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TESTING OF SHORT SALE HYPOTHESES ON THE U.S. MARKET IN THE PERIOD FROM 1990 TO 2015

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Abstract

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The purpose of this paper is to investigate the validity of short sale hypotheses the NYSE and NASDAQ in the period 1990–2015. Short has been regulated in the U.S. market since the 1930s by so-called up-tick rules and other legal acts. The aim of this regulation was to prevent short sellers from adding to the downward momentum when the price of an asset was already experiencing sharp declines. During the 1990s, short sale regulations changed several times. In this paper, panel regression is applied to investigate short sale determinants on the NYSE and NASDAQ. Short seller motivation and the results are compared with those for particular markets and sub periods that represent different legal regulations of short selling activities in the period from 1990 to 2015.

Keywords: short sale hypotheses, panel regression, NYSE, NASDAQ, regulation, short sale, short interest, determinants

INTRODUCTION

Short selling allows traders to borrow and sell a stock without actually owning it. To close a short position, traders must buy back the stock in the future and realize gains or losses based on the difference between the selling and buying price. Advocates of short selling offer several benefits, such as efficient pricing in stock markets or the incorporation of negative information in prices. Critics of short selling argue that short sellers may hammer a stock's price below its fundamental value. These predatory short selling practices are one of the reasons why short selling was prohibited or limited several times.

In the past two decades, there has been an increase in short selling activity in the equity market. In the NYSE and the NASDAQ, from 1988 to 2002, the annual growth rate of short interest in both equity markets was more than 20 % per year (Kot, 2007).

Using short selling data from 1990–2015 from the NYSE and NASDAQ, the aim of this paper is to investigate determinants affecting the short selling level and whether there is any difference in short-sellers' motivations among different short selling regulatory environments.

The paper aims at empirically assessing determinants of short sales within different legal environments. The investigation is aimed at the following fields: which factors affect the short interest level and how they differ in particular markets; and are there any differences if a legal environment changes?

Related Literature

The investors' motivations for short selling are summarized in four hypotheses–Trend Hypothesis, Overpricing Hypothesis, Arbitrage Hypothesis and Taxation Hypothesis (currently) with minor importance. A number of studies exist on short selling in recent years that lead to different fields. An examination of the Overpricing Hypothesis as a reason for a short sale can be found in the following studies: Dechow *et al.* (2001), Desai *et al.* (2002), Boehmer *et al.* (2013) and Asquith *et al.* (2005). These authors investigate the relation between short sale restrictions and stock prices. Trend Hypothesis as a motivation for a short sale is investigated, e.g., by

Jagadeesh and Titman (1993). Brent *et al.* (1990) and Arnold *et al.* (2005) deal with Arbitrage Hypothesis.

Trend Hypothesis (1) (also known as Following the Trend Hypothesis), according that short sellers close their positions if the stock prices have increased short term in the past, is the basis of the findings of Jagadeesh and Titman (1993). They demonstrate that stocks with a high (low) rate of returns at the horizon from three to 12 months repeat this high (low) rate of return at the horizon of the next three to 12 months.

Overpricing Hypothesis (2) expects that investors have inside information. When they expect that the stock is overpriced, short selling is a way to capitalize it. Diamond and Verreichia (1987) point out that a short sale is an expensive transaction and short sellers trade only if they expect that the price will significantly decrease as a compensation for these costs and risks. Dechow, *et al.* (2001) emphasize the relation between the low level of fundamental factors and the level of short selling. The aim of these studies is to analyse the information's contents on short selling and suggest trading strategies based on the information intercorporate in short selling.

The Arbitrage Hypothesis (3) argues that short sellers participate in overpricing between a stock and convertible security. A high correlation between an instrument and an instrument that is going short is demanded. And (4) Taxation Hypothesis only has a limited impact on short interest nowadays because of the elimination of opportunity to defer capital gain tax if an investor is shorting securities. (Arnold *et al.*, 2005).

Brent *et al.* (1990), Dechow *et al.* (2001), Angel *et al.* (2003), Desai *et al.*(2002) or Kot (2007) and Kot (2014) may be referred to as the main authors that deal with short selling determinants. Brent *et al.* (1990) analyse short selling motivation based on three of the above-mentioned hypotheses. They find that short interest follows a seasonal pattern that is weakly consistent with the Taxation Hypothesis. Further stocks with high betas and the existence of convertible securities or options tend to have a higher level of short interest.

Dechow *et al.* (2001) document that short sellers open positions in the stock of firms with low ratios of fundamentals (such as earnings or book value) to market value and close their positions at the ratios mean-revert. They also point out the importance of transactions' costs in the decision-making process of short sellers. Angel *et al.* (2003) examine the frequency of short selling in stocks listed on NASDAQ and analysed stock characteristics. They get that a short sale is more common among stocks with high returns than stocks with weaker performance, and further actively traded stocks are more shorted. Short selling also depends directly and positively on stock price volatility. Desai *et al.* (2002) examine the relationship between the level of short interest and stock return on NASDAQ. They found out that heavily shorted stocks experience significant negative abnormal returns with respect to market, size, book-to-market and momentum factors. The higher level of short interest is a stronger bearish signal. Kot (2007) finds that a short-selling activity is positively related to arbitrage opportunities and hedging demand, and negatively related to previous short-term returns. Deev and Linnertova (2014) analysed short selling activity with ETFs because ETFs short interest is 10 times higher than short interest with common stocks. They determine several long-term stable characteristics of ETFs that contribute to the total level of short interest.

Recent analysis of the short sale is focused on analysis of short sale constraints. This topic became important during the financial crisis when governments temporarily reaccepted short sale limitations, which had been relaxed during the previous 20 years. For example, Mohamand *et al.* (2015) investigate the ban on the short selling of specified financial-sector stocks in September 2008 introduced by the UK's Financial Services Authority. Grullon *et al.* (2015) investigate the impact of Regulation SHO that relaxes short-selling constraints on a random sample of U.S. stocks to test whether capital market frictions have an effect on stock prices and corporate decisions. Hasan *et al.* (2015) investigate whether a such selling activity before the 2008 short ban reflected financial companies' risk exposure in the subprime crisis. Duong *et al.* (2015) examine the impact of a market-wide mandatory disclosure policy on short selling on the Tokyo Stock Exchange.

Short Sale Regulation

After the Wall Street crash in 1929, many laws were passed to restrict short selling. On October 1931, the NYSE prohibited short selling at a price lower than a pre-previous short sale price. The uptick rule specifies that a stock can only be shorted at a transaction price that is at least one tick higher than the price of the most recent trade with a different price. On February 1932, another restriction was adopted, when brokers were required to obtain written authorization of a customer before lending their shares. The regulation was later imposed on other market subjects such as mutual funds, e.g., the Taxpayer Relief Act. In 1938, the SEC adopted an uptick rule and in 1940, the Investment Company Act was adopted to restrict mutual funds' ability to short. In 1997, the Taxpayer Relief Act repealed the short sale rule and the market timing ability of mutual funds increased significantly. The changes of short selling regulations were followed by a period of market strength and rapid trading. Under the SHO Regulation program, 1,000 stocks started trading without short sale price tests in May 2005. This test exception was extended for several times and existed till 2007, when the uptick rule was removed by the SEC.

But in response to the financial crisis, the SEC adopted a temporary emergency rule to stop naked short selling in 2008 for major financial firms,

I: *A list of regulation changes in the U.S. market*

Date	Rule or change of a rule
06/10/1931	NYSE prohibited short sales on a downtick
22/06/1936	Short-sale rule was introduced in the Tax Payer Act
01/02/1938	NYSE's test was extended to all exchanges
22/08/1940	Short selling was restricted by mutual funds
05/08/1997	Short-sale rule was repealed
03/01/2005	Requirements for limited naked short selling was prepared by the SEC
03/07/2008	Uptick rule was removed by the SEC
21/07/2008	Temporary ban of naked short selling for financial firms was adopted
17/09/2008	Short sale ban was widened for 797 stocks and another temporary rule for limitation of naked short selling was adopted by SEC. The short-selling activities of option market makers were limited.
24/02/2010	Alternative uptick rule was introduced

Source: Author

and later, the SEC added a new temporary rule to regulate the short sale. The short selling ban expired on October 2008, and in February 2010, the SEC adopted a new rule to put restrictions on short-selling activities. This alternative uptick rule restricts short selling from driving down the price of a stock when the stock has already declined by more than 10 % in one day. The relevant changes for the period 1997–2015 in short selling regulation in the U.S. market are summarized in Tab. I.

Data and Methodology

The data used in this paper is gathered from Bloomberg and represents monthly observations of the NYSE and NASDAQ from January 1990 to December 2015. As the short sale was differently regulated at that time, the whole period is, for further analysis, split up into several sub periods representing different regulatory frameworks.

- Period I: 1990/01–1997/08 in that period short sale is regulated by the uptick rule and several short sale restrictions are imposed on mutual funds
- Period II: 1997/09–2004/12 short sale regulation imposed on mutual funds is lifted
- Period III: 2005/01–2007/1 locate and close-out requirements for broker-dealers are established to curb naked short selling, the uptick rule is removed by the SEC
- Period IV: 2008/01–2008/12 an emergency rule to stop naked short selling in 19 major financial firms and a later ban on short selling of 797 stocks. Regulation of clearing agencies, broker-dealer and options market makers
- Period V: 2009/01–2010/02 short selling ban expired at the end 2008.
- Period VI: 2010/03–2015/12 the SEC approves alternative uptick rule designed to restrict short selling from furthers driving down the price of a stock that has dropped more than 10 % in one day

To investigate the motivation of short sellers, several variables were constructed to be complied with the above-mentioned short sale hypotheses.

Short interest is defined as a short selling ratio (SIR) and represents how many days it will take short sellers to cover their positions:

$$SIR_i = \frac{Total\ number\ of\ shares\ i\ selling\ short}{Average\ daily\ trading\ volume\ of\ i} \quad (1)$$

Cumulative return (RETURN) is calculated as:

$$RETURN_i = \frac{Current\ Price\ of\ Security\ i - Original\ Price\ of\ Security\ i}{Original\ Price\ of\ Security\ i} \quad (2)$$

The variable is lagged 12-months to proxy short-term stock returns. If investors are trend-followers, they will buy the stock if the past short-term price is increasing and sell or short if the past short-term price is decreasing. Short-sellers close positions if the stock prices increased in the past short-term and open positions if the prices decreased in the past short-term.

Excess return ALPHA is calculated because of the same reasons, but it reflects the systematic risk of a stock. The variable is lagged 12months to record the activities of trend followers.

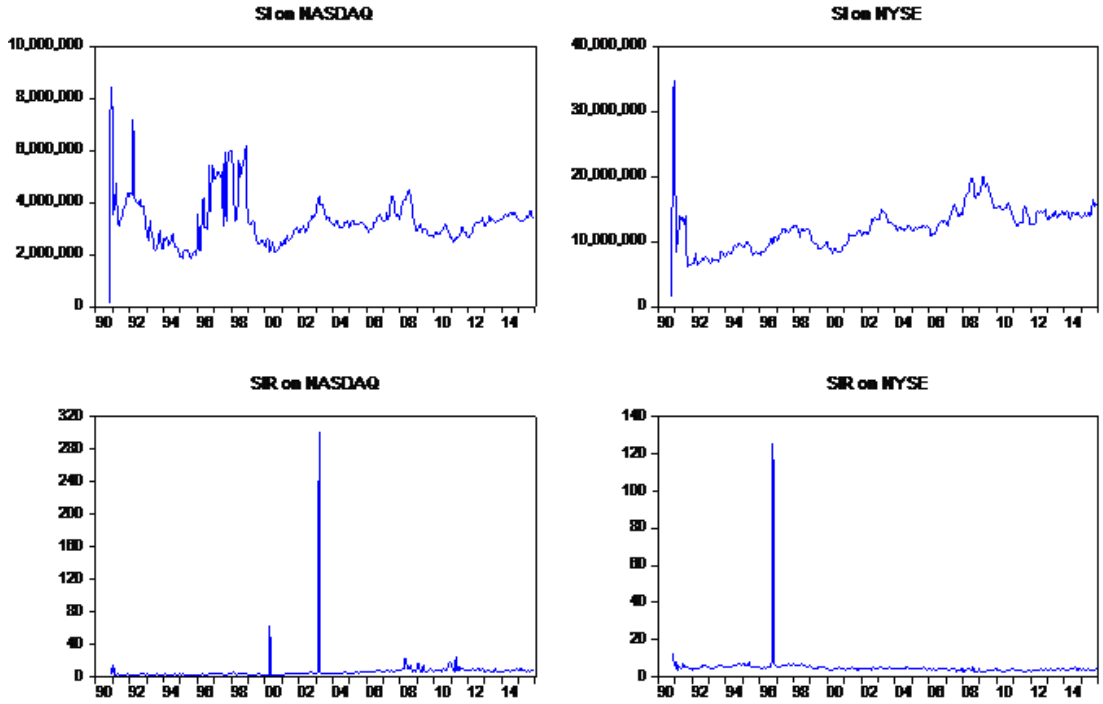
$$ALPHA_i = \left(\frac{Y_i}{N_i}\right) - \beta_i \cdot \left(\frac{X_j}{N_j}\right) \quad (3)$$

Where:
X_j... is the vector of percentage differences of a market (market index *j*)
Y_i... is the vector of percentage differences of a dependent security (equity *i*)
$N_{i,j}$..is the total number of percentage difference points
β_i.... measures systematic risk of a security

Two fundamentals variables are used as a proxy for the probability of overvaluation. Dechow at al. (2001) find a strong relation between the short sellers' activity and low fundamental ratios. Book-to-market ratio (BTM) and Earnings yields (ETM) are used to demonstrate overpricing motivation for opening short positions. The variable volatility VOL is also used to measure overpricing. The more volatile stocks are more likely overpriced. Market capitalization (logarithm) CAP can be used as a proxy of information transparency. The stocks with higher information transparency better reflect intrinsic value and are less likely overpriced and shorted.

The Hedging and Arbitrage Hypothesis is a measure by the number of call (variable CALL) and put (variable PUT) options. An option listing has a positive and negative effect on short selling. Shares are sold short to hedge option positions in the stock or to arbitrage the difference between the price of options and underlying stocks. In a situation the option has a positive effect on the short-sale level, options are a substitute for short selling. If investors want to profit from decreasing stock prices, they can short sale the stock, buy a put option or sell a call option. These three methods have the same purpose. The existence of an option can have a positive or negative effect on the short sale level.

Borrowing costs are measured by three variables. The market capitalization (logarithm) CAP is a proxy for borrowing costs because large stocks have lower borrowing costs than smaller stocks D'Avolio (2002), Geczy *et al.* (2002). Institutional ownership is an alternative measure of the borrowing costs as well. Market capitalization can be also used as a proxy for an overpricing hypothesis. The stocks of large cap companies less likely differ from their fundamental values. The IN_NO is defined as natural logarithm of 1 plus the number of institutional holdings the stock (Chen *et al.* (2002), Asquith *et al.* (2005), Nagel (2005), Kot (2007), Kot (2014),). IN_RATIO is a share of the number of shares hold by institutional investors to shares outstanding. Both variables could have a positive relation with the short interest ratio. Liquidity can also be used to measure borrowing costs. More actively traded stocks are more often short sale than stocks with limited trading volume and wider spread (Angel *et al.* (2003)). Liquidity is measure by the bid ask spread SPREAD.



1: *Short Interest and the Short Interest Ratio 1990–2015*
Source: Author in Eviews

II: *Correlation Matrix– the NYSE*

	SIR	RETURN	ALPHA	ETM	BTM	VOL	CALL	PUT	CAP	IN_ RATIO	IN_NO	SPREAD
SIR	1.000											
RETURN	0.032	1.000										
ALPHA	-0.010	-0.007	1.000									
ETM	-0.079	-0.095	-0.047	1.000								
BTM	-0.092	-0.067	-0.081	0.486	1.000							
VOL	-0.098	0.007	-0.007	0.118	0.102	1.000						
CALL	-0.177	-0.005	-0.025	0.198	0.109	0.444	1.000					
PUT	-0.155	-0.011	-0.018	0.199	0.084	0.432	0.946	1.000				
CAP	-0.261	0.028	0.009	0.015	-0.117	0.379	0.591	0.602	1.000			
IN_ RATIO	0.143	-0.015	0.000	-0.086	-0.013	-0.239	-0.222	-0.211	-0.300	1.000		
IN_NO	-0.190	-0.052	-0.014	0.140	-0.056	0.346	0.611	0.622	0.685	-0.244	1.000	
SPREAD	0.029	0.014	0.045	-0.193	-0.165	-0.058	-0.135	-0.092	0.022	0.149	-0.054	1.000

Source: Author in Eviews

III: *Correlation matrix NASDAQ*

	SIR	RETURN	ALPHA	ETM	BTM	VOL	CALL	PUT	CAP	IN_ RATIO	IN_NO	SPREAD
SIR	1.000											
RETURN	0.007	1.000										
ALPHA	-0.033	0.018	1.000									
ETM	0.078	-0.006	-0.145	1.000								
BTM	0.033	-0.024	-0.23	0.351	1.000							
VOL	-0.064	-0.048	-0.021	0.17	0.197	1.000						
CALL	-0.062	0.003	0.012	0.012	-0.04	-0.016	1.000					
PUT	-0.064	0.004	0.011	0.01	-0.043	-0.016	0.993	1.000				
CAP	-0.192	0.027	0.104	-0.17	-0.378	-0.296	0.272	0.286	1.000			
IN_ RATIO	-0.011	-0.004	-0.014	-0.011	0.001	-0.027	0.016	0.019	0.01	1.000		
IN_NO	-0.156	0.035	0.053	-0.174	-0.371	-0.277	0.239	0.251	0.303	0.016	1.000	
SPREAD	0.115	-0.009	-0.038	0.102	0.162	0.066	-0.03	-0.032	-0.253	-0.004	-0.292	1.000

Source: Author in Eviews

Fig. 1 demonstrates short interest ratio and short interest in both markets in the period 1990–2015. Focusing on short interest, the short positions are larger on the NYSE compared with NASDAQ. The maximum shares sold on the NYSE reached 30,000,000 million in the analysed period, on the NASDAQ, approximately 8,000,000. On the other hand, SIR is higher on NASDAQ than the NYSE. It means that short sellers may close their open short positions faster on the NYSE than on NASDAQ.

Tables II and III report the correlation among variables. On the NYSE, a higher correlation is measured between SIR and four other variables, which indicates that SIR is lower if a call or put option is available and also for large capitalization companies. SIR also decreases with the number of institutional investors. On NASDAQ, SIR correlates with three variables. SIR is lower for large cap companies but higher for stocks with higher institutional holdings and spread.

Panel Regression

The relationship between SIR and independent variables is investigated by the panel regression model with fixed effect. The fixed effect model was chosen based on the results of the Hausman test.

Due to a high correlation between CALL and PUT, only one of them is in the regression and in the total there are two models of the regression analysis. Where SIR_{it} measures short interest ratio of security *i* at time *t*. Independent variable $RETURN_{it}$, $ALPHA_{it}$ were chosen in terms of Trend Hypothesis. BTM_{it}, *ETMit*, *VOLit* are independent variables representing Overpricing Hypothesis, $CALL_{it}$ could be seen as a proxy for Arbitrage and Pricing opportunities or Borrowing costs. CAP_{it}, IN_NO_{it}, IN_RATIO_{it} *and* $SPREAD_{it}$ represent Borrowing

Costs. is the unknown intercept for each entity (n entity-specific intercepts), is the coefficient for that independent variable and is the error term.

Model I equation:

$$SIR_{it} = \beta_1 RETURN_{it} + \beta_2 ALPHA_{it} + \beta_3 ETM_{it} + \beta_4 BTM_{it} + \beta_5 VOL_{it} + \beta_6 CALL_{it} + \beta_7 CAP_{it} + \beta_8 IN\_RATIO_{it} + \beta_9 IN\_NO_{it} + \beta_{10} SPREAD_{it} + \alpha_1 + \ldots + \alpha_i + u_{it} \quad (4)$$

Model II equation:

$$SIR_{it} = \beta_1 RETURN_{it} + \beta_2 ALPHA_{it} + \beta_3 ETM_{it} + \beta_4 BTM_{it} + \beta_5 VOL_{it} + \beta_6 PUT_{it} + \beta_7 CAP_{it} + \beta_8 IN\_RATIO_{it} + \beta_9 IN\_NO_{it} + \beta_{10} SPREAD_{it} + \alpha_1 + \ldots + \alpha_i + u_{it} \quad (5)$$

Definitions of variables and their expected impact on the short interest level are summarized in the following table (Tab. IV). The variables are backed by a particular hypothesis.

Results of Panel Regression

Tab. V and Tab. VI demonstrate results for the full sample. On the NYSE, the average short interest ratio reaches 3.93 days and average short interest represents 14.01 million shares monthly. At the same time, NASDAQ's short interest ratio is two times higher (7.37 days) but monthly there are only 5.8 million shares shorted on average. The other variables are very similar for both markets, only the NYSE is more volatile than NASDAQ (average monthly volatility reaches 237.96 % compared with 33.70 % on NASDAQ). NASDAQ is riskier for short selling, and short squeeze risk is higher on this market than is indicated by high short interest ratio and low short interest at the same moment. A short interest ratio lower than seven days (Seneca (1976)) is considered a threshold.

On the NYSE, short sellers prefer stocks with a positive last 12-months' performance, a low book-to-market ratio and low market capitalization. The institutional ownership is also important for short sellers and has a positive impact on the short sale level. The last 12months' return and the fraction of shares held by institutional investors are the strongest determinants of short sale activity on the NYSE, with a power of 2.47 and 2.83 days, respectively. A positive sign of the RETURN coefficient indicates that short sellers short stocks if the past short-term performance is good. This evidence is inconsistent with momentum strategy (Jagadeesh and Titman (1993), Kot (2007), Kot (2014)) and short sellers expect, rather, overpricing of these stocks and a change in the trend than a continuing trend in the near future. This corresponds with Angel *et al.* (2003), who find the same finding on NASDAQ. The results are also consistent with the findings of Dechow *et al.* (2001) about the negative sign for market capitalization and the book-to-market ratio. The Overpricing Hypothesis claims short sellers prefer to short low fundamental-to-market ratio stocks. This also indicates that stocks or small-cap companies are more likely overpriced and, therefore, more suitable for short sale. Further, results also suggest that short sellers take into consideration borrowing costs. On NASDAQ, the importance of market capitalization and institutional ownership is stronger than on the NYSE, as both institutional holdings variables are statistically significant.

Sub-period analysis is demonstrated in Tab. VII for the NYSE and Tab. VIII for NASDAQ. The first period, from 1990 to 1997/08, represents the strong regulation of short sale activity by the existence of the uptick rule and other limitations of short sale, especially for institutional investors. The average level of short interest ratio gets 5.66 days on the NYSE and 3.25 days on NASDAQ, but the average number of short interest is similar on both markets and reaches approximately 10 million shares monthly. The NYSE is also a more volatile market than NASDAQ (30 days volatility is 242.3 % and 52.7 %, respectively). On the NYSE, only the number of put options determines the short sale level with a negative sign.

On NASDAQ, more statistically significant results can be found for this period. The abnormal return ALPHA is statistically significant with a negative sign. This indicates that short sellers look up this variable for a trend measure. The negative sign of a coefficient indicates short-sellers trade the stocks based on the past trend–it means that they buy if the past return was good and short or sell stocks if the past short-term excess return was bad. The finding is consistent with a momentum strategy. The short sellers also target less volatile stocks, which is against the Overpricing Hypothesis, but it supports the idea that short sellers do not open a short position if they are not able to predict the future tendency of a performance. Thus, more volatile and risky stocks are less likely to be shorted.

Period II represents the releasing of short sale regulations. The first exception was imposed on the mutual fund industry. Short interest ratio achieves 4.65 days on the NYSE and 4.07 on NASDAQ. On both markets, approximately 11.5 million shares are shorted monthly. On both markets, following the Trend Hypothesis is confirmed by a negative sign of the excess return variable. Market capitalization is another determinant that influences the short interest ratio on both markets. Its sign is negative and confirms the Overpricing Hypothesis because stocks of small companies are more likely overpriced. The results for other variables are mixed and divided.

Period III constitutes the first sign of a renewed short sale limitation. The first regulation is aimed at so-called naked short selling. The average SIR on the NYSE is 4.05, and 6.78 days on NASDAQ.

Further, it represents 12.48 million and 9.40 million monthly shorted stocks, respectively.

Also in this period, short sellers prefer stocks of small companies for short sales–this is demonstrated by a negative sign of the market capitalization variable CAP for both markets and both models. For both markets, a negative sign of earnings yield (ETM) is common as well. This variable has the strongest explanatory power from all significant variables for this period. On Fig. 1, the beginning of an upward trend in Short Interest on both market in this period is demonstrated, and because of the symptoms of the financial crisis, this indicates the importance of the Overpricing Hypothesis. Short sellers choose stocks with a higher probability of overpricing and a low-to-fundamental ratio. On NASDAQ, volatility is still a significant variable that lowers the total value of the short interest ratio.

Period IV represents the year 2008 and several short sales bans imposed on financial stocks. The short interest ratio is two times higher on NASDAQ (7.88 days) compared with the NYSE (3.54 days), but at that time, 16.64 million stocks (compare with 9.21 million stocks on NASDAQ) are shorted on the NYSE monthly. On the NYSE, only two variables are reflected in short sale ratio. The previous rate of return is important for short sellers and has a positive impact on the short sale level. Another variable is market capitalization, but beside previous periods, its sign is positive. On NASDAQ, short sellers still prefer stocks of small companies with a positive excess return, low book-to-market ratio and low 30-days' volatility.

The period 2009/01 to 2010/02 paints an unlimited time of short sale. The last short sale ban expired at the end of 2008. On NASDAQ, SIR is still two-times higher than on the NYSE (6.51 day, 3.76 days, respectively), but on the NYSE, monthly shorts approximately 15.8 million shares, on NASDAQ, it is only 7.0 million. On the NYSE, short sellers prefer stocks with a negative earnings yield and stocks of large cap companies. The variable CAP has a stronger impact on the short sale level, compared to in the previous sub-period. The existence of a call or put option also negatively influences the level of the short sale. On NASDAQ, investors prefer stocks with a negative excess return that can be considered overpriced. Further, a low book-to-market ratio, 30days volatility and market capitalization are demanded. The existence of a put or call option decreases the total level of the short sale.

The last period from 2010/03 to 2015/12 means alternative ways of short sale regulation with adopting of a new uptick rule. On the NYSE, the past rate of return and past excess return influence the level of short sale. Next, short sellers choose shares with low book-to-market value and low capitalization. Institutional ownership is also relevant for the level of the short sale. On NASDAQ, short sellers are focused only on the excess return. However, book-to-market is positive on this market. They also prefer stocks with low 30-days' volatility, low market capitalization and significant holdings of institutional investors. Existence of both types of option decreases the short interest ratio on NASDAQ as well. Finding about the impact of call option existence is against the expectation of the Arbitrage Hypothesis, as Brent *et al.* (1990) and Danielsen and Sorescu (2001) show, options facilitate short selling activities. This could suggest that option is an alternative instrument for short selling that is cheaper and less risky. In this situation, the option might be considered to be a substitute of a short sale and, thus, lower the level of the short sale.

Results for particular sub-periods are different for the NYSE and NASDAQ. The level of short sale ratio is positively influenced by the previous performance of stocks and results are stronger in periods of short sale regulation, such as 2008/01–2008/12, where several emergency rules were adopted, and 2010/03–2015/12, when the alternative uptick rule was adopted. The fundamental ratio earnings yield negatively influences the level of SIR. This is consistent with the Overpricing Hypothesis as found by Dechow *et al.* (2001). Call options decrease the short sale level, which is against expectations, and the Arbitrage and Hedging hypothesis can support the idea about the costs of short selling. The last statistically significant variable is market capitalization CAP. The impact of this variable is mostly negative, which indicates that short sellers prefer stocks of small cap companies for shorting. This rule only changed in the period from 2008/01 to 2008/12, when short sale was banned for several stocks, and in the following period.

On NASDAQ, excess return ALPHA is statistically significant in all periods. A negative sign of this variable indicates the overpricing of stocks used for short sale. Only in the period of short sale limitation, with several temporary bans, does the sign of this variable change from negative to positive. Fundamental ratio book-to-market is statistically significant, but its impacts vary over time. Compared with results for the NYSE, the volatility is statistically significant in all periods and decreases the total SIR. As well as on the NYSE, the short interest ratio is higher for small cap companies.

IV: *Variable Description*

Variable	Abbreviation	Description	Hypothesis	Expected Sign
Short Interest Ration	SIR	The total number of shares an investor has sold short divided by the average daily trading volume for a specific time period. This is also called the 'days-to-cover ratio' because it tells, given the stock's average trading volume, how many days it will take short sellers to cover their positions if positive news about the company lifts the price.		
Cumulative return	RETURN	The performance of a stock over a particular period.	Trend Hypothesis	-
Alpha	ALPHA	Indication of whether a stock is undervalued or overvalued in relation to other stocks with similar systematic risk.	Trend Hypothesis	-
Book-to-market ratio	BTM	The comparison of a company's net asset value per share to its share price.	Overpricing Hypothesis	-
Earnings yield	ETM	The comparison of a company's per share to its share price.	Overpricing Hypothesis	-
Number of call option outstanding (logarithm)	CALL	The total number of call option contracts (all available strikes and expirations) outstanding for a given underlying.	Arbitrage and Hedging Hypothesis Borrowing costs	+ -
Number of put option outstanding (logarithm)	PUT	The total number of put option contracts (all available strikes and expirations) outstanding for a given underlying.	Borrowing costs	-
Volatility	VOL	Volatility 30 Day–a measure of the risk of price moves for a security calculated from the standard deviation of day-to-day logarithmic historical price changes. The 30-day price volatility equals the annualized standard deviation of the relative price change for the 30 most recent trading days closing price, expressed as a percentage.	Overpricing Hypothesis	+
Market Capitalization (logarithm)	CAP	Total market value of all of a company's outstanding shares stated in the pricing currency. Capitalization is a measure of corporate size.	Borrowing costs Overpricing Hypothesis	+ -

Variable	Abbreviation	Description	Hypothesis	Expected Sign
Institutional holders	IN_NO	Number of institutional holders	Borrowing costs	+
Institutional holdings	IN_RATIO	The fraction of shares outstanding held by institutional investors	Borrowing costs	+
Bid Ask Spread	SPREAD	Average of all bid/ask spreads. The bid/ask points used for the computation correspond to the quotes received for the period indicated by calculation interval ending in the complete trading day	Borrowing costs	-

Source: Author

CONCLUSION

Short selling plays an important role in financial markets. Short selling activity increased significantly in the last decades. The motivation of short sellers is summarized by four hypotheses and borrowing costs must also be taken into account. In this paper, variables that can represent proxies for particular short selling hypothesis are suggested. Further, using data from the NYSE and NASDAQ, these hypotheses are tested during the period 1990–2015. Because in the last decades the short sale was regulated and deregulated several times, this period is spit up based on important changes in short sale regulation.

The findings of panel regression are the following. A short sale can be explained by the Trend Hypothesis, suggesting that a short sale is higher for stocks that recorded a price increase in the previous 12 months. The Overpricing Hypothesis, as a motivation by a short sale, was confirmed by fundamental ration book-to-market and market capitalization–when short sellers prefer stocks with a low book-market value and lower market capitalization. Short sale activity is also influenced by the existence of an option. An option indicates a substitute for a short sale. An investigation of borrowing costs confirms that short sellers prefer stocks with higher institutional holdings to shares outstanding and a higher number of institutional investors. On NASDAQ, short sellers measure overpricing by the excess return rather than the cumulative return. The variable's volatility decreases the short sale level but it is only significant on NASDAQ.

The level of short sale ratio is positively influenced by previous performance of stocks and results are stronger in period of short sale regulation, such as 2008/01 – 2008/12 where several emergency rules were adopted and 2010/03 – 2015/12 when alternative uptick rule was adopted. Fundamental ratio earnings yield negatively influence the level of SIR. This is consistent with Overpricing hypothesis as find Dechow *et al.* (2001). Call options decrease short sale level that is against the expectation and the Arbitrage and Hedging hypothesis but can support the idea about the costs of short selling. The last statistically significant variable is market capitalization CAP, the impact of this variable is mostly negative that indicate that short sellers prefer stocks of small cap companies for shorting. This rule only changes in the period from 2008/01 to 2008/12 when short sale was banned for several stocks and in the following period.

Overpricing hypothesis as a motivation by short sale was confirmed by fundamental ration book-to-market and market capitalization. Short sellers prefer stocks with low book-market value and lower market capitalization. Short sale activity is also influenced by existence of an option. Investigation of borrowing costs confirms that stocks with higher institutional holdings to shares outstanding and higher number of institutional investors are preferred.

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V: *Full Sample Results*

	NYSE			NASDAQ				
Model I	**Coefficient**	**Model II**	**Coefficient**	**Model I**	**Coefficient**	**Model II**	**Coefficient**	**Expected effect sign**
CONST.	20.51 (1.30)		19.34 (1.3)		31.11 (3.2)		32.08 (2.62)	
RETURN	2.47*** (0.22)		2.45*** (0.22)		–0.73 (0.54)		–0.85* (0.44)	-
ALPHA	–0.01 (0.00)		–0.01 (0.00)		–0.05** (0.02)		–0.06*** (0.01)	-
BTM	–1.34*** (0.14)		–1.41*** (0.14)		0.20 (0.25)		0.38* (0.2)	-
ETM	–0.09 (0.98)		–0.37 (0.98)		3.50** (1.28)		–0.10 (1.5)	-
VOL	0.00 (0.00)		0.00 (0.00)		–0.07*** (0.00)		–0.07*** (0)	+
CALL	–0.03 (0.03)		–		–0.08* (0.06)		–	+/-
PUT	–		0.11*** (0.02)		–		–0.05 (0.04)	-
CAP	–1.33*** (0.09)		–1.32*** (0.09)		–2.12*** (0.26)		–2.22*** (0.21)	+/-
IN_RATIO	2.83*** (0.14)		2.93*** (0.14)		4.56*** (0.43)		5.79*** (0.4)	+
IN_NO	0.6*** (0.15)		0.55*** (0.15)		0.98** (0.42)		0.84** (0.35)	+
SPREAD	–0.33 (0.37)		–0.3 (0.37)		0.23*** (0.04)		0.10*** (0.04)	-
R^2 **Number of Observations**	**0.57** 22311		**0.57** 22311		**0.57*** 14944		**0.58** 14647	

Standard error is demonstrated in parenthesis
*, ** and *** indicate significance at the 10 %, 5 % and 1 % level, respectively
Source: Author in Eviews

VI: *Sub-period Results–the NYSE*

Variable	Period I		Period II		Period III		Period IV		Period V		Period VI	
	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II
CONST.	7.18 (6.95)	6.30 (6.95)	19.9 (1.06)	19.83 (1.06)	23.00 (1.39)	23.89 (1.41)	–2.86 (3.39)	–4.06 (3.03)	–8.14 (2.72)	–12.12 (2.70)	20.51 (1.30)	19.34 (1.30)
RETURN	0.7 (0.92)	0.71 (0.92)	0.21 (0.95)	0.19 (0.96)	0.18*** (0.24)	1.25*** (0.24)	3.07*** (3.00)	3.00*** (3.03)	0.32** (2.72)	0.15 (2.71)	2.47*** (0.22)	2.45*** (0.22)
ALPHA	–0.01 (0.03)	–0.01 (0.03)	–0.02*** (0.19)	–0.03*** (0.19)	0.00 (0.00)	0.00 (0.00)	–0.02 (0.03)	–0.02 (0.24)	–0.02 (0.19)	–0.02 (0.19)	–0.01*** (0.01)	–0.01*** (0.01)
BTM	–0.27 (0.85)	–0.27 (0.84)	–0.05 (0.01)	–0.12 (0.01)	–0.29 (0.21)	–0.41** (0.21)	0.00 (0.19)	–0.02 (0,03)	0.07 (0.16)	0.07 (0.02)	–1.34*** (0.14)	–1.41*** (0.14)
ETM	–1.06 (1.31)	–0.81 (1.31)	–0.01*** (0.01)	–0.01*** (0.01)	–5.89*** (1.26)	–6.13*** (1.28)	–1.03 (1.20)	–1.05 (0.19)	–3.27** (0.97)	–2.96*** (0.98)	–0.09 (0.98)	–0.37 (0.98)
VOL	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (1.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
LOG_CALL	0.18 (0.12)		–0.15*** (0.03)	–	–0.1*** (0.04)		–0.17** (0.09)	–	–0.46*** (0.07)	–	–0.03 (0.03)	–
LOG_PUT	–	0.33*** (0.09)	–	–0.05*** (0.02)	–	0.05* (0.03)	–	–0.09 (0,00)	–	–0.15 ** (0.06)	–	0.11*** (0.02)
LOG_MK	–0.18 (0.44)	–0.19 (0.44)	–0.85*** (0.06)	–0.90*** (0.06)	–1.07*** (0.09)	–1.21*** (0.09)	0.52*** (0.19)	0.54 *** (0.08)	1.03*** (0.16)	1.07*** (0.15)	–1.33*** (0.09)	–1.32*** (0.01)
INST_RATIO	–	–	–	–	–	–	–	–	–	–	2.83*** (0.14	2.93*** (0.13)
INST_NO	–	–	–	–	–	–	–	–	–	–	0.6*** (0.15)	0.55*** (0.15)
SPREAD	–	–	–	–	–	–	–	–	–	–	–0.33 (0.37)	–0.3 (0.36)
R^2	**0.50**	**0.51**	**0.47**	**0.47**	**0.63**	**0.63**	**0.68**	**0.68**	**0.71**	**0.71**	**0.57**	**0.57**
Number of Observations	3,983	3,952	23,928	23,928	12,913	12,912	4,850	4,580	5,190	5,190	21,965	21,965

Standard error is demonstrated in parenthesis
*, ** and *** indicate significance at the 10 %, 5% and 1 % level, respectively
Source: Author in Eviews

VII: *Sub-period Results–NASDAQ*

Variable	Period I		Period II		Period III		Period IV		Period V		Period VI	
	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II	Model I	Model II
CONST.	11.08 (9.46)	9.92 (1.56)	4.19 (1.50)	5.67 (1.51)	11.15 (3.06)	11.36 (3.05)	25.96 (7.40)	26.48 (7.44)	6.51 (3.89)	20.3 (5.85)	31.11 (3.20)	9.92 (1.56)
RETURN	-0.53 (0.68)	-0.58 (0.44)	-0.20 (0.24)	-0.18 (0.24)	-0.92 (0.43)	-0.91 (0.43)	-0.31 (0.55)	-0.15 (0.55)	0.55 (0.43)	0.26 (0.49)	-0.73 (0.54)	-0.38 (0.34)
ALPHA	-0.11*** (0.50)	-0.10** (0.01)	-0.09*** (0.02)	-0.08*** (0.02)	-0.19** (0.03)	-0.19*** (0.03)	0.21** (0.09)	0.22*** (0.09)	-0.24*** (0.03)	-0.19*** (0.05)	-0.05** (0.01)	-0.08*** (0.44)
BTM	-1.69** (1.72)	-1.50** (0.18)	1.71*** (0.23)	1.51*** (0.22)	2.37*** (0.48)	2.38*** (0.48)	-0.54** (0.32)	-0.56** (0.32)	-0.84*** (0.26)	-0.42** (0.27)	0.2*** (0.24)	1.37*** (0.01)
ETM	13.75*** (6.99)	13.65*** (1.03)	2.57 (2.18)	0.65 (2.18)	-5.11** (3.16)	-5.12* (3.16)	1.99 (1.34)	1.97 (1.35)	0.91 (0.89)	-0.27 (0.99)	3.05 (1.29)	1.92* (0.18)
VOL	-0.02*** (0.00)	-0.02*** (0.03)	-0.02*** (0.00)	-0.02*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.05*** (0.00)	-0.04*** (0.00)	-0.07** (0.00)	-0.07*** (1.03)
CALL	-0.21 (0.15)		-0.01 (0.05)		0.24*** (0.07)		-0.03 (0.18)		-0.38*** (0.08)		-0.08*** (0.05)	
PUT		-0.11 (0.04)		0.24*** (0.04)		0.30*** (0.07)		0.01 (0.15)		-0.22*** (0.09)		-0.08* (0.00)
CAP	-0.36*** (0.66)	-0.34*** (0.30)	0.06 (0.11)	-0.18* (0.11)	-0.35** (0.22)	-0.40** (0.22)	-1.05** (0.52)	-1.11*** (0.52)	0.39 (0.28)	-0.69** (0.41)	-2.12*** (0.26)	-2.11*** (0.04)
INST_RATIO											0.93** (0.41)	0.94*** (0.30)
INST_NO											4.46*** (0.42)	5.61*** (0.40)
SPREAD											0.23*** (0.04)	0.11*** (0.04)
R^2	**0.65**	**0.65**	**0.53**	**0.54**	**0.64**	**0.64**	**0.66**	**0.66**	**0.66**	**0.70**	**0.57**	**0.60**
Number of Observations	812	812	6 139	6 127	5 022	5 022	2 315	2 307	4 975	2 753	14 944	14 647

Standard error is demonstrated in parenthesis
*, ** and *** indicate significance at the 10 %, 5 % and 1 % level, respectively
Source: Author in Eviews

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