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No Negativity Allowed During Uncertain Periods!

A Comparison of short sale restriction during the Eurozone crisis and Covid-19 Pandemic

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Abstract

During uncertain periods, regulators have been known to restrict the ability to short sell in markets. The stated reason is to help calm the markets and to reduce the volatility. The purpose of this paper is to examine if this stated goal was achieved by the regulators during the Eurozone crisis and the Covid-19 Pandemic, as well as comparing the impact on volatility for these two periods. This is done using a Difference in Difference estimator, with two approaches. Where the first one examines the volatility on an index level, while the second one examines the volatility solely for stocks in the financial sector. The results indicate that the Treatment effect, i.e. the short selling restriction, is significant and positive for all approaches except for the Index Approach during the Eurozone crisis. This implies that the restriction increased the volatility during these uncertain periods, instead of decreasing it. Therefore we argue, in line with previous literature, that a short selling ban should not be used to try and calm down the markets.

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1. Introduction

1.1 Background

Short selling has long been a subject of interest among market participants. The academic perspective is that short selling aids the market in price discovery, eliminating arbitrage opportunities and increasing the market quality by e.g providing more liquidity (Bessler & Vendrasco, 2020). However, others argue that short selling could be an undesirable feature as it could increase volatility and negative returns during already extreme and volatile periods (Geraci, Garbaravicius & Veredas, 2018).

The Covid-19 Pandemic, a period of major economic uncertainty due to the impact on supply and demand of the lockdowns, caused one of the fastest and most brutal declines in the markets in a century, where naturally the volatility was high (Siciliano & Ventoruzzo). Regulators in six European countries took an individual decision to introduce a short selling ban, namely; Austria, Belgium, France, Greece, Italy and Spain. This temporary ban restricted investors from not only short selling but also transactions that could constitute or increase net short positions on stocks during March 18 to May 18, 2020 (Siciliano & Ventoruzzo, 2020). Moreover, because the ban during Covid-19 only lasted for two months, all stocks were included (not only financial stocks as during the Eurozone crisis) and there was no data on any type of banking crisis or systematic risk; it makes this ban unique (Bessler & Vendrasco, 2020).

The reason that regulators often implement a restriction is to ensure financial stability, regulators often refer to lower volatility as a reason for the ban. However, this statement goes against the majority of literature that has been done on the subject, the research actually says the opposite (Alves, Mendes & Silva, 2016; Battalio & Schultz, 2011; Beber, Fabbri, Pagano & Simonelli, 2020; Beber & Pagano, 2013; Bessler & Vendrasco, 2020; Boehmer, Jones & Zhang, 2013; Helmes, Henker & Henker, 2017; Marsh & Payne, 2012; Siciliano & Ventoruzzo, 2020). In a recent paper by Bessler & Vendrasco (2020) they present the previous literature and that it does not recommend short selling

restrictions, even in a crisis or uncertain periods, because market quality, i.e volatility, liquidity and price discovery mechanisms are affected negatively. They are surprised that regulators in Europe would implement the ban during Covid-19 as it goes against all the previous literature, and that examining the outcome is of great importance. Alves, Mendes & Silva (2016) mention that the effects of short selling restrictions are occasional and that therefore each ban deserves to be studied. This especially applies for studies done in Europe and that they call for special attention because of the lack of empirical evidence from the impact of short selling bans as compared to the United States. Beber et. al (2020) has an approach which is similar to earlier studies, however they include not only one but two crises, namely the Financial crisis and the Eurozone crisis. No such comparison has been done on the European markets, due to the lack of natural experiments, which is what this paper now can rectify with the emergence of Covid-19 which functions like a natural experiment (Siciliano & Ventoruzzo, 2020). The literature appears to agree that there is a loss of market quality in case a restriction has been implemented. There has however not been as much focus given to analyzing whether or not the goals stated by the regulators when implementing the ban have been achieved or not (Helmes, Henker & Henker, 2017). For that reason, this paper will try to address the gaps in the literature by investigating if the short selling bans in Europe contributed in calming the markets, as was the stated goal of the regulators. Since there exists a large literature on the Eurozone crisis, the focus of this paper will mainly be on the Covid-19 Pandemic which has had less coverage and also on the difference between the two European restrictions.

The research question:

- *Did the short selling restrictions during the Eurozone crisis and the Covid-19 Pandemic reduce the volatility?*

For both the Eurozone crisis and the Covid-19 Pandemic, pre- and post-restriction periods are created. Enabling the use of a Difference-in-Difference estimator to answer the research question. France and Belgium are included in the treatment group while Germany and the Netherlands are in the control group. Two different approaches will be

used, where the first will examine the volatility on an index level. The second will examine the volatility only for the stocks in the financial sector. In doing so we find that during Covid-19 the decision to restrict short selling in both approaches leads to an increase in volatility as is seen by the Treatment effect, δ, which is positive and significant. However, during the Eurozone crisis the δ-parameter is only significant and positive for the financial sector, while for the index it is insignificant and negative. The restriction on short selling increased volatility in the ranges of 1.18% to 3.87% on a monthly basis, depending on the approach. The restrictions thus, did not achieve the stated goal by the regulators of reducing volatility. Instead it did the opposite of what it was meant to do and increased the volatility.

1.2 Short Selling

Short selling a stock is a trading strategy in which an investor tries to profit or gain other advantages from a decline in the price of the security. A short seller thus has a negative expectation of the security or the market (Siciliano & Ventoruzzo, 2020). A majority of all short sales are done by institutions, while individual investors only represent a small minority (Boehmer, Jones & Zhang, 2008). Boehmer, Jones & Zhang (2008) finds that during 2000-2004, 13% of the total volume on NYSE consisted of short sales. Furthermore, Diether, Lee & Werner (2009) finds that during 2005, 24% of NYSE share volume was short sales, while for Nasdaq it was 31%.

As a desirable feature on the market, short selling has long been a subject of interest. The academic perspective is that short selling aids the market in price discovery, eliminating arbitrage opportunities and increasing the market quality by e.g providing more liquidity (Bessler & Vendrasco, 2020). Short sellers generally increase information efficiency and market quality (Boehmer & Wu, 2013; Bris, Goetzmann & Zhu, 2007). In addition, short selling is also useful for hedging strategies, risk management and mitigating bubbles (Diether, Lee & Werner 2009). Other researchers however, argue that short selling could be an undesirable feature as it could increase volatility and negative returns during already extreme and volatile periods (Geraci, Garbaravicius & Veredas, 2018). Moreover, short selling might not only be a bet on a declining security

price, instead it could also be used to influence or even determine a declining trend as the investor sells large amounts of shares in a stock. This strategy might then further enhance a downward spiral, forcing the price of a stock down further than what would have been reasonably expected by fundamentals. It thus might harm companies by increasing their cost of capital (Siciliano & Ventoruzzo 2020). On top of this, a short seller could open a short position and then start sharing negative opinions that might be true, misleading or even incomplete as to hurt the price of the asset. This behavior might then be illegal and classified as market manipulation.

1.3 Litterature

There is a large literature on short selling and its role in price discovery and enhancing market efficiency. The literature begins with Miller (1977), who argues that given a short sale constraint, pessimistic traders will be driven out of the market. This will lead to an upward bias in the prices, as the valuations will reflect the views of more optimistic traders. Building on this work, Diamond and Verrecchia (1987) use a rational expectations model and focus on the speed of adjustment for prices to private information. They claim that short sale restrictions will reduce the speed at which prices adjust to private information, especially negative information. These studies both argue that the existence of short sellers helps market efficiency by increasing the speed of adjustment to new information and also that prices reflect the true value of assets. Banning short selling would then reduce informational efficiency and thus decrease market quality.

More recent studies investigating bans on short selling and its effect on volatility, liquidity, price discovery and overpricing find that restrictions have a negative impact on market quality (Alves, Mendes & Silva, 2016; Bessler & Vendrasco, 2020, Hermes, Henker & Henker, 2017; Siciliano & Ventoruzzo, 2020). The studies do however examine different time periods and markets. Alves, Mendes and Silva (2016) examined the impact that the short selling restriction had in Belgium, France, Italy and Spain in August 2011. They report an upsurge in volatility after the restriction for all stocks.

Furthermore the volatility of the banned financial stocks was higher compared to those who were not. In addition they also found that the change in volatility after the restriction was higher for those stocks which were banned.

Bohl, Reher and Wilfling (2016) and Helmes, Henker and Henker (2017) examine the effect of the Financial crisis on specific markets. Bohl, Reher and Wilfling (2016) examines the German market, using the stocks within the DAX-index as both test and control groups while Helmes, Henker and Henker (2017) compares Financial stocks in Australia with matched Canadian stocks. Bohl, Reher and Wilfling (2016) analyze the volatility of stock returns prior to and during the implementation of the short selling bans on the German stock market during September 2008 to July 2010. They find that for the German stock market there was an increase in the conditional variances, an increase in volatility persistence and for stocks which were affected by the short selling restriction the effect was especially pronounced. For this reason they state that the volatility on stock returns can be seen as proof of a destabilizing impact of short selling constraints. They give an explicit recommendation to regulators to not restrict short selling during market downturns to try and stabilize the market. This opinion is shared by Helmes, Henker and Henker (2017) who also come to the conclusion that the stated goal of the regulators to calm the Australian market was not achieved by banning short selling. Helmes, Henker and Henker (2017) finds that the restriction did not reduce volatility or stabilize stock prices, instead it rather worsened market quality in that there was an increase in volatility, increased bid ask spread and reduced trading activity. They therefore argue against the regulator's stated reason for the short selling restriction.

Bessler and Vendrasco (2020) and Siciliano and Ventoruzzo (2020) also conclude that regulators should be careful in taking the decision of implementing short selling restrictions during market crises, as the restrictions give rise to negative consequences on market quality and their lack of effectiveness. The studies do however discuss that there could be political pressure or reasons for introducing restrictions.
The discussion of short selling and if it contributes to an efficient market or not has led to regulators intervening over the years (Jiang, Habib & Hasan, 2020). The literature

studying the impact of short selling restrictions on market quality seems to find that there is a loss in market quality, even if this restriction is during a crisis.

However, regarding the role of short sellers there are mixed theories, where either they are informed traders, skilled at identifying overvalued stocks by collecting and processing information (Engelberg, Reed & Ringgenberg, 2012), that brings mispriced assets closer to their fundamental price (Boehmer, Jones & Zhang, 2008; Diamond & Verrecchia, 1987). Contrarily they are seen by others as uninformed agents who increase volatility and drive prices away from fundamentals by using predatory strategies and also use trade based manipulation scheme (Allen & Gale, 1992; Brunnermeier & Oehmke, 2014; Brunnermeier & Pedersen, 2005; Goldstein & Guembel, 2008). During “normal times”, short sellers function as vital information intermediaries who strengthen the information environment (Jiang, Habib & Hasan, 2020). However, during times of turmoil, aggressive short sellers could increase volatility and negative stock returns, this applies especially to smaller firms (Geraci, Garbaravicius & Veredes, 2018). Some of the most critical risks are predatory investors and market manipulation leading to mispricing of stocks and increased volatility (Allen & Gale, 1992; Brunnermeier & Oehmke, 2014). A consequence of this might be that in times of great market uncertainty regulators might be forced to intervene to reduce the risks and in so allowing the positive information effects of short selling to prevail (Bessler & Vendrasco, 2020). Both Beber et al. (2020) and Bessler and Vendrasco (2020) state these reasons as why regulators might intervene, yet both of them find that the results in terms of e.g volatility are worse, due to the intervention. In conclusion, according to Siciliano & Ventoruzzo (2020), the majority of empirical papers observe that short selling has a positive effect on price efficiency and liquidity. Thus supporting the notion that short selling is an important part in maintaining an efficient market.

2. Methodology

2.1 Difference-in-Difference

In order to analyze the effect that short-selling restrictions have on volatility we apply a Difference-in-Difference estimation. A similar method has been applied in previous studies (e.g., Alves, Mendes & Silva, 2016; Beber & Pagano, 2013; Boehmer, Jones & Zhang, 2013; Siciliano & Ventoruzzo, 2020) in order to analyze the effect that short-selling restrictions have during different periods. The reason behind applying this framework is that the Difference-in-Difference framework allows for a comparison of two time periods, a pre-event and a post-event period, and two different groups, one treated and one untreated group, in order to return a result where differences are highlighted. In the case of this study we want to compare two groups. The first group consists of France and Belgium where a short-selling restriction was introduced. The second group consists of Germany and the Netherlands where no such restrictions were introduced. The comparison is done by examining the time before and after this restriction was put in place.

The Difference-in-Difference estimator combines two single difference estimators. The first of these two single difference estimators is the "Cross-sectional comparison" specified in Equation 1 below. This part examines and compares our two different groups over a sample period and by doing so avoids problems with omitted trends in the data (Roberts & Whited, 2013). The difference between the two groups is captured by the parameter γ as the variable $D_{\text{Restricted-group}}$ is a dummy variable set to 1 if the observation belongs to the treatment group, i.e. France or Belgium, and 0 otherwise.

$$y = \alpha + \gamma D_{\text{Restricted-group}} + u \tag{1}$$

The second single difference estimator is the time series comparison, specified in Equation 2 below. This part examines and compares a single group before and after an event. In the case of the introduction of a short-selling restriction the time series comparison examines the volatility before and after the restriction was put in place. The

dummy variable $D_{\text{Restriction-period}}$ period takes on the value 1 if the observation belongs to the post-restriction period i.e. when policy makers had decided on restricting short-selling, and 0 if prior to that, hence the parameter β captures the difference between time periods.

$$y = \alpha + \beta D_{\text{Restriction-period}} + u \quad (2)$$

The Difference-in-Difference estimator combines the two and allows for an analysis that is able to avoid problems of omitted trends as well as unobserved differences between the two different groups (Roberts & Whited, 2013). Putting the cross-sectional component, the time series component and an additional dummy variable which is equal to 1 for the treatment group in the treatment period (this is simply done by multiplying the two previously mentioned dummy variables with one another) gives us the following model which will be the base of the further analysis;

$$y = \alpha + \beta D_{\text{Restricted-group}} + \gamma D_{\text{Restriction-period}} + \delta D_{\text{Restricted-group-during-restriction-period}} + u \quad (3)$$

In the finalized model y is our dependent variable, α is a constant and μ is the residual error term. $D_{\text{Restriction period}}$ is a dummy variable which if equal to 1 indicates that the observation takes place after the introduction of short-selling restrictions. This dummy variable does not depend on whether an observation belongs to one of the countries where a short-selling restriction was put in place. It rather indicates if the observation belongs to the time period after such a restriction was introduced, regardless of group participation. As such β captures the difference before and after the restrictions. $D_{\text{Restricted-group}}$ is a dummy variable which takes on the value 1 if the observation is taken from the treatment group i.e. one of the countries where a short-selling restriction was put in place. In a similar fashion to the previous dummy variable this group specific dummy does not depend on time and will be set to 1 for all observations belonging to a group where a short-selling restriction was put in place regardless of when the observation was collected. Accordingly γ captures the difference in group fixed effects between the treatment group and the control group. Lastly the dummy variable

$D_{\text{Restricted-group-during-restricted-period}}$ is the product of $D_{\text{restricted-group}}$ and $D_{\text{restriction-period}}$ and therefore equal to 1 if and only if the observation belongs to the treatment group after the restrictions were put in place. In practice this means that this dummy variable is equal to 1 if the observation belongs to one of the countries where a short-selling restriction was introduced during the time where said restriction was active. The related coefficient, δ, isolates the causal effect of a short-selling restriction. All variables are summarized in Table 1 below, where the difference between the two different groups and time periods are also visualized.

Table 1 - Interpretation of the Difference-in-difference parameters

	Post-restriction	Pre-restriction	Difference
Restricted group	$\alpha + \beta + \gamma + \delta$	$\alpha + \gamma$	$\beta + \delta$
Non-Restricted group	$\alpha + \beta$	α	β
Difference	$\gamma + \delta$	γ	δ

Note: Table 1 displays the parameters used in calculating the value of the dependent variable for all possible combinations of the Difference-in-difference regression. For example, if an observation belongs to the group facing restrictions during the time period when the restrictions are in place its value is determined by the sum of every parameter i.e. $\alpha + \beta + \gamma + \delta$. The table also visualizes the difference between how the dependent variable is calculated between time periods and which group it belongs to.

The key assumption needed for the difference-in-difference estimation to provide valuable results is the so-called parallel trend assumption. For the parallel trend assumption to hold it should be true that in absence of treatment the difference between the control group and the treatment group should be constant over time (Angrist & Pischke, 2009). For this study, the parallel trend assumption means that had it not been for the policy decision of restricting short-selling of certain indices or stocks the trend between the securities subject to these restrictions and the securities unaffected by them would have shared the same trend. The parallel trend emphasizes the importance of choosing a suitable control group in order to draw a meaningful conclusion from the

difference-in-difference regression. For this reason a number of requirements for both the treatment group and the control group are listed in section 2.3.1 about the delimitations of this study. Lastly, there is no formal statistical test that can be used in order to confirm that the parallel trend assumption is fulfilled, instead controlling for the assumption relies on visual inspection of the data (Angrist & Pischke, 2009).

2.2 Research design

In our study we adopt two different approaches. Firstly we follow the methodology of Bohl, Reher and Wilfling (2016) and analyze the changes in volatility on an index level. This is done in order to get an understanding of the market as an aggregate and not just a single stock. Because of the differences in implementation of short-selling restrictions between the two time periods it will also allow for a comparison between restrictions targeted at a specific sector versus the entire market. Secondly we follow a majority of the previous literature (e.g., Alves, Mendes & Silva, 2016; Beber & Pagano, 2013; Bessler & Vendrasco, 2020; Boehmer, Jones & Zhang, 2013; Helmes, Henker & Henker, 2017) by analyzing a sample of stock within the financial sector. The reason behind this is that previous literature mainly focuses on the financial sector, as well as the fact that during the Eurozone crisis it was this particular sector that was the target of short-selling restrictions.

2.2.1 Index

In the index approach the treatment group consists of the main indices in France and Belgium, i.e the CAC40 Index and the BEL20 index. A downside with this approach is that a few stocks are cross listed, resulting in certain stocks belonging to these indices not being affected by the short-selling restrictions as they are still available for short-selling in non-restricted markets. The two indices in the treatment group, as well as the two in the control group consisting of Germany and the Netherlands i.e. the DAX and AEX are all market cap-weighted. This means that the individual components included in each of the investigated indices are weighted in the index as per their market capitalization. A possible drawback with this is that a single stock may be contributing to a disproportionate impact on the volatility of the index. This means that

the changes in index volatility may be driven by only a few stocks in that index. However, we still choose to proceed with this approach as it is true that certain parameters are affected to a higher degree by certain companies. The index approach will also serve well as a comparison between the two events analyzed in this study. Because of the difference in how the restriction was implemented in the treatment group, with only the financial sector being targeted during the Eurozone crisis as opposed to the whole market during the Covid-19 Pandemic. Because of this the index approach during the Eurozone crisis will be of particular interest as it could indicate whether or not the restriction placed on the financial sector was impactful enough to affect the indices.

2.2.2 Financial sector

In the second part of our analysis we break down the indices and target stocks in the financial sector. By doing this we can compare differences in the financial sector, both between treatment and control group as well as between the two events. This approach is of specific interest as it is the subject of investigation in a majority of the previous literature, attributed to the fact that short-selling restrictions have most often specifically targeted financial securities. This approach will also enable us to compare the two event periods to see potential differences and similarities between short-selling restrictions targeted at the financial sector versus targeting the whole market.

2.3 Sample

2.3.1 Delimitations

Before conducting the analysis a number of delimitations had to be considered. During the Eurozone crisis, on the 11th of August 2011, four countries decided to introduce short selling restrictions on securities in the financial sector. Similarly during the Covid-19 Pandemic, on the 18th of March 2020 six countries decided on introducing market wide short-selling restrictions. Since part of the aim of the study is to compare

differences between the two periods the list of countries introducing short-selling restrictions were cross referenced narrowing the potential candidates down to three countries for the treatment group. In order to obtain reliable results from the Difference-in-Difference regression the countries in the treatment group and the control group should share similar characteristics and fulfill three different requirements which led to Spain being excluded from the treatment group. As a result the treatment group consists of two countries which are going to be matched with a control group of two countries based on the following three requirements. Firstly, in order to be included the country must have a credit score of at least A from the three main credit rating agencies Moody's, S&P Global Rating and Fitch Ratings which allows for a fair comparison with respect to financial characteristics. Secondly, corresponding to previous research (e.g. Alves, Mendes & Silva, 2016) the countries should share similar industry distribution, and thirdly they should also share the same regulatory characteristics. Effectively both of the groups should react to the same supply and demand shocks and share the same regulatory environment. Choosing the right control group is of utmost importance since both the treatment and group and control group should be directly comparable (Alves, Mendes & Silva, 2016). The reason behind this is because one of the key assumptions of the Difference-in-Difference framework is that in absence of the short-selling restriction the treatment and control group would be equally affected and share similar movements when hit by the shock originating from the Eurozone crisis and the Covid-19 Pandemic. Based on these assumptions the two countries that were assigned to constitute the control group were Germany and the Netherlands.

2.3.2 Data

In order to conduct our analysis we collected data from Bloomberg. First we collected data for each of the four indices used in our analysis in order to conduct a comparison on a broader level. For the financial sector approach we collected data on financial stocks. For the Eurozone crisis we collected data on the stocks affected by the short selling-restriction, these are then included in the treatment group. The control group consists of financial stocks included in the DAX and AEX indices. For the Covid-19

crisis we collected data on financial stocks included in each of the indices. When looking into all of the stocks included in the indices we came across a number of stocks which were cross listed and two cases of stocks being included in two of the indices. We decided to exclude these two stocks as well as any cross listed stocks as it may affect the results we obtain negatively. After the sorting was done the final sample consisted of 16 stocks, where 9 were included in the treatment group and 7 were included in the control group, for the Eurozone crisis. For the Covid-19 Pandemic a total of 21 stocks were included in the analysis of which 11 belonged to the treatment group and 10 belonged to the control group. The time frame considered stretched from the 30th of January 2011 until the 13th of February 2012 for the Eurozone crisis and from 30th of August 2019 until the 15th of May 2020 for the Covid-19 crisis.

Table 2 - Sample distribution by event, group and time period.

Eurozone crisis - Index		
Number of observations	Restricted group	Non-restricted group
Before restriction	232	232
After restriction	260	260
Total number of observations: 984		
Eurozone crisis - Financial sector		
Number of observations	Restricted group	Non-restricted group
Before restriction	1044	812
After restriction	1179	912
Total number of observations: 3947		
Covid-19 Pandemic - Index		
Number of observations	Restricted group	Non-restricted group
Before restriction	239	237
After restriction	80	80
Total number of observations: 636		
Covid-19 Pandemic - Financial sector		
Number of observations	Restricted group	Non-restricted group
Before restriction	1324	1185
After restriction	440	400
Total number of observations: 3349		

Note: Table 2 summarizes all of the data included in the sample. The different data points are then divided by event i.e. Eurozone crisis or Covid-19 Pandemic, group i.e. subject to short-selling restrictions or not and lastly by time i.e. before/after the restrictions were put in place. For example there were 912 observations in the non-restricted group after restrictions were introduced. The total number of observations for each subsample is listed in *Italic.*

2.4 Modeling volatility

For our study we are investigating the effects of short-selling restrictions on volatility. Volatility is therefore included as the dependent variable in the Difference-in-Difference regression. Volatility however, is a latent variable and therefore not directly observable. Therefore we need to find a way to estimate volatility based on observable historical data (Bollerslev, Hood, Huss & Pedersen, 2018). Ideally, volatility should be modeled using high frequency intraday data with small intervals in order to calculate daily realized volatility. Due to data limitations we instead use daily observations in order to model volatility. For both the indices and the financial sector we calculate realized volatility using daily returns for each of the stocks in our sample.

2.4.1 Realized volatility

In order to estimate the volatility for both indices and the financial sector we follow the methodology of Siciliano and Ventoruzzo (2020) and calculate the realized volatility of each stock included in the sample based on its historical data. In order to do this we use historical closing prices and calculate the daily return for each index or stock. Based on these daily returns we calculate the monthly volatility which is done by letting N be equal to 20, which is the number of trading days in a month. This means that each observation will be calculated using a moving window of 20 observations. Realized volatility is calculated with the following equations:

$$Realized\ Variance\ = \sum_{i=1}^{N} r_t^2 \tag{4}$$

$$Realized\ Volatility\ = \sqrt{Realized\ Variance} \tag{5}$$

Where

r_t is the daily return of the stock calculated as $ln(S_t) - ln(S_{t-1})$

S_t is the price of the stock at time t

3. Results

3.1 Eurozone crisis

3.1.1 Index

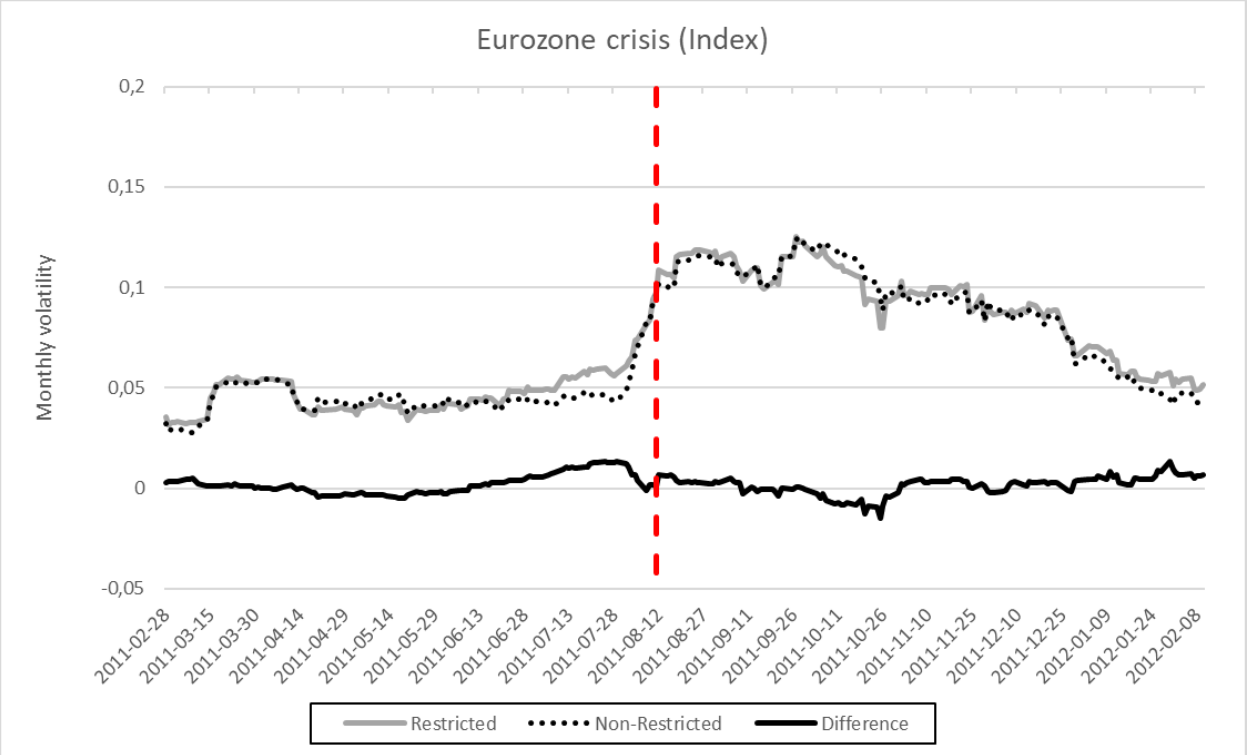

Figure 1 - Index volatility during the eurozone crisis before and after the introduction of the short-selling restriction

Note: Figure 1 plots the index volatility during the eurozone crisis estimated by realized volatility and a 20-day moving window. The vertical red line indicates the day on which the short-restriction was introduced for the restricted indices (August 11th 2011).

Figure 1 displays the foundation for the Eurozone crisis index analysis. The plot visualizes the dependent variable in the Difference-in-Difference regression (DiD). Both the volatility of the restricted indices and the non-restricted indices are plotted and the solid black line is the difference between them. As can be made out from the graph, the volatility of both groups closely follows one another during the sample period. By visual inspection we can gain insight on the potential outcome of the DiD estimation. Most obvious is the difference in volatility between the two time periods, before and after the

introduction of the short-selling restriction. This suggests that the Time Fixed Effect in the DiD estimation will likely yield a significant result. As for the parallel trend assumption we can assume that it is fulfilled as the difference between the two groups looks like it is at large constant before the introduction of the short-selling restriction. However, this seems to be true even after the policy was put in place where the volatility of both groups keeps following each other closely. As such it could be that the result does not yield any significance with regards to either Group Fixed Effects nor any Treatment Effect. From here we proceed with presenting the Difference-in-difference regression results.

Table 3 - Regression results (Eurozone crisis, Index)

Dependent variable: Volatility		
No. Observations: 984		Adjusted R^2: 0.5544
Parameter	Coefficient	P-value
α (Intercept)	0.0462 (0.0013)	0***
β (Time Fixed Effect)	0.0446 (0.0017)	0***
γ (Group Fixed Effect)	0.0022 (0.0018)	0.229
δ (Treatment Effect)	-0.0005 (0.0025)	0.836

Note: Table 3 presents the results of the Difference-in-Difference regression where the dependent variable i.e. daily volatility is a function of a Constant, a Time Fixed Effect, a Group Fixed Effect and a Treatment Effect (the restriction). Each coefficient is interpreted as a monthly effect and details of what each parameter represents are presented in (Equation 3). The standard error for each parameter is presented within the parenthesis below its respective coefficient. Each of the coefficients is also connected to a p-value indicating its statistical significance level (Berger & Mortera, 1991). Each p-value is assigned either *, ** or *** depending on its significance level. * indicates significance level on the 10 % level i.e. p-value < 0.1. ** indicates significance on the 5 % level i.e. p-value < 0.05. *** indicates significance on the 1 % level i.e. p-value < 0.01.

In Table 3 the results from the Difference-in-Difference estimation of the index approach for the Eurozone crisis are displayed. In total there were 984 observations and the adjusted R-squared was calculated to 0.55. As the Table shows the Constant and the Time Fixed Effects were in the case of the index approach both positive and significant

on the 1 % level (p-value < 0.01). The parameter for the Group Fixed Effect and the Treatment effect (i.e. the restriction of short selling) were both not significant at the 10 % level (p-value > 0.1). That the Group Fixed effect is insignificant indicates that there is no statistically significant difference between the control and the treatment group in the pre-restriction period. For the Treatment effect, being insignificant means that there was no significant difference on the index's volatility after the introduction of a short-selling restriction on the financial stocks in the index. The volatility corresponding to the pre-restriction period for the treatment group is calculated as the Constant plus the Group Fixed Effects, $\alpha + \gamma$. This translates to a monthly index volatility equal to 4.84% for the treatment group. For the control group in the same period the volatility is given by only the Constant, α, which means it is 4.62%. Comparing these we can see that the volatility for the treatment group is 4.76% higher compared to the control group in this period. The post-restriction volatility for the treatment group is given by all the parameters, $\alpha + \gamma +$ $+ \delta$ which sums up to 9.25% in monthly volatility. While for the control group it is given by the Constant plus the Time Fixed Effects, $\alpha +$, leading to 9.08%. For the post-restriction period the monthly volatility was 1.87% higher for the treatment group compared to the control group. Since the parameter of importance, the Treatment effect, δ, which examines the causal effect of the restriction, is negative it means that the volatility was reduced. However, it is also insignificant, which means that only the Time Fixed effect, , has influence over the difference in volatility before and after the restrictions were introduced. As a result, post-restrictions the volatility for both treatment and control group can be said to be the same.

3.1.2 Financial sector

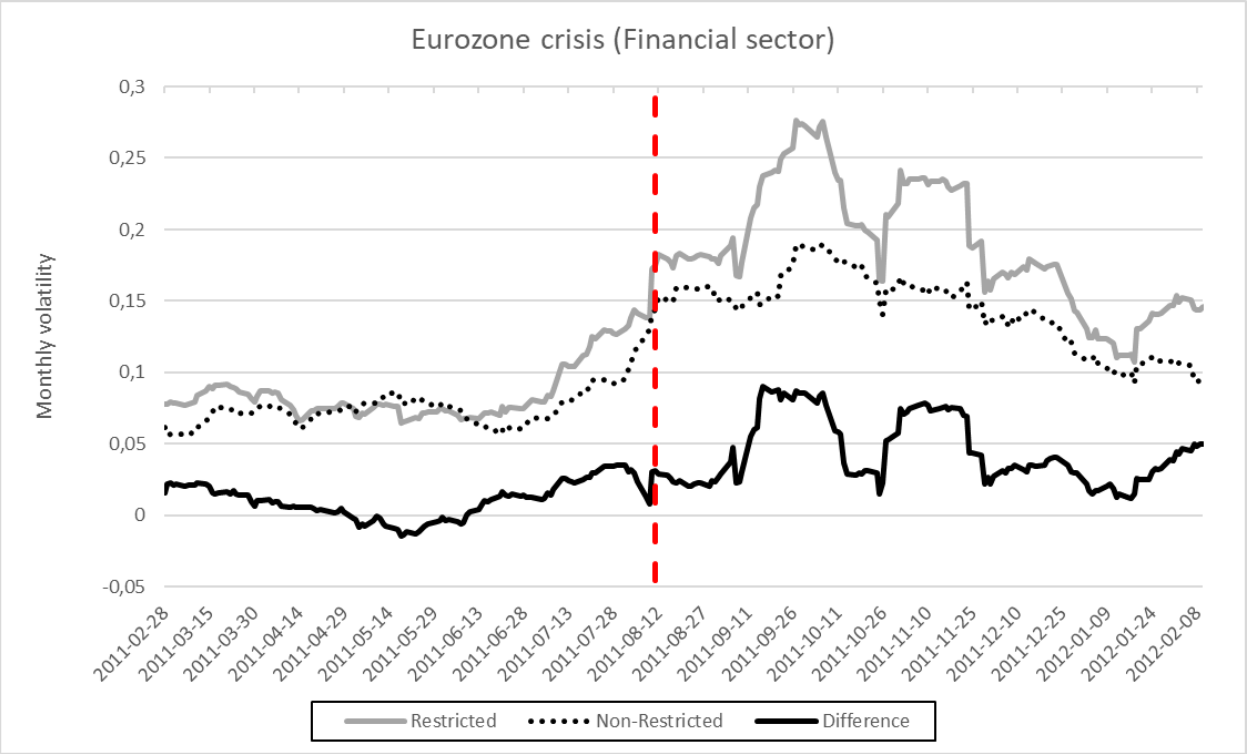

Figure 2 - Financial sector volatility during the eurozone crisis before and after the introduction of the short-selling restriction

Note: Figure 2 plots the financial sector volatility during the eurozone crisis estimated by realized volatility and a 20-day moving window. The vertical red line indicates the day on which the short-restriction was introduced for the restricted indices (August 11th 2011).

Figure 2 displays the foundation for the Eurozone crisis financial sector analysis. The plot visualizes the dependent variable in the Difference-in-Difference regression. Both the volatility of the restricted indices and the non-restricted indices are plotted and the solid black line is the difference between them. Prior to the introduction of the short-selling restriction the difference between the two groups was rather stable however not without fluctuations, this slightly weakens the parallel trends assumption. Nonetheless both groups often exhibit comovements prior to the restrictions, something that cannot be said about the time period after the short-selling restrictions. The post-restriction volatility is substantially different between the two groups. Both groups experience a considerable increase in volatility however for the restricted financial

sector the increase is much larger which can also be made out by comparing the difference between the two groups. The figure indicates that the Difference-in-Difference estimation for the sample will likely yield both a time fixed effect and a group fixed effect as well as possibly a treatment effect. Below the regression results are presented.

Table 4 - Regression results (Eurozone crisis, Financial sector)

Dependent variable: Volatility		
No. Observations: 3947		Adjusted R^2: 0.4692
Parameter	Coefficient	P-value
α (Intercept)	0.0781 (0.0018)	0***
β (Time Fixed Effect)	0.0713 (0.0026)	0***
γ (Group Fixed Effect)	0.0148 (0.0025)	0***
δ (Treatment Effect)	0.0387 (0.0034)	0***

Note: Table 4 presents the results of the Difference-in-Difference regression where the dependent variable i.e. monthly volatility is a function of a Constant, a Time Fixed Effect, a Group Fixed Effect and a Treatment Effect (the restriction). Each coefficient is interpreted as a monthly effect and details of what each parameter represents are presented in (Equation 3). The standard error for each parameter is presented within the parenthesis below its respective coefficient. Each of the coefficients is also connected to a p-value indicating its statistical significance level (Berger & Mortera, 1991). Each p-value is assigned either *, ** or *** depending on its significance level. * indicates significance level on the 10 % level i.e. p-value < 0.1. ** indicates significance on the 5 % level i.e. p-value < 0.05. *** indicates significance on the 1 % level i.e. p-value < 0.01.

The results from the financial sector approach are displayed in Table 4. In total there were 3947 observations and the adjusted R-squared was calculated to 0.47. After running the Difference-in-Difference regression on the individual stocks belonging to the financial sector in the treatment and control group we find that all of the parameters are statistically significant and have a positive coefficient. The Constant, the Time Fixed Effect, the Group Fixed Effect and the Treatment Effect are all positive and significant on the 1 % level (p-value < 0.01). In the pre-restriction period the monthly stock volatility

for the control group is given by the Constant, α, resulting in 7.81% of volatility. For the Treatment group it is given by the Constant plus the Group Fixed Effect, $\alpha + \gamma$, which gives a volatility of 9.29%. The volatility for the treatment group is therefore 18.95% higher than the control group in the pre-restriction period. Following the restrictions the post event volatility is given by the Constant plus the Time Fixed Effects, $\alpha +$, for the control group and by all the parameters, $\alpha + \gamma +$ $+ \delta$, for the treatment group. This results in a monthly volatility of 14.94% for the control group and 20.29% for the treatment group. For the post-restriction period the volatility of the treatment group is 35.8% higher than for the control group. The Treatment Effect, δ, is statistically significant with a positive value of 3.87%, which suggests that the implementation of short selling-restrictions on the financial sector leads to a further increase in volatility in the markets, instead of the goal of a decrease.

3.2 Covid-19 Pandemic

3.2.1 Index

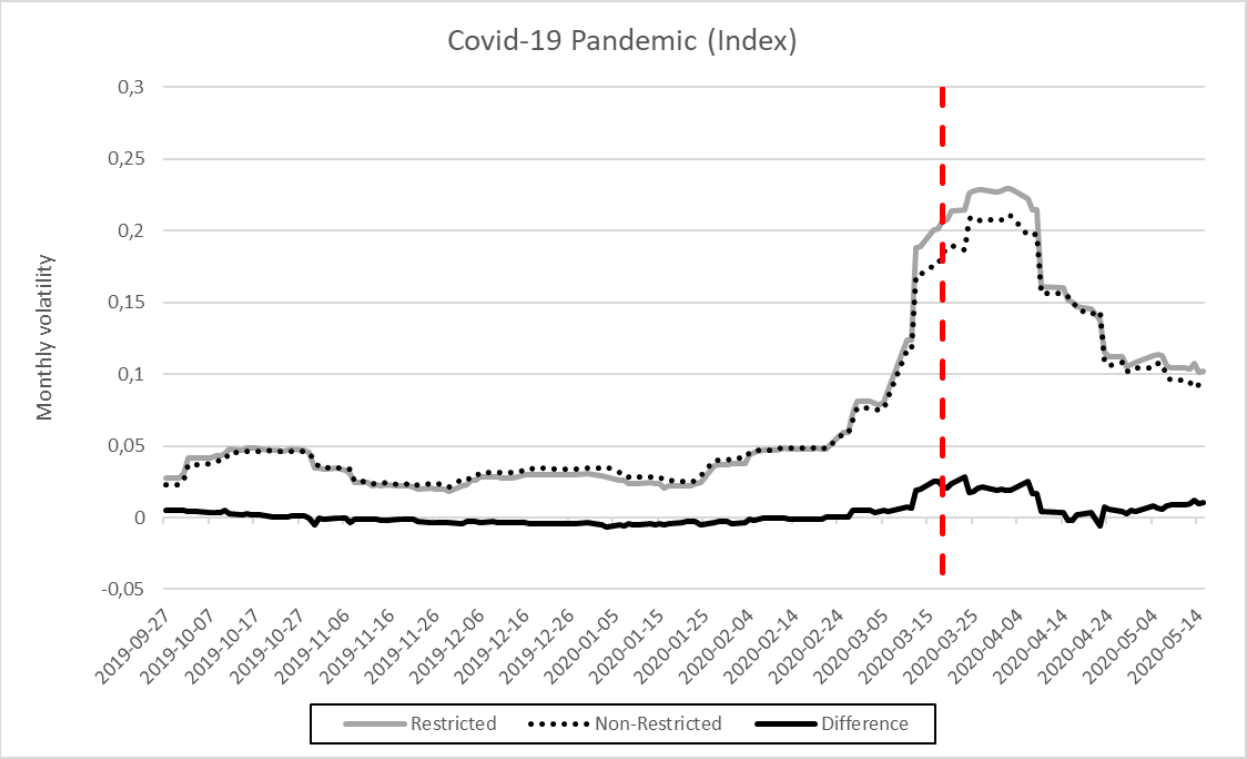

Figure 3 - Index volatility during the Covid-19 Pandemic before and after the introduction of the short-selling restriction

Note: Figure 3 plots the index volatility during the Covid-19 Pandemic estimated by realized volatility and a 20-day moving window. The vertical red line indicates the day on which the short-restriction was introduced for the restricted indices (March 18th 2020).

Figure 3 displays the foundation for the Covid-19 Pandemic index analysis. The plot visualizes the dependent variable in the Difference-in-Difference regression. Both the volatility of the restricted indices and the non-restricted indices are plotted and the solid black line is the difference between them. Prior to the introduction of the short-selling restriction the movement of the index volatility seems almost identical for both of the group, this makes a compelling case for the parallel trend assumption. The presence of a Time Fixed Effect is once again clear as there is an obvious increase in volatility for both groups after the restriction was introduced. The presence of a Group Fixed Effect is less than certain as the movement of both groups seem almost identical. The larger increase in volatility of the restricted group post-restriction suggests the presence of a

Treatment Effect. Below the regression results of the Difference-in-Difference estimation are presented.

Table 5 - Regression results (Covid-19 Pandemic, Index)

Dependent variable: Volatility		
No. Observations: 636		Adjusted R^2: 0.6278
Parameter	Coefficient	P-value
α (Intercept)	0.0446 (0.0034)	0***
β (Time Fixed Effect)	0.1058 (0.0048)	0***
γ (Group Fixed Effect)	-0.0062 (0.0068)	0.856
δ (Treatment Effect)	0.0118 (0.0024)	0***

Note: Table 5 presents the results of the Difference-in-Difference regression where the dependent variable i.e. monthly volatility is a function of a Constant, a Time Fixed Effect, a Group Fixed Effect and a Treatment Effect (the restriction). Each coefficient is interpreted as a monthly effect and details of what each parameter represents are presented in (Equation 5). The standard error for each parameter is presented within the parenthesis below its respective coefficient. Each of the coefficients is also connected to a p-value indicating its statistical significance level (Berger & Mortera, 1991). Each p-value is assigned either *, ** or *** depending on its significance level. * indicates significance level on the 10 % level i.e. p-value < 0.1. ** indicates significance on the 5 % level i.e. p-value < 0.05. *** indicates significance on the 1 % level i.e. p-value < 0.01.

In Table 5 the results of the Difference-in-Difference regression applied to the monthly index volatility of the Covid-19 Pandemic are displayed. In total there were 636 observations and the adjusted R-squared was calculated to 0,628. The regression shows that the Constant, the Time Fixed Effect and the Treatment Effect are all positive and significant on the 1% level (p-value < 0.01) while the Group Fixed Effect is negative albeit close to zero and not statistically significant on the 10% level (p-value > 0.1). In the pre-restriction period the monthly stock volatility for the Treatment group is given by the Constant plus the Group Fixed Effect, $\alpha + \gamma$, which gives a volatility of 3.84%. For the control group it is given by the Constant, α, resulting in 4.46% of volatility. The volatility for the control group is therefore 16.15% higher than the treatment group in the pre-restriction period. However, since the pre-restriction difference in volatility between

treatment and control group is the Group Fixed Effect which, again, was close to zero and insignificant the result suggests that there was no difference in index volatility between the two groups prior to the event. After the restrictions were put in place the treatment groups volatility is calculated as the sum of all the parameters, $\alpha + \gamma + + \delta$, which gives a monthly volatility of 15.6%. For the control group it is given by the Constant plus the Time Fixed Effects, $\alpha +$, which leads to a volatility of 15.04%. Furthermore, the post-restriction volatility is 3.72% higher for the treatment group compared to the control group. The Treatment Effect, δ, is statistically significant with a positive value of 1.18%, which suggests that the implementation of short selling-restrictions on the financial sector leads to a further increase in volatility in the markets.

3.2.2 Financial sector

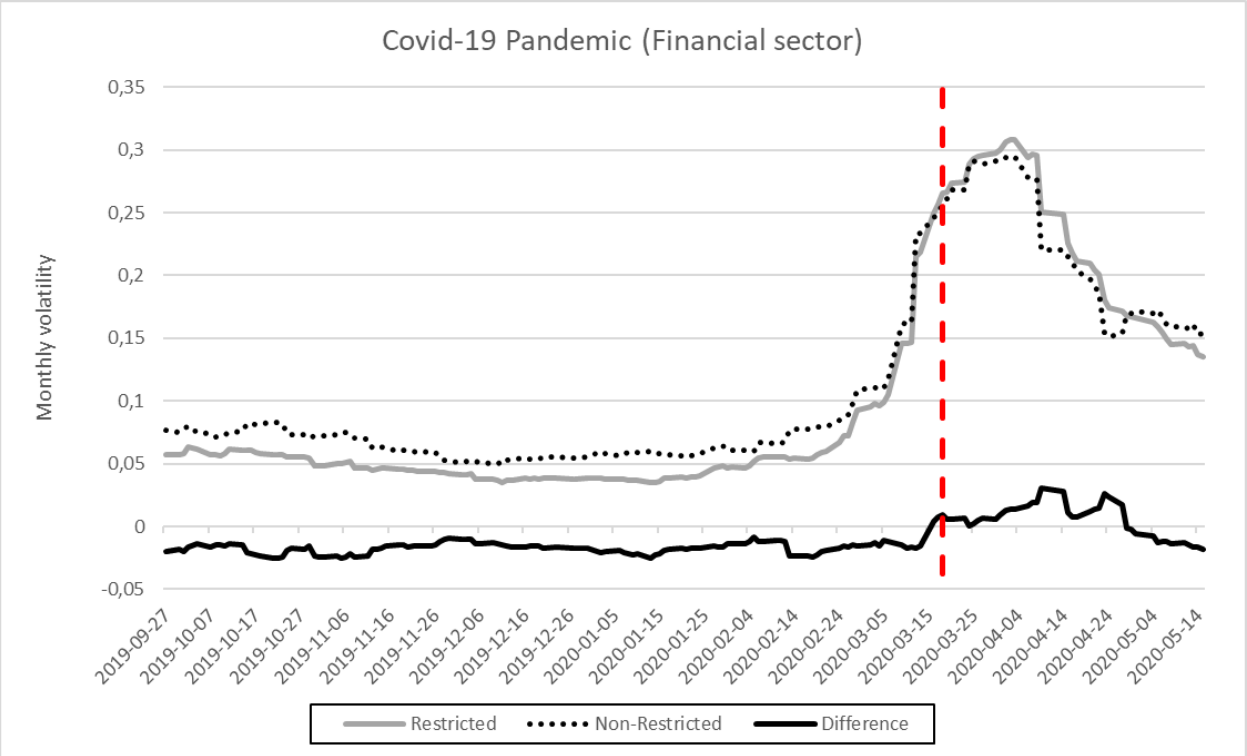

Figure 4 - Financial sector volatility during the Covid-19 Pandemic before and after the introduction of the short-selling restriction

Note: Figure 4 plots the financial sector volatility during the Covid-19 Pandemic estimated by realized volatility and a 20-day moving window. The vertical red line indicates the day on which the short-restriction was introduced for the restricted indices (March 18th 2020).

Figure 4 displays the foundation for the Covid-19 Pandemic financial sector analysis. The plot visualizes the dependent variable in the Difference-in-Difference regression. Both the volatility of the restricted indices and the non-restricted indices are plotted and the solid black line is the difference between them. Prior to the introduction of the restrictions the difference between the two groups is largely constant which supports the assumption of the presence of a parallel trend. Once more the most obvious result is the presence of a Time Fixed Effect where the financial sector volatility is substantially higher post restrictions. As for the Group Fixed Effect the non-restricted group shows a higher volatility up until the restrictions were put in place. The fact that the difference between the two groups switches from being negative prior to the restrictions to being

positive post restrictions suggests the presence of a Treatment effect. Below the results of the Difference-in-Difference regression are presented.

Table 6 - Regression results (Covid-19 Pandemic, Financial sector)

Dependent variable: Volatility		
No. Observations: 3349		Adjusted R^2: 0.5667
Parameter	Coefficient	P-value
α (Intercept)	0.0764 (0.0017)	0***
β (Time Fixed Effect)	0.1419 (0.0033)	0***
γ (Group Fixed Effect)	-0.0170 (0.0023)	0***
δ (Treatment Effect)	0.0220 (0.0046)	0***

Note: Table 6 presents the results of the Difference-in-Difference regression where the dependent variable i.e. monthly volatility is a function of a Constant, a Time Fixed Effect, a Group Fixed Effect and a Treatment Effect (the restriction). Each coefficient is interpreted as a monthly effect and details of what each parameter represents are presented in (Equation 5). The standard error for each parameter is presented within the parenthesis below its respective coefficient. Each of the coefficients is also connected to a p-value indicating its statistical significance level (Berger & Mortera, 1991). Each p-value is assigned either *, ** or *** depending on its significance level. * indicates significance level on the 10 % level i.e. p-value < 0.1. ** indicates significance on the 5 % level i.e. p-value < 0.05. *** indicates significance on the 1 % level i.e. p-value < 0.01.

The final results, which is the Difference-in-Difference regression applied to the financial stocks of the four different indices used in the previous regression, is presented in Table 6. In total there were 3349 observations and the adjusted R-squared was calculated to 0.567. The result shows that all of the parameters, the Constant, the Time Fixed Effect, the Group Fixed Effect and the Treatment Effect are all significant on the 1% level (p-value < 0.01). Of these four parameters, the Constant, the Time Fixed Effect and the Treatment effect are all positive while the Group Fixed Effect is negative. This means that before the introduction of the short-selling restrictions the monthly volatility in the treatment group is given by the Constant plus the Group F mixed Effects, $\alpha + \gamma$, and since γ is negative the resulting value is equal to 5.94%. The corresponding value for

the control group is equal to 7.6 %. Hence, the volatility for the control group is 27,95% higher than the treatment group. After the short-selling restriction was put in place the volatility of the treatment group is calculated as the sum of all of the coefficients which is equal to 22.23%. For the control group the post event volatility is calculated as the Constant, α, plus the Time Fixed Effect, , and is equal to 21.7 %. Thus making the treatment group's volatility 2.9% higher than the control group in the post-restriction period. The Treatment effect, δ, is positive with a value of 2.2%, meaning like the previous two regressions that the volatility was increased after the restriction was implemented.

4. Conclusion

The objective of this paper was to examine if the regulators stated goal of calming the markets with a short selling restriction during the Eurozone crisis and the Covid-19 Pandemic was achieved by a decrease in volatility on the banned stocks. As Well as examining the differences between the two different restrictions in Europe during the Eurozone crisis and the Covid-19 Pandemic. This was done by analyzing the volatility, using a Difference-in-Difference estimator. Two different approaches were used following previous studies, where the first was an Index Approach and the second a Financial Sector Approach.

For the Covid-19 Pandemic, the results of the Treatment effect, δ, which is the effect that the restriction has on volatility, is significant and positive for both approaches. This implies that the implementation of the short selling ban increased volatility of 1.18% in the Index Approach and 2.28% in the Financial Approach. We can see that the Treatment effect is largest for the Financial approach. These results are similar to those of Siciliano and Ventoruzzo, (2020) who find that the negative effects of the short selling restriction are more pronounced for the financial stocks. Furthermore, the estimated volatility from the Index Difference-in-Difference regression shows that the control group had a volatility which was 16.15% higher than the treatment group in the pre-restriction period. However, in the post-restriction period, the treatment group had 3.72% higher volatility than the control group. The difference in volatility between the groups thus shifted substantially. The same can be seen in the Financial Approach, where in the pre-restriction period the control group had 27.95% higher volatility than the treatment group. After the ban in the post–restriction period there was once again a big shift where the treatment group had 2.9% higher volatility than the control group. So, for both of the approaches, the control group had the highest volatility in the pre-restriction period, while in the post-restriction period this had shifted so that the treatment group had the highest volatility. The case for Covid-19 is thus that the restrictions failed to reduce the volatility. Instead it negatively affected market quality in the banned

countries, which in our case is seen by the increased volatility. These results are consistent with the findings of Bessler and Vendrasco, (2020).

For the Eurozone crisis, the results of the Treatment effect, δ, which is the effect that the restriction has on volatility, is significant and positive only for the Financial Approach, while for the Index Approach it is negative and insignificant. For the Financial Approach this implies that the implementation of the short selling ban increased volatility of 3.87%. This result is similar to those of Alves, Mendes & Silva (2016), who find an upsurge in volatility for the financial stocks and that this effect is especially pronounced in the banned stocks. For the Index Approach there was no significant difference in volatility, this means that the short selling restriction of the financial stocks did not affect the whole indices volatility. So, only the Time Fixed Effect had an impact on the volatility, which is suspected because this regression is done during a time of crisis in the European markets. However, that the Treatment effect, δ, is so markedly insignificant is a little bit surprising, as we expected the short selling restriction on the financial sector to have, although not to a significant extent, some impact on the volatility. Furthermore, the estimated volatility from the Financial Difference-in-Difference regression shows that the treatment group had a volatility which was 18.95% higher than the control group in the pre-restriction period. This was further increased in the post-restriction period, where the treatment group had 35.8% higher volatility than the control group. The volatility thus substantially increased after the restrictions. Because the Treatment Effect was insignificant for the Index approach these values can be said to be the same.

Comparing the two crises, we can see that the Treatment Effect in the Financial Approach was highest for the Eurozone crisis with a δ-parameter of 3.87% compared to the same for Covid-19 of 2.2%. This is for us expected, as during the Eurozone crisis there was a lot of focus on the financial institutions which were in distress following the Financial crisis as compared to Covid-19 where there was more of a general uncertainty in the markets. For the Index Approach the Treatment effect was 1.18% during Covid-19, while the same for the Eurozone was -0.0005 and insignificant. It is to be expected that the Treatment effect during Covid-19 would be the largest as the short

selling ban was imposed on the whole market and not just the financial subsection as during the Eurozone crisis. However, as stated above, we expected at least some signs of impact from the short selling restriction in a sort of spill-over effect. This does however point towards the possibility of using policy in order to target a specific sector in order to influence its volatility while the same policy will not influence the market as a whole. Unfortunately, in the case of the Eurozone crisis this kind of policy decision proved to have an unwanted effect.

As a quick disclaimer, which arises for all Difference-in-Difference models, the validity of these results depends on the parallel trend assumption. As has been stated, this assumption is not possible to formally test. We have however visually inspected the Figures, examining that there is no difference in the trend between the treatment and control group before the treatment (i.e restriction). Thus indicating that the parallel trend assumption is satisfied, implying that the results are reliable.

To summarize, the results support previous literature in suggesting that the implementation of a short selling restriction increases the volatility rather than decreases it. The stated goal of the regulators was thus not achieved. Rather it was the opposite of what policy makers intend for it to do and they should therefore be cautious when introducing such bans. This does not mean however that there is no reason to implement such a ban, only that the stated goal of reducing volatility lacks effectiveness and that the benefits need to outweigh the negative consequences which a ban has on market quality.

Further research could investigate other reasons for regulators to implement short selling restrictions. This since in spite of all the academic literature, regulators still implement these bans. This might be because of another motive other than the stated one, like for example appearing to be doing something in a crisis.

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