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“Short Selling: New Information brought into the Market and the Influence on Price Efficiency“

Seminararbeit

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1. Introduction

In this paper we want to examine the impact of short selling relating to the price efficiency. On the one hand, shorting activity is a risky business with a lot of constraints you must keep in mind. On the other hand, it leads to balance the market. For that reason, we will illustrate the positive correlation between short selling and price efficiency and exhibit that specific short sale orders contain new information for the market participants. We illustrate these results by analyzing a regression model and further key figures such as the reversals magnitude. Afterwards we investigate the consequences of short-sale constraints and show that constraints reduce the efficiency of prices and decelerate the process of price adjustment. Therefore, we make use of a rational expectation model to clarify the negative relation between short selling constraints and price efficiency. We also compare these findings with empirical results. But first, we will give an introduction of the mechanics of short selling and the regulatory restrictions of the U.S. Security and Exchange Commission (SEC) and non-regulatory restrictions.

2. Fundamentals

2.1. The Functionality of Short Selling

By shorting a stock, you benefit from decreasing prices in contrast to buying a stock. However, there are still other possibilities to yield gains from a bear market with derivates like options or futures. This arises the question: “What is the specific characteristic of a short sale?”

Shorting a stock is characterized by borrowing the stock you want to sell. The short seller realizes the stocks on the market and is forced to cover his position when the lender calls it back. Covering implies that he must acquire the number of stocks, he borrowed previously, to hand it back to the lender.

For example, the short seller realizes the borrowed stock X for \$100 on the market but is forced to cover his position at the end of the duration. If the price decreases, as he expects, he can rebuy the stock for example \$50 and gains a profit of \$50 a stock. On the contrary, he will suffer a loss of \$50 if the price rises for example to \$150. It is important to say that we disregard in this example loan fees and dividend payouts to illustrate this mechanic in a clarifying way. In practice, you must be distinctly aware that restrictions like short squeezes, dividend payouts or loan fees reduce the profit or can potentially lead to losses. These hurdles you must keep in mind when you are interested in shorting a stock (Kumar (2011), p. 209, p. 213).

2.2. Non-Regulatory Restrictions

In this paragraph we will exhibit the risks of shorting a stock. Those risks can result from regulatory restrictions or non-regulatory restrictions. In this chapter we will examine the impact of non-regulatory restrictions relating to short selling. We talked about the mechanism of borrowing which includes opportunity costs for the lender. For that reason, the short seller must pay loan fees and lost dividends over the duration to the lender as compensation. If a stock is difficult to borrow relating to high demand or limited supply, the borrowing costs are automatically higher. Those hurdles imply additional costs which cut the profit of the short seller and may be considered as additional constraints besides the regulatory restrictions. Another risk factor is the payoff distribution which we can see in Figure 1 and Figure 2. By comparing a Short Sale with a Long Put you can see that the maximum payoff is limited to the price of the stock less the costs for the options premium relating to the Long Put. We consider the option premium in Figure 2 to illustrate the payoff of a Long Put in a more realistic way. Otherwise the maximum loss of a Long Put would amount zero and would arise the question why you even decide to sell a stock short. Nevertheless, the striking difference is the downside. If the price rises, against expectations, the maximum loss amounts the options premium when we look at the Long Put in Figure 2. In contrast we can see in Figure 1 that the maximum loss of a short sale is unlimited by increasing prices (Kumar (2011), p. 209, p.216).

Figure 1: Payoff-Distribution of a Short Sale with Strike $150 exclusive non-regulatory restrictions e.g. loan fees or dividend payouts.

Figure 2: Payoff-Distribution of a Long Put with Strike $150 including options premium of $50.

Furthermore, the duration of a short sale is an important part and is associated with additional risk namely the recall risk. This implies that the lender of a stock can recall his shares at any time. If the price of a stock has not decreased in the way you had expected, or in worst case has increased, and the lender forces you to cover your position, you probably make losses because you must cover your short position for a higher price than expected (Boehmer et al. (2008), p. 523).

Another risk factor, you must keep in mind is the short squeeze and can occur when a stock is heavily shorted. When the price increases, against expectations, the short sellers try to cut their losses and cover their short position immediately. As a result, the demand increases which implies that the stock price will rise even more (Kumar (2011), p. 209).

But there are also opportunities for short selling such as pair trading, market-making activities or arbitrage possibilities (Kumar (2011), p. 216). Nevertheless, an even more important opportunity or rather consequence of short selling is that new information enters the market and gets incorporated into prices. In the next paragraphs we will analyze this relation and illustrate the impact of short selling relating to efficient prices and the consequence of short selling restrictions.

3. Regulations of the SEC

In this section we want to give you a brief overview of the restrictions the SEC implemented in order to prevent the artificial descend of stocks triggered by large institutions.

But first of all, what does the SEC actually do? On their official website they describe their duty the following:

> *"The mission of the U.S. Securities and Exchange Commission is to protect investors, maintain fair, orderly, and efficient markets, and facilitate capital formation."* (SEC (2013))

Now the question arises, what does this have to do with short selling? Like it was already mentioned in the last section, short selling is used to profit from falling prices (Kumar (2015), p. 212). The problem is, that in contrast to put options, for example, short selling has a direct impact on stock prices. When many people sell a stock X short at the same time, the supply of X will increase. Because more supply leads to lower prices, X´s price will decrease. And if there are no regulations which give the stock a chance to recover, it could end up in a slippery slope with the stock´s price going to zero. This is great for people who have sold this stock short, because they make a lot of money, but it could destroy companies which are actually healthy.

Therefore, one strategy for large institutions, like hedge funds, could be to drive companies artificially into bankruptcy or at least to manipulate firm decisions. People who use this kind of strategy are called bear raiders and to prevent them from doing so, the SEC has implemented certain rules (Grullon et al. (2015), p. 1738).

The first rule the SEC has adopted was the so-called Uptick Rule in 1938. When a stock trends down, the price is not constantly falling. There are ups and downs and the idea behind the uptick rule is, that you are only allowed to place a short sale order if the price moves up (SEC (2015)).

So, for example a stock´s price is constantly falling from $90 to $80. In this time, you are not allowed to sell the stock short. Only when the price moves up again you are allowed to do so and thereby it does not matter how much the price goes up. A single cent would be enough ($80.01). The idea is, that this little uptick will give the stock a chance to recover from the downward trend (Grullon et al. (2015), p. 1738).

This rule remained until 2004, when the SEC announced to remove short selling constraints from one-third of randomly selected stocks from the Russel 3000 stocks, in order to conduct a study, whether the uptick rule has a significant impact on stock prices. As a result, the "Rule 201" was implemented as a successor of the uptick rule in 2010. You are only allowed to sell short if the stock has dropped less than 10% in one day. You can find a list with prohibited stocks on the NASDAQ website.

The last rule we want to introduce is the "Rule 203 (b)(1) and (2)". Before executing a short sale you must ensure and document that you can acquire the securities you want to sell short. Not locating the security is also known as "naked short selling" and can lead to a failure to deliver (SEC (2015)).

In the last part, we will explain in detail which effects these constraints have on prices and their efficiency.

4. Information Process of Short Selling

The efficiency of the capital market is divided into three dimensions. One of them is the information efficiency, which states that it is not possible to gain excess returns with specific investment strategies over a long period. This hypothesis implies the fact that all information is immediately incorporate into a price at the time of publication. Thus, an efficient price contains the sum of historically, publicly and non-publicly market relevant information (Prof. Dr. C. Breuer).

Short sales contain this information, especially negative-related information and thus, short sellers are the reason for introducing them into the market by identifying overvalued stocks. Assuming, all short sellers are prohibited to trade and there is the announcement of negative news relating to a specific stock. In this case, the price of the stock declines when other traders sell the stock. But the requirement for the sale is that they must hold the stock. Wherever this is not the case, the pessimistic opinions get not incorporated into the price. In other words, the mechanism of unrestricted short selling is the reason that the negative-related information, regardless whether you hold the stock or not, is considered into the price. Therefore, short selling can prevent bubbles, due to the fact that short sellers identify overvalued stocks. This downward trend was also shown in Australia where certain short positions were published and decreasing prices, relating to the shorted stocks, were the result of this publication (Boehmer et al. (2008), p.491). For that reason, short sellers must face up with accusations of destabilizing prices (Boehmer/Wu (2013), p. 310) and regulatory restrictions by the SEC.

As we have seen in the Fundamentals, the maximum loss of a short sale is unlimited. In addition, non-regulatory restrictions like loan fees and dividend payouts constitute further risks for short sellers. In other words, short sellers must be well informed traders to compensate those risks. In the following we examine how short sellers receive their information and which short sales are the most informing sales.

In order to profit from a bear market and to receive an advantage towards other traders, short sellers must anticipate news announcements of the stocks they intend to sell short. Therefore, they trade before information is published because otherwise they cannot cover to a lower price in the future. But in fact, short sellers do not anticipate news. The short ratio, which denotes the short volume relative to total trading volume decreases a bit when leading up to a news event and increases slightly after a news event. All in all, the short ratio is nearly constant which implies that on average, the point in time when short sellers trade is the same as other market participants trade (Engelberg et al. (2012), p.261, p.268). On the one hand, this result disproves the thesis that short sellers anticipate news events to receive an information advantage. On the other hand, it clarifies that the most important points in time for market relevant information are news events. This relation is supported by the fact that future price movements are more precise on news days and especially when the news are related negatively (Engelberg et al. (2012), p.261).

In addition to the timing of short sales, there is the evidence that the order size of short sales is also an important component relating to the information contained. Sales with at least 5.000 shares have the most exact predictability for future prices, so consequently, stocks with a more intense short volume perform below-average on the contrary to lightly shorted stocks. Boehmer, Jones and Zhang also figured out that nonprogram institutional short sales intensify the results above. Nonprogram trades are contemporaneous orders with less than 15 securities. In contrast, short sales by individuals are on average less, or, to be more precise, not informed (Boehmer et al. (2008) p. 494, p. 495, p. 502, p. 516).

The fact that the most informed and thus the most profitable short sales were transacted on news days also suggests, that short sellers make use of the point in time because of higher liquidity. Higher liquidity is associated with lower transaction costs. Engelberg, Reed and Riggenberg tested the hypotheses on three measures to illustrate the relation between transaction costs and news events. In this paper we focus on two of the tree measures namely the rebate rate and the bid-ask-spread. Both measures reflect the transaction costs and are thus a measure for the liquidity in the market. The rebate rate denotes a rate for the borrower referring to a provided collateral and can thus be viewed as opportunity costs (Engelberg et al. (2012), p. 264, p. 275). The bid-ask-spread in absolute terms is the spread between the minimum price the owner wants to receive, the so-called floor, and the maximum price a buyer is prepared to pay which describes the ceiling.

To confirm the hypothesis, that transaction costs are lower on news events, either the rebate rate must increase, or the bid-ask-spread must decrease on news events, because of a decreasing ask price or an increasing bid price. We can see the results in Table 1 and note that neither of the two events occur. On the contrary, in t = 0 the bid-ask-spread increases by 3.9% and the Rebate Rate decreases by roughly 0.1% in comparison to t – 5. This result signifies that transaction costs for short sellers are higher on news events and therefore we can reject the liquidity hypothesis (Engelberg et al. (2012), p. 274).

The reason why large short sale orders on news events are the most informing relates to the fact that short sellers can process public information and select the specific parts, they require for their trades. In some cases, short sellers anticipate news announcements and are therefore able to make use of non-publicly available information, but on average the advantage of short sellers is the great ability to analyze the publicly available information on news events to disclose downtrends on the market (Engelberg et al. (2012), p. 273, p. 276). In this manner, short sellers act as informed traders and provide the negative observations, they received of the information on news events.

Event time	Rebate rate (in %)	Bid-ask spread (in %)
t - 5	3.849	0.154
t = 0	3.846	0.160
t + 5	3.860	0.154

Table 1: Borrowing from Engelberg et al. (2012), p. 274. Cross-sectional means of the Rebate rate and bid-ask spread for NYSE-listed and traded securities between 2005 and 2007. Rebate rate is the annualized rate in percentage points. Bid-ask spread is measured as a percentage of the closing mid-price on each day. T - 5 illustrates the value of the two key figures 5 days before a news event, whereas t + 5 describes the value 5 days after a news event. T = 0 illustrates the value on the news event. All values are significant at the 1% level.

5. Price Efficiency

5.1. Pricing Error

In this part of the paper, we illustrate the positive relation between short selling activity and price efficiency by reference to the pricing error. The pricing error s illustrates the temporary and non-information related deviation from the transaction price p regarding to the efficient price m (Boehmer/Wu (2013), p. 292).

$$p = m + s \tag{1}$$

Assuming the pricing error s returns zero, we can see in (1) that the transaction price p is the most efficient price and follows a random walk. A random walk means that all information is incorporated into the current price whereby it is not possible to predict the performance because the price is either overvalued or undervalued. (Prof. Dr. W. Breuer). Boehmer and Wu used this simple equation to underline that short selling leads to efficient prices. To confirm this relation, an increase in shorting activity should lead to a decline in the pricing error which implies an improvement relating to efficiency. First, we can see this relation by reference to the negative correlation of -0.16 in the appendix between shorting and the pricing error, which illustrates the opposite trend and thus an evidence that short selling is a contributor for price efficiency. Further evidence provides the regression model of Boehmer and Wu, which we can see in (2). The dependent variable reflects the pricing error. The explained variables are shorting activity and further control variables such as trading volume or order imbalance (Boehmer/Wu (2013), p. 296, p. 297).

$$Efficiency = \propto + \beta * Shorting + \gamma * Controls + \varepsilon \qquad (2)$$

To demonstrate that short selling activity enhances price efficiency, β must be negative to reduce the pricing error. For the regression results we disregard the control variables and focus on the variable $Shorting$. An increase in shorting by a standard deviation of 0.099 signifies that the pricing error decreases by 0.65%. In comparison, the mean of the pricing error amounts 0.095 which means that shorting activity is responsible for a pricing error decrease of roughly 7% relating to its mean. You can see these results and a more precise description of the pricing error, the correlation and the variable shorting in the appendix.

Furthermore, we can examine the positive relation between short selling activity and price efficiency by another measure, namely the half-life of a stock´s pricing error. This measure indicates the time, for example how many days, a stock needs to decrease the pricing error by half. Boehmer and Wu ascertain that the measure decreases from 1.6 days to 0.8 days when you compare lightly shorted stocks and heavily shorted stocks. This relation implies that heavily shorted stocks incorporate the public and private information faster because of a lower half-life´s pricing error (Boehmer/Wu (2013), p. 300, p. 301).

As a conclusion it is fair to say that short selling has an enhancing impact on price efficiency when we regard short-term measures. An increase in shorting leads to a decrease of the pricing error and the half-life of the pricing error and consequently to a greater price efficiency. The regression results of Boehmer and Wu provide evidence that short selling is an important component for the process of price discovery relating to a short period (Boehmer/Wu (2013), p. 301).

5.2. Return Reversals

In this section of the paper we want to refute statements that short selling leads to price destabilization and reveal ultimately that short sellers do not cause extreme price declines and thus inefficiency. To demonstrate this, we consider extreme price movements with an extreme downside trend following a reversal and apply two assumptions. First, this downside trend is not based on information because otherwise there would exist no reversal. Second, short sellers are informed traders who keep prices in line. These assumptions assume that short sellers reduce their activity with commencement of the downside trend. They are sophisticated traders and know that the price declines because of no-information events and reverse in the further course. In other words, if short sellers trade on and shortly after no-information price declines they will suffer probably a loss because they cover their position at increasing prices. On the contrary, if short sellers cause extreme price declines and destabilization of prices, short selling should increase on and short after no-information price declines in order that prices will fall even further. Boehmer and Wu examined this issue by formulating a further regression in terms of extreme negative returns, with the depending variable $Reversal\ Magnitude$, we can see in (3) and the explanatory variable $\Delta\ Shorting$ which reveals the variation in shorting between day 1 and day 0. We disregard again the other explanatory variables (Boehmer/Wu (2013), p. 309, p. 310, p. 312).

$$Reversal\ Magnitude = \frac{|R(t=1)|}{|R(t=0)|} \tag{3}$$

The bottom of the fraction denotes the extreme downside trend in $t = 0$, whereas the top of the bottom denotes the return or more specifically the reversal of the price in $t = 1$. In order to stabilize the price after an extreme price decline, the return in $t = 1$ must increase whereby also the reversal magnitude increases. To provide evidence that short sellers keep prices in line requires therefore a positive coefficient of the variable $\Delta\ Shorting$. The result of Boehmer and Wu´s regression suggests a coefficient of 0.311 and significance at the 1% level. It implies that an increase in shorting signifies a greater return in $t = 1$ and thus, a stabilization or more specifically an approach of the stock´s price to its prior level (Boehmer/Wu (2013), p. 312).

If short sellers manipulate prices or exacerbate price declines for these reversals, you would expect that short selling is related negatively to the reversal magnitude, because a smaller reversal magnitude leads to a smaller increase in prices and therefore to a slight price adjustment.

6. Impact of Short Sale Constraints on Price Efficiency

Lastly, we want to derive a rational expectation model by Diamond and Verrecchia (1987) and compare it with empirical results found by Saffi and Sigurdsson who tried to give an answer to those hypotheses.

In the previous part we have already mentioned the definition of efficient prices but in this section, we concentrate on Saffi and Sigurdsson´s. They “define price efficiency as the degree to which prices reflect all available information in terms of speed and accurancy” (Saffi/Sigurdsson (2011), p. 822).

6.1. The Rational Expectation Model

The model we want to introduce is a simple rational expectation model developed by Diamond and Verrecchia in 1987 which is based on Glosten and Milgrom (1985). In this model there are two types of trades which are either informed or uninformed and market makers who set the bid and ask prices. Each of them is risk neutral. The informed traders want to sell short because they think they can make money based on their private information. The uninformed traders want to sell short because of liquidity reasons. Possible reasons are, for example, that they have a need to consume at that time or that there are some investment opportunities for which they need money (Diamond/Verrecchia (1987), p. 280).

Now let us assume that there are three categories of short selling costs which could occur. The first category is that nobody is constraint or precluded from selling short so everybody is able to short at no cost (c_1). The second category is that there are short selling constraints. You can consider constraints to be something like extra costs, for example high interest fees or the fact that you are not able to reinvest your proceeds immediately. In this model we assume delays in receipt of proceeds (c_2) which means that they only drive uninformed investors out of the market, who only want to trade for liquidity reasons. The last category is short selling prohibition (c_3). This affects both types of traders equally. Examples for this kind of cost can be exorbitant fees that would eliminate your profit or you are simply prohibited from taking part such as the Uptick Rule (Diamond/Verrecchia (1987), p. 281).

Now we can figure out a tree diagram which depicts all possible processes which can lead to either buy, sell, short or no trade (see appendix Figure 3). First of all, the true value of the asset can be either 0 or 1 with a probability of one half, where $v = 0$ refers to a worthless asset. After that, the probability that you have the need to trade is g and that you do not have to is $(1 - g)$. The following action depends on your private information. If you are an informed investor and $v = 1$ then you buy the asset. If $v = 0$ you obviously want to get rid of the share. So, if you own it, you simply sell it, but if you do not, it depends on which short selling cost affects you. If you are an uninformed trader you could either buy or sell an asset. The only case where you would buy a share is, when you have experienced a liquidity shock. Why would you otherwise trade against better informed traders (Diamond/Verrecchia (1987), p. 284)?

If you look at the tree diagram in the appendix you might notice some problems. The first problem is that there are two ways a no-trade takes place. Either the traders do not want to trade, or the traders want to but are precluded due to short sale prohibitions. The second problem is that nobody, neither traders nor market makers, can distinguish between short sales or ordinary sales. Thus, there are only three, instead of four, observable actions (Diamond/Verrecchia (1987), p. 285). For each of these actions we have derived the probability of occurrence by adding up the probability for each path in the diagram. The results you can find in Table 2:

Actions directly overserved	Conditional probabilities when state-of-nature is $v = 1$ (q_1^A)	Conditional probabilities when state-of-nature is $v = 0$ (q_0^A)
Buy	$\frac{1}{2}g(1+a)$	$\frac{1}{2}g(1-a)$
Sell-or-short	$\frac{1}{2}g(1-a)(h+[1-h]c_1)$	$\frac{1}{2}g(1+a)(h+[1-h]c_1)+ga(1-h)c_2$
No-trade	$1-g+\frac{1}{2}(1-h)(1-a)(c_2+c_3)$	$1-g+\frac{1}{2}(1-h)[(1-a)(c_2+c_3)+2ac_3]$

Table 2: Taken from Diamond and Verrecchia (1987), p. 285

Now we have to figure out what effects short prohibitions and short restrictions have (Diamond/Verrecchia (1987), p. 287-292). We do so by deriving the probabilities from Table 2 again, but now for the cases when there are no restrictions or prohibitions, which serve as our bench mark, when short selling is forbidden for everyone and when there are only restrictions in form of delayed receipt of proceeds. Further we compare the conditional expected values and unconditional probability of action for each case.

To determine the effects of short selling prohibitions we can compare the results of Table 10 (see appendix), where Panel A is the base case where everybody who wants to go short is able to do so at any time. Because it is hard to say in which direction the value of the equations has changed, Diamond and Verrecchia have set each parameter to $\frac{1}{2}$. Hence, we simply have to compare the outcomes which are written right next to the equations.

We can see that the values in the row "Buy" do not change, at all. This implies that the prohibition of short sales has no effect on buying. Neither the ask price P_1^B ($\frac{3}{4}$) nor the conditional and unconditional probabilities that a buy takes place have altered. But the values in the “Sell-or-short” and “No-trade” row do have adapted. The probability (conditional and unconditional) that a trader sells has decreased while the probability of a no-trade has increased. This is because the number of sales drops due to the number of traders who are prohibited from selling short. Those not executed trades were listed in the category “No-trade” instead which drives up its probability. Therefore, a period of no-trade is informative and implies bad news.

The most interesting figure is the bid price P_1^S ($\frac{1}{4}$) which did not change like you have probably expected. The reason is, that a prohibition of short sales affects both informed and uninformed traders the same, which means the ratio of both types of traders stays the same. Nevertheless, the bid-ask-spread will increase as informative trades are prevented due to short sale prohibitions and as the market makers are risk averse they use the higher spread as protection (Diamond/Verrecchia (1987), p. 287-292).

As speed is a key figure of price efficiency, we have to investigate how the number of periods stock prices need to react on bad news, $\overline{N}_0$, and good news, $\overline{N}_1$ changes. Let our initial price be $P_0 = \frac{1}{2}$. We can now measure how many periods it takes for prices to either exceed (good news) or fall below (bad news) a certain benchmark. For example, $P^H = \frac{3}{4}$ and $P^L = \frac{1}{4}$, which denote the higher and lower benchmark prices. The result is, that $\overline{N}_0$ and $\overline{N}_1$ are both increasing functions of c_3. This means that the more people are constraints from short selling the longer it takes for prices to adjust to bad and good news. $\overline{N}_0/\overline{N}_1$ is also increasing, thus it takes longer to adjust to bad news than to good news when short sales constraints exists. This relation is supported by the findings of Boehmer and Wu, who examine the impact of short selling relating to price delays regardless of short sale constraints. They show that the coefficient of shorting on negative news events (-0.528) is less than on normal days (-0.365) and therefore leads to a greater price efficiency around downtrends. This result is consistent with the findings of the previous part that future price movements are more precise on news days and especially when the news are related negatively (Engelberg et al. (2012), p. 261). You can find these results in Table 6 in the appendix.

All in all, prohibiting short sales decreases the efficiency of prices due to higher number of periods of adjustment and increased bid-ask-spread which implies a less liquid market (Diamond/Verrecchia (1987), p. 287-292).

The case of receipt proceeds yields some different results (Diamond/Verrecchia (1987), p. 292-297). The values for the action “Buy” remain the same but the results for “No-trade” and “Sell-or-short” are slightly different (see Table 10 Panel A and C in the appendix). As only the uninformed traders are restricted (liquidity trades are prevented), the information content of short sales increases and the trades are more precise and no-trades remain uninformative. This means it takes less periods for adjustments ($\overline{N}_0$ and $\overline{N}_1$, decreasing functions of c_2) especially to bad news ($\overline{N}_0/\overline{N}_1$ decreasing function of c_2). The bid-ask-spread increases as the bid-trades are more informative. When many traders sell or short, there must be a reason apart from liquidity reasons. Thus, the bid price falls. But the more trades are made the more information are prevailed which closes the spread over time.

You can see that both, prohibitions and constraints, have contrary effects. While prohibition of short sales decreases the price efficiency, short sale constraints increases it. But Diamond and Verrecchia argue, that the effect of short sell prohibitions would dominate in real life, because there are more well-informed traders and the less informed traders are not completely uninformed like in this model. A cost which would influence only the less informed traders would act like short prohibitions (Diamond/Verrecchia (1987), p. 292-297).

After we explained the model and findings by Diamond and Verrecchia, we want to briefly supplement them another rational expectation model by Bai, Chang and Wang (2006). In their opinion, there are two reasons for selling short: risk sharing and speculating on private information (Bai et al. (2006), p. 4).

First of all, let there be symmetric information, which means that all investors have similar information about the stock´s payoff. In this case short sell constraints would always lead to an increase in stock prices and decreasing volatility (Bai et al. (2006), p. 10). In contrast to that, short sell constraints under asymmetric information can cause confusion and uncertainty among uninformed investors. This implies rising volatility or risk. If the price signal $S \in [-1;1]$, which indicates whether you should buy or sell, is exactly so small that the informed investor´s demand is zero, S still reflects all available information. But the moment S falls below this point, informed investors want to sell short and short sell constraints take effect. Now S does not reflect all information anymore and the stock´s price becomes uninformative (Bai et al. (1987), p. 12-15). As the investors in this model are not risk neutral but risk averse, higher level of perceived uncertainty by uninformed investors causes decreasing demand. The uninformed investors request lower prices as compensation for higher level of risk.

All in all, you can see that when we move on to the next subsection to discuss empirical results, we can expect them to imply that short sale restrictions decrease the price efficiency (slower adjustment process and high volatility) and lower prices.

6.2. Empirical Results

After investigated what results we have to expect, based on theory, in this section we want to answer the question whether empirical results are consistent with theory.

Saffi and Sigurdsson used a global dataset from 2005 to 2008 including stocks from 31 countries (Saffi/Sigurdsson (2011), p. 829). As proxies for short selling they used lending supply and loan fees. But whenever using loan fees as proxy, you have to take a look at both, the supply and demand side, because both can be the reason for increasing loan fees (Saffi/Sigurdsson (2011), p. 823).

Furthermore, they used two delay measures to provide information regarding the speed of adjustment. The first delay measure (D1) compares the fluctuation of stock returns from a regression where lagged market returns are included with results when those lags are constrained to zero (Saffi/Sigurdsson (2011), p. 827f):

$$D1_i = 1 - \frac{R^2_{\delta_i^{(-n)}=0, \forall n \in [1,4]}}{R^2} \tag{4}$$

The higher D1 the longer the price adjustment takes. Because the first delay measure does not take magnitude of fluctuation into account, the second delay measure (D2) does so (Saffi/Sigurdsson (2011), p. 828):

$$D2_i = \frac{\sum_{n=1}^{4} |\delta_i(-n)|}{|\beta_i| + \sum_{n=1}^{4} |\delta_i(-n)|} \tag{5}$$

Again, the higher D2 the lower the price efficiency. The results are, that lending supply has negative influence on both delay measures which is significant at the 1% level. This implies that a high level of lending supply leads to faster adjustment and thus makes the prices more efficient. The loan fees, on the other hand, have no or only little negative influence on the delay measurers (see appendix Table 7).

In addition to this there are three measures for a liquid market, which are also an indicator for the efficiency of markets. First of all, turnover (total weekly traded amount divided by total market capitalization (Saffi/Sigurdsson (2011), p. 835)) is positively correlated with lending supply ($\rho = 0.36$) and negatively with loan fees ($\rho = -0.04$). The bid-ask-spread is positively correlated with loan fees ($\rho = 0.35$) and negatively correlated with lending supply ($\rho = -0.44$). The same for zero-return-weeks (lending supply $\rho = -0.28$, loan fees $\rho = 0.18$). You can see that, as expected, higher loan fees reduce the market liquidity while lending supply improves it (see appendix Table 8).

Last, we take a look not on price measures for price efficiency but on those which are the reason that short selling constraints were implemented. Regulators like the SEC expected from those constraints, that they would decrease the downside risk, negative skewness, the frequency of extreme negative returns and total volatility. But the empirical results show, that on the one hand it is true that higher lending supply reduces the frequency of extreme positive returns and excess skewness but on the other hand it also reduces the frequency of extremely negative returns and does not have any significant impact on downside risk or total volatility. Higher loan fees have even negative effects. They increase the total volatility, downside risk and frequency of extreme high returns (see appendix Table 9).

As conclusion you can say, that these results are consistent with the expectations from the rational expectation models. Short selling constraints decrease the price efficiency and do not even serve their purpose why they have been implemented initially.

7. Summary

In this paper we figured out how short selling works and how it is constrained by certain regulators. Furthermore, we found out that short sellers are, on average, informed traders who are great at analyzing public information, hence the most informed trades take place at time of arriving news with a large order. Short sellers provide negative-related information into the market and lead to the fact that prices are more efficient. In the following parts we showed that constraining short sales leads to price inefficiency. We proofed this by analyzing pricing errors with the result that short selling, indeed, improves price setting. In the last part, we related the theory, in form of a rational expectation model, with empirical results from a researcher team which tried to verify the hypothesis nearly thirty years after they have been drawn. All findings we made yield the same results, short sales improve the price efficiency by decreasing the speed of adjustment, the total volatility and frequency of extremely low returns. This is in stark contrast to the view regulators have on short selling which arises the question if those constraints should be reduced more or even abolished.

8. Appendix

Regression output mentioned in section "Pricing Error":

	$\sigma(s)/\sigma(p)$	Price Delay
$\sigma(s)/\sigma(p)$	1.00	0.23
Price Delay	0.23	1.00
Shorting	-0.16	-0.14

Table 3: Borrowing from Boehmer/Wu (2013), p. 298. Averages of monthly cross-sectional correlations between shorting, pricing error and price delay. $\sigma(s)/\sigma(p)$ is the pricing error. Shorting describes shares shorted standardized by trading volume on a given stock. Monthly price delay is estimated to the annual price delay of Hou and Moskowitz (2015).

Variable	Mean	Median	SD
$\sigma(s)/\sigma(p)$	0.095	0.062	0.104
Shorting (%)	19.7	18.4	9.9

Table 4: Borrowing from Boehmer/Wu (2013), p. 298. Daily average of NYSE-listed stocks from 2005 to 2007. Shorting describes shares shorted standardized by trading volume on a given stock. $\sigma(s)/\sigma(p)$ is the pricing error. SD denotes the standard deviation.

	Coefficient	p-Values
Intercept	0.250	0.00
LagShorting	-0.066	0.00

Table 5: Borrowing from Boehmer and Wu (2013), p. 296. Extract of the regression results for NYSE-listed stocks from January 2005 to December 2007. LagShorting describes shares shorted by shares traded on a given stock lagged one day. The variable is significant at the 1% level.

Regression output mentioned in section “Rational Expectation Model”:

	Coefficient	p-Values		Coefficient	p-Values
Panel A			Panel B		
LagShorting	-0.365	0.00	LagShorting	-0.528	0.00

Table 6: Borrowing from Engelberg et al. (2012), p.261. Extract of the regression results for NYSE-listed common stocks from January 2005 to December 2007. The dependent variable in Panel A is the monthly price delay. The dependent variable in Panel B is a price delay that uses only down market returns. LagShorting denotes monthly average of daily shares shorted standardized by shares traded and lagged one month. LagShorting is significant at the 1% level.

Regression outputs and pairwise correlations mentioned in section “Empirical Results”:

	ρ^{Cross}	D1	D2
Supply	-0.100	-0.097	-0.080
	$[0.047]^{*}$	$[0.015]^{+}$	$[0.024]^{+}$
Fee	0.015	0.000	-0.021
	$[0.020]$	$[0.009]$	$[0.006]^{+}$

Table 7: Borrowing from Saffi/Sigurdsson (2011), p. 838). Extract of a regression output. For complete output table see original paper. The standard errors are written in brackets. *=significant at the 5% level and +=significant at the 1% level.

	Zero-return-weeks	Turnover	Bid-Ask
Supply	-0.28	0.36	-0.44
Fee	0.18	-0.04	0.35

Table 8: Borrowing from Saffi/Sigurdsson (2011), p.838. Pairwise correlation of explanatory variables.

	Exc(Skew)	Down	Up	Down Risk	Vol
Supply	-0.076	-0.029	-0.069	-0.010	-0.019
	$[0.015]^{+}$	$[0.014]^{*}$	$[0.013]^{+}$	$[0.016]$	$[0.016]$
Fee	0.044	-0.147	-0.101	0.111	0.172
	$[0.019]^{*}$	$[0.019]^{+}$	$[0.017]^{+}$	$[0.020]^{+}$	$[0.021]^{+}$

Table 9: Borrowing from Saffi/Sigurdsson (2011), p. 846. Extract of a regression output. For complete output table see original paper. Exc(Skew) is based on the residuals of local market-model regression. Down (Up) is the fraction of returns two standard deviations below (above) the previous year´s average. The standard errors are written in brackets. *=significant at the 5% level and +=significant at the 1% level.

Tree diagram mentioned in section "Rational Expectation Model":

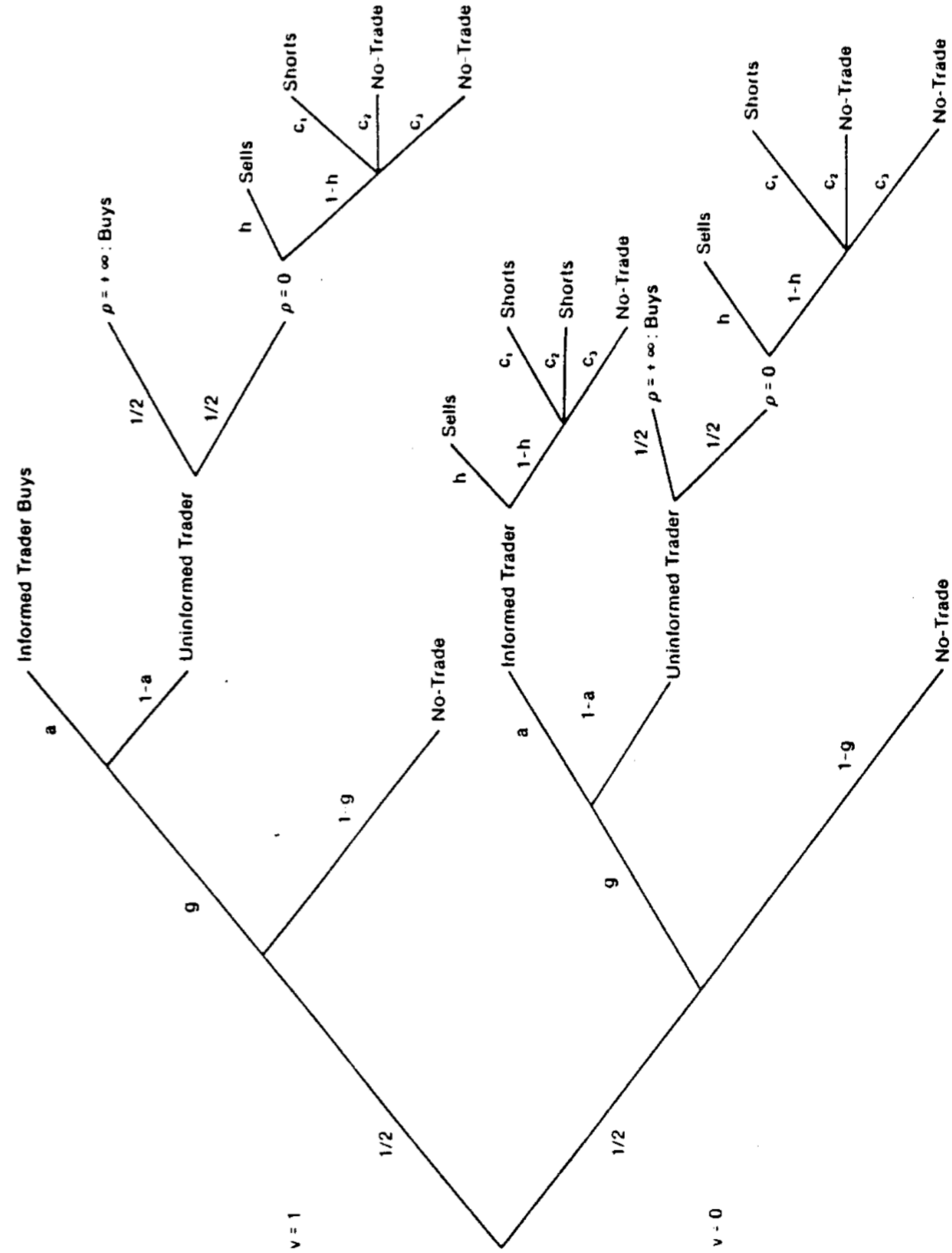

Figure 3: Taken from Diamond and Verrecchia (1987), p. 283. This tree diagram shows you all possibilities how a buy, short, sale or no-trade can take place, with $v \in \{0; 1\}$ the value of the asset, g the probability that a trader wants to trade, a the probability that a trader is informed, h the probability that a trader owns the asset, ρ the liquidity shock and c_i the three types of cost.

Three cases of short sale constraints mentioned in section "Rational Expectation Model":

Action	Conditional expected values of the asset at $t = 1$ (P_1^A)	Conditional probabilities when state-of-nature is $v = 0(q_0^A)$	Conditional probabilities when state-of-nature is $v = 1(q_1^A)$	Unconditional probability of action
Panel A ($c_1 = 1, c_2 = 0, c_3 = 0$):				
Buy	$\frac{1}{2}(1+a)$; $\frac{3}{4}$	$\frac{1}{2}g(1-a)$; $\frac{1}{8}$	$\frac{1}{2}g(1+a)$; $\frac{3}{8}$	$\frac{1}{2}g$; $\frac{1}{4}$
Sell-or-short	$\frac{1}{2}(1-a)$; $\frac{1}{4}$	$\frac{1}{2}g(1+a)$; $\frac{3}{8}$	$\frac{1}{2}g(1-a)$; $\frac{1}{8}$	$\frac{1}{2}g$; $\frac{1}{4}$
No-trade	$\frac{1}{2}$	$1-g$; $\frac{1}{2}$	$1-g$; $\frac{1}{2}$	$1-g$; $\frac{1}{2}$
Panel B ($c_1 = 0, c_2 = 0, c_3 = 1$)				
Buy	$\frac{1}{2}(1+a)$; $\frac{3}{4}$	$\frac{1}{2}g(1-a)$; $\frac{1}{8}$	$\frac{1}{2}g(1+a)$; $\frac{3}{8}$	$\frac{1}{2}g$; $\frac{1}{4}$
Sell-or-short	$\frac{1}{2}(1-a)$; $\frac{1}{4}$	$\frac{1}{2}gh(1+a)$; $\frac{3}{16}$	$\frac{1}{2}gh(1-a)$; $\frac{1}{16}$	$\frac{1}{2}gh$; $\frac{1}{8}$
No-trade	$\frac{1}{2}\frac{1-g+\frac{1}{2}g(1-h)(1-a)}{1-g+\frac{1}{2}(1-h)}$; $\frac{9}{20}$	$1-g+\frac{1}{2}g(1-h)(1+a)$; $\frac{11}{16}$	$1-g+\frac{1}{2}g(1-h)(1+a)$; $\frac{9}{16}$	$1-g+\frac{1}{2}g(1-h)$; $\frac{5}{8}$
Panel C ($c_1 = 0, c_2 = 1, c_3 = 0$)				
Buy	$\frac{1}{2}(1+a)$; $\frac{3}{4}$	$\frac{1}{2}g(1-a)$; $\frac{1}{8}$	$\frac{1}{2}g(1+a)$; $\frac{3}{8}$	$\frac{1}{2}g$; $\frac{1}{4}$
Sell-or-short	$\frac{1}{2}\frac{h(1-a)}{h(1-a)+a}$; $\frac{1}{6}$	$\frac{1}{2}gh(1-a)+ga$; $\frac{5}{16}$	$\frac{1}{2}gh(1-a)$; $\frac{1}{16}$	$\frac{1}{2}gh(1-a)+\frac{1}{2}ga$; $\frac{3}{16}$
No-trade	$\frac{1}{2}$	$1-g+\frac{1}{2}g(1-h)(1-a)$; $\frac{9}{16}$	$1-g+\frac{1}{2}g(1-h)(1-a)$; $\frac{9}{16}$	$1-g+\frac{1}{2}g(1-h)(1-a)$; $\frac{9}{16}$

Table 10: Borrowing from Diamond and Verrecchia (1987), pp. 289, 290, 294. Panel A is the base case where there are no restrictions nor prohibitions. Panel B is the case where short selling is prohibited for everyone and Panel C where all traders face delayed receipt of proceeds.

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