The effect of short interest on the subsequent stock performance in NASDAQ-100 companies

Author: Dominik Schindler
University of Twente
P.O. Box 217, 7500AE Enschede
The Netherlands
d.schindler@student.utwente.nl

This quantitative paper investigates the relationship between the *short interest ratio* and *abnormal return* of an underlying security on a monthly basis. Short interest data for a 36-month period from January 2012 through December 2014 from NASDAQ-100 companies were used to examine the expected negative relationship. The results however do not support the expectations by stating a significant positive relationship following the 'contrarian view'. An increase of the short interest ratio of 1% leads to a 60 basis points gain in abnormal returns. The relationship becomes even stronger by another 16 basis points after introducing the control variable *firm size* measured by the market capitalization.

Supervisors:
Xiaohong Huang
Henry van Beusichem
Peter-Jan Engelen
Samy A.G. Essa
George Iatridis
Rezaul Kabir

Keywords
Short selling, short interest, stock performance, abnormal return, market capitalization, financial market

5th IBA Bachelor Thesis Conference, July 2nd, 2015, Enschede, The Netherlands.

1. INTRODUCTION

Short selling of stocks has become an increasing practice on financial markets. While in 1984 only nine percent of total trading volume on the NYSE was caused by short sales of which 80% of those positions were taken by specialists (Brent et al., 1990), this number had been doubled by 2005 (Asquith et al., 2005). Similarly, Boehmer et al. (2008) reported that more than 20% of total trading volume was sold short. In 2009, this number had even increased to 32% of NASDAQ volume according to Diether et al. (2009). Hence one can see the increasing importance of short selling on financial markets. Short selling is thereby defined as a stock sold on the secondary market which is not owned by the seller but was borrowed from a broker or institutional investor (Brent et al., 1990; Dechow et al., 2001; D'Aviolio, 2002; Platt, 2002; Kedrosky, 2003; Ackert & Athanassokos, 2005) in order to re-purchase the share later at a lower price to cover the position and "to extinguish the initial loan of the stock" (Dechow et al., 2001, p. 79). Short selling is therefore a direct measure to gain from declining stock prices.

In recent decades, the fear of short selling having negative effects on stock markets especially through exacerbating market downturns and thus destabilizing markets has led to the implementation of regulative rules and constraints in many countries all over the globe. The US hereby serves as a good example where the Securities and Exchange Commission (SEC) introduced the uptick rule which requires short sellers to sell shares only at a price higher than the last recorded price in order to prevent selling in falling markets and thus worsening the price declines (Smaby et al., 1997; Ackert & Athanassokos, 2005). While some literature support the concerns of the SEC that short sellers drive prices too far away from the stock's fundamental value and hence destabilize markets (Shkilko et al., 2012; Henry & Koski, 2010), other researchers reported the contrary. Smaby et al. (1997) for example stated that short sellers did not exacerbate price declines in falling markets and instead added liquidity in bull markets by short selling stocks which had experienced large price increases and thus potentially deviated from their fundamental values.

Further studies have supported that argument and additionally mentioned several positive aspects of short selling. Firstly, as already mentioned it is an important element in efficient markets by driving stock prices closer to their fundamental values (Diamond & Verrecchia, 1987; Dechow et al., 2001). According to Boehme and Wu (2012) stock prices are more accurate if short sellers are more active in the market which leads to the fact that public information is incorporated more quickly (Aitken et al., 1998). Since short sellers are also able to identify financially distressed firms and thus potentially underperforming stocks (Asquith & Meulbroek, 1996; Dechow et al., 2001; Desai et al., 2002), they generally support market and price efficiency (Boehmer & Wu, 2012).

This research paper therefore aims to investigate the following research question:

How do short interest ratios affect the subsequent stock performance of companies incorporated in the NASDAQ-100 index on a 36-month period between January 2012 and December 2014?

Short interest can thereby be defined as the number of shares sold short of a security. The time frame is chosen for two reasons. First of all, the data are the most up-to-date available and secondly, no major legal regulations affecting and constraining short selling has taken place within this period which otherwise would have deteriorated the validity and reliability of the research results. This paper therefore contributes to the ongoing discussion of short interest being an indicator of subsequent stock underperformance. Previous studies so far have not reached consensus by reporting contrasting relationships in their empirical findings as will be discussed in Section 2.

The remainder of this paper is organized as follows. Section 2 gives a literature overview of prior research studies by highlighting three different schools of thought. Section 3 discusses the methodology and develops the hypothesis to be tested. Section 4 checks the data for regression suitability and is followed by Section 5 which reports the empirical findings. Section 6 discusses the implications and leads to the final Section 7 which concludes the paper.

2. LITERATURE REVIEW

2.1 Objectives of Short Sellers

Previous literature has found that a short sale of a stock is performed for multiple reasons. While speculators use the practice to gain profits from price declines, other short sellers attempt to hedge their open positions in order to secure a certain capital gain (Woolridge & Dickinson, 1994; Brent et al., 1990). Hedging hereby often comes along with tax purposes by which capital gains are delayed in order to recognize the profit in later tax periods if the investor expects a lower tax rate. This tax implication is called 'shorting against the box' and accounts "for about 5 percent of the outstanding short interest" (Brent et al., 1990, p. 280). Another reason brought forward by Hurtado-Sanchez (1978) aims to take advantage of arbitrage in merger situations by shorting the acquiring firm and taking a long position in the firm to be acquired.

2.2 Different Schools of Thought Emerged

However, different reasons for selling short do not explain the relationship between short interest levels and the subsequent performance of stocks. Over the last decades researchers have not been able to reach consensus by reporting contrasting empirical findings which led to the emergence of three different schools of thought.

2.2.1 First School of Thought

The first school of thought does not find any relationship between short interest and stock performance. Mayor (1968) was the first to examine the relationship between short interest and movements in stock prices by employing multiple regression analyses. He found no significant relationship. He further argued that short sellers are not capable of performing better than a chance model. Those results can be attributed to the random walk hypothesis which states that a market's past performance has no indication of future price movements and therefore, traders cannot predict price changes in equities leaving a non-significant relationship between short positioning of investors and subsequent stock returns. Similarly, Smith (1968) could not find a significant relationship. Smith also used a size variable in order to account for the supply of stocks available and reported that a smaller supply led to a bigger price impact of short interest levels. In addition to prior findings, Hurtado-Sanchez (1978) reported that short interest does not serve as a predictor of stock performance and thus does not increase predictability of future returns. He concluded that short sales therefore stabilize markets by limiting excess returns of individual stocks. Similarly, Woolridge and Dickinson (1994) did not find a significant relationship between changes in the level of short interest and monthly stock returns using simple linear regression analysis. Instead, they reported that short interest increases with increasing market prices and short sellers are not able to take abnormal profits at the "expense of less informed traders" (Woolridge & Dickinson, 1994, p. 20). They further mentioned that the R^2 for

their regression did not show a good fit which led to the conclusion that short positions do not affect monthly returns. Another proponent of this school of thought is Brent et al. (1990). Their empirical findings support the view that no relationship between short interest levels and stock returns exists and thus concluded that short interest is inefficient in predicting subsequent stock returns. They further stated that after periods of high stock returns, periods of increased short interest follow. Additionally, short interest increased for firms with high betas representing the volatility of the stock compared to the market.

2.2.2 Second School of Thought

The second school of thought is also called the 'contrarian school' (Aksu & Gunay, 1995) or 'Wall Street wisdom' (Epstein, 1995). Proponents of the contrarian school argue that high short interest represents potentially high demand of stocks in future since open short positions have to be covered at some point in time by re-purchasing shares. That would lead to increasing buying pressure and may result in a 'short squeeze' which is characterized by upward price spikes. These spikes would trigger more pressure for short sellers to cover their positions and can thus be seen as a bullish indicator. The first to report a bullish relationship was Hanna (1976) who found increased short ratios [which is the short interest in relation to average daily trading volume] to have a positive effect on stock prices. He tested whether a model based on the assumption that large increases in short interest ratios are a bullish signal and therefore outperform a chance model. The results supported the assumption-based model by generating significantly better results. These findings were partially corroborated by Aksu and Gunay (1995) who tested for co-integration of prices, short interest, and trading volume and in fact found neither a positive nor a negative relationship. However, they presented evidence for short interest, stock prices, and average daily trading volume to be contemporaneously interrelated in a significantly positive way.

2.2.3 Third School of Thought

The third school of thought is the most widely dispersed view among academic researchers and has found much support especially in the last two decades. Under this speculative view, a high short interest is seen as a bearish signal. This is due to the fact that high short interest indicates pessimism among investors (Aksu & Gunay, 1995). Since short selling bears significantly more risk with simultaneously capped gains compared to simply buying stocks, most of the short sellers are professional investors (Woolridge & Dickinson, 1994; Brent et al., 1990;). Professional investors are hereby assumed to be better informed and in possession of superior knowledge. Therefore, a high level of short interest signals that not all negative information is incorporated into the stock price leading to an overvaluation of the security (Ackert & Athanassokos, 2005). Consequently, short sellers as a cohort are able to detect securities which may underperform the market benchmark (Desai et al., 2002; Dechow et al., 2001; Asquith & Meulbroek, 1996).

The first proponent of this third school of thought was Seneca (1967) who performed a regression analysis of the S&P 500 index and the short interest level with a 15-day lag on the NYSE. The results showed a negative relationship. Similarly, Kerrigan (1974) reported a significant negative relationship between short interest and the return of the S&P 500. By analyzing the abnormal returns of stocks from January 1973 until June 1979, Figlewski (1981) was able to verify the significant negative relationship between the previously mentioned variables. Unlike prior researchers, Diamond and Verrechia (1987) investigated which effects short selling constraints had on the speed of price adjustments to new information. Since short selling is very costly due to constraints, borrowing costs and alike, they argued that by reducing the costs, especially negative information would be incorporated into stock prices more quickly. On top of that, they also showed that an unexpected increase in short interest signals bad news since more market participants expect the stock to be overvalued. Almost a decade later, Asquith and Meulbroek (1996) picked up the topic again and likewise reported that stocks with a short interest level of above 2.5% of all shares outstanding experienced a significant negative performance compared to other stocks with smaller short positions. The research of Smaby et al. (1997) investigated short selling and trading abuses on NASDAQ and reported that short sellers augment their short positions especially if stock prices recently increased significantly. They additionally found that short sellers on NASDAQ earned abnormal profits, though they were smaller compared to the NYSE/AMEX market. These findings suggest a negative relationship between increases in short interest and subsequent return which is consistent with Choie and Hwang (1994) who found that stocks with high short interest significantly underperformed the benchmark index S&P 500 on a one-month period.

Aitken et al. (1998) investigated the Australian stock market where short sales are made public without a time lag but immediately after the order had been executed. They, too, found a significant negative relationship using the calendar-time portfolio approach.

Post-millennial, different variables and aspects have been related to short interest. Dechow et al. (2001), for example, investigated the positioning of short sellers and found out that they often sell stocks short with low fundamental (e.g. book value) to market value ratios. If these ratios reverse, short sellers cover their positions and extinguish the initial stock loan. The authors' empirical findings also show a negative relationship between short interest and stock returns. Stock returns hereby declined monotonically with short interest levels (Dechow et al., 2001). In common with prior research, Desai et al. (2002) reported negative abnormal returns for highly shorted stocks using the calendar-time portfolio approach. They further stated that this relationship is linear, implying that increases in short interest lead to increases in the magnitude of negative abnormal returns. Desai et al. (2002) also added a time variable to their research and document that the relationship between short interest and negative stock returns persists for up to 12 months after the release of short interest data. Furthermore, their research showed that firms which are highly shorted have a higher probability of being delisted within 36 months after the large short interest. In 2002, D'Aviolio researched the market for borrowing stocks by using proprietary data recording two years of short interest. He focused on the rebate rate of borrowed stock which is the "interest rate institutional short sellers receive on the proceeds of the sale" (Asquith et al, 2005, p. 247). D'Aviolio's (2002) discoveries are twofold. On the one hand, he reported that low rebate rates lead to negative abnormal returns and on the other hand, market-adjusted returns are worst for stocks sold short which had to be covered by being squeezed out of their positions. Proprietary data was also used by Angel et al. (2003) who investigated NASDAQ data over three months on a daily basis. The results document negative abnormal returns which quickly followed large short sale positions during the day. Boehme et al. (2004) included a size variable into their research and showed that especially small stocks with high short interest ratios underperform the market significantly.

So far, most of the research focused on the American market. Therefore, Ackert and Athanassokos (2005) investigated the Canadian market which is less regulated compared to their Southern counterparts. Nonetheless, the Canadian market showed similar results. The authors reported that short interest is

"contemporaneously associated with negative abnormal returns" (p. 1730) and these excess returns become even more significant for small firms where shortable shares are rare. However, they point out that they cannot claim that the short interest caused the excess returns, rather is the short interest ratio an indicator of future negative returns caused by current overvaluation. To extend their research, they introduced size as another variable and found a positive relationship with excess returns. Also in 2005, Asquith et al. used a four-factor time-series regression to investigate the interrelations between short interest, institutional ownership, and stock returns. They found that highly shorted stocks underperform the market linearly. This relationship becomes even stronger, the lower institutional ownership is and persists, similar to Desai et al. (2002), for several consecutive months. More recent studies (e.g. Boehmer et al., 2008) examined daily short activities and find that lightly shorted shares perform better than heavily shorted shares suggesting a negative relationship. Interestingly, because contrary to prior researchers, Au et al. (2008) documented a negative relationship between short interest and forward abnormal returns using daily data, but that relationship is non-monotonically. That means that short interest has a point of diminishing returns, i.e. extreme high levels of short interest lead to positive future stock returns and thus a bullish indication. The most recent study by Boehme et al. (2010) created equally weighted portfolios with different short interest ratios and found that portfolios with small short interest ratios have "large and statistically significant positive abnormal returns" (p. 80). In their study, using the four-factor Fama-French model, returns of different short interest portfolios differed up to 2.2% per month and thus suggest a significant underperformance of heavily shorted stocks.

2.3 A Fuller Theory of Short Selling

In 2002, Platt introduced a 'fuller theory of short selling' which recognized the underlying psychology of investor decisions. The paper focused on greed and fear. Greed was according to Platt (2002) the prevalent reason for short sale demand if stocks were overvalued, while fear led to short sale demand if investors expected that financially distressed firms will potentially go bankrupt. These two factors thus are explanatory variables for short selling activity.

The body of research has shown that empirical studies so far have not been able to reach consensus on the nature of the relationship between short interest levels and the subsequent performance of stock prices. Different methodological analyses have been employed, i.e. regression analyses, calendar-time portfolio approach, and time-series studies, which led to results diverging in their magnitude and sometimes contrasting findings. The research can hereby be clustered in three main streams, with the early research finding no significant relationship between short interest and stock performance. Research until the mid-1990s reported mainly a positive relationship while the most recent findings support the speculative view with high short interest indicating a negative subsequent stock performance which is simultaneously the most widely dispersed empirical point of view. Furthermore, research studies so far have strongly focused on the American market with only a few exceptions. Aitken et al. (1998) investigated the Australian market, Ackert and Athanassokos (2005) researched the Canadian market.

The paper continues with the derived hypothesis, the methodology of the research and describes the data sample employed.

3. METHODOLOGY

3.1 Derived Hypothesis

It is expected that the independent variable 'short interest' precedes the dependent variable 'stock performance'. The relationship is expected to be negative following the 'speculative view'. Furthermore, the relationship between the two continuous variables is expected to be linear following Desai et al. (2002) and Asquith et al. (2005).

Figure 1. Expected Relationship

Following the expected relationship, the hypothesis in question is developed:

$\boldsymbol{H_1}$**:** The short interest ratio is negatively related to abnormal return.

The majority of academics reported in their prior studies a (significant) negative relationship between the short interest of a stock and the subsequent performance. Thereby, abnormal returns were often used as a measure. This paper defines abnormal return as the return of a security that exceeds a certain market benchmark, i.e. the NASDAQ-100 index, and thus cannot be explained by the overall rate of return for the market. This paper used the NASDAQ-100 index and concomitantly firms included in that index because of high trading activity and liquidity as well as availability of data. Furthermore, frequent shorting activity in NASDAQ-100 stocks generates many observations and a good sample size compared with other smaller indices.

For short interest, the ratio between shares sold short and the average daily trading volume on a monthly basis serves as a proxy. In order to be able to compare shorting activity across stocks with different trading volumes, the standardization is important. While other studies define short interest as the ratio of shares sold short and the total number of outstanding shares, (e.g. Asquith et al., 2005; Desai et al., 2002; Asquith & Meulbroek, 1996) this paper uses trading volume as a divisor because it represents actual trading activity. This is important since short sellers hold their positions only on a short-term basis with an average day-to-cover ratio between three to five days (Boehmer & Wu, 2012). Thus, actual trading volume is preferred over outstanding shares. Stock performance is measured by calculating abnormal return of stock i in month t (ARi_t) compared to the benchmark index NASDAQ-100 using the following formula

$$R_{it} = R_{ft} + \beta_{it} * (R_{mt} - R_{ft}) + AR_{it} \quad (1)$$

with R_{ft} being the risk-free rate of return on the market at time *t*, β_{it} represents the beta of the stock *i* in month *t* and R_{mt} is the return of the market, i.e. the NASDAQ-100 in month *t*. Beta for each individual stock on a monthly basis was calculated against the NASDAQ-100 benchmark using daily adjusted closing prices. That implies that the beta calculated refers to the risk or volatility of the expired month. The return of the stock *i* in month *t* (R_{it}) is calculated using adjusted monthly closing prices of the underlying security. Since dividends, stock splits and other payouts are not considered in the data given, closing prices were adjusted to be comparable. The above mentioned equation (Equation 1) is employed based on the capital asset pricing model (CAPM) because it benchmarks the stock return not only for the market return, but accounts for underlying market conditions too, i.e. the risk-free rate and the risk associated with the stock. The

equation is hence seen as superior to other simplified calculations which only compare the pure market and stock returns. This is consistent with Ackert and Athanassakos (2005) who also based their excess return calculations on the CAPM.

3.2 Regression Models

In order to determine the causal relationship between short interest and stock performance, the variables are tested employing regression analysis. Prior literature also used the calendar-time portfolio approach, however this paper employs regression analysis for feasibility and data availability reasons. Regression is further preferred over the event study method "calendar-time portfolio" because the paper is not concerned with the announcement of the short interest ratio itself but rather the level over a certain time period. The simple linear regression model following the research by Mayor (1968) and Woolridge and Dickinson (1994) is used in order to see whether and how the relationship changed over time since academics reported differing results over the last five decades. Hence, the regression looks as follows

$$AR_{it} = \alpha_0 + b_{it} * SIR_{it} + \epsilon_{it}. \qquad (2)$$

AR_{it} is the abnormal return of stock *i* at the end of month *t*, a_0 represents the constant regression coefficient, b_{it} is the regression slope coefficient for stock *i* at time *t*, SIR_{it} is the short interest ratio of stock *i* at time *t* and ε_{it} terms the regression error for stock *i* at time *t*. The short interest ratio thereby represents the average of the trading volume and the shares sold short over the prior month period and are reported at the last trading day of each month. Therefore, the short interest data is lagged by nature. If the results are to support Hypothesis 1, the regression coefficient b_{it} must be significantly smaller than zero and thereby indicating a contrast to Mayor (1968). A simply negative coefficient does not prove statistical significance.

In a second step, the results will be tested by introducing size of the firm as a control variable. Consequently, the regression model has to be adjusted to the following

$$AR_{it} = \alpha_0 + b_{1_{it}} * SIR_{it} + b_{2_{it}} * SIZE_{it} + \epsilon_{it}. \quad (3)$$

Firm size was previously included by Smith (1968), Boehme et al. (2004), and Ackert & Athanassokos (2005) who reported a positive relationship with abnormal returns. The market value at the beginning of each month will be used as a measure of company size which indicates that a constant supply of stocks is given which is important in order to be able to borrow shares which are then shorted. Furthermore, Smith (1968) reported that smaller supply of stocks led to a larger price impact of short interest levels which led to the inclusion of firm size. The proxy for company size will be the market capitalization of the firm in the month at question.

The regression analysis will be performed using SPSS software.

The results will also be tested for robustness using three dummy variables for months with relatively high short interest levels. Furthermore, a different methodological approach will be applied as well as a different definition of the short interest ratio.

In prior literature, the control variable 'option' was also introduced in order to explain the effect of short interest ratios on abnormal return (Ackert & Athanassokos, 2005; Figlewski & Webb, 1993). 'Option' explains whether the firm is optioned or not. However, this paper does not include the control variable 'option' since it is based on data from the NASDAQ-100 which includes 100 of the largest securities by market capitalization listed on the NASDAQ stock exchange. The NASDAQ-100 index is not only highly liquid and heavily traded but also all of the firms are optioned which allows for excluding this variable.

4. DATA

4.1 Data Set and Assumption of Normality

The set of data contains records of 36 months starting in January 2012 through December 2014 of all NASDAQ-100 companies.

Monthly short interest data had been derived from *Wall Street Courier*. Daily as well as monthly stock returns were downloaded from Yahoo! Finance including for dividends and stock splits/ reverse splits adjusted monthly closing prices. The data for market size on a monthly basis were provided by the *Bureau van Dijk Database.*

Figure 2 shows the distribution of average short interest ratios over the investigated period of time. While for example Desai et al. (2002) have reported increasing short interest levels over the previous years, the data this paper is based upon only shows an incremental increase in short interest ratios. However, it is interesting to note that short interest levels are in all three years highest in August, followed by a decrease in September and October before they rise again in November and December (marked in red). The peaks of short interest levels at the end of each year have already been found by Dyl (1978) and can be explained by hedging purposes in order to delay capital gains to the subsequent tax period if a lower tax rate is expected. This procedure is called shorting against the box (Brent et al., 1990). The peak in August however cannot be explained by this reason and has not been discussed in prior literature. Reasons for high short interest ratios in August may be the end of the fiscal year for many companies. Another reason might be the holiday season of many professional investors and financial institutions.

The initial data set included 2918 records which were checked for outliers. Outliers for each variable were removed at the one and 99 percentile leaving a total of 2748 records from 82 listed firms. The set of data was then checked for regression suitability. First of all, in order to generate a normal distribution each variable was checked for skewness and kurtosis. For the variable abnormal return, no conspicuousness was found. The variable was normally distributed. However, for the other two variables, deviations were present. Both variables short interest ratio and market capitalization are skewed to the right and had kurtosis values beyond the suggested cut-offs between +1 and -1. Therefore, the natural logarithm was used to transform both variables. This is consistent with Ackert & Athanassakos (2005) who also transformed the variables in the same manner.

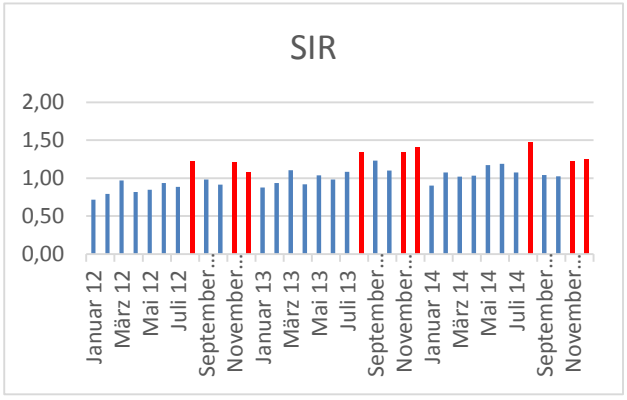

Figure 2. Distribution of SIR per month

Table 1. Descriptive Statistics

	N	Minimum	Maximum	Mean	Median	Std. Deviation	Skew-ness	Kurtosis
ARit (%)	2,748	- .18	.20	.0082	0.0075	.061	.051	.420
SIR (%)	2,748	.57	17.28	3.778	2.74	2.916	1.732	3.236
Market_cap (in million dollars)	2,748	5.106	415.684	34.514	15.205	50.367	3.722	17.437
Raw_return (%)	2,748	- .24	.70	.0225	0.022	.069	.426	4.169
Beta	2,748	- 2.90	7.17	.8484	0.833	.561	.716	7.708
Valid N (listwise)	2,748							

The improvements can be seen in the values for skewness and kurtosis. While the original data for both short interest ratio and market capitalization are far beyond the cut-off values for skewness (1.732 and 3.722 respectively) and kurtosis (3.236 and 17.437 respectively). The transformed value for *ln_SIR* falls within the cut-off value for skewness while *ln_market_cap* shows only a very slight skewness (0.199 and 1.079 respectively). For kurtosis, the transformed values are even more clearly within the cut-off range with values for *ln_SIR* of -0.571 and *ln_market_cap* of 0.446 indicating no abnormal curve.

4.2 Descriptives

The descriptive statistics (see Table 1) of the previously introduced variables show that for each variable, the number of observations is N = 2,748. One can see that the variables *SIR* and *market_cap* are skewed to the right, while *ARit*, *raw_return* and *beta* are not. For kurtosis, the dependent variable *ARit* is not outside the range between +1 and -1 which shows that it does not suffer from kurtosis. All other variables used show much higher kurtosis levels above +1.

For *ARit* the data set contains records with a range of 38% from -18% up to +20% and a mean of 0.82% with a standard deviation of 6%. A mean close to zero (-0.28%) for abnormal return was also reported by Smaby et al (1997) who investigated the NASDAQ market from January 1987 through December 1991. For the SIR variable, the descriptives report a range of 16.71% from 0.57% to 17.28% and a mean of 3.78% with a standard deviation of 2.91%. The descriptives reported by Desai et al. (2002) who investigated the NASDAQ market from 1988 through 1994 show a steady increase in the mean and median of the short interest ratio over time. While in 1988 the mean (median) SIR was only 0.51% (0.08%), it increased to 1.14% (0.16%) until 1994. From those descriptives one can also see that the data of Desai et al. (2002) were also skewed to the right consistent with the data this paper is based upon. Since, as already stated, the short interest has more than doubled since the 1980s, the descriptives for the data at hand seem to be reliable. This is further supported by Angel et al. (2003, p.66) who had "a close look on short selling on NASDAQ" on a daily basis from September 2000 through December 2000. They reported a mean (median) value for short interest of 2.36% (1.57%). The maximum reported by Angel et al. (2003) was 62.94%. This is very different from the maximum value of 17.28% reported above. However, the 95 percentile can be found at 7.34% which indicates that the very high short interest is caused by a few outliers.

Market_cap ranges from 5.106 million dollars to 415.684 million dollars with a mean (median) of 34.514 (15.205) million dollars and a standard deviation of nearly 50.367 million dollars.

One can also note that the raw return's mean (2.25%) is larger than the mean of the abnormal return (0.82%) which indicates that the market has over the investigated period on average a positive return. The mean for beta of 0.8484 is smaller than 1 which would imply that the mean risk of the stock is smaller than if one was to invest in the entire market. Since this is mathematically not possible, this deviation can be explained by the sample size of only 82 firms instead of all 100 firms incorporated in the benchmark index NASDAQ-100.

By comparing the descriptives with prior studies one can conclude that the data set employed for this paper is generalizable and reliable.

In order to check the data for multicollinearity problems, a Pearson correlation matrix has been derived which can be seen in Table 2.

Table 2. Pearson Correlation Matrix

	ARit	ln_SIR	ln_market_cap
ARit (%)	-	.069***	.049**
ln_SIR	.069***	-	- .253***
ln_market_cap	.049**	- .253***	-

*** Significant at the 0.01 level
** Significant at the 0.05 level

The results show that for all three variables, 2,748 observations are available. Additionally, there is correlation between all three variables. According to the Pearson statistic, AR_{it} is positively correlated to the short interest ratio (0.069) which is also positively correlated with market capitalization (0.049). The positive sign of the correlation between the short interest ratio and abnormal return is contrary to what recent literature studies and theoretical considerations would suggest. The above found correlation therefore does not follow the speculative view but rather the contrarian school of thought by affecting abnormal return in a positive direction. However, this will be further investigated later in this paper. The correlation matrix further shows a negative correlation (-0.253) between market capitalization and short interest ratio. The correlation matrix not only shows the correlation between these variables but also has another important implication. Since all of the correlations are between the cut-off values of +0.9 to -0.9 (Field, 2009) one can say that the variables do not suffer from multicollinearity which is one assumption of regression analysis. Since there is no general rule regarding the cut-off values, even smaller ranges (e.g. between +0.5 and -0.5) do not lead to the conclusion of multicollinearity in the data at hand.

All of the correlations are significant at the 99% confidence interval except for the correlation between abnormal return and market capitalization, which is only significant at the 95% confidence interval.

5. EMPIRICAL RESULTS

5.1 Simple Regression

After examining the variables for regression suitability, the data were analyzed using simple (see Equation 2) and multiple regression (see Equation 3).

If the regression analyses were to support the expected hypothesis from Section 3.1. it is expected to find a negative correlation with a significant negative regression coefficient for the variable short interest ratio.

In a first step, the variables of the regression model were checked for heteroscedasticity and the independence of standardized residuals. The results clearly support the assumption of homoscedasticity and also show a normal distribution of the standardized residuals. The differences between the original data of each variable and the transformed data can be seen in Figures 3-8 (see Appendix). Figure 3 shows the histogram of the residuals using original data. The residuals are normally distributed. However, in Figure 4, one can already see an indication that the original variables may not be suitable for regression analysis since the P-P-Plot shows deviations between the suggested line and the observed residuals. Figure 5, the scatterplot of the residuals, shows a very unequal distribution of the residuals indicating heteroscedasticity which indicates that the data have to be transformed. As mentioned above, the data for short interest ratio and market capitalization were transformed using the natural logarithm. By transforming the data, the distribution and suitability improved drastically. Figure 6 shows the normal distribution of the residuals in a histogram.

Figure 7 shows the P-P-Plot for the transformed values. It can be seen that each residual only very slightly deviates from the suggested line indicating normal distribution. The problem of heteroscedasticity, which was present in the original data has been solved for due to the transformation. The scatterplot of the residuals now shows a cloud indicating homoscedasticity (Figure 8).

Using the transformed variables, the error terms or residuals are independent which can be seen by the Durbin-Watson test (test statistics of 1.997).

In a second step, the test of the model using ANOVA was performed which resulted in a significant F-value (F = 13.005) at the 95% threshold (p-value < 0.005).

The Pearson correlation coefficient shows a positive relation with a value of 0.069. By performing the regression analysis, the reported regression coefficient b_{it} has a value of 0.006 with a significant t-statistic (t = 3.606) at the 95% confidence interval which is equal to a percentage of 0.60 or 60 basis points. This is calculated by using the exponential function e and thus the inverse calculation of the natural logarithm.

The result implies that a one percent increase in the short interest ratio leads to an increase of 0.6% in abnormal return. Therefore, one can conclude that short interest has a strong and significant positive effect on the subsequent performance measured in terms of abnormal return of the underlying equity (Table 3). Therefore,

Table 3. Results Regression Analyses

	Simple Regression	**Multiple Regression**		**Altern. Multiple Regression[2]**	**Multiple Regression (dummy)[3]**
		SPSS (OLS)	**Smart PLS[1] (Bootstrapping)**		
	B (t-test)	B (t-test)	B (t-test)	B (t-test)	B (t-test)
ln_SIR	0.006*** (3.606)	0.008** (4.414)	0.087*** (4.266)		
ln_market_cap		0.005*** (3.629)	0.071*** (3.619)	0.006*** (3.970)	
ln_SIR_outst				0.005*** (4.114)	
Dummy_August					- .015*** (-3.457)
Dummy_November					.011*** (2.660)
Dummy_December					.009** (2.132)
Adj. R^2	0.005	0.009	0.009	0.009	0.017
No. of Obs.	2748	2748	2748	2748	2748

*** Significant at the 0.01 level

** Significant at the 0.05 level

[1] Standardized coefficients are reported due to different methodology. However, in OLS, they only slightly differ from unstandardized coefficients.

[2] The Alternative Multiple Regression defines the short interest ratio as "short interest divided by total number of shares outstanding".

[3] The Multiple Regression (dummy) used dummy variables for the month in which high SIR observations (August, November, December) occurred.

Hypothesis 1 is rejected at an alpha level of 5%. However, the R^2 statistic reports a very low value which is below 1% (Table 3) indicating little practical implications. Hence, even though the analysis shows a statistically significant result, the practical relevance is negligible due to a very small R^2 statistic.

Since the simple regression was to see whether the relationship between the two variables has changed over the last five decades potentially caused by regulations, higher liquidity or increased short selling, this paper followed the approach of Mayor (1968) and Woolridge and Dickinson (1994) who also reported a very low R^2 statistic of below 1%. The sign of the relationship is positive at a statistically significant 95% confidence interval. While Mayor (1968) and Woolridge and Dickinson (1994) report no significant relationships, the results of this paper do find support by other literature. The findings are consistent with Aksu and Gunay (1995) who found that short interest, stock prices, and average daily trading volume are contemporaneously interrelated in a significantly positive way. Furthermore, already in 1976, Hanna supported the contrarian view by reporting that increased short ratios have a positive effect on stock prices. Therefore, this paper is consistent with prior findings. On the contrary, Desai et al. (2002) who investigated the NASDAQ market of which the NASDAQ-100 market is derived from, find a negative relationship and thus an opposite conclusion. The difference in results compared to Desai et al. (2002) may be caused by the different sample of firms but also by financial regulations who have taken place after the financial crisis in 2008/09.

In any case, the initially expected relationship of abnormal return being negatively affected by short interest ratios cannot be accepted based on the outcomes of the regression which reports a strong significant positive value for the regression coefficient.

5.2 Multiple Regression

Subsequently, the multiple regression following Equation 3 including the variable market capitalization was executed. Here, again it is expected that the short interest ratio is negatively related to abnormal return, but market capitalization is expected to have a positive effect on abnormal returns following Ackert and Athanassokos (2005).

As described in Section 4.1. both independent variables were transformed using the natural logarithm in order to be able to perform a multiple regression analysis.

Using the sample of N = 2,748 with df = 2,747, the model is significantly better than using just the mean to predict the outcomes with a F-value of 13.117 at a significance level of 95% and thus has explanatory power for abnormal return. The multiple regression produced statistically significant results for both variables. The transformed short interest ratio is significantly positively related with a value of 0.008 which is equal to 0.76% or 76 basis points. The t-test (t = 4.414) proved statistical significance at the 95% confidence interval (Table 3). By including the variable market capitalization in the model, the impact of short interest indeed becomes bigger on abnormal return with an increment of 16 basis points. This result is not consistent with early research by Aksu and Gunay (1995) and Hanna (1976), however contrasts most of the recent literature. Especially Smaby et al. (1997), Desai et al. (2002) and Angel et al. (2003) who all investigated the NASDAQ market reported significant negative relationships. However, one has to mention that all of the previous NASDAQ studies were executed before the financial crisis which led to an implementation of multiple financial regulations for short selling practices.

For the control variable market capitalization, the regression analysis reports a coefficient value of 0.005 which is equal to 0.49% or 49 basis points. Even though the t-test shows statistical significance (t = 3.629) (Table 3) it can be said that the practical relevance of the underlying result is virtually non-existent – consistent with the result of the simple regression. This practical irrelevance is derived from the R^2-statistic. The R^2 of the multiple regression has a value of 0.9% which is almost twice as high as it was in the simple regression analysis, however still very small meaning that the variance in abnormal return can be explained only to 0.9% by the independent variables short interest ratio and market capitalization.

Similar to the simple regression performed earlier but unlike other recent research, this paper finds a positive relationship between short interest ratios and abnormal returns. The findings hence support the 'contrarian view' or 'Wall Street wisdom' which assumes that a higher short interest leads to higher future demand since the short positions eventually have to be covered. This higher demand indicates that prices will rise which may force other short sellers to cover the positions involuntarily resulting in price spikes. This effect is called 'short squeeze'. However, it also has to be mentioned that the probability of being squeezed out of a short position becomes lower, the higher the trading activity on the market is because investors willing to buy shares always find another investor willing to sell his shares at a mutually satisfying price level.

The reported positive result for market capitalization and abnormal return are consistent with Ackert & Athanassakos (2005). Even though they investigated the Canadian market which is compared to the NASDAQ-100 less liquid and less actively traded, they found the same positive relationship.

5.3 Tests for Robustness

The results of the multiple regression are tested threefold. First, three dummy variables for the months with relatively high short interest are introduced. That means that the effect of the three months August, November and December, where short interest ratios were in all three years higher compared to the other months, is investigated. Secondly, the regression is repeated using another computer program called 'Smart PLS' which is contrary to SPSS variance based and can therefore also calculate relationships between variables which are not normally distributed using the bootstrap-function. Lastly, the regression is duplicated using a changed short interest variable. As described above, some studies used short interest ratio defined as shares sold short divided by the number of shares outstanding while this paper so far has used average trading volume as a divisor. This however can lead to unreliable results if a share is not frequently traded but an institutional investor with inside information sells a larger stake of shares short.

As one can see in Figure 2, short interest ratios in the months August, November and December are higher in all three years than in all other months. Therefore, three dummy variables – *Dummy_August*, *Dummy_November*, and *Dummy_December* – were introduced. Thus a time-component is taken into account. The ANOVA statistic is significant (F = 8.681) at an alpha-level of 1%. Performing the regression leads to the following results (Table 3): The values for each dummy variable are -0.015% (t = -3.457), 0.011% (t = 2.66), and 0.009% (t = 2.132) respectively. The coefficients for the dummy variables in August and November are significant at a 99% confidence interval, while the dummy variable for December is significant at the 95% confidence interval. The adjusted R^2-statistic reports a similarly small value of 1.7%. So one can conclude that abnormal return in August is -0.15% smaller than in the other months, while the abnormal return in November and December is higher with values of 0.011% and 0.009% respectively. Since these

differences are deemed to be very small the time-component can be neglected. Hence, the results derived in the multiple regression seem to be robust. However, the robustness is further investigated.

The second robustness test is performed by using the bootstrap function of 'Smart PLS'. The bootstrap function is based on the central limit theorem which states that regardless of the distribution of the initial set of data, a sufficiently large sample of independent variables will be distributed normally. That implies that as long as many different samples of a sufficient population size are drawn from the original underlying sample, the mean of the distribution of the new samples will be normal assuming random sample selection. The bootstrap function of Smart PLS draws 1000 subsamples of the original sample using random selection.

The results are more or less identical with the SPSS multiple regression output. For short interest ratio, Smart PLS reports a standardized coefficient value of 0.087 and for market capitalization a value of 0.071. The standardized instead of the unstandardized coefficients are reported due to the different technique applied. The t-test statistics are both significant at the 95% confidence interval for short interest ratio (t = 4.266) and market capitalization.

The R^2 statistic is the same with 0.9% of the variance in the dependent variable abnormal return accounted for by the two independent variables compared to the SPSS analysis.

Thus, one can say that the results provided by SPSS are supported by the Smart PLS results who were calculated using different underlying assumptions and analysis methodologies.

A third test for robustness using a differently defined short interest variable is executed subsequently. In Section 3.1. it was described that different academic studies have defined short interest by using the total number of shares outstanding as a divisor. Since this paper so far has used average trading volume instead of shares outstanding, the multiple regression analysis is duplicated with the differently defined short interest variable. The initial multiple regression model is therefore changed to the new model which is referred to as alternative multiple regression. Similarly to the initial model, the short interest variable (outstanding) is transformed by using the natural logarithm. Following that, all assumptions for multiple regression are met which led to the following regression outcome (see Table 3):

While the model summary still shows a small value for R^2 (0.9%) which is consistent with the original multiple regression, the coefficient values have slightly changed. *Ln_SIR_outst* which is the new variable is positively related to abnormal return with a coefficient value of 0.005 at a significance level of 95% (t = 4.114). If the result is corrected for the natural logarithm, it shows a value of 0.55% or 55 basis points indicating again a significant effect on abnormal return. The effect of market capitalization on abnormal return has slightly increased with a coefficient value of 0.006 or 56 basis points in the new model at a 95% confidence interval (t = 3.970). The ANOVA test also showed a model fit at the 95% confidence interval (F = 11.834).

All of the above described tests for robustness support the initially found results indicating high validity and reliability. The results lead to the conclusion that the expected relationship (H_1) for short interest ratios and abnormal return could not have been substantiated by the multiple regression analyses. Instead, it has been proven that in the period from January 2012 through December 2014, short interest ratios are significantly positively related to abnormal returns of the underlying security on a monthly basis. Thereby, it seems to be irrelevant whether the short interest ratio is defined in terms of shares sold short by average trading volume or by the total number of shares outstanding. For market capitalization, the regression outcomes point out that the expected relationship found evidence in the empirical analyses. Market capitalization is thus according to the results positively related to abnormal return, meaning that the larger a firm is in terms of its market value of equity, the higher its abnormal returns are. However, it has to be mentioned that even though the reported outcomes are statistically significant mainly due to the large sample size of 2,748 observations, the R^2 statistic of less than 1% for most tests indicates almost no practical relevance.

6. DISCUSSION

6.1 Implications and Limitations of Study

As already stated, the R^2 statistics for all analyses are very low. Even though this is consistent with Woolridge and Dickinson (1994) for the simple regression model one cannot neglect the implications. The statistical significance of all variables can be logically explained by the large sample size of N = 2,748 observations which makes the probability that the results occurred randomly by nature very small. So every set of data of this size is likely to have a significant p-value. However, as in this paper, the results have to be interpreted combined with the R^2 statistic because it states how much of the variance in the dependent variable is caused by a change in the independent variable(s). Since for this paper, R^2 statistics are always very small and often below 1%, one has to conclude that even though a statistically significant relationship has been found, the practical relevance and significance is negligible.

Furthermore, reasons for deviating results from recent studies which reported mainly negative relationships between short interest and abnormal return may be manifold. First of all, recent literature focused mainly on the American market, especially the NASDAQ composite which is composed of many very small and less frequently traded stocks of which only 100 of the mostly traded and largest firms by market capitalization are composed in the NASDAQ-100 index which this paper is based upon. Secondly, no published academic study has used comprehensive data following the financial crisis in 2008/2009. This is deemed important since the regulative authorities, especially the SEC in the United States, have implemented many regulations and restrictions on short selling following the market downturn which may have changed the effect on returns of the underlying securities and has therefore not been incorporated in academic studies. A third limitation may be that this paper used monthly short interest data which is revealed twice a month – mid-month and at the end of each month. However, since the average day-to-cover ratio of short sales is between three to five days (Boehmer & Wu, 2012) but the short interest data lags at least 15 days, it may come to diverging results. Daily data for example were used by Angel et al. (2003) who investigated the NASDAQ index, but also by Au et al. (2008).

6.2 Directions for further Research

Future research therefore has to take the above mentioned arguments and limitations into account in order to determine the relationship between short interest and abnormal return. A good starting point might also be to use data samples which cover both periods before the financial crisis and after the financial crisis. This comparison might give interesting insights how financial regulations have altered short selling practices and concomitantly the relationship with abnormal return. The research could also be transferred to other stock indices with high liquidity and large firms incorporated in order to test the found relationship.

Thereby, it might also be important to understand how short interest is influenced. As already stated in this paper, firm size is correlated to abnormal return but also short interest. Especially the latter correlation so far has not been investigated by any academic study even though it might be very interesting to further research upon.

The results of the multiple regression analyses in both SPSS and Smart PLS have shown a correlation between short interest ratio and market capitalization with a coefficient value of 0,197. While there is no academic paper which has investigated the bivariate relationship between those two variables, this paper only gives a limited insight for future research to pick up and extend upon.

The negative correlation between *ln_market_cap* and *ln_SIR* with a Pearson statistic of -0.253 (Table 2) would thus lead to the conclusion that the bigger the firm in terms of market value of equity is, the smaller is the short interest ratio for the same security. One could explain this relationship with the in 2002 by Platt introduced "Fuller Theory of Short Selling". Platt argued that short selling is caused by psychological factors prevalent in investor's minds. He argued that investors may sell a share short either due to greed or fear. Fear thereby describes the psychological state of investors of financially distressed firms who are likely to go bankrupt. This can also be derived from Desai et al. (2002) who reported that heavily shorted firms have a significantly higher probability of being delisted or declaring bankruptcy 36 months following the beginning of high short interest. Hence, one can argue that firms with a high market capitalization are much less likely to declare bankruptcy or experiencing financial distress than less capitalized firms which would lead to lower short interest ratios and a negative relationship between those two variables.

While this is only speculation, future studies should put this bivariate relationship at the core of their research in order to substantiate possible explanations.

Another possible direction for future research is to investigate whether the spikes in short interest levels in August (see Figure 2) are generalizable for other time periods and what events may cause these deviations.

7. CONCLUSION

This paper has investigated the effect of short interest on the subsequent stock price performance on a month-to-month basis. The initial research question of how short interest ratios affect the subsequent performance of stocks of companies incorporated in the NASDAQ-100 index on a 36-month period between January 2012 and December 2014 by using monthly short interest data has been tested by simple and multiple regression analyses. Firm size proxied by the market value of equity has been included as a control variable. The NASDAQ index which was used in prior studies suffers from the shortcoming that many very small firms are incorporated which are not frequently traded. Thus, this paper is the first to use the NASDAQ-100 index as the benchmark.

Since previous research had not been able to reach consensus by reporting contrasting relationships over the last five decades, three schools of thoughts have emerged which are supplemented by a fourth less mainstream way of thinking. This paper therefore has contributed to the ongoing discussion whether short interest serves as an indicator for stock performance.

In Section 3 the expected relationship has been developed which led to the establishment of the main hypothesis that short interest negatively affects abnormal returns on a monthly basis. The simple regression analysis following Mayor (1968) and Woolridge and Dickinson (1994) using a transformed short interest variable has shown that the expected relationship could not be substantiated. Instead, the results showed the opposite. The positive relationship between the short interest ratio and abnormal return has a coefficient value of 0.60% or 60 basis points. That implies that each increase in the short interest ratio by 1% is followed by an increase in the abnormal return of 60 basis points indicating a strong effect. One can thus conclude that short interest serves as a positively related antecedent of abnormal return. This finding is consistent with the 'contrarian view'.

In a second regression analysis, firm size measured in terms of market capitalization had been introduced as a control variable. The expected relationship for firm size following Ackert and Athanassakos (2005) is positive with abnormal return. The results support the expectation by reporting a significantly positive relationship of 0.49% per 1% increase in market capitalization. The initial relationship between the short interest ratio and abnormal return states similar results compared to the simple regression model by having a significantly positive effect of 0.76% respectively 76 basis points. Thus, by introducing firm size as a control variable and holding it constant the effect of short interest has increased by 16 basis points.

The results were further tested for robustness by introducing dummy variables for the three months August, November and December in which short interest levels spiked. Though, the introduction of the dummy variables has not led to new results. On top of that, 'Smart PLS' instead of 'SPSS' as the statistics software was used. Furthermore, the independent variable short interest ratio had been defined differently following a second stream of literature by putting the level of short interest in relation to the total number of shares outstanding instead of average trading volume. Nonetheless, the aforementioned results were supported by all robustness tests leading to no further insights. Hence, one can conclude that regarding the definition of the short interest ratio, it is almost irrelevant whether average trading volume or total number of shares outstanding is used as a divisor since the relationship is in both scenarios positive. However, using average trading volume, the relationship is stronger with a coefficient value of 0.76% instead of 0.55%.

By comparing the results reported in Section 5, it is once again interesting to note that even though all relationships found are statistically significant, the results suffer from very small R^2 statistics indicating low practical relevance. The statistical significance, which is caused to a large extend by the big sample size, has therefore be interpreted together with the R^2 statistic.

In Section 6, implications as well as limitations of this study have been discussed. Future research has to take the aforementioned limitations into account in order to finally reach consensus on the effect of short selling on abnormal return.

8. ACKNOWLEDGMENTS

Many thanks go to the Finance & Accounting supervisor team and especially to Dr. Ms. X. Huang who has always been available for inquiries and feedback on any issues over the entire process period.

9. REFERENCES

Ackert, L. F., & Athanassakos, G. (2005). The relationship between short interest and stock returns in the Canadian market. *Journal of Banking & Finance*, *29*(7), 1729-1749.

Aitken, M. J., Frino, A., McCorry, M. S., & Swan, P. L. (1998). Short sales are almost instantaneously bad news: evidence from the Australian stock exchange. *The Journal of Finance*, *53*(6), 2205-2223.

Aksu, C., & Gunay, E. (1995). An empirical analysis of the causal relationship between short interest and stock prices. *Journal of Business Finance & Accounting*, *22*(5), 733-749.

Angel, J. J., Christophe, S. E., & Ferri, M. G. (2003). A close look at short selling on Nasdaq. *Financial Analysts Journal*, *59*(6), 66-74.

Asquith, P., & Meulbroek, L. K. (1996). *An empirical investigation of short interest*. Division of Research, Harvard Business School.

Asquith, P., Pathak, P. A., & Ritter, J. R. (2005). Short interest, institutional ownership, and stock returns. *Journal of Financial Economics*, *78*(2), 243-276.

Au, A. S., Doukas, J. A., & Onayev, Z. (2008). Daily short interest, idiosyncratic risk, and stock returns. *Journal of Financial Markets*, *12*(2), 290-316.

Boehme, R., Danielsen, B., Sorescu, S. 2004. Short sale constraints, differences of opinion, and overvaluation. *Journal of Financial and Quantitative Analysis*, forthcoming.

Boehmer, E., Huszar, Z. R., & Jordan, B. D. (2010). The good news in short interest. *Journal of Financial Economics*, *96*(1), 80-97.

Boehmer, E., Jones, C. M., & Zhang, X. (2008). Which shorts are informed?. *The Journal of Finance*, *63*(2), 491-527.

Boehmer, E., & Wu, J. J. (2012). Short selling and the price discovery process. *Review of Financial Studies*, *26*(2), 287-322.

Brent, A., Morse, D., & Stice, E. K. (1990). Short interest: explanations and tests. *Journal of Financial and Quantitative Analysis*, *25*(02), 273-289.

Choie, K. S., & Hwang, S. (1994). Profitability of short-selling and exploitability of short information. *The Journal of Portfolio Management*, *20*(2), 33-38.

D'Avolio, G. (2002). The market for borrowing stocks. *Journal of financial economics*, *66*(2), 271-306.

Dechow, P. M., Hutton, A. P., Meulbroek, L., & Sloan, R. G. (2001). Short-sellers, fundamental analysis, and stock returns. *Journal of Financial Economics*, *61*(1), 77-106.

Desai, H., Ramesh, K., Thiagarajan, S. R., & Balachandran, B. V. (2002). An investigation of the informational role of short interest in the Nasdaq market. *The Journal of Finance*, *57*(5), 2263-2287.

Diamond, D. W., & Verrecchia, R. E. (1987). Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics*, *18*(2), 277-311.

Diether, K. B., Lee, K. H., & Werner, I. M. (2009). Short-sale strategies and return predictability. *Review of Financial Studies*, *22*(2), 575-607.

Dyl, E. A. (1978). Short selling and the capital gains tax. *Financial Analysts Journal*, *34*(2), 61-64.

Epstein, G. (1995). Short can be sweet. *Barron's National Business and Financial Weekly*.

Field, A. (2009). *Discovering statistics using SPSS*. Sage publications.

Figlewski, S. (1981). The informational effects of restrictions on short sales: some empirical evidence. *Journal of Financial and Quantitative Analysis*, *16*(4), 463-476.

Figlewski, S., & Webb, G. P. (1993). Options, short sales, and market completeness. *The Journal of Finance*, *48*(2), 761-777.

Hanna, M. (1976). A stock price predictive model based on changes in ratios of short interest to trading volume. *Journal of Financial and Quantitative Analysis*, *11*(5), 857-872.

Henry, T. R., & Koski, J. L. (2010). Short selling around seasoned equity offerings. *Review of Financial Studies*, *23*(12), 4389-4418.

Hurtado-Sanchez, L. (1978). Short interest: its influence as a stabilizer of stock returns. *Journal of Financial and quantitative analysis*, *13*(5), 965-985.

Kedrosky, P. (2003). Selling short-selling short. *National Post (Financial Post section, March 25), FP15*.

Kerrigan, T. J. (1974). The short interest ratio and its component parts. *Financial Analysts Journal*, *30*(6), 45-49.

Mayor, T. H. (1968). Short trading activities and the price of equities: some simulation and regression results. *Journal of Financial and Quantitative Analysis*, *3*(3), 283-298.

Platt, H. D. (2002). A fuller theory of short selling. *Journal of Asset Management*, *5*(1), 1-34.

Seneca, J. J. (1967). Short Interest: bearish or bullish?. *The Journal of Finance*, *22*(1), 67-70.

Shkilko, A., Van Ness, B., & Van Ness, R. (2012). Short selling and intraday price pressures. *Financial Management*, *41*(2), 345-370.

Smaby, T. R., Albert, R. L., & Robison, H. D. (1997). Short selling and trading abuses on Nasdaq. *Financial Services Review*, *6*(1), 27-39.

Smith, R. D. (1968). Short interest and stock market prices. *Financial Analysts Journal (November -December)*, 151 – 154.

Woolridge, J. R., & Dickinson, A. (1994). Short selling and common stock prices. *Financial Analysts Journal*, *50*(1), 20-28.

10. APPENDICES

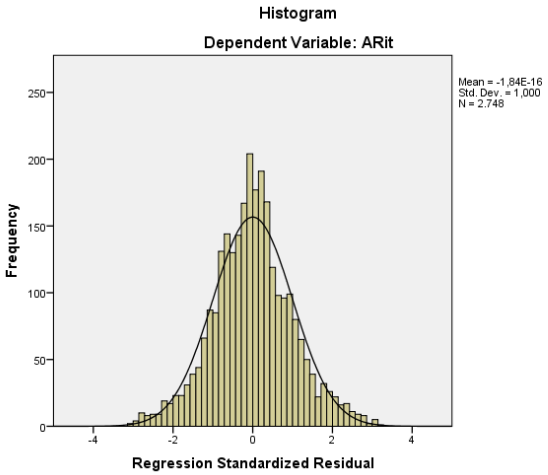

Figure 3. Original values residuals histogram

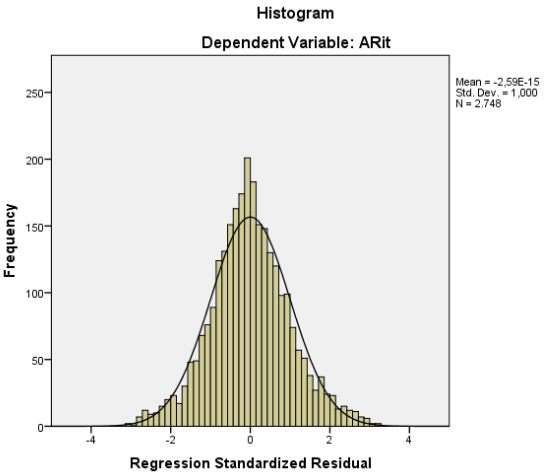

Figure 6. Transformed values residuals histogram

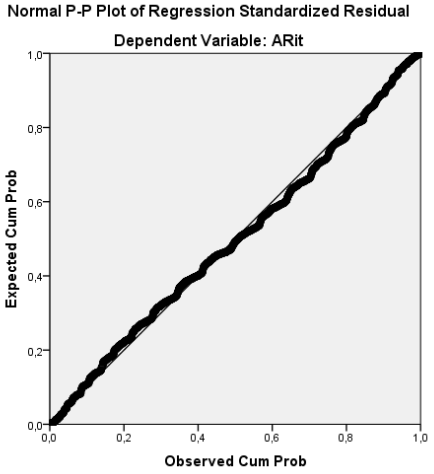

Figure 4. Original values residuals P-P-Plot

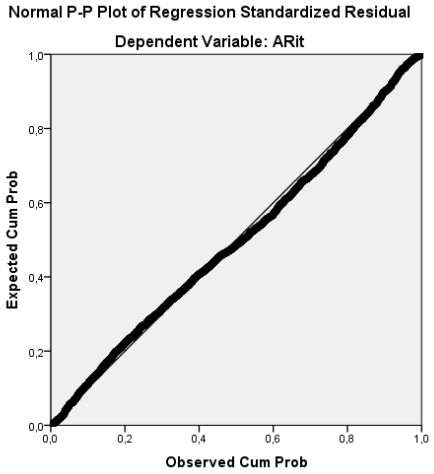

Figure 7. Transformed values residuals P-P-Plot

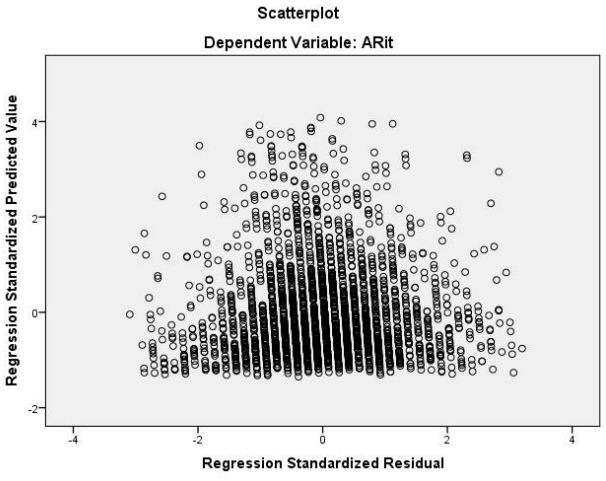

Figure 5. Original values residuals scatterplot

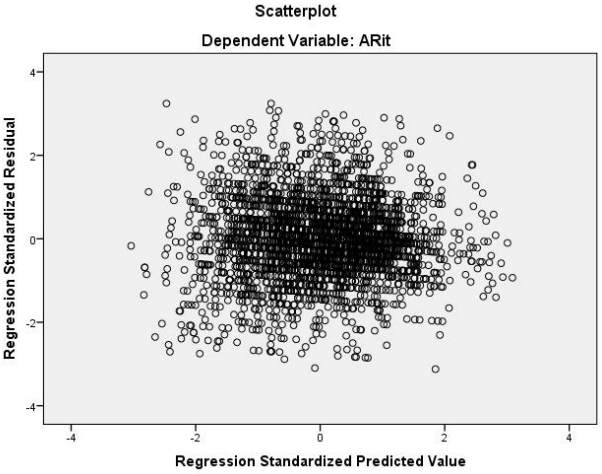

Figure 8. Transformed values residuals scatterplot