ERASMUS UNIVERSITY ROTTERDAM
ERASMUS SCHOOL OF ECONOMICS

Bachelor Thesis Economics & Business

An empirical analysis on the relationship between returns, short interest and the interest rate

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Finish Date:	09-08-2023

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Abstract

In this study I look at the effect of short interest on the aggregate market returns and how is this effect being moderated by the interest rate. This is study is being performed by looking at all American stock listed companies over a period of 1992 to 2022 this data was acquired from the wharton research center. The short interest proves to have a negative effect on the aggregate market returns which is in line with other research papers while the moderated short interest shows a positive effect on market returns which increases with the interest rate. Short interest in combination with interest rates can give provide a better understanding of stock market returns.

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1 Introduction

Short interest is the amount of shares of a stock that have been sold short and not yet covered or repurchased by the short sellers. It is a measure of market sentiment and the degree to which investors expect a decline in the price of that specific stock. When a stock is shorted, this share is borrowed from a third party and sold on the market hoping to profit from a decline in the stock price. The profit or loss will be realised when the share is repurchased from the market. The risks of short selling center around one key point. The potential profit and loss are exactly opposite to a long position. The potential loss is unlimited since the price of a share can rise infinitely, while the potential profit is limited to the current price since the price can not go below zero. Another potential risk for short sellers is a short squeeze, this occurs when the demand for the share increases sharply as this leads to a higher price and a lower availability of shares. The most notable example of this particular risk was the GameStop debacle in 2021. During 2020 and the start of 2021 the short interest in GameStop increased to a point that it exceeded 100% of the outstanding shares. This was noted by daily traders. One group in particular discussing the short squeeze was r/WallStreetBets, a page on the popular internet forum Reddit. These traders started buying and holding as many shares of GameStop as they could. This lead to a short squeeze, forcing short sellers to cover their short positions by buying back the shares and guard themselves from higher potential losses, driving up the price in the process. On the other hand, successful short sellers can profit greatly from overvalued businesses. If the short seller has good timing and a correct analysis significant profits can be realised by capitalizing on a decline in stock price. short selling, has long been an integral practice in financial markets, gathering both advocates and critics. Some researchers argue that short interest serves as an important source of liquidity and price discovery, helping to correct overvalued stocks and contributing to market efficiency. In contrast, others contend that short selling can exacerbate downward price movements, leading to increased volatility and potential market manipulation.

This relation between the short interest and aggregate stock returns is discussed by Rapach et al. "short interest index is arguably the strongest known predictor of the equity risk premium" (Rapach et al., 2016, p.64). Angel et al. (2003) also found a significant negative return on stocks days after a day of significantly high short selling. The unit of analysis in this context is excess return or the risk premium of the aggregate stock return, this percentage represents a selected group of stocks. It is measured using a market index, since this is one instrument tracks the price movements of a selected group of stocks. In the paper by Rapach et al. (2016) the S&P 500 is used. The short interest, is related to the the aggregate stock return, through market dynamics. Short interest can have an impact on the aggregate stock return due to the actions and behavior of short sellers. When short interest is high, it indicates a larger number of investors expecting a decline in stock prices. If these expectations are correct, it can lead to selling pressure in the market, which can then result in a

downward price movements and have a negative impact on the aggregate stock return. Similarly, if short sellers' expectations are proven wrong, it can create a buying pressure that might contribute to positive movements in the stock market. Therefore, the level of short interest can serve as a potential predictor for the aggregate stock return by reflecting market sentiment and influencing the supply and demand dynamics in the stock market.

Similar to the study of Rapach et al. (2016) I aim to prove the short interest is a effective predictor of stock performance. This study aims to confirm that the relationship between short interest and stock performance is moderated by the the real interest rate. Low real interest rates can force investors who are on a search for yield to more risky stocks and portfolios. The relation between interest rate and overconfidence has also been researched by Coşkun et al. (2023) who studied the motivation behind overconfidence in two subperiods of positive and negative interest rates. One of the options for a more risky portfolio are short positions (Risk, Return and the Search for Yield – IMF F&D, 2021). On the other hand, lending money becomes cheaper in periods of lower real interest. There could be less incentive to use short positions in a long short portfolio and just replace a part of the short positions with a low interest loan. The relation of real interest rate and stock performance has also been discussed in papers before, such is also the case in Huang et al. (2016) who find a significant negative relation between real interest rates and the stock market.

In this research we will use single predictive regression analysis where short interest is the only predictor and multiple predictive regression analysis where both short interest and the real interest rates will be the predictor. The program used to perform this regression will be Python3. Predictive regression analysis is a statistical technique employed in finance and economics to examine the relationship between a predictor variable and an outcome variable. In addition to predictive regression analysis, this research will also employ detrending. Detrending can help eliminate the influence of long-term market trends or macroeconomic factors on the relationship between short interest and the aggregate stock return. By detrending the data, the research can isolate the short-term fluctuations in short interest and examine their impact on the stock market performance. The research will also utilize Ordinary Least Squares (OLS) regression analysis as a statistical technique to investigate the effect of predictors on the expected outcome. The short interest is proxied by taking the average weighted short interest of many stocks. The short interest is normalized the total outstanding shares for that given stock. The aggregate market return is represented by the excess return of the S&P 500. The real interest rate will be obtained from the federal reserve. The data used for this research will focus on the period of 2015 to 2022. But a larger data set will be used to confirm the results from the inspirational article. This will be a data set from 1974 to 2014. The type of data used in this research is secondary as it will be acquired from federal reserve bank st.Louis, yahoo finance and the Wharton Research Data Service.

I expect to find a negative relation between the short interest and the aggregate stock returns. This effect might be moderated by the low interest rate. Moderator is also expected to have a negative impact on the aggregate stock returns. This should be visible from the correlation between the excess market returns and the lagged weighted short interest. By exploring this relationship in periods of low interest rates, I hope to increase the readers awareness of the mechanics at work on the stock market. However, I do not expect that this research will give the final answer on how to predict the stock market. More and new variables with a strong predictive power might be added to create a better understanding of the dynamics at work on the stock market.

The remainder of this paper is structured as follows. Section 2 discusses the relevant literature and empirical studies on the subject. Followed by section 3 in which we discuss the data and methodology used to perform the research.

2 Theoretical Framework

2.1 Short interest

Short interest in its essence represents the sentiment of a stock. Investors create or buy short positions when they expect a drop in price. As such short interest is seen as an indicator of current market sentiment. " An increase in short interest often signals that investors have become more bearish, while a decrease in short interest signals that they have become more bullish" (Mitchell Updated July 14, 2022, p.1).

One of the first if not the first economic paper to discuss short interest was Emery (1899). The topic of this paper was futures in the grain market which coincidentally is also the reason for writing this paper. It is an empirical study which discussed an event where two parties clashed with one party having a short interest while the other was at the bottom of the full movement. The price went up quite a bit but, the short interest party did not incur devastating losses as they could charge for storing the gain. This Before unseen situation was enabled by new factors. Rise of grain elevators, this allowed grain to be stored in larger quantities and for longer periods of time. Allowing traders and farmers to wait for a better price or stock up in periods of low prices Lee (1937). Another factor in this situation was the expansion of the railroad system. This expanded railroad system allowed for transport over larger distances. Relating to Emery (1899) this allowed farmers in more remote regions to sell their grain in larger cities or ports. Around the time Emery (1899) was written the government also started to get involved with new legislation's such as the Interstate Commerce Act of 1887 which aimed to regulate railroad fares to prevent discriminatory practices (Interstate Commerce Act (1887), 2022). and the Sherman Anti-Trust Act of 1890 which intended to promote fair competition and prevent monopolies (Sherman Anti-Trust Act (1890), 2022). These legislation's

being enacted so quickly after one another leads me to believe Emery's grain market was quite a hot topic at the time to which he provided valuable insights.

After Emery 1899 many papers followed promoting or condemning short interest or short selling. One of which is Arnold et al. (2005) which took a look at the effect of the taxpayer relief act of 1997 this law prevented investors from short selling against the box. Short selling against the box according to the Nasdaq (Selling short against the box Definition, z.d.) is selling a stock which is actually owned by the seller but held in safekeeping. The seller covers by for the share with securities or simply does not want to disclose its ownership of the stock. This method was used to defer capital gains taxes but, became obsolete under the Taxpayer Relief Act of 1997. As it was just a method to defer capital gains we can assume that at least some of the traders that went short before 1997 were not informed investors. This is confirmed by the by Arnold et al. While looking at a large sample of short interest announcements before and after the taxpayer relief act of 1997 was enacted they found short interest to have a higher level of information and predictive power. This was the effect from the reduction in noise that was caused by the uninformed investors before the law became effective. After the paper by Arnold et al. Akbas et al. (2013) findings supported the idea that short interest includes relevant information. In their paper Akbas et al. looked at all common stocks listed on the NYSE, Amex and NASDAQ during a twenty-two year period. They argued that short sellers are informed traders who generate relevant information with their short positions. As the informed traders can correctly predict negative earning surprises and bad news months ahead of the actual event. This expectation of negative earnings and bad news is indicated by the level of short interest. A higher level of short interest directly relates to the informed investors having a higher expectation of negative earnings surprises and bad news. Akbas et al. argued that their ability to predict such future events is the dominant factor to predicting the future returns.

Short interest also has a causal relation with the volatility of stock prices according to Baklaci et al. (2016). Baklachi et al. using a sample of individual stocks as well as approximate the market indicated by S&P 500 found that this relation holds both for individual stocks as well as for the entire market. Not only did they find evidence for effect of short interest on volatility, but also for a bilateral causality. From their conclusion we can infer that short interest can trigger volatility but also that a highly volatile market can intensify short trading and increase the short interest. This matches common economic beliefs. Volatility represents the risk of a stock, as a higher volatility means relatively larger price swings. If the volatility of a stock were to increase leading to more uncertainty informed investors would be more inclined to open or increase their short position as a higher uncertainty must be priced.

Short interest is generally accepted as an indicator for market sentiment. As Arnold et al. (2005, p.1308) who use the short interest as an albeit noisy sig-

nal of bearish market sentiment, illustrate. Short interest can be measured as a property of stock as firms are obligated to publish these number bimonthly (Short Interest Reporting — FINRA.org, z.d.). As short interest is accepted as a indicator of market sentiment and a property of a stock it makes it readily available. And as there is legislation on publishing this data it should have a standardized format. The unit of analysis used for the short interest will be an aggregation of the short interest of different stocks. These short interests are represented by the total short interest in shares represented by an absolute number, the total short interest as a percentage of the total shares and lastly the total short interest as a percentage of the total shares outstanding. These numbers are relatively easy to obtain as this data that is already reported by companies (Short Interest Reporting — FINRA.org, z.d.) and as investors take interest in this companies like Morningstar keep track of these statistics.

2.2 Empirical studies on short interest

In this section I will discuss empirical studies on short interest. In these studies the relation of short interest on market returns will be discussed. I focus on the Aggregate stock returns as the outcome. Aggregate stock returns refers to the performance of a collection of stocks. It represents the cumulative return of all the individual stocks that are included in the collection multiplied by their weighting. Aggregate stock return is a measure of the collective performance. As the aggregate stock returns I will be using the S&P 500 as this index covers the performance of a wide range of stocks and is commonly used as a benchmark for stock returns. This measure helps investors, analysts and Researches estimate the overall performance and volatility of a large set representing the stock market.

Seneca (1967) was one of the earliest papers on short interest that used a quantitative method to address this issue. Seneca (1967) was written because of problems raised in the Econometrics Seminar at the University of Pennsylvania and poses the question whether large short positions have a bullish or bearish effect. They argue that the essence of a short position reflects a pessimistic judgement, while the counter argument states that an increase in short interest can lead to an increase in potential demand as the short positions need to be closed. The paper tested these hypothesis using regression analysis to isolate the effect of short interest. While looking at the relation between short interest and stock returns Seneca (1967) found that while short positions can create demand and thus influence prices in a positive manner, this completely over looks the very nature of short interest. Short interest in nature is an expectation for the price to fall as this is the origin of its profitability. In this paper Seneca found short interest not to be an variable that affects stock price, but rather a predictor for the related stock price.

2.2.1 Predicting the stock market

Predicting the stock market has been the objective of many papers one of the earliest papers on this subject was Cowles (1933). Cowles Tried to find evidence whether market forecasters could actually outperform the market. The paper used regression analysis to review data of financial services, insurance companies and financial publications. If the forecasters could manage to outperform the average common stocks this could be seen as skill of the forecaster. In this paper however none of the data sets exhibited significant skill on the forecasters and as they all lost to the average common stock. If this study were to be replicated 90 years later a different result could be found. As discussed before by Arnold et al. (2005) legislation's such as the taxpayer relief act of 1997 had a significant effect on the information contained in short interest. Similarly Fama, a fairly familiar name discussed the predictability of stock prices in one of his works Fama (1965). In this paper the predictability of stock prices based on their history is researched. The article looked at two theories, one for and one against prices being able to predict their own future. Chartist theory where the prices contain information about the future behaviour. On the other hand was the theory of random walks that could prove otherwise. Random walks argue that the next price of a stock or security is as random as a random series of numbers. Based on daily prices of each of the 30 stocks of the Dow-Jones Industrial Average between 1956 to 1962. Fama concluded that past prices could not be used to increase expected profits, however he also stated that the information contained in past prices could be useful depending on the question asked. While just price is not enough to predict the future development Fama did find it to contain information. More recent Zhang (2006) looked at information uncertainty and its effects on stock returns. Information uncertainty is an aspect every trader, both private and institutional, have to deal with. In this paper evidence is found that initial price adjustments as response to news is often incomplete. This effect is even stronger for cases with higher levels of uncertainty. Where a good news event leads to a positive price adjustment in the short term it will still increase more since the information has not been fully incorporated.

2.2.2 Short interest on market returns

Diamond and Verrecchia (1987) study the effect of short interest on the adjustment of security prices. They conclude that short interest should have a negative effect on stock returns. As short selling is costly for traders as such short sales will occur less frequent as a method to obtain liquidity. Instead it is more likely that the traders involved in short selling are informed traders. If these informed traders are willing to short these stocks, this implies the trader has obtained unfavorable information. Coming back to the conclusion that short interest has a negative effect on the stock returns. This however is not proven using an data set. Instead they use mathematical equation supporting their claims. An

opposite view is discussed by Granville. Granville (1963) Elaborates on a then popular view. As short sales need to be closed at a given point in the future it should create extra future demand. As such short positions should have a positive or bullish effect on the underlying asset. Seneca tested this reasoning four years later in his 1967 paper.

Aitken et al. (1998) looks at the relationship of short interest on stock return, this is similar to my research but it looks at a different scale namely individual stocks and on a intradaily basis. They found a significant and negative relationship between short sales and following stock price. They also assume informed investors to be the driving force behind the short interest. As such their short sales give a negative incentive to other traders lowering the price of the stock in question. This is in line with Seneca 1967. Elaborating further on how informed traders decide to short a stock is Dechow et al. (2001). Besides traders being informed Dechow et al. (2001) also looks at the the positioning of short sellers. short sellers tend to identify stocks with low fundamental to price ratios. Using these ratios overpriced or under performing firms can be identified before this information is fully Incorporated in the price. combining this with additional information that these short sellers posses they predict future stock returns. Dechow et al. provide evidence that the short sellers in their sample, which includes stocks from NYSE and Amex firms during 1976 to 1993, actively exploit the ratios to successfully predict the future return.

Rapach et al. (2016) show the effect of short interest on aggregate stock return. As the unit of analysis aggregate stock returns were used. The S&P 500 is an indicator for this aggregate stock return as it contains a large amount of common stock from a plethora of companies. For the predictor an short interest index was created and used. In this paper the authors show short interest to be the strongest known predictor of aggregate stock returns. The authors argue that the information contained in the short interest has the ability to predict the future cash flow news. With this ability they argue that the future returns can be predicted.

2.2.3 Hypothesis

Hypothesis 1: Aggregate short interest has a negative effect on aggregate market returns.

2.3 The moderating role of the interest rate

2.3.1 Interest rate

In the most simplified manner interest rate is the cost of capital. When one borrows capital there is a cost attached to it. This rate that has to be paid is the interest rate. Interest rate is not the inflation. Inflation represents the rate at which the prices of overall good changes. The real interest rate is the interest rate that accounts for inflation. according to Knight (1934) interest rate can be interpreted as a perpetual income expressed as a fraction of the capital, as a demand price for capital, or of capital as the demand price for perpetual income. One of the earlier papers on interest rates namely Lutz (1940) explores the relation between short-term interest rates and long-term interest rates. Important to note is effect of short-term interest on long interest. The short-term interest should create an expectation of the long-term interest, however this only holds true if the public trusts the short term interest to be stable. As we have seen in the past this is not always the case. Also important to note is that investors use the interest rate to assess capital efficiency. The investment should return at least as much as the interest rate.

The interest rate will be used as a moderator on the relation of short interest on aggregate market returns. Addo & Sunzuoye (2013) set out to explore the relationship between interest rates and stock returns. They looked at the effect of interest rates and treasury bills on stock returns. They found interest rates to have a negative effect on stock market returns, however this effect was weak and not significant. While this paper did not find a significant effect of interest rates on returns it did prove a positive relationship between the predictive variables and their joined effect on stock market returns.

Jammazi et al. (2017) set out to test whether Granger causality hold for the relation of short interest on market returns. However they show that the granger causality does not only hold for interest rate on stock returns but also the other way around. For most periods in the data set used by Jammazi et al. there was a significant bidirectional causal relation. This would imply that both variables can be used to predict one another.

One of the early studies that looks into the relation of interest rates on returns is Sweeney & Warga (1986). Sweeney and warga used the relation between government bond yields on market returns and electric utilities. They found the government bonds to have an effect on the stock returns represented by the aggregation of the New York Stock Exchange. This relationship holds even stronger for electric utilities. These articles all look into the relation of our moderator interest rates and our outcome market returns.

The relationship between interest rates and short interest is less often explored in financial papers. Buch et al. (2014) uses a survey on risk taking at banks during and after periods of monetary expansion and contraction. It shows that

institutions exhibit more risk seeking behaviour. This is caused by the search for yield. As interest rates are very low institutions are more inclined to look at riskier investment opportunities to replace lost gains. This is combined with lower risks as the cost of money very low in these periods. It can also be noted that in periods of higher interest rates these institutions become more risk averse as risks are more costly an safer investment opportunities also provide better returns.

Martinez-Miera and Repullo (2017) explores the search for yield while looking at the relation between interest rates, credit spreads and structure and risk the banking system. They reason that an increase in savings leads to reduction in interest rates and spreads, this in turn induces more risk taking behaviour. While these papers look at a different unit of measure I assume that investors and informed investors behave in a similar manner. As bonds will have lower returns in periods of low interest rates, there investors are more inclined to turn to risky investments. These investors are on a similar search for yield. Informed investors could increase their short stakes as they become more risk seeking influencing the information contained in the short interest.

In a similar manner when investors and institutions alike are more risk seeking and change their views on shorting stocks. While the interest rate is lower leading to lower returns on bonds and cheaper credit. This could have a significant effect on the stock market. A change in the short interest could have an inverse effect on the stock market returns. While a decrease in return on bonds will force investors that are on a search for yield to the stock market representing the more risky but higher return option opposed to bonds.

2.3.2 Hypothesis

Hypothesis 2: Low interest rates increase the predictive power of short interest on aggregate market returns.

3 Data & Methodology

3.1 sample and data collection

This sample will contain the excess aggregate market returns and a short interest index. This short interest index will be constructed by taking the equally weighted the short interested of outstanding shares of multiple stocks. Sources of all the short interests used will be mentioned in the variables subsection. The all stocks in this short interest index will be listed in the appendix once the short interest index is fully constructed. The sample will contain data from April 1998 to December 2022. The date April 1998 was taken as the start date of my sample as from that the data set I used from Wharton Research Data

Service from now on WRDS has short interest data available. As this is my main predictor and yahoo finance is my source for this information. The data was collected in June of 2023. For this thesis I will use previously collected and reported data. The real interest rate will be collected from the WRDS. Short interest and market returns will be collected from both yahoo finance and WRDS. A more detailed description of the data and its origin will be available in the subsection of each variable.

3.2 Variables

3.2.1 Aggregate short interest index

Aggregate short interest index, aims to capture the full short interest of the market. It is the equally weighted short interest divided by the outstanding shares of all stocks listed on the NYSE, AMEX, and NASDAQ. To obtain this index I divided the short interest by the outstanding shares for each month all companies in the data set. This data is available in the comp_na_daily_all data set in WRDS. This data was de-trended and transformed to a natural logarithm to follow the practice of Rapach et al.(2016). First the log is taken of the equal weighted short interest index and the results are then de-trended to have a mean of zero. Lastly the data is transformed to have a standard deviation of one.

$$Short\,interest\,of\,outstanding_i = Short\,interest_i / Shares\,outstanding_i \quad (1)$$

$$Aggregate\,short\,interest\,index_i = Short\,interest\,\bar{o}f\,outstanding_i \quad (2)$$

3.2.2 Interest rate

Interest rate, the interest rate aims to capture the cost of capital. This cost can influence both the stock market returns and short choices by investors as it influences the cost of the investment opportunity. I hope for this to capture the variable to capture the effect of the cost of capital on informed investors when they go short. In this study I will be using the one-month Treasury bill rate with a monthly frequency from Ibbotson Associates. The one-month interest rate was the best option for me as I will be using a one month lag, as we want to know the predictive effect of the explanatory variables on the outcome variable not the correlation between the two.

3.2.3 Excess aggregate market returns

Excess aggregate market returns, the excess aggregate market returns I will be using should capture the movement of the entire market. It is calculated as the value-weight return on all NYSE, AMEX, and NASDAQ stocks (from CRSP) minus the **Interest rate**. This data is collected from the WRDS using the fama french 3 factor plus momentum monthly frequency query form. The tests including this variable will have an adjusted start date as this data is only

available from April 1998 onward. This data has a monthly frequency
This data was transformed to a natural logarithm to follow the practice of the inspirational article. As market returns can be negative a log is not possible without complex numbers. This issue was solved as Hudson (2015) states: " Logarithmic returns are approximately equal to simple returns. Inspection of the formula connecting logarithmic and simple returns $RLt = ln(1 + RSt)$"

$$Excess\,aggregate\,market\,return = Aggregate\,market\,return - Interest\,rate \tag{3}$$

3.3 Control Variable

3.3.1 Inflation

Inflation, it is intended to capture the increase in price of all products including the stocks included in the **Excess aggregate market returns**. I will be using the consumer price index from now on CPI to account for the inflation, the data is monthly. This data is collected from the: Consumer Price Index for All Urban Consumers: All Items in U.S. City Average (CPIAUCSL) data series on https://fred.stlouisfed.org/

3.4 Methodology

3.4.1 Analyses

In this study, I will employ Ordinary Least Squares (OLS) regression techniques to analyze our time series data. My primary objective is to examine the relationship between an **Excess aggregate market return** and the **Short interest index**, while considering the moderating effect of the **Interest rate** and controlling for **Inflation** and **Taxpayers relief act**. I employ OLS regression, assuming constant variance and uncorrelated errors, to estimate the initial parameters. through this regression I am aiming to gain a deeper understanding of the dynamics between the relationships within the data set.

3.4.2 Formula

in this subsection and hereafter the following variables will use a different notation.
Excess aggregate market returns will be referred to as EAMR.
Short interest index will be referred to as SII.
Interest rate will be referred to IR.

$$EAMR_i = \beta_0 + \beta_1 SIIt - 1 * \beta_2 IR_{t-1} + \beta_3 \textbf{ControlVariables} + \epsilon_i \tag{4}$$

3.5 Practical execution

In this study, I will use an alternative program to perform my analysis and build my data set. Building my data set was done by storing all the collected data in the Variables and Control variables sections inside a PostgreSQL database. I then used the Python 3 SQLAlchemy package to form a connection between the PostgreSQL database and my python scripts. I use these python scripts to format data and perform the regression. This was done to make it easier to query data sets on demand. To process the data and run the actual regression I will use the Python3 statsmodels package. Statsmodels will be used to perform the actual regression where the Python3 package stargazer will be used to create the tables represent the data such as estimated coefficients, standard deviation and explanatory power of the models. It is possible to work with other programs like excel, stata, spss and r to perform a similar regression analysis however I feel more comfortable using this method as the entire process of data transformation and analysis can be managed in Python.

4 Results

4.1 General Model Interpretation

The models are estimated using Ordinarily Least Squares. Both the excess market returns and the short interest index are transformed to their natural logarithms. As such the coefficient of of the short interest index can be interpreted as an elasticity. When the short interest index increases with 1 standard deviation the percentage change in excess market returns is the coefficient value of the short interest index. The interest rate and the inflation are not natural logarithms as such the coefficients have to be interpreted differently. When the risk free rate or the inflation changes by 1 the percentage change in excess market return is the coefficient value, a value of 1 would be near impossible for these factors as this would mean an interest rate or inflation of 100% for the given period. The interaction term is more difficult to interpret as it multiplies the standardized natural logarithm value of the short interest index with the not natural logarithm value of the risk free rate. As such we will be looking at the interaction term in a more general way where a larger coefficient indicate a strong stronger effect and a negative coefficient indicates a decrease in excess market returns. In the subsections below I will discuss the different models and their coefficients on a individual level.

4.2 hypothesis 1

Hypothesis: Aggregate short interest has a negative effect on aggregate market returns.

4.2.1 Frequency: Monthly

Table 1: Regression results monthly frequency

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.004	0.006*	0.010***	0.012***
	(0.003)	(0.003)	(0.004)	(0.004)
SII	-0.001	-0.001	-0.004	-0.005
	(0.003)	(0.003)	(0.005)	(0.005)
CPI		-0.923		-1.001
		(0.924)		(0.945)
IR			4.524	9.273
			(18.605)	(19.135)
Moderated_SII			2.213	3.438
			(4.851)	(4.987)
Observations	296	296	296	296
R^2	0.000	0.004	0.017	0.021
Adjusted R^2	-0.003	-0.003	0.007	0.007
Residual Std. Error	0.048 (df=294)	0.048 (df=293)	0.048 (df=292)	0.048 (df=291)
F Statistic	0.064 (df=1; 294)	0.532 (df=2; 293)	1.675 (df=3; 292)	1.537 (df=4; 291)
Note:				*p<0.1; **p<0.05; ***p<0.01

There are four models that I estimated on the monthly frequency. None of the monthly frequency models has a high R^2, where model 1 with only the SII has the lowest R^2 of 0.0% and model 4 with all independent variables has the highest R^2 of 2.1%, meaning that the best of the four models can explain 2.1% of the variance of the EAMR. There is a slight increase in significance of the models with the introduction of new independent variables. The Adjusted R^2 however shows that in the monthly frequency model the control variable CPI does not increase the explanatory power of the model.

The estimated coefficients stay similar to the models without control variables. The signs stay the same but the values do differ a bit, the main example of this is the IR in model 4 its coefficient increases a lot with the inclusion of the control variable. In line with what I expected is the negative sign of the SII across all 4 estimated models. This leads me to believe that the SII does have a negative effect on the EAMR. Besides the constant however there are no significant estimated coefficients in the model and as the explanatory power of the models at monthly frequency is also quite low it is challenging to use it as conclusive evidence to support or reject the hypothesis.

4.2.2 Frequency: Quarterly

Table 2: Regression results quarterly frequency

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.013	0.024*	0.029**	0.040***
	(0.009)	(0.013)	(0.013)	(0.015)
SII	-0.004	-0.006	-0.011	-0.019
	(0.009)	(0.010)	(0.016)	(0.016)
CPI		-1.770		-1.955
		(1.330)		(1.383)
IR			2.217	11.784
			(21.263)	(22.208)
Moderated_SII			1.566	4.033
			(5.534)	(5.775)
Observations	98	98	98	98
R^2	0.002	0.020	0.038	0.058
Adjusted R^2	-0.009	-0.001	0.007	0.018
Residual Std. Error	0.093 (df=96)	0.093 (df=95)	0.093 (df=94)	0.092 (df=93)
F Statistic	0.152 (df=1; 96)	0.962 (df=2; 95)	1.231 (df=3; 94)	1.433 (df=4; 93)
Note:				*p<0.1; **p<0.05; ***p<0.01

I estimated the same models on a quarterly frequency. The quarterly frequency models have a higher R^2 compared to the monthly frequency models. Model 1 with only the SII has the lowest R^2 of the four with 0.2% and model 4 with all independent variables again has the highest R^2 of 5.8%, meaning that the best of the four models can explain 5.8% of the variance of the EAMR. Similar to the monthly frequency the addition of extra variables increases the R^2 of the models, however different from the monthly frequency the addition of the control variable CPI does increase the Adjusted R^2 meaning the addition of the control variable on the quarterly frequency does increase the explanatory power.

The estimated coefficients change more with the inclusion of control variable than in the monthly frequency, however the sign of the coefficients stays the same. A increase in coefficients can be seen when comparing model 3 and 4. The coefficient of the main independent variable SII increases more than 70% and the moderator IR and Moderated_SII increase even more with the inclusion of the control variable. In line with what I expected and the monthly frequency model is the negative sign of the SII across all estimated models. This increases my belief that the SII has a negative effect of the EAMR. Similar tot he monthly frequency models the only significant estimated coefficient is the constant and the explanatory power of the models at the quarterly frequency albeit higher than the monthly frequency model is still only 5.8% at best. As such the quar-

terly frequency model does not provide strong evidence to support or reject the hypothesis.

4.2.3 Semi-Annual

Table 3: Regression results semi-annual frequency

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.027*	0.094***	0.064***	0.129***
	(0.016)	(0.020)	(0.021)	(0.021)
SII	-0.003	-0.019	-0.006	-0.055**
	(0.016)	(0.014)	(0.025)	(0.023)
CPI		-5.368***		-5.905***
		(1.178)		(1.171)
IR			-8.580	21.040
			(17.482)	(15.249)
Moderated_SII			-1.126	6.484
			(4.543)	(3.956)
Observations	49	49	49	49
R^2	0.001	0.311	0.127	0.447
Adjusted R^2	-0.020	0.282	0.068	0.396
Residual Std. Error	0.113 (df=47)	0.095 (df=46)	0.108 (df=45)	0.087 (df=44)
F Statistic	0.036 (df=1; 47)	10.406*** (df=2; 46)	2.175 (df=3; 45)	8.879*** (df=4; 44)
Note:				*p<0.1; **p<0.05; ***p<0.01

The same four models are also estimated on a semi-annual frequency. The semi-annual frequency models have the highest R^2 compared to the monthly and quarterly frequency models. Model 1 with only the SII has the lowest R^2 of only 0.1% which is below even the R^2 of 0.2% of the model 1 at the quarterly frequency. The other models provide a much higher R^2 with the inclusion of the control variable model 2 archives a R^2 of 31.1% compared to the R^2 of model 1 with 0.1%. Model 3 with the moderator variable and interaction term has a R^2 of 12.7%, this increases to a R^2 of 44.7% with the inclusion of the control variable in model 4. Similar to the R^2 of the models the Adjusted R^2 increases with the inclusion of the control variable and is higher for the model with the moderator variable and interaction term than the one with only the SII.

When comparing the coefficients of model 1 to model 2 the inclusion of the control variable changes the coefficient of the SII quite a bit from -0.003 to -.019. While the change is large the estimated coefficients are both negative as expected and in line with the previous models. A larger difference can be seen when looking at model 3 and 4. The coefficient for the SII goes from -0.006 to -0.055 and becomes significant at 5% confidence level. A first in model 3 are the

negative coefficients for the moderator variable and interaction term, but these coefficients return to their positive values with the inclusion of the CPI. As the negative coefficients for the moderator variable and interaction term only occur in model 3 of the semi-annual frequency, model 4 has a higher explanatory power and the moderator coefficients are more in line with previous estimated values I expect the positive nature to be correct.

4.2.4 Hypothesis Answer

I do not reject the following hypothesis: Aggregate short interest has a negative effect on aggregate market returns.

The SII has a negative coefficient across all three models. I will be looking at the 4^{th} model for the interpretation of the coefficients. The coefficient of the SII from the monthly frequency can be interpreted as follows a one standard deviation increase in the SII would lead to a 0.5% decrease in the EAMR. However as the p value is larger than 10% this can hardly be called a significant effect. The SII coefficient in the quarterly frequency model can be interpreted as a 1.9% decrease in the EAMR for a one standard deviation increase in the SII. Similar to the monthly frequency as the p value is larger than 10% this can not be interpreted as a significant effect either. Lastly in the half year frequency model a one standard deviation increase in the SII would lead to a 5.5% decrease of the EAMR. In this model the corresponding p value is smaller than 2% this effect is significant at the 5% level indicated by the **. This negative effect of the SII is comparable to previous studies that worked on the aggregate level such as Rapach et al. (2016)

4.3 Hypothesis 2

Hypothesis: Low interest rates increase the predictive power of short interest on aggregate market returns.

4.3.1 Frequency: Monthly

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.004	0.006*	0.010***	0.012***
	(0.003)	(0.003)	(0.004)	(0.004)
SII	-0.001	-0.001	-0.004	-0.005
	(0.003)	(0.003)	(0.005)	(0.005)
CPI		-0.923		-1.001
		(0.924)		(0.945)
IR			4.524	9.273
			(18.605)	(19.135)
Moderated_SII			2.213	3.438
			(4.851)	(4.987)
Observations	296	296	296	296
R^2	0.000	0.004	0.017	0.021
Adjusted R^2	-0.003	-0.003	0.007	0.007
Residual Std. Error	0.048 (df=294)	0.048 (df=293)	0.048 (df=292)	0.048 (df=291)
F Statistic	0.064 (df=1; 294)	0.532 (df=2; 293)	1.675 (df=3; 292)	1.537 (df=4; 291)
Note:				*p<0.1; **p<0.05; ***p<0.01

This is the same table as the one used in section **4.2.1** where I discussed the model in more detail. In this section I focus more on the effect of the moderator as these are required for the second hypothesis.
When comparing model 2 and 4 where the difference is the inclusion of the moderator and the interaction a relatively small but clear increase in the explanatory power of the models can be observed. By including these variables the R^2 increases from 0.4% to 2.1%. Contrary to what I expected the estimated coefficients for the moderator and interaction term are positive.

4.3.2 Frequency: Quarterly

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.013	0.024*	0.029**	0.040***
	(0.009)	(0.013)	(0.013)	(0.015)
SII	-0.004	-0.006	-0.011	-0.019
	(0.009)	(0.010)	(0.016)	(0.016)
CPI		-1.770		-1.955
		(1.330)		(1.383)
IR			2.217	11.784
			(21.263)	(22.208)
Moderated_SII			1.566	4.033
			(5.534)	(5.775)
Observations	98	98	98	98
R^2	0.002	0.020	0.038	0.058
Adjusted R^2	-0.009	-0.001	0.007	0.018
Residual Std. Error	0.093 (df=96)	0.093 (df=95)	0.093 (df=94)	0.092 (df=93)
F Statistic	0.152 (df=1; 96)	0.962 (df=2; 95)	1.231 (df=3; 94)	1.433 (df=4; 93)
Note:				*p<0.1; **p<0.05; ***p<0.01

This is the same table as the one used in section **4.2.2** where I discussed the model in more detail. In this section I focus more on the effect of the moderator as these are required for the second hypothesis. Similar to the monthly frequency model I will compare model 2 and 4 as these models show the difference of including the moderator and interaction. By including the moderator and interaction in the quarterly model the R^2 increases from 2.0% to 5.8%. Similar to the monthly frequency the estimated coefficients for the moderator and interaction term are positive.

4.3.3 Semi-Annual

This is the same table as the one used in in section **4.2.3** where I discussed the model in more detail. In this section I will focus more on the effect of the moderator as these are required for the second hypothesis. Once again I will start by looking at model 2 and 4 as these models show the difference of including the moderator and interaction. By including the moderator and interaction in the semi-annual model the R^2 increases from 31.1% to 44.7%. For the semi-annual models I will also look at model 3. This model has a lower explanatory power than model 4 because it lacks the control variable, however model 3 does have a negative coefficient for the moderator and the interaction term. While the negative coefficient is in line with what I expected I will assume them to be incorrect. As mentioned before in section **4.2.3** as the previous models all

	Dependent variable: EAMR			
	(1)	(2)	(3)	(4)
Constant	0.027*	0.094***	0.064***	0.129***
	(0.016)	(0.020)	(0.021)	(0.021)
SII	-0.003	-0.019	-0.006	-0.055**
	(0.016)	(0.014)	(0.025)	(0.023)
CPI		-5.368***		-5.905***
		(1.178)		(1.171)
IR			-8.580	21.040
			(17.482)	(15.249)
Moderated_SII			-1.126	6.484
			(4.543)	(3.956)
Observations	49	49	49	49
R^2	0.001	0.311	0.127	0.447
Adjusted R^2	-0.020	0.282	0.068	0.396
Residual Std. Error	0.113 (df=47)	0.095 (df=46)	0.108 (df=45)	0.087 (df=44)
F Statistic	0.036 (df=1; 47)	10.406*** (df=2; 46)	2.175 (df=3; 45)	8.879*** (df=4; 44)
Note:				*p<0.1; **p<0.05; ***p<0.01

estimated a positive coefficient for the moderator and interaction and model 4 has a higher explanatory power than model 3 I will assume the positive nature of the coefficients to be most likely.

4.3.4 Hypothesis Answer

Given the lack of significant results for the moderated SII I only have partial support for the following hypothesis: Low interest rates increase the predictive power of short interest on aggregate market returns.
The models including the IR and the moderated SII perform much better than their partial models. Where the half year frequency model estimates a significant coefficient for the SII the partial counter part does not come close to that significance level. As the moderated SII estimated a positive coefficient the effect of the negative SII gets reduced more during periods with a higher IR. During periods with a lower IR the effect of the negative SII gets reduced a lot less.

5 Conclusion

In this thesis I looked at the effect of short interest on the aggregate market returns and the moderating role of the interest rate. Previous research has looked at the effect of short interest on the aggregate market returns and others explored the relation on a one to one level. The moderating role of the interest rate on short interest however had not been explored yet. To gain a better insight in this moderating effect of short interest and the interest rate I aimed to answer the question: How can the moderating effect of real interest rate on the short interest help predict stock market returns.

To answer this research question and test my hypotheses, data from all American stock listed companies was used from a period of April 1882 till December 2022. Data about short positions is reported twice per month, stock data, interest rate being available on a daily interval. The data set showed a negative relation between short interest and market returns while the moderated coefficient had a positive relation with market returns. This data however was only significant at the half year frequency. The monthly and quarterly models return comparable coefficients but not a large R^2 nor did they return significant coefficients.

In this study I conclude that like recent literature shows short interest has a negative effect on stock returns. This relation did not yield a high predictive value on the monthly and quarterly frequency, leading to belief there are other factors at play that might not be included in the current model. On the half year frequency model the the short interest shows a significant predictive power. The moderator effect not providing significant results, interpreting the current coefficients makes me suggest that the lower the interest rate is the stronger the negative effect of the short interest on stocks returns.

While other literature has proven that short interest is a strong predictor on the shorter term when looking at the individual level this holds true but, at the aggregate level this is not very significant. When looking at a longer horizon short interest and the moderated short interest can help predict or provide a better insight in aggregate stock returns.

Limitations

One of the limitations of this Research is in the available data set. I used data staring April 1992 till December 2022. It would be interesting to see if the results would be similar with a data set that started before 1980 or longer before so that the effect of the Tax payers relief act could be reviewed and more periods of monetary constraints could be observed. Due to time constraints and data availability I was unable to add more control variables on the aggregate level, such as financial ratios. I think that the predictive power of the models could be improved even further. This would be more feasible on smaller data sets,

compared to all stock listed companies. I would recommend future researches to further explore the moderating effect on short interest or to look at this effect on a company to company basis.

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