following Parkinson (1980). Volume is percentage of trading volume over number of shares outstanding. Bid-ask spread is difference between daily closing ask and bid prices over ask price. *, **, *** denote significance at the 10, 5 and 1% levels, respectively using a two-tail test. Standard errors are reported in parentheses.

Figure 5.3 plots the cumulative average abnormal returns, average volatility, volume and bid-ask spread for the two matched samples, as well as the difference between the two samples, from 10 days before to 30 days after the removal of the ban in January 2009. The comparison between Figure 3 and Panel B of Table 5.5 indicates that the difference between the two

matched samples is substantial for the three market-quality measures: volatility, volume and bid-ask spread. These results suggest that the ban had a negative effect on market quality.

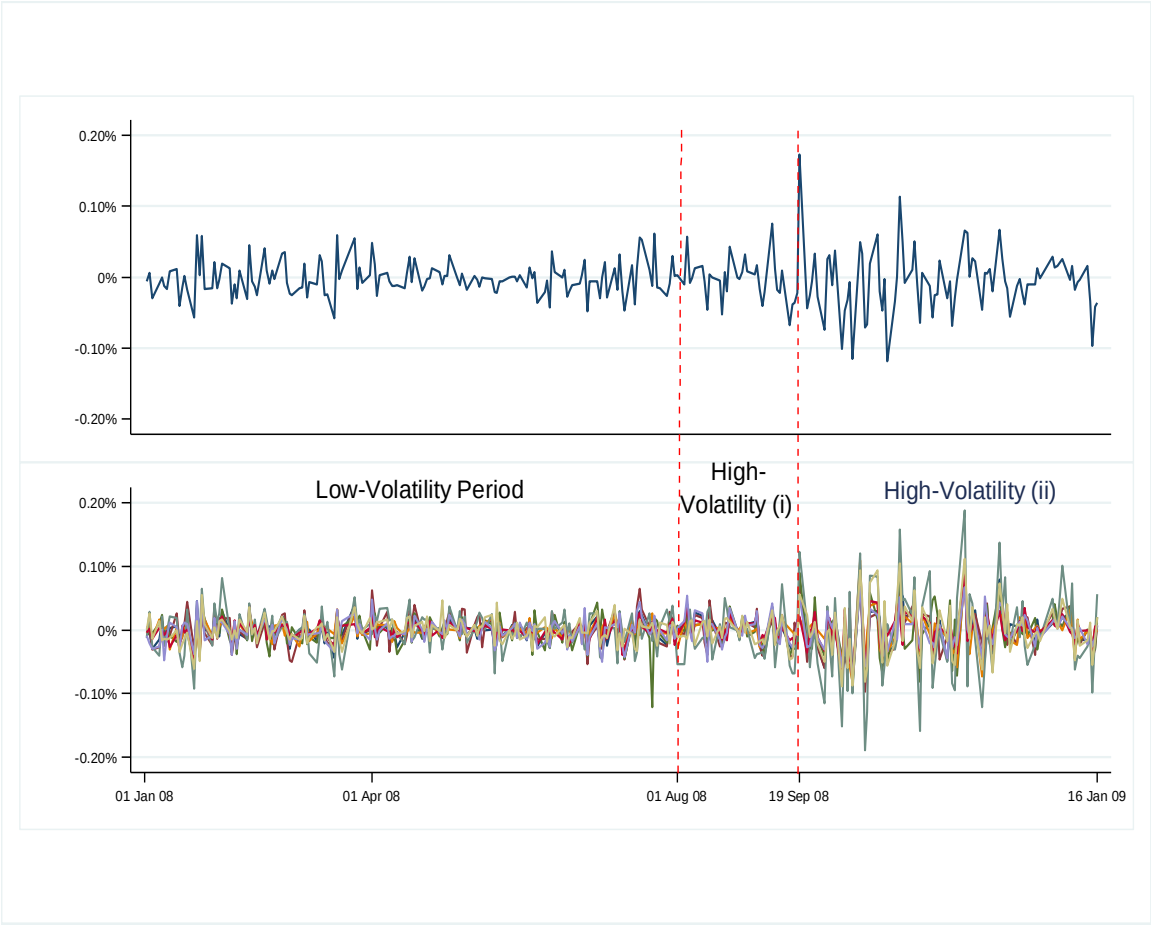
Figure 5.3 Event study cumulative average abnormal returns, average volatility, volume and bid-ask spread around the removal of the short-selling ban

Notes: This figure compares the average cumulative abnormal returns, volatility, volume and bid-ask spread for the stocks subject to the removal of short-selling ban and the matched samples, over an event window of 41 trading days (10 trading days before through 30 trading days after) around the removal of the short-selling ban for each stock. The number of stocks subject to the removal of short-selling ban, and the number of stocks in the matched samples is 30. The ban was removed on 16th January 2009.

5.5.3 Cross-sectoral Contagion

According to the FSA Discussion Paper, one of the FSA's motives for the imposition of the ban on short selling was to prevent a possible collapse in the prices of financial stocks from spreading to other non-financial sectors. Figure 5.4 presents a comparison of the volatility of index returns for the financial and non-financial sectors for three periods. The low-volatility reference period is 1st January 2008 to 31st July 2008. The two high-volatility periods are: (i) 1st August 2008 to 18th September 2008, immediately preceding the imposition of the ban; and (ii) 19th September 2008 to 16th January 2009, when the ban was in force.

Figure 5.4 Volatility of financial sector index and other non-financial sector indices



Notes: This figure presents a comparison of volatility in the daily stock market index returns for the financial sector and the daily index returns for eight non-financial sectors, for the low-volatility period 1st January 2008 to 31st July 2008, and two high-volatility periods: (i) 1st August 2008 to 18th September 2008, immediately prior to the imposition of the short-selling ban; and (ii) 19th September 2008 to 16th January 2009, while the ban was in force. Volatility is daily logarithmic return based on closing price for each sector. Daily closing prices for each sector are sourced from Datastream. The non-financial sectors are industrials, technology, telecommunication, utilities, basic materials, consumer goods, consumer services, and oil and gas.

As described in Section 5.5.3, we investigate whether there is evidence of contagion from the financial sector to several non-financial sectors, immediately before the imposition of the short-selling ban and while the ban was in force. We compare heteroskedasticity-adjusted correlations between daily returns on a financial sector stock price index, and the daily returns on indices for eight non-financial sectors, during the high-volatility periods (i) and (ii), with the corresponding correlations for the low-volatility reference period[38]. We use t-tests to determine whether the heteroskedasticity-adjusted correlations for periods (i) and (ii) differ significantly from the (unadjusted) correlations for the reference period.

[38]For the test for the significance of the difference between two correlation coefficients, the t-statistics are calculated using Fisher's z- transformation:

$$t = \frac{(z^h - z^l)}{\sqrt{[1/(n^h - 3)] + [1/(n^l - 3)]}}$$

where n^h and n^l are the numbers of daily returns observations during the high- and low-volatility periods,

$$z^h = \frac{1}{2} ln\left(\frac{1+\rho^h}{1-\rho^h}\right)$$

and z^l is similarly defined.

Table 5.6 Unadjusted and heteroskedasticity-adjusted cross-sectoral correlation coefficients

Panel A - Cross-Sectoral Correlation Coefficients over Low and High Volatility (i) Period

	Low-Volatility		High-Volatility (i)				Test	Contagion
Sectors	ρ^l	*std error*	ρ^h	*std error*	$\rho^h{}_{adj}$	*std error*	**Statistics**	**Occurs ?**
Industrials	0.833	0.045	0.864	0.089	0.803	0.105	-0.46	No
Technology	0.720	0.057	0.693	0.127	0.604	0.141	-1.05	No
Telecommunication	0.555	0.068	0.848	0.094	0.783	0.110	2.17	**Yes**
Utilities	0.441	0.074	0.389	0.163	0.316	0.168	-0.74	No
Basic Materials	0.490	0.072	0.320	0.167	0.258	0.171	-1.38	No
Consumer Goods	0.653	0.062	0.772	0.112	0.691	0.128	0.35	No
Consumer Services	0.790	0.050	0.851	0.093	0.788	0.109	-0.03	No
Oil and Gas	0.444	0.074	0.451	0.158	0.370	0.164	-0.45	No

Panel B - Cross-Sectoral Correlation Coefficients over Low and High Volatility (ii) Period

	Low-Volatility		High-Volatility (ii)				Test	Contagion
Sectors	ρ^l	*std error*	ρ^h	*std error*	$\rho^h{}_{adj}$	*std error*	**Statistics**	**Occurs ?**
Industrials	0.833	0.045	0.789	0.068	0.545	0.093	-4.23	No
Technology	0.720	0.057	0.770	0.071	0.522	0.095	-2.36	No
Telecommunication	0.555	0.068	0.686	0.081	0.431	0.100	-1.18	No
Utilities	0.441	0.074	0.607	0.088	0.361	0.104	-0.68	No
Basic Materials	0.490	0.072	0.691	0.080	0.436	0.100	-0.49	No
Consumer Goods	0.653	0.062	0.610	0.088	0.364	0.103	-2.88	No
Consumer Services	0.790	0.050	0.781	0.069	0.536	0.094	-3.41	No
Oil and Gas	0.444	0.074	0.754	0.073	0.503	0.096	0.55	No

Notes: This table reports correlation coefficients between the daily stock market index returns for the financial sector and the daily index returns for eight non-financial sectors, between the low-volatility period 1st January 2008 to 31st July 2008, and two high-volatility periods: (i) 1st August 2008 to 18th September 2008, immediately prior to the imposition of the short-selling ban; and (ii) 19th September 2008 to 16th January 2009, while the ban was in force. The comparisons between the low-volatility period, and the two high-volatility periods (i) and (ii), are presented in Panels A and B, respectively. ρ^l and ρ^h are the unadjusted correlations for the low- and high-volatility periods, respectively, and $\rho^h{}_{adj}$ is the heteroskedasticity-adjusted correlation for the high-volatility period. The t-statistics test the significance of the difference between the heteroskedasticity-adjusted correlation for the high-volatility period, and the unadjusted correlation for the low-volatility period. A positive difference that is significant at the 0.05 level (one-tail test) is interpreted as evidence of contagion in the final column.

Table 5.6 reports the results. In Panel A, the unadjusted correlation for period (i) is higher than the correlation for the reference period for five of the eight non-financial sectors: industrials, telecommunication, consumer goods, consumer services, and oil and gas. However, the heteroskedasticity-adjusted correlation is higher than the correlation for the reference period for only two sectors: telecommunication and consumer goods. For the

telecommunication sector, the difference between the period (i) correlation and the reference period correlation is significant at the 0.05 level. Adopting the FR interpretation, there is evidence of cross-sectoral contagion during period (i), immediately prior to the imposition of the short-selling ban, from the financial sector to the telecommunication sector.

In Panel B, the unadjusted correlation for period (ii) is again higher than the correlation for the reference period for five of the eight non-financial sectors: technology, telecommunication, utilities, basic materials, and oil and gas. The heteroskedasticity-adjusted correlation is higher than the correlation for the reference period for only one sector: oil and gas; and in this case the difference between the period (ii) correlation and the reference period correlation is insignificant. Accordingly, there is no evidence of cross-sectoral contagion during period (ii), while the short-selling ban was in force.

Taken together, these results provide some justification for the FSA's concerns over contagion. There is evidence of a significant contagion effect from the financial sector to the telecommunication sector during the period immediately preceding the imposition of the short-selling ban; but there is no evidence of any significant contagion effect in respect of seven other non-financial sectors. During the period when the ban was in force, there is no evidence of any contagion from the financial sector to any of the eight non-financial sectors. This pattern suggests the ban may have contributed positively towards mitigating the risk of contagion at the height of the financial crisis.

5.6 Conclusion

In this paper, we examine the impact on stock prices and market quality of the ban on the short selling of stocks in 35 financial sector companies in the UK, implemented by the Financial Services Authority between September 2008 and January 2009. We test for evidence of cross-sectoral contagion from financial sector stocks to non-financial sector stocks. The average abnormal return on the stocks that were subject to the ban, on the day the ban was imposed on each stock, was 1.62%. Over a 30-day period, however, the difference between the returns on stocks that were subject to the ban, and the returns on a matched sample, was insignificant. This suggests that the effect of the ban may have been short-lived. Even though short sellers were prohibited from shorting the stocks, long sellers were still able to liquidate their holdings. The stocks that were subject to the ban appear to have experienced a decline in market quality, as measured by volatility and liquidity. When the ban was lifted, the price of the stocks that had been subject to the ban fell by an average of 13.65% over the first three days. Over a longer period of 30 days, however, these losses were recovered.

Overall, our evidence is consistent with Diamond and Verrecchia's (1987) hypothesis of no overpricing effect and lower market quality following the imposition of a ban on short selling. Although there is evidence consistent with Miller's (1977) overpricing hypothesis, both when the ban was imposed and when it was lifted, in both cases any effect was transitory and short-lived. Within 30 days of the imposition of the ban, and within 30 days of its removal, the difference in average cumulative abnormal returns between the stocks that were subject to the ban and the matched samples becomes negligible, and statistically insignificant. Our findings are consistent with previous UK studies that report deterioration in market quality. When the short-selling ban was imposed, the stocks that were subject to the ban registered higher

volatility, lower standardized volume and a wider bid-ask spread on average than their counterparts in the matched samples.

In respect of the FSA's concerns over cross-sectoral contagion, we find evidence of a significant contagion effect from the financial sector to the telecommunication sector during a six-week period immediately prior to the imposition of the short-selling ban. Accordingly the FSA's concerns over contagion are justified to some extent, though there is no evidence of contagion in respect of seven other non-financial sectors. There is no evidence of any significant contagion effect from the financial sector to any of the eight non-financial sectors during the period when the ban was in force. This pattern suggests that the ban may have contributed positively towards addressing the FSA's concerns over contagion.

Chapter 6

Is Shorting of Exchange Traded Funds a Dangerous Financial Sport?

6.1 Introduction

An interesting yet unexplored empirical question for short sellers, academics, and regulators is whether short selling in Exchange Traded Funds (ETFs) leads to predictable changes in ETF prices. An ETF is a security that tracks a basket of stocks, an index, or a fund. Traditionally, an increase in the short interest in a stock is often viewed as a signal that the stock price is going to fall, since market participants may believe that short sellers possess significant private information. In general, a short sale is costlier to execute than a long sale. In the UK, to short an ETF, sellers first have to locate the ETF they want to short and they then have to pay the borrowing costs. As a result of this constraint, Diamond and Verrecchia (1987) predict that only investors who have strong expectations of a significant price decline will choose to short, hence significant increases in short interest should be followed by negative abnormal returns. However, this prediction is not shared by all. Gastineau (2004,

2008), for example, argues that large short interest positions in ETFs may be motivated by a tax-related reason and thus lack informational content.

Our study is motivated by Gastineau (2004, 2008) who further argues that a large short interest does not necessarily indicate that short sellers expect an ETF portfolio to underperform other ETFs in the same sector. Interestingly, this intuition has never been followed by an empirical exercise or a theoretical analysis, possibly due to the lack of suitable ETF short interest data as well as the opaqueness of ETF data in general. To our knowledge, this study is the first to undertake an empirical exercise as to whether increases in ETFs lead to underperformance of ETFs. Using a high frequency of daily ETF short interest data, we sort all arithmetic increases in ETF short interest into deciles. We find that the decile with the highest increases in short interest yields positive cumulative average returns, whereas the decile with the lowest increases shows negative cumulative average returns.[39]

Our results offer insights about ETF shortings, which are quite different from individual stock shortings. Generally, empirically, in stocks, the higher the level of short interest, the greater the negative abnormal returns (Figlewski, 1981; Asquith and Meulbroek, 1995; Desai, Ramesh, Thiagarajan, and Balachandran, 2002; Asquith, Pathak, and Ritter, 2005), or the higher the increases in short interest, the more negative the abnormal returns (Senchack and Starks, 1993; Choie and Hwang, 1994). However, our results for ETF shortings generally show that the higher the increases in short interest, the higher the cumulative average returns, and vice versa. We argue that different types of players are involved in shorting ETFs. The

[39]An arithmetic increase in ETF short interest is a simple increase in the ETF short interest ratio from one day to the next. The ETF short interest ratio is the percentage of available lendable ETFs sold short.

high increases in ETF short interest might be due to hedgers' positions, whereas the low increases in short interest might be due to speculators' positions. The hedgers short because they are bullish and they want to protect their portfolio, but the speculators short because they are bearish and they want to profit from their expectations. Interestingly, this interpretation of results points to an executable trading opportunity, that is, to go against the hedgers and to gang up with the speculators; this translates into a strategy of going long on the ETF deciles that yield the highest increases in short interest and going short on the ETF deciles that give the lowest increases in short interest. After transaction costs, this strategy can yield an average profit of 10.29 percent per annum.

The remainder of this paper is organized as follows. In the next section, we provide a brief description of the characteristics of ETFs listed on the London Stock Exchange and the lending fees. We review the related literature on the informational content of short interest in Section 6.3. Section 6.4 describes our data and research methodology. Section 6.5 reports our results and, finally, Section 6.6 offers some concluding remarks.

6.2 Exchange Traded Funds and Lending Fees

Exchange Traded Funds are a variation of open-ended funds, listed and traded on exchanges like shares. ETFs normally track a basket of stocks or an index, and, unlike normal open-ended funds, they are traded continuously on an exchange, meaning that they can be purchased, sold, and even shorted at any time during market trading hours. The distinctive advantage of ETFs is that they allow investors to gain exposure to a diverse range of assets and offer simple and efficient access to broad and sector indices. By going long or short on ETFs, investors can effectively gain access to a whole basket of stocks or an entire index

without having to become involved in the cumbersome process of investing in each of the constituent stocks. This feature makes ETFs a highly efficient investment tool. Hedgers can go short on ETFs to create a portfolio insurance so as to protect the portfolio against market risk. On the other hand, speculators might go short on ETFs if they hold a bearish view of ETFs prices.

The first ETF was listed on the London Stock Exchange's Main Market in April 2000. This was followed by a steady growth in the number of funds listed. In January 2002, the value of ETFs traded during the month was only £6 million, but by January 2003 this value had risen to £172 million, and by January 2006 the value of ETFs traded amounted to £799 million (Chelley-Steeley and Park, 2011). In February 2007, the stamp duty for foreign domiciled ETFs was abolished and resulted in the number of ETFs listed on the London Stock Exchange increasing by a massive 146 percent, with the monthly value traded increasing by 103 percent and the number of trades in the month increasing by 88 percent.[40]

In the UK, all ETF contracts are cleared through the central counterparty, namely Euroclear UK and Ireland. As the UK's central securities depository, Euroclear provides custodian services and operates the securities settlement system for almost all UK securities and at least 83.2 percent[41] of UK unit trust funds, including ETFs. Euroclear has published monthly and daily stock lending data since September 2003. In order to short ETFs, sellers first have to locate and borrow the ETFs, and thus the stock lending data on ETFs can be regarded as a reasonable proxy for the outstanding level of short interest in ETFs. As far as ETF lending

[40]http://www.londonstockexchange.com/specialist-issuers/etfs/etfs.htm
[41]Euroclear UK and Ireland Market Performance Statistics for October 2011.

fees are concerned, the annual loan premium can range from nearly 10 basis points in a very low interest rate environment to a maximum of about 30 basis points if management recapture is built into the loan premium. If the loan premium rises above that level, ETF short sellers will begin to switch to futures contracts, and some ETFs investors will create ETF shares to lend (Gastineau, 2004).

6.3 Related Literature

The extant literature provides three different perspectives on the expected relationship between short interest and stock returns. Diamond and Verrecchia (1987) develop a model using a rational expectation framework and predict that short interest should bear a negative relationship with stock returns. They argue that when short selling is restricted, either directly or through the imposition of additional costs, uninformed traders tend to be driven out of the pool of shorts and informational efficiency may be improved. In this scenario, only well-informed traders (those with very strong expectations of a price decline) will choose to bear the cost of shorting stock, and unexpected, unusually large increases in short interest tend to signal poor subsequent returns.

This view is supported by a number of prior empirical studies (Asquith and Meulbroek, 1995; Aitken, Frino, McCorry, and Swan, 1998; Desai et al., 2002; Asquith et al., 2005; Boehmer, Jones, and Zhang, 2008; Diether, Lee, and Werner, 2009). In particular, Aitken et al. (1998) find that short sales are bad news as short sellers tend to use market orders to execute selling orders; this suggests that they are informed traders. Asquith and Meulbroek (1995), Desai et al. (2002), and Asquith et al. (2005) all find that high levels of short interest in stocks are bearish signals of a negative relationship between level of short interest and stock returns.

Senchack and Starks (1993) and Choie and Hwang (1994) study the relationship between change in short interest and stock returns, and they too find that large increases in short interest are bearish signals. Thus, their studies also support Diamond and Verrecchia's prediction. Choie and Hwang's (1994) study is particularly interesting as they find that large increases in short interest signal more about short selling returns than does a high level of short interest. Boehmer et al. (2008) document, over 20 trading days, that heavily shorted stocks on the New York Stock Exchange (NYSE) significantly underperform lightly shorted stocks and that institutional non-program shorts are the most informed. Diether et al. (2009) too find that short sale strategies pay off in their dataset; portfolios of long, slightly light shorted stocks and short, heavily shorted stocks yield positive abnormal returns, over five trading days.

The second perspective, which is the one mostly shared by technical traders and analysts, argues for a positive relationship between a high level of short interest and stock returns. Although the literature is a bit dated, this view, which is also known as the "Wall Street view," is well accepted among practitioners. From this perspective, a high level of short interest represents a latent demand for shorted stocks. Short positions need to be covered eventually, and this will result in the future purchase of stocks that will keep the stocks advancing. A high level of short interest therefore is a bullish signal (Epstein, 1995). Proponents of this perspective also suggest, from a contrarian point of view, that institutional investors do not sell short, so a high level of short interest indicates the increasing and misguided pessimism of the public and traders.[42] They believe that the majority of the investing public and traders

[42]Biggs (1966) quoted Joseph Granville's trading rule "*If the short interest is rising it means people are growing bearish on the issue. The further short interest rises, the more bearish is the public opinion on the stock. The*

are usually wrong, so a high level of short interest is a good buying indicator, hence a bullish signal (Biggs, 1966; Fosback, 1995). Despite its huge following among practitioners, we find no empirical evidence to support this view.

The final perspective offers no expected relationship between a high level of short interest and stock returns. Brent, Morse, and Stice (1990) explain that the increasing trend in short interest in the US from 1974 to 1985 relates mostly to hedging and arbitrage, and they argue that short interest is less informative if it is motivated by arbitrage-related reasons. Woolridge and Dickinson (1994) select a random sample from the NYSE, the American Stock Exchange and NASDAQ and study monthly short interest for the period 1986 through 1991; they conclude that short sellers on average do not possess superior investment timing skills and do not generate unfair profits by driving security prices down. They argue that short sellers provide liquidity to the market by shorting into up markets and reducing short positions in down markets. Au, Doukas, and Onayev (2009), using a long horizon weekly UK dataset from 2003 to 2006, also find no significant relationship between a high level of short interest (proxied by stock lending) and stock returns, and they deduce that using short interest as a selling signal may not be optimal. Short selling in the UK, according to Au et al. (2009), is dominated by arbitrage-related activities, and hence lacks informational content.

As far as ETFs are concerned, no empirical exercise has been undertaken to study the price impact following shortings of ETFs. As mentioned in the introduction, Gastineau (2004, 2008) intuits that large short interest positions in ETFs may be motivated by tax-related reason,

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market cannot accommodate that many people as being right and thus the stock is destined to advance. A rising short interest is bullish, the longer it rises, the more bullish it is."

again lacking informational content, and that a large short interest does not necessarily indicate that short sellers expect an ETF portfolio to underperform other ETFs in the same sector.

Given that the first view is the most dominant both analytically and empirically, we expect, a priori, that high increases in short interest in ETFs will yield significant negative stocks returns.

6.4 Research Methodology

6.4.1 Sample Selection

The dataset for daily shares on loan for all ETFs traded on the London Stock Exchange are obtained from Euroclear UK and Ireland for the period June 2006 through April 2010 and used as a proxy for the level of short interest. There are 86 ETFs in our short interest population; these are listed and described in Table 6.1. This shows that most of the ETFs traded on the London Stock Exchange during the period are equity funds, with some debt, real estate, and commodity funds. The ETFs' description and daily closing price are compiled from Bloomberg and Datastream. The population consists of 20,912 ETF daily increases in short interest observations.

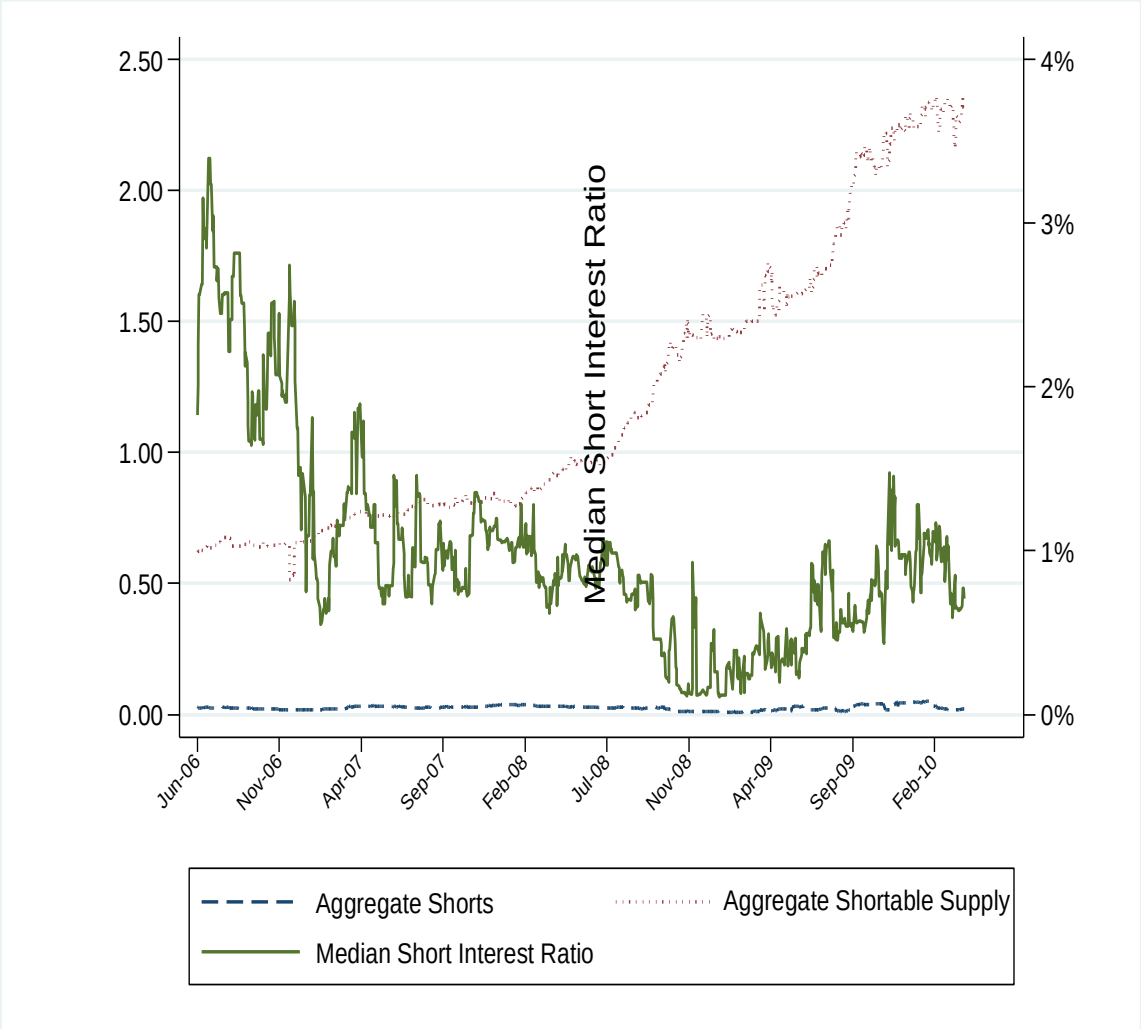
Table 6.1 ETF Population

Ticker	ETF Name	Type	Ticker	ETF Name	Type
ALTE	Etfx Daxglobal Alternative Energy	Equity	IMEU	Ishares Msci Europe	Equity
BRIC	European Etf Ishares	Equity	IMIB	Ishares Ftse Mib	Equity
DJMC	Ishares Dj Euro Stoxx	Equity	INFR	Ishares Ftse/Macquarie	Equity
DJSC	Ishares Dj Euro Stoxx	Equity	INRG	Ishares Global Clean Energy	Equity
EEX5	Ishares Barclays Euro Corp Bond	Debt	INXG	Etf Ishares £ Idx Lkd	Debt
EEXF	Ishares Barclays Euro Corp Bond	Debt	IPRP	Ishares Ftse/Epra Euro	Equity
EQQQ	Nasdaq 100 European	Equity	IPRV	Ishares S&P Listed Private	Equity
EUE	Ishares Dj Eurostoxx 50	Equity	IPXJ	Ishares Msci Pacific	Equity
EUN	Ishares Dj Stoxx 50	Equity	ISEM	Ishares Msci Emerging Markets	Equity
IAEX	Ishares Aex	Equity	ISF	Ishares Ftse 100	Equity
IAPD	Ishares Dj Asia/Pacific	Equity	ISFE	Ishares Ii Public Ltd Co	Equity
IASP	Ishares Ftse Epra/Nareit	Real Estate	ISJP	Ishares Iii Public Ltd Co	Equity
IBCI	Ishares Euro Inflation	Debt	ISP6	Ishares Iii Public Ltd Co	Equity
IBCX	Ishares Euro Corp	Debt	ISUS	Ishares Msci Usa Islamic	Equity
IBGE	Ishares Barclays Euro Treasury Bond	Debt	ISWD	Ishares Msci World Islamic	Equity
IBGL	Ishares Euro Govt Bond 15-30	Debt	ITKY	Ishares Msci Turkey	Equity
IBGM	Ishares Euro Govt Bond 7-10	Debt	ITPS	Ishares $ Tips	Debt
IBGS	Ishares Eur Govt	Debt	ITWN	Ishares Msci Taiwan Index	Equity
IBGX	Ishares Euro Govt Bond 3-5	Debt	IUKD	Ishares Ftse Uk Dividend Plus	Equity
IBTM	Ishares $ Treasury Bond 7-10	Debt	IUKP	Ishares Ftse Epra/Nareit	Real Estate
IBTS	Ishares $ Treasury Bond	Debt	IUSA	Ishares S&P 500	Equity
IBZL	Ishares Msci Brazil	Equity	IUSP	Ishares Ftse Epra/Nareit	Real Estate
IDFX	Ishares Public Ltd Co	Equity	IWDP	Ishares Ftse Epra/Nareit	Equity
IDJG	Ishares Dj Euro Stoxx	Equity	IWRD	Ishares Msci World	Equity
IDJV	Ishares Dj Eurostoxx	Equity	IWXU	Ishares Ftse Developed	Equity
IDNA	Ishares Msci North America	Equity	IXMU	Ishares Msci Europe Ex-Emu £	Equity
IDVY	Ishares Dj Eurostoxx	Equity	LQDE	Ishares Usd Coporate Bond	Debt
IEBC	Ishares Barclays Euro Corp Bond £	Debt	LTAM	Ishares Msci Latin America	Equity
IEEM	Ishares Msci Emerging Markets	Equity	MIDD	Ishares Ftse 250	Equity
IEER	Ishares Msci Eastern Europe	Equity	S250	Source Markets Ftse 250 Source	Equity
IEGA	Ishares Barclays Euro Treasury Bond £	Debt	SACC	Ishares S&P 500 (Acc)	Equity
IEGY	Ishares Barclays Euro Govt Bond	Debt	SCAN	Ishares Msci Canada	Equity
IEMB	Ishares Jpmorgan Usd	Debt	SCOV	Ishares Iii Public Ltd Co	Debt
IEMI	Ishares S&P Emerging	Equity	SE15	Ishares Barclays Euro Corp	Debt
IEUR	Ishares Ftseurofirst 80	Equity	SEMA	Ishares Msci Emerging Markets (Acc)	Equity
IEUT	Ishares Ftse Eurofirst	Equity	SEMS	Ishares Msci Emerging Markets	Equity
IEUX	Ishares Msci Europe	Equity	SGIL	Ishares Iii Public Ltd Co	Debt
IFFF	Ishares Msci Ac Far East	Equity	SGLD	Source Physical Markets Public Ltd Co	Commodity
IGLS	Ishares Ftse Uk Gilts	Debt	SGLO	Ishares Citigroup Global Govt	Debt
IGLT	Ishares Ftse Uk All	Debt	SLXX	Ishares Public Ltd Co	Debt
IH2O	Ishares S&P Global Water	Equity	SMEA	Ishares Msci Europe (Acc)Plc	Equity
IJPN	Ishares Msci Japan Shares	Equity	WOOD	Ishares S&P Timber	Commodity
IKOR	Ishares Msci Korea	Equity	XLKS	Technology S&P Us Sel	Equity

Notes: This table contains the tickers, names, and types of funds of all Exchange Traded Funds traded on the London Stock Exchange during the study period June 2006 through April 2010.

Figure 6.1 illustrates the growing importance of ETF shorting on the London Stock Exchange across the period covered by the data sample. We present three measures: the aggregate quantity of shorted ETFs, the aggregate supply of ETFs in Euroclear, and the median of the short interest ratio, which expresses short interest as a percentage of the available supply of ETFs. We observe an upward trend in the aggregate supply of ETFs over the sample period. Shorting of ETFs, however, appears to become less prevalent, both in terms of aggregate volume and as a percentage of the available supply, towards the end of the sample period.

Figure 6.1 Time Series of Three Short Selling Measures for ETF Shares



Notes: This figure shows market aggregate shorts, shortable supply, and median short interest ratio for ETF shares traded on the London Stock Exchange from June 2006 through April 2010. The short interest ratio is the percentage of available (lendable) supply of ETF shares sold short. The aggregate shortable (lendable) supply is the total number of ETF shares that can be borrowed and shorted. The aggregate shorts is the total number of ETF shares that has been borrowed and shorted by investors.

As we are investigating whether shorting ETFs is a dangerous financial sport, we are particularly interested in ETFs that experience an increase in short interest. An increase in short interest essentially means that these ETF shares are being shorted. We define the short interest ratio as the number of ETF shares on loan divided by the number of ETFs shares to be loaned through Euroclear. An increase in short interest is the simple arithmetic increase in this ratio from one day to the next. We exclude observations from the sample if the increase in short interest is zero or negative, and, all in all, this gives us a sample of positive increase in short interest in ETFs of 3,673 observations. On the basis of the increase in short interest, we further sort the samples into 10 deciles and we present the descriptive statistics for each decile in Table 6.2. Decile 1 represents the lowest increase in short interest and Decile 10 denotes the highest increase in short interest.

Table 6.2 Summary Statistics

Decile	*N*	Mean (%)	Median (%)	Std Dev (%)	Min (%)	Max (%)
1	368	0.001225	0.001126	0.000864	0.000003	0.002824
2	367	0.005835	0.005587	0.001957	0.002843	0.009555
3	367	0.014277	0.013674	0.003133	0.009567	0.020298
4	368	0.027627	0.027109	0.004725	0.020325	0.037313
5	367	0.049775	0.049288	0.007554	0.037395	0.063776
6	367	0.086203	0.086487	0.013218	0.064080	0.110965
7	368	0.146402	0.144476	0.022391	0.111336	0.189189
8	367	0.257535	0.249771	0.047037	0.189386	0.354368
9	367	0.515602	0.492018	0.114927	0.357140	0.740680
10	367	2.437146	1.219512	5.679575	0.741372	71.375000

Notes: This table presents the summary statistics of increases in ETF short interest for each decile during the sample period June 2006 through April 2010. Decile 1 contains the lowest increases whereas Decile 10 contains the highest increases in ETF short interest. An increase in short interest is a simple arithmetic increase in the ETF short interest ratio from one day to the next. The short interest ratio is the percentage of available (lendable) supply of ETF shares sold short.

6.4.2 Research Design

In the US, ETF short interest data are not publicly available. However, a weekly summary can be requested from the American Stock Exchange, and institutional ownership as a proxy for supply of shortable ETF shares can be retrieved via 13-F filings and similar quarterly filings with the U.S. Securities and Exchange Commission (Gastineau, 2004). This institutional constraint makes study on the informational content of ETF shorting impossible in the US. In the UK however, Euroclear publishes daily ETF share lending positions on the third trading day, so for example data relating to stock lending positions on Monday will be made available on Thursday, and this institutional setting specifically allows us to investigate the price impact following an increase in ETF short interest.

As we are comparing between sorted ETF deciles, we adopt the Harper, Madura, and Schnusenberg (2006) approach of assuming no tracking error between ETFs and the underlying index. This assumption specifically states that the ETFs are essentially the same as the underlying index and, more importantly, allows us to compare the performance of each decile directly following the shorting of ETFs, thus side-stepping benchmarking issues. Moreover, from a hedger point of view, the tracking error between ETFs and benchmark indices is just a small consideration relative to fluctuating roll-over risks (Gastineau, 2004). Without having to dwell on benchmarking issues, we attempt to test whether shorting ETFs following an increase in short interest can yield abnormal profits. The model specification is as follows:

$$R_{it} = Log_n\left(\frac{P_t}{P_{t-1}}\right) \qquad (6.1)$$

$$\bar{R}_i = \frac{1}{30}\sum_{t=30}^{t=1} R_{it} \tag{6.2}$$

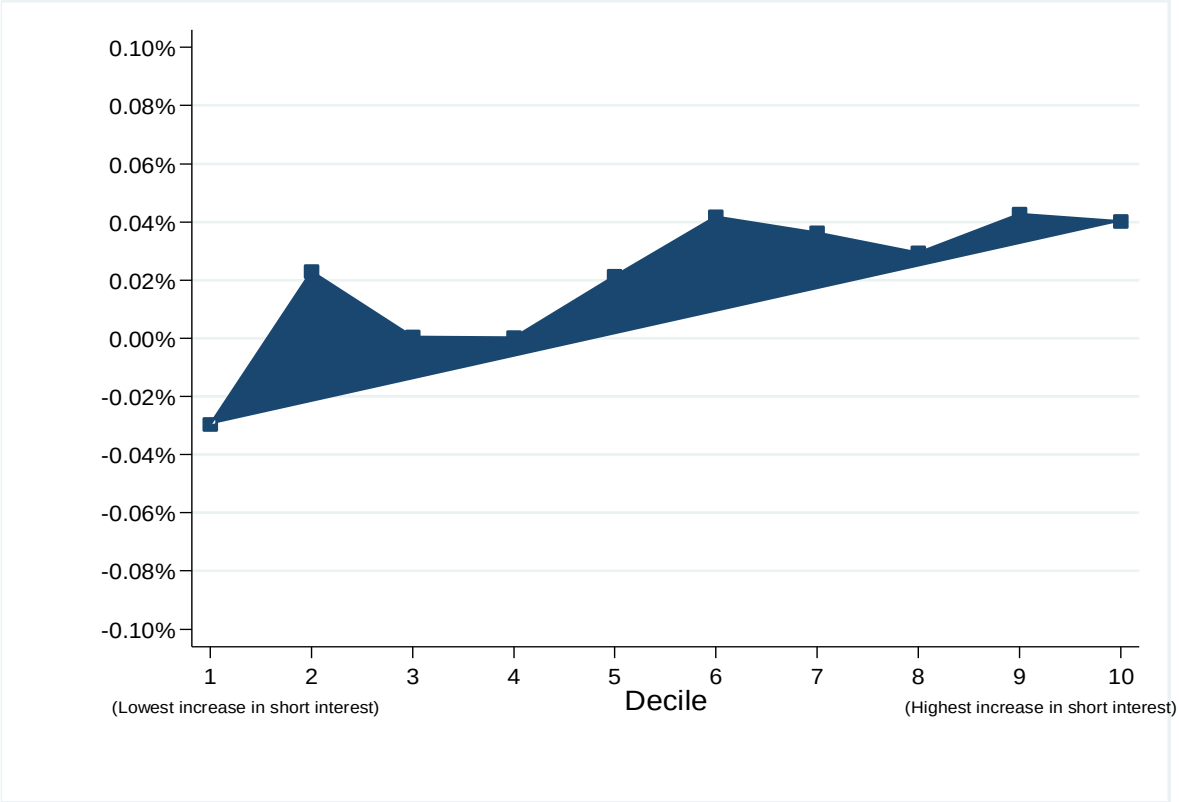
$$\bar{R}_{decile\ j} = \frac{1}{N}\sum_{i=1}^{N} \bar{R}_i \tag{6.3}$$

$$CAR_{decile\ j,t} = \frac{1}{N}\sum_{i=1}^{N} R_{it} \tag{6.4}$$

where R_{it} is the daily logarithmic return for ETF i on day t, P_t and P_{t-1} is the price of ETF on one day and the day before, $\bar{R}_i$ is the average return for each ETF, $\bar{R}_{decile\ j}$ is the average return for each decile (calculated over all ETFs in each decile) for 30 days from day+1 through day+30, $CAR_{decile\ j,t}$ is the average cumulative return (calculated over all ETFs in each decile across each day) on day t.

We tabulate the average returns for each sorted decile in Figure 6.2. Interestingly, this figure shows that Decile 1, which experiences the lowest increase in short interest, yields a negative average return of -0.03 percent, whereas Decile 10, which experiences the highest increase in short interest, yields a positive average return of 0.04 percent. This result is in sharp contrast to Senchack and Starks (1993), and Choie and Hwang (1994) who find positive abnormal returns for stocks that experience a significant large increase in short interest. Of the 10 deciles, only Decile 1 yields a negative average return, whereas Decile 3 and Decile 4 show almost zero average returns, and the remainder of the deciles, Decile 2, 5, 6, 7, 8, 9, and 10, show positive average returns.

Figure 6.2 Average Returns



Notes: This figure tabulates the average returns for each ETF decile for 30 days following increases in short interest in ETFs. Increases in ETF short interest are sorted in deciles. Decile 1 contains the lowest increases whereas Decile 10 contains the highest increases in ETF short interest. An increase in short interest is a simple arithmetic increase in the ETF short interest ratio from one day to the next. The short interest ratio is the percentage of available (lendable) supply of ETF shares sold short. Average returns are ETF average daily logarithmic returns.

To investigate the price impact on ETFs following shorting, we cumulate returns for each decile across ETFs and over the post-publication period (day+3 through day+30). Gastineau (2004, 2008) argues that, since ETF shortings are made to offset investors' portfolio risks, large increases in short interest in ETFs do not indicate that such ETFs underperform other ETFs in the same sector. This intuition is somewhat counterfactual to Diamond and Verrecchia's (1987) hypothesis that short sellers are sophisticated traders that possess significant private information, hence shorting should lead to underperformance of stocks. Interestingly, if Gastineau is right, shorting of ETFs following an increase in short interest is highly risky, because such a strategy will result in heavy losses to the short seller.

6.5 Empirical Results

6.5.1 Impact of ETF Shorting on Cumulative Average Returns

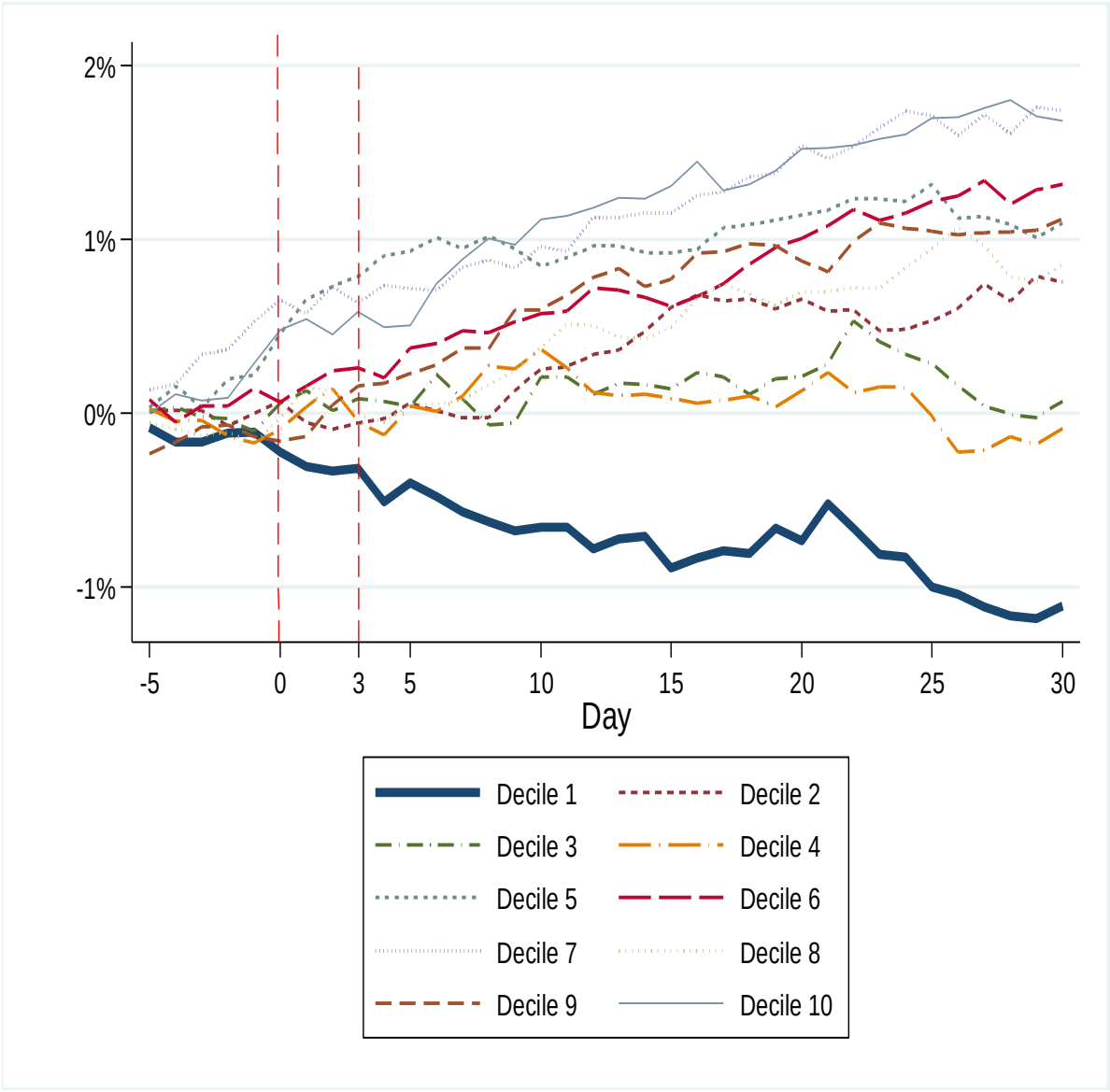
We chart cumulative average returns for each decile in Figure 6.3 on the basis of the cumulative values presented in Table 6.3. Surprising as it seems, we find no underperformance for heavily shorted ETFs as in Decile 10 and no overperformance for lightly shorted ETFs as in Decile 1. Rather, these results suggest the opposite; heavily shorted ETFs give positive cumulative returns, whereas lightly shorted ETFs yield negative cumulative returns. Over the period of 30 days, the only shorting strategy that makes considerable profit is shorting Decile 1. Another shorting strategy that yields profit is shorting Decile 4, but the profit appears too small to make it worthwhile. Shorting in other deciles would be disastrous. Generally speaking, shorting other than Decile 1, after transaction costs, might not be a profitable strategy. This result essentially suggests that shorting ETFs blindly can become a dangerous financial sport to an ambitious short seller.

Table 6.3 Average Returns (AR) and Cumulative Average Returns (CAR) for All Deciles (in %)

	Decile 1		Decile 2		Decile 3		Decile 4		Decile 5		Decile 6		Decile 7		Decile 8		Decile 9		Decile 10	
Day	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR	AR	CAR
-5	-0.081	-0.081	0.017	0.017	0.005	0.005	0.028	0.028	0.034	0.034	0.077	0.077	0.134	0.134	-0.057	-0.057	-0.233	-0.233	0.000	0.000
-4	-0.084	-0.165	-0.002	0.015	0.032	0.037	-0.073	-0.045	0.123	0.157	-0.127	-0.050	0.036	0.170	-0.033	-0.090	0.067	-0.166	0.110	0.110
-3	0.001	-0.164	0.001	0.016	-0.059	-0.022	0.007	-0.038	-0.125	0.032	0.094	0.044	0.169	0.338	-0.039	-0.129	0.088	-0.079	-0.036	0.074
-2	0.050	-0.114	-0.086	-0.070	-0.011	-0.033	-0.092	-0.130	0.165	0.197	0.000	0.044	0.029	0.367	0.020	-0.109	0.012	-0.067	0.015	0.089
-1	0.006	-0.108	0.068	-0.002	-0.071	-0.104	-0.043	-0.173	0.023	0.220	0.098	0.141	0.160	0.527	-0.066	-0.175	-0.067	-0.134	0.198	0.288
0	-0.114	-0.221	0.073	0.071	0.160	0.056	0.079	-0.094	0.235	0.455	-0.078	0.063	0.126	0.653	0.148	-0.027	-0.028	-0.161	0.192	0.479
1	-0.085	-0.306	-0.126	-0.055	0.075	0.131	0.132	0.038	0.199	0.654	0.094	0.158	-0.080	0.573	0.176	0.149	0.029	-0.132	0.064	0.543
2	-0.029	-0.335	-0.036	-0.091	-0.117	0.014	0.105	0.143	0.077	0.731	0.086	0.244	0.156	0.730	-0.019	0.130	0.181	0.050	-0.089	0.454
3	0.017	-0.318	0.035	-0.056	0.069	0.083	-0.191	-0.048	0.057	0.789	0.016	0.260	-0.096	0.634	-0.141	-0.010	0.109	0.158	0.132	0.586
4	-0.191	-0.509	0.024	-0.032	-0.014	0.070	-0.077	-0.126	0.118	0.907	-0.054	0.205	0.104	0.738	-0.042	-0.053	0.014	0.173	-0.088	0.498
5	0.106	-0.403	0.093	0.060	-0.031	0.038	0.167	0.041	0.026	0.933	0.170	0.375	-0.020	0.718	0.105	0.052	0.055	0.228	0.007	0.505
6	-0.076	-0.479	-0.046	0.014	0.185	0.223	-0.030	0.011	0.078	1.011	0.028	0.403	-0.011	0.707	0.000	0.053	0.054	0.281	0.239	0.745
7	-0.086	-0.565	-0.041	-0.027	-0.140	0.083	0.090	0.101	-0.063	0.948	0.071	0.473	0.134	0.841	0.023	0.076	0.095	0.377	0.141	0.886
8	-0.061	-0.626	0.000	-0.027	-0.149	-0.065	0.174	0.275	0.070	1.019	-0.011	0.462	0.042	0.883	0.091	0.167	-0.005	0.372	0.120	1.006
9	-0.049	-0.675	0.160	0.133	0.010	-0.055	-0.020	0.255	-0.072	0.946	0.063	0.525	-0.045	0.837	0.076	0.243	0.221	0.593	-0.035	0.971
10	0.020	-0.655	0.122	0.254	0.263	0.207	0.114	0.369	-0.099	0.847	0.048	0.574	0.125	0.962	0.136	0.379	0.004	0.598	0.146	1.117
11	0.002	-0.653	0.013	0.268	0.001	0.208	-0.108	0.261	0.048	0.895	0.016	0.590	-0.032	0.930	0.136	0.515	0.084	0.682	0.019	1.136
12	-0.129	-0.783	0.069	0.337	-0.097	0.111	-0.142	0.119	0.068	0.963	0.131	0.720	0.197	1.128	-0.008	0.507	0.101	0.783	0.047	1.183
13	0.061	-0.722	0.028	0.365	0.062	0.173	-0.016	0.103	0.001	0.964	-0.010	0.711	0.001	1.129	-0.070	0.437	0.051	0.834	0.058	1.242
14	0.015	-0.706	0.107	0.472	-0.010	0.163	0.008	0.111	-0.040	0.924	-0.045	0.666	0.025	1.154	-0.006	0.430	-0.103	0.731	-0.004	1.237
15	-0.182	-0.889	0.137	0.609	-0.022	0.141	-0.026	0.085	-0.003	0.922	-0.048	0.617	-0.001	1.153	0.063	0.494	0.040	0.771	0.069	1.307
16	0.056	-0.833	0.074	0.683	0.093	0.235	-0.027	0.059	0.024	0.945	0.054	0.672	0.102	1.255	0.169	0.663	0.149	0.921	0.140	1.447
17	0.041	-0.791	-0.036	0.646	-0.025	0.210	0.016	0.075	0.122	1.068	0.077	0.749	0.020	1.275	0.082	0.745	0.011	0.932	-0.162	1.285
18	-0.018	-0.809	0.014	0.661	-0.102	0.108	0.027	0.102	0.019	1.087	0.110	0.858	0.086	1.361	-0.057	0.688	0.046	0.977	0.033	1.319
19	0.150	-0.659	-0.059	0.601	0.094	0.202	-0.064	0.038	0.027	1.113	0.098	0.956	0.023	1.384	-0.067	0.621	-0.014	0.963	0.080	1.399
20	-0.076	-0.736	0.058	0.659	0.010	0.212	0.091	0.129	0.027	1.141	0.052	1.008	0.159	1.543	0.078	0.700	-0.087	0.877	0.122	1.521
21	0.216	-0.519	-0.071	0.589	0.074	0.286	0.107	0.235	0.030	1.171	0.073	1.081	-0.076	1.467	0.001	0.700	-0.061	0.815	0.006	1.527
22	-0.141	-0.661	0.006	0.595	0.249	0.535	-0.116	0.119	0.065	1.236	0.092	1.173	0.071	1.538	0.023	0.723	0.176	0.991	0.017	1.544
23	-0.153	-0.813	-0.120	0.475	-0.122	0.413	0.034	0.154	-0.003	1.233	-0.063	1.110	0.108	1.646	-0.006	0.718	0.104	1.096	0.034	1.578
24	-0.016	-0.829	0.010	0.485	-0.074	0.339	-0.005	0.149	-0.012	1.221	0.043	1.153	0.093	1.739	0.122	0.839	-0.032	1.064	0.027	1.605
25	-0.171	-1.000	0.046	0.531	-0.053	0.286	-0.166	-0.017	0.096	1.317	0.069	1.222	-0.026	1.713	0.109	0.948	-0.015	1.049	0.092	1.697
26	-0.042	-1.042	0.072	0.603	-0.126	0.160	-0.206	-0.223	-0.194	1.123	0.028	1.250	-0.115	1.599	0.123	1.071	-0.021	1.028	0.006	1.703
27	-0.074	-1.117	0.143	0.746	-0.116	0.044	0.010	-0.214	0.009	1.132	0.091	1.341	0.123	1.721	-0.107	0.964	0.013	1.040	0.052	1.755
28	-0.050	-1.166	-0.101	0.645	-0.050	-0.006	0.078	-0.136	-0.043	1.089	-0.136	1.205	-0.110	1.611	-0.179	0.785	0.005	1.046	0.049	1.804
29	-0.015	-1.181	0.144	0.789	-0.020	-0.026	-0.044	-0.180	-0.079	1.010	0.081	1.286	0.151	1.763	-0.027	0.758	0.010	1.056	-0.092	1.712
30	0.072	-1.109	-0.032	0.757	0.095	0.069	0.091	-0.090	0.084	1.094	0.032	1.318	-0.019	1.744	0.098	0.856	0.063	1.119	-0.029	1.683

Notes: This table reports the average and cumulative average returns for each ETF decile from day-5 to +30 following increases in short interest in ETF. Decile 1 contains the lowest increases whereas Decile 10 contains the highest increases in ETF short interest.

Figure 6.3 Cumulative Average Returns for All ETF Deciles



Notes: This figure presents the comparison of cumulative average returns from five trading days before through 30 trading days after between the ten deciles. Day0 is the day of occurrence of increases in ETF short interest. Day3 is the day when the short interest information on ETFs is released to the public. Increases in ETF short interest are sorted in deciles. Decile 1 contains the lowest increases whereas Decile 10 contains the highest increases in ETF short interest. Cumulative average returns are cumulative values of daily logarithmic returns of ETFs for each decile.

We offer a number of plausible explanations for the findings. First, the results may infer that most heavy shortings in ETFs, as evidenced by high increases in short interest, are due to portfolio hedging strategies deployed by hedgers. It appears that these hedgers expect the index or the ETFs to go up and, since their investment objective is to hedge their portfolio, they short ETFs heavily so as to attain their desired hedge ratio and protect their portfolio

against market risk. Remember, the hedgers' goal is not to speculate, but rather to strike a balanced long–short portfolio that gives the lowest variance. Second, light shortings in ETFs, as evidenced by low increases in short interest, are likely to be undertaken by investors or traders with no intention of hedging their portfolio. These speculators short ETFs because they have bearish expectations and they foresee that the ETF price is going to drop in near future. Their speculative positions should be smaller than those of hedgers; however, these light shortings may signal to the market that sophisticated traders with private information are actually shorting the ETFs. Third, as dangerous as this game of shorting may seem, we believe that it can be exploited to become a profitable trading opportunity, specifically by going against the hedgers' shorts and following the speculators' shorts. In essence, this strategy involves the execution of two legs: a) going long on the most shorted ETFs as in Decile 10 and b) going short on the least shorted ETFs as in Decile 1.

6.5.2 Strategy of Going Long on Decile 10 and Short on Decile 1

In this section, we assume that we undertake the strategy of going long on Decile 10 and short on Decile 1. The profitability of this strategy is plotted on Figure 6.4. Remember, Decile 1 is the least shorted ETF and contains increases in the short interest ratio ranging from 0.0000025 percent to 0.0028237 percent, whereas Decile 10 contains increases in the short interest ratio ranging from 0.74 percent to 71.38 percent. To execute this strategy, specifically, an ETF investor has to read the daily ETF short interest ratio from Euroclear, and carefully select and classify the increase in the short interest ratios that fall within Decile 1 and Decile 10.

Deciles other than Decile 1 and 10 should not be used to execute this strategy. Figure 6.4 shows that the maximum profit for this strategy is attained on day+28 after an event day of increase in short interest, that is, 25 days (day+28 minus day+3) after the ETF investor retrieves the short interest information from Euroclear. Gross profit from this strategy is about 2.07 percent (2.97 percent on day+28 minus 0.90 percent on day+3), or 207 basis points.

While this strategy appears to show a substantive economic significance, we also conduct a test to determine its statistical significance. The test statistic is the ratio of cumulative average returns to its estimated standard deviation over 26 days from day+3 through day+28, and is given by:

$$CAR_{decile\ j,26} \Big/ \sqrt{\sum_{t=3}^{t=28} \hat{S}^2(\bar{R}_{decile\ j})} \qquad (6.5)$$

where

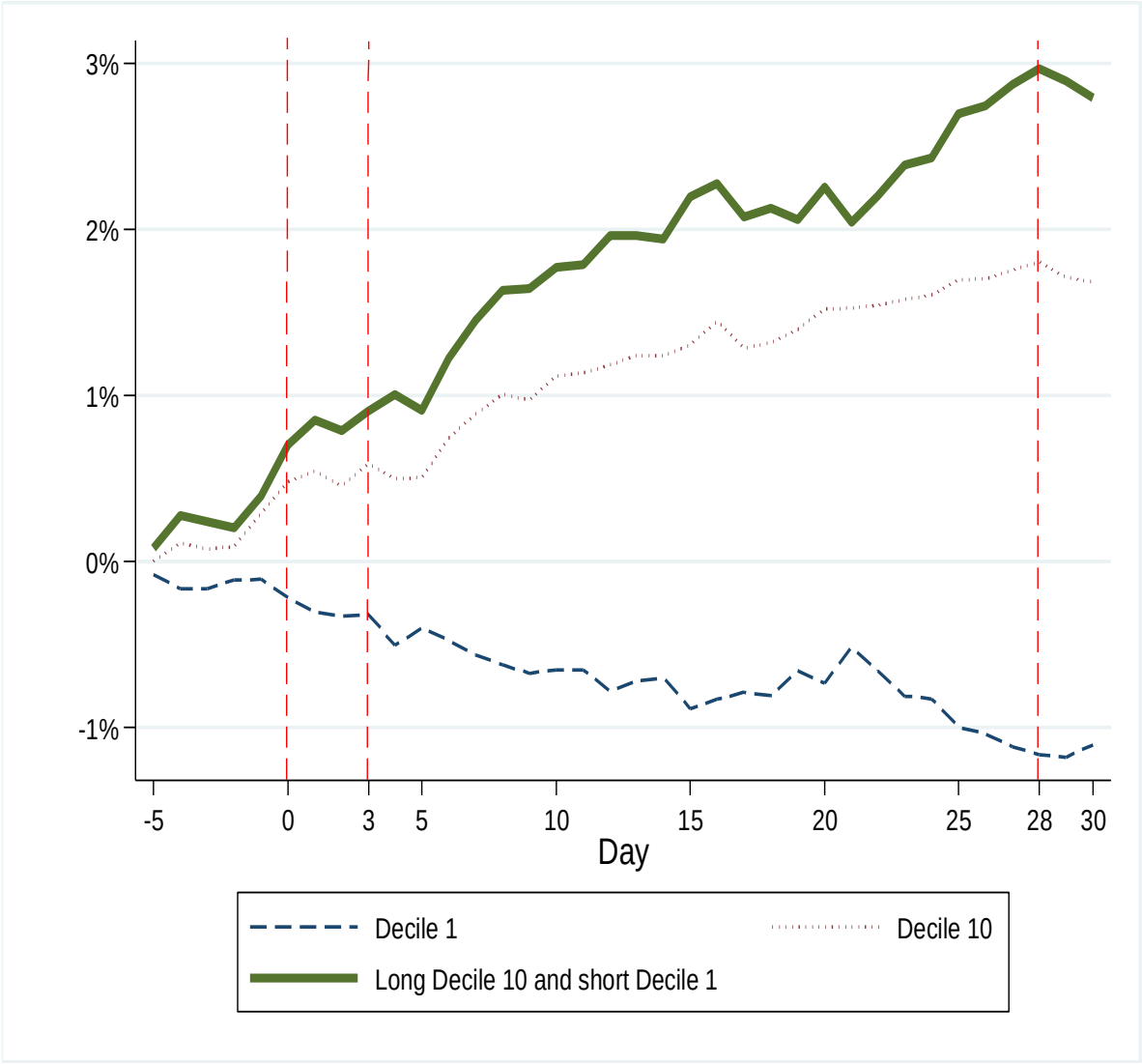
$$\hat{S}^2\ (\bar{R}_{decile\ j}) = \frac{1}{26-1} \sum_{t=3}^{t=28} (\bar{R}_{decile\ j} - \bar{\bar{R}}_{decile\ j})^2 \qquad (6.6)$$

We compute test statistics for Decile 1 and Decile 10 and find a massive ratio of -8.19 and 16.64 respectively. These test ratios specifically indicate that the cumulative average returns for a strategy of shorting Decile 1 and going long Decile 10 are significant at 1 percent level.

With respect to transaction cost, Gastineau (2004) demonstrates that a round trip buy and sell transaction cost for an ETF such as iShares S&P 500 is 48.20 basis points in 2002 and 44.80 in 2003.[43] We believe that the transaction cost for ETFs could become cheaper each year given the creation of more ETFs in the market; and assuming that these transaction costs do not vary very much across markets, we attempt to estimate the net profit from this strategy.[44] As we do not want to suppress the transaction costs too much, we take the average transaction cost of 46.5 ((48.2+44.8)/2) basis points for a round trip buy and sell ETF transaction. Since this strategy involves two legs of going long on Decile 10 and short on Decile 1, the total transaction cost would be 93 (46.5*2) plus pro-rated ETF lending fees of 30 basis points per annum or 2.5 basis points per month, equaling 95.5 (93 + 2.5) basis points per round trip of this strategy. The net profit then would be around 111.5 (207 – 95.5) basis points for a 26-day turnover. If annualized, the net profit yields 1,029 (111.5*(240/26)) basis points or 10.29 percent returns per annum.[45]

[43] Gastineau (2004) quoted these transaction costs from McNally and Emmanuel (2002). Included in this transaction cost is the impact cost on the spread of underlying stocks.
[44] Mazumder, Chu, Miller, and Prather (2007) estimate that a round trip transaction cost for ETFs around the world is around 30 basis points, whereas Yuan, Zheng, and Zhu (2006) document a transaction cost of 10 basis points for emerging markets' ETFs.
[45] This calculation is based on the assumption of 240 trading days in a year.

Figure 6.4 Cumulative Average Returns for Strategy of Going Long Decile 10 and Short Decile 1



Notes: This figure charts the cumulative average returns from five trading days before through 30 trading days after for a strategy of going long Decile 10 and short Decile 1. Day0 is the day of occurrence of increases in ETF short interest. Day3 is the day when the short interest information on ETFs is released to the public. Increases in ETF short interest are sorted in deciles. Day28 is the day when this strategy yields the highest cumulative average returns. Decile 1 contains the lowest increases whereas Decile 10 contains the highest increases in ETF short interest. Cumulative average returns are cumulative values of daily logarithmic returns of ETFs for each decile.

6.6 Conclusion

In this paper, we examine the profitability of shorting ETFs listed on the London Stock Exchange. As far as we are aware, this paper is the first to study the price impact following shortings in ETFs. Tracking errors aside, shorting an ETF is like shorting an index and, from the practitioner and academic perspective alike, the price impact is very interesting to study as there is more than one type of player involved in ETF shortings. Since different types of ETF players have different objectives in ETF shortings, the signals given are not easy to interpret, and this makes ETF shorting a dangerous financial sport.

On the basis of the arithmetic increase in the ETF short interest ratio, we sort all the increases in the short interest ratio into 10 deciles and, subsequently, we cumulate the average returns for each decile following the increase in short interest. We find that the cumulative average returns for the most shorted ETFs deciles are quite different from prior studies of high increases in short interest in individual stocks, which predict underperformance of stocks following high increases in short interest. We find no underperformance of ETFs; instead, we find overperformance of ETFs following high increases in short interest; but for low increases in short interest, we find underperformance of ETFs. This finding contrasts significantly to prior studies on high increases in short interest documented by Senchack and Starks (1993) and Choie and Hwang (1994).

We attribute our findings to different types of players involved in shortings of ETFs. The high increases in ETF short interest might be due to hedgers' balancing positions whereas the low increases in short interest might be due to speculators' speculative positions. The hedgers short because they are bullish and the speculators short because they are bearish. Interestingly, this interpretation of results points to an executable trading opportunity, that is, to go against

the hedgers and to gang up with the speculators; this translates into a strategy of: a) long Decile 10 and b) short Decile 1. On average this strategy can yield a profit of 10.29 percent per annum after transaction costs.

Our evidence appears to provide insights on how to interpret high and low increases in ETF short interest. Failure to exercise caution and careful interpretation in relation to shorting ETFs can render ETF shorting a dangerous financial sport. Certainly this sport of ETF shorting is not for the faint hearted.

Chapter 7

Summary and Conclusion

7.1 Summary of the Thesis

This thesis focuses on three different aspects of short selling in the UK market: the informational content of short interest, the effect of the short-selling ban on market quality, and the informational content of exchange traded funds' (ETFs') short interest. Research on short selling has suffered from a dearth of high-frequency, high-quality data in appropriate quantities. Short-selling data has only been available at monthly intervals, and only over the last few years has daily interval data been obtainable. The present study has benefited from this greater availability of high-frequency short-selling data. Furthermore, the enactment of a short-selling ban by the FSA, which has been the subject of debate between supporters, dissenters and researchers alike, has created a lot of interest in short interest recently. Looking back at history, whether the 'South Sea bubble' that led to Sir John Barnard's Act in 1734, or the financial crisis in 2008/2009 that led to the recent short-selling ban, time and time again has the blame for tumbling UK financial markets been directed at short sellers.

The first of the main objectives of the current study was to analyse empirically the impact of short selling on stock returns. A distinction is made between two types of shorts: valuation and dividend arbitrage shorts. The empirical results indicate that, whilst large increases in short interest in valuation shorts are associated with significant negative abnormal returns, large increases in dividend arbitrage shorts are less informative. With respect to dividend arbitrage shorts, however, the informational content of short interest is dependent on the state of the economy.

As for robustness checks on the informational content on short interest, the results indicate that shorting anomaly persists and that short-term, daily negative abnormal returns as well as alphas are not sensitive to the assumed model for expected returns, and to the choice of estimation windows. However, the results for alphas for the smallest bottom one percentile of increases in short interest are sensitive to the choice of weightings. It appears value and equal weightings yield different results for the smallest increases in short interest portfolio. The conflicting results may require disclosure of both weightings.

Regarding the impact of the FSA's short-selling ban on stock prices and market quality, the current study finds no evidence that the FSA's objective of protecting market quality was achieved through its prohibition of the short selling of financial stocks. With regard to the FSA's concerns over cross-sectoral contagion, there is evidence of a significant contagion effect from the financial sector to the telecommunications sector during the six-week period immediately prior to the imposition of the short-selling ban. However, there is no evidence of any significant contagion effect from the financial sector to any of the eight non-financial

sectors during the period when the ban was in force. Therefore, the short-selling ban may have been successful in preventing contagion, thereby protecting capital market stability.

With respect to the informational content of ETF short interest, the present study finds that high increases in short interest are followed by positive abnormal returns, while low increases in short interest are followed by negative abnormal returns. The results indicate that different types of players are involved in the ETF market. The high increases in ETF short interest might be due to hedgers' balancing positions, whereas the low increases in short interest might be due to speculators' speculative positions. The hedgers short because they are bullish and the speculators short because they are bearish. Consequently, the results indicate a profitable trading opportunity, that is, to go against the hedgers and gang up with the speculators; this translates into a strategy of going long on the ETFs with the highest increases in short interest and short on those with the lowest increases in short interest. On average, this strategy can yield a profit of 10.29 percent per annum after transaction costs.

7.2 Implications of the Research

With respect to the informational content of short interest, the present study offers two important implications. First, it appears that investors do react to the disclosure of large increases in short interest, while the fact that valuation short sellers are shorting into a strong market rather than chasing a downward trend may suggest that the short sellers are acting on private information. Second, this study observes different degrees of informativeness of short interest disclosure for valuation and dividend arbitrage shorts respectively, and this may imply that these two different types of shorts are executed by two different sets of traders, who are scrutinizing two different sets of information.

The robustness checks on the informational content of short interest yield one important implication. Despite Fama's (1998) strong rebuttal, claiming apparent anomalies are methodological illusions, this study finds that shorting anomalies persist in all the models under study, particularly with respect to the top percentile with the largest increases in short interest.

As regards the short-selling ban and cross-sectoral contagion, the current study finds no evidence that the FSA's objective of protecting market quality was achieved through the prohibition of the short selling of financial stocks. Instead, there is evidence of a deterioration in market quality when the ban was in force. However, the ban may have been more successful in preventing contagion, and in a way FSA's concern about a potentially cross-sectoral contagion, to some extent, is substantiated. Based on the effect of the recent ban on short selling, it appears that regulatory intervention of this kind will be seen as a panacea in the event of similar crises in the future.

In relation to informational content of ETF short interest, the evidence in the present study appears to provide insights into how to interpret large and small increases in ETF short interest. Interestingly, it does not carry informational content similar to that contained in the short interest on individual stocks. With stocks, a large increase in short interest is a bearish signal but for ETFs, a large increase in short interest is a bullish signal. Failure to exercise caution and careful interpretation in relation to shorting ETFs can render ETF shorting a dangerous financial sport.

7.3 Limitations and Suggestions for Future Research

The present study has employed stock-lending data as a proxy for covered short selling, hence it focuses only on covered short selling. Naked short selling, as mentioned earlier, was not subject to the ban in the UK market. Given the difference between naked and covered short selling, it would be interesting to examine whether naked short selling has the same impact on stock returns as covered short selling. Where naked short-selling data become available, this limitation should naturally be on the agenda for future research in this area. Furthermore, the evidence thus far indicates that valuation short sellers in the UK market are sophisticated traders with private information and that they tend to short in a strong market rather than chasing a downward trend. It would be interesting to see whether research could be undertaken to explore the decision-making process of valuation short sellers, that triggers them into shorting in a strong market, and so unravel the mystery surrounding these so-called sophisticated traders or short sellers. Future research, for example, could dig out first-hand information from the industry regarding who might be the valuation short sellers, and conduct interviews to study their decision making sources. While the majority of researchers believe short sellers to be traders with superior information, it is high time that this area of research is investigated more deeply.

Finally, although by enacting the short-selling ban the FSA did not achieve its desired objective of protecting market quality, it appears that its concerns over cross-sectoral contagion were justified to some extent and thus bans on short selling may be used as panaceas in similar financial crises in the future. Avgeouleas (2010) argues, from a legal point of view, that a circuit breaker or trading halt on individual stocks may be a better solution for protecting market quality than enacting a prohibition on short selling. This may well provide an interesting research area in the future. Future research could investigate the

reasons behind short-selling bans and study the possibility of laying out circuit breakers from the risk, cost and benefit point of view. In addition, future research should explore the possibility of cross-sectoral contagion in other developed and emerging markets at the onset of as well as during short-selling bans, thus providing market regulators with the opportunity to assess the effectiveness of such measures in achieving their objectives.

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Appendix

Event-study Multi-day Cumulative Abnormal Returns for All Benchmarks Related to Figure 3.4

	Panel A. Valuation Shorts			Panel B. Dividend Arbitrage Shorts		
Event Window	**FF3F**	**MM**	**CAPM**	**FF3F**	**MM**	**CAPM**
(-15,+30)	0.04%	-0.14%	0.51%	-1.22%	-1.48%	-0.86%
Overall	(0.14%)	(0.13%)	(0.13%)	(0.09%)	(0.10%)	(0.10%)
	0.31	-1.04	3.88***	-12.89***	-15.59***	-8.95***
(-15,0)	0.76%	0.62%	0.84%	-0.12%	-0.36%	-0.14%
Pre-event	(0.15%)	(0.14%)	(0.14%)	(0.11%)	(0.11%)	(0.11%)
	5.02***	4.33***	5.92***	-1.09	-3.37***	-1.31
(0,+15)	-0.40%	-0.47%	-0.03%	-1.38%	-1.40%	-0.98%
Post-event	(0.14%)	(0.13%)	(0.13%)	(0.09%)	(0.10%)	(0.10%)
	-2.85***	-3.50***	-0.21	-14.65***	-14.22***	-9.90***
(+3,+4)	-0.28%	-0.33%	-0.31%	0.07%	0.06%	0.09%
Immediate	(0.09%)	(0.07%)	(0.07%)	(0.14%)	(0.18%)	(0.18%)
post-publication	-5.94***	-4.52***	-4.13***	0.52	0.32	0.47
(+3,+17)	-1.48%	-1.41%	-1.20%	-0.35%	-0.36%	-0.15%
Extended	(0.05%)	(0.09%)	(0.09%)	(0.09%)	(0.10%)	(0.10%)
post-publication	-16.67***	-15.17***	-12.89***	-3.91***	-3.69***	-1.57

Notes: This table reports the results of a multi-day event study analysis of cumulative abnormal returns for different event windows and for both the valuation and dividend arbitrage shorts subsamples for the period of September 2003 to April 2010. The total number of observations (*N*) for valuation shorts and dividend arbitrage shorts are 455 and 500, respectively. Abnormal returns are measured relative to the UK Fama-French (1993) three-factor model (FF3F), market model (MM) and Capital Asset Pricing Model (CAPM). Following Brown and Warner (1985), we construct a multi-day test statistics to show significance. Standard errors of the cumulative abnormal returns are in parentheses. *, **, *** denote statistical significance at 10, 5 and 1%, respectively and are preceded by the test statistics.