LOUVAIN
School of Management

UNIVERSITE CATHOLIQUE DE LOUVAIN

LOUVAIN SCHOOL OF MANAGEMENT

Study of the impact of the European Short Sell Regulation on the European stock markets' liquidity, volatility and price formation process

Promoteur: Leonardo Iania

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Mathieu Parijs

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List of Acronyms

BLUE: Best Linear Unbiased Estimator.

CDS: Credit Default Swap.

DD: Difference in Difference, econometrics technique.

DTCC: Depository Trust & Clearing Corporation. This US Company active in financial services provides clearing and settlement services.

ESMA: European Securities and Markets Authority.

FSA: Financial Services Authority

FSMA: Financial Services and Markets Authority.

MiFID : Directive sur les marchés d'instruments financiers (Directive 2004/39/CE)

NCA: National Competent Authority.

OLS: Ordinary Least Squares method.

SEC: Securities and Exchange Commission.

SPSS: Statistical Package for the Social Sciences

SSR: Short Selling Regulation (conducted by the European Parliament in March 2012 and toke place as from 1st of November 2012).

Introduction

The world has recently been shaken by a non-precedent financial crisis. The rapidity and the globalization of the financial markets lead to more and more complex financial instruments. These interconnections between markets across the globe have the capacity to spread crisis around the world in no time. So what are the right regulators and government's attitudes facing such market complexity? Should they let it go or on the contrary, should they regulate?

On the one hand, advocates of the Neoliberals' movement tend to promote the market economy, in the name of individuals' freedom, by advocating market deregulation. By definition a deregulated market is only regulated by itself, without any governmental intrusion, in opposition to the Welfare State since the post war years.

On the other hand, some markets' stakeholders tend to promote the regulation of the financial markets. This idea was even integrated by Adam Smith into its book "The Wealth of Nations" (1776), as exception to its Invisible Hand Theory. For Smith, who witnessed the bursting of a financial bubble decimating Scottish banking system, finance was a serious risk to damage society. Indeed, he argued in his book "The Wealth of Nations" (1776),

"*Such regulations may in some ways seem like a violation of nature liberty of a few individuals, but the freedom of some could compromise the security of the whole society. As for the obligation to build walls to prevent the spread of fires, states, in free countries as in despotic countries are required to regulate trade in banking services".*

But what are the consequences of such market regulation for the financial world and what should be the limits of the regulators into the systems? Should there be a limit? Those questions are mainly political and ideological, but it is possible to evaluate the impact of some financial regulations on financial markets.

This study will try to evaluate the impact of a recent European law concerning short sell regulation, in application since November 2012, on the stock market.

The regulation has been done through the voting of the "Regulation (EU) 236/2012 of the European Parliament and of the Council on short selling and certain aspect of credit default swaps." The aim of this regulation is to put a common legal frame around the short practice in Europe.

By putting a frame and limit some short sell practice; the European regulation could have modified some primary market characteristics: this is the core questioning of this paper: "Did the regulation voted by the European Parliament have impacted the market, and if yes did it worsen or improved it?" The markets' impact of the regulation will be discussed on a 3-measures basis: market liquidity, volatility and price formation process.

To answer this question, the paper is organized in three parts:

First, a literature review will describe the core characteristics of the short sell product and the main motivations of such activity will be enunciated. Moreover, the European short sell regulation will be developed. Finally, previous theories in the field of short selling and a brief academicals review of impact of short sell regulation on market's liquidity, volatility and price formation process will be exposed.

Then, the quantitative analysis will deeper describe and develop market liquidity, volatility and price formation process. On a second step, the methodology used to compute and evaluate impact of the European short sell regulation will be enunciated.

Finally the findings section will expose results of potential impact of the regulation on market liquidity, volatility and price formation process. This section will also compare results found in the frame of this study with prior studies held across the world.

Motivations

The motivations for this paper are multiples: it constitutes indeed a perfect conjunction between public necessity and personal curiosity.

Public necessity first, it has the willingness to be in line with a previous study made by the European Securities and Markets Authority (ESMA). As for every rule adopted by the European Parliament, the implication of the short sell regulation voted in 2012 had to be studied by European institutions. In the case of the short sell regulation, the ESMA made a report but it stated it was "too early to achieve proper data assessment" and continued to propose "a re-assessment of the regulation at a later stage, with greater time scope." Not enough data were available to be critical, as stated by the ESMA. That is why I decided to explore the subject.

Moreover, this subject is very appealing to me. Indeed, I have always been attracted and fascinated by non-common financial product, such as short selling, and by European institution. Voting common regulations for all members so that legislations between members' states converge is one of the core objectives of the E.U.

Assembling the two aspirations for finance and E.U. by assessing a law adopted by the European Parliament represented for me a nice challenge.

1. Literature Review

This literature review puts together many financial and theoretical concepts for the well understanding of the study related to the short selling regulation (SSR) in Europe. The following chapter will first present a big picture of the short sell activity, this particular and curious technique, often seen as pure speculative instrument by the ordinary mortal. The motivations for acting as short seller will also be debated. Then, the historical background will be developed and the recent regulation will be explained in details, in order to have a full knowledge of what is the European short sells regulation about and its implication for market participants. Finally, theories debated by academicians relating to short sell benefits and inconvenient will be presented. The theories relating to market impact will mainly be articulated around three market characteristics: the market's liquidity, the market's volatility of returns and market's prize formation process. Those markets characteristics will be the ones on which potential impact of the SSR will be evaluated.

1.1. What is short selling?

As a first approach toward short selling, let's briefly explain the stakes, characteristics and motivations of the short sell activity in our modern globalized world.

1.1.1. Global overview

In the finance world, short selling refers to the action of selling any financial instrument being borrowed or not owned by the seller the day the instrument is negotiated. But the seller promises to be able to hold the security the day of the delivery. The sold instrument is generally a security but one can also short sell commodities and currencies. Behind such financial arrangement, the seller expects that the price of the security will fall. If the price of the security goes down after the short sell, the seller can re-buy the same security and close out the transaction making a capital gain. The capital gain of such financial actor is, de facto, limited to the value of the security. But since the

security's price can reach an infinite value, the security's seller theoretically exposes himself to an unlimited loss, while investor buying a security can only face a loss amounting to its initial investment. In practice, the "normal" short seller is required to insure his position by giving a counterparty to cover potential losses. If the instrument's price rises above threshold, the inability to cover losses will cause the liquidation of the position by its counterparty or broker. Several options exist to cover a short position such as options and reverse repo, but the most common way to cover his position is to borrow the securities from a third party. Indeed, the other techniques have a significative impact on the treasury of the financial actor. In the financial terminology, it is said that a short seller is in, a "Short" position, in contrast with the buyer who has a "Long" position.

1.1.2. Difference between "Normal" & "Naked" short selling

On one side, as it is stated before, a "normal" short seller is taking on a negative position in a security, by borrowing one from a third-party, being a broker or bank. After the re-buy of the security, the investor gives the security back to the third party and makes a gain/loss if the price of the security decreased/increased.
On the other side, a "naked" short sell occurs when the seller do not borrow any security before selling it. Short supply, low liquidity, lacks of lenders and procedure's cost are multiple reasons for adopting a so-called "naked" position.

When the seller is not able to meet its engagement in delivering the security, and no covers are possible, the trade is over, or "fails": in the financial definition the trade is considered to have "failed-to-deliver". It is important to note here that fail-to-deliver are not proper to naked short selling activity. Indeed, some market participants going long on the market could also face such failed-to-deliver situation if the seller is not able to meet the engagement neither. Failed-to-deliver notifications are regularly made public from the SEC in the U.S. Having the whole failed-to-deliver data's is not pertinent because of the bias coming from other than naked short sell activity. That is why failed-to-deliver activity is difficult to estimate. Different options can be adopted when facing failed-to-deliver: the trade remains open or the buyer may be credited the share from the DTCC. In this case, the credit facility is valid till the short seller borrows the security

or closes out the position. As it will be detailed in a later section, naked-short-selling is now banned as from 1st November 2012 in the European zone.

1.1.3. Motivations

The willingness of a financial actor to go on a short position in a security can be justified by multiple objectives. Brent et al. (1990) identified three main motivations: "Arbitrage and Hedging, Tax motivations and speculation".

Following their studies, the major explanation of using short sell is for arbitrage & hedging purpose. Hedge Funds offer various investment strategies that have in common to rely exclusively on short sell combinations. Three different common arbitrage strategies are using short sell procedures:

- Convertible arbitrage: an investment strategy involving an arbitrage between convertible bonds and stock securities. A fund buys a convertible bond with an option price that seems to be under-valued and sells short at the same time the stock security to make an arbitrage margin. Since convertible bonds are not always priced efficiently (market illiquidity, psychology, volatility), arbitrageurs exploit those little inefficiencies to make positive margins.

- Equity market-neutral arbitrage: this strategy results in opposite evolution's expectation of two companies within the same sector or a company compared to its global sector. It leads an investor to take both a long position in a security and a short position in another one.

- Merger arbitrage: In a case of a takeover bid of a company over another, a classic arbitrage consists to buy the security being bought and sell short the security of the potential buyer, and take on a margin.

In general, these strategies amount to take on long positions on expected undervalued securities and short position in securities expected to go downward.

Even though previous strategies are part of the day-to-day work of hedge funds, short sell financial securities are not easily available to the public in general. Indeed, banks and brokerage firms do not offer short sell possibilities to common clients. This is mainly due to the high-risk short sellers face by entering in such financial activity. By definition, losses on short sell are unlimited. That is why sufficient financial guaranties are needed.

As stated by Brent et al. (1990) "short selling may be motivated by tax incentives". In the United States for example, individual investors willing to speculate downward on a security held in their portfolio may qualify the sale as a short sell if it fulfills the following three conditions:

- "Not make any other cover on long position"
- "Liquidate its short position in the last 30 days of the year"
- "Keep the long position for at least 60 days beyond".

If the conditions are fulfilled, the seller will then be taxed on the gain derived, not from the difference between the product of the sale and the average price of the long position, but on the redemption of his short position. This was known as a shorting "against the box" and allowed to defer tax on gains. Brent et al (1990) indicated "delaying the recognition of a gain is interesting for investors willing to be taxed a lower rate on a later period". This strategy is not longer attractive since the Taxpayer Act (1997) in the United States of America.

Finally, short selling can be used for speculative ends. Speculative market participants only use the short sell to "bet" on a future downward trend of a specific financial security. The proportion of short seller active for speculative motivation is difficult to evaluate, meanwhile those financial participants have huge impact on market. From impacts discussed by academicians, Chen and Singal (2003) have reported, "speculative short sellers participate in a significant manner in the weekend effect in the market." In short, the weekend effect is an observation made on market, where the stocks prices rise on Fridays and fall on Mondays. Following Chen and Singal (2003), "the incapacity to trade on weekends tends the short sellers to close their position on Fridays' and re-open them the following Monday." So these short sellers' behaviors tend to stress and accentuate the weekend effect.

1.2. The regulation and its historical background

"There is no academic evidence that short sellers by themselves brought a company down without other underlying reasons," said Paul Asquith, a professor of finance at MIT's Sloan School who specialized in the study of short selling. Despite affirmations such as the one made by Mr. Asquith coming from around the world's studies, governments and regulators have always tried to ban or reduce short sell activity in period of market crashes. Let's review main regulations adopted by lawmakers since a few centuries first, and more precisely since last crash of the XXIth century. Post-subprime crisis measures will then be exposed, followed by the European SSR. This historical background's objective is to see governments' position concerning short selling activity facing major crisis.

1.2.1. Before the crisis

Short selling has almost everywhere a negative image. Indeed, it is associated with speculation in the collective consciousness. As Reuters noted (2008), "short sellers have been the villains for 400 years". Authorities have banned the short sell after many crisis or share price drop. It started in 1609 when merchant made the first short sell ever in the Dutch East India Company. The story happened again in 1929, 1987 and 1997 in the U.S. More recently, after the 2008 crisis, authorities from all around the world adopted a stricter regulation to set up some frame to the short positions.

1.2.2. Since the 2008 crisis

Despite studies highlighting the fact that short sell does not worsen stock markets when they are dropping and studies held by Charoenrook and Daouk (2005) notifying "there is no evidence that short-sale restrictions affect either the level of skewness of returns or the probability of market crash."; as from 2008, many countries decided to set up short time frame to limit or ban the short sell on some or all financial securities. Indeed, many governments were worried by the fact that short selling could worsen the stock

price drop, would threaten the financial institution's viability and enhance their exposure to systematic risk.

Despite some individual actions taken by governments, the European Union didn't have any position over short selling prior 2012. Moreover, countries' regulations differed from each other. During the September 2008 crisis, major European governments decided to ban or reduce short sell activity to stop putting downward pressure on the market and particularly on banks. In the U.K, for example, the FSA limited short sells on 29 major financial stocks, regulation valid for a period of a few months only. The 2011 so-called Sovereign crisis puts pressure on governments to ban short sell activity and especially on financial sectors' stocks. That is why, "countries such as France, Italy, Spain and Belgium decided to regulate short sell for a period of fifteen days on financial stocks in 2011"[1]. To put an end to partial regulations and difference between European countries, the European Union decided to vote an amendment in March 2012 to set up a European short selling frame, applicable as from the first November 2012.

Contrarily to the European Union, the U.S SEC adopted a rule concerning the short sale restrictions back in February 2010[2]. Indeed, following the SEC and the Rule 201 of Regulation SHO, "the Commission adopted a stock price restriction known as the Alternative Uptick Rule". The aim of this rules resides in the fact of banning short sell activity on a specific stock if this last one has suffered of a more than 10% price decrease in a period of one day. As stated by the SEC Agency, it would "stop putting downward pressure on this specific stock."

1.2.3. The European Short Sell Regulation

The European Parliament decided to vote a rule concerning "Short Selling and certain aspects of the credit default swaps" (called later "the Regulation" or "SSR"). This rule was voted in March 2012 and came into force on 1st November of the same year. Following the ESMA (2013), the aim of the new Regulation that came into force in 2012 was to achieve the following markets' specificities:

[1] http://www.euractiv.com/euro-finance/eu-countries-curb-short-selling-news-506980
[2] http://www.sec.gov/answers/shortrestrict.htm

- “Increase the transparency of short positions held by investors in certain EU securities”. Following the Regulation, the short sellers must report and disclose net short position to relevant financial authorities. The net short position is written in percentage of the total shares capitalization issued by the company. The net short position as a percentage of issued share capital of the company is calculated by dividing the net short position in equivalent shares by the total issued share capital. By the Regulation: “net short position over 0,2% must be indicated to local financial authorities, moreover this net short position needs to be public over 0,5%”. Annex 1 provides an illustration of a Belgium notification document that needs to be filled in by investors under notification constrain. Meanwhile, some exemptions are accessible to some market makers and dealers. Annex 6 details the eligible market participants having the possibility of not disclosing some net short position in Belgium. In addition to that, some exceptions exist for some shares across Europe, so that not all shares must be disclosed to relevant NCA. Even if 9491 shares are exempted so far across the European Union, no exemption is accorded to any Belgian share[1].

- “Reduce settlement risks and other risks linked with undercover or naked short selling.” This objective is achieved through the implementation of a law forcing market participants to have located or borrowed the financial security before short selling. This indicates, “Naked short selling has now be banned as from November 2012”.

- “Insure that Members and ESMA are perfectly coordinated in facing exceptional economic situation, and give them power to limit systemic risks in such situations.” In case of emergency regulation in local government, it is the ESMA’s role to coordinate the regulation and coordinate it at the European level. Moreover, it is the ESMA’s role to analyze actions taken by local National Competent Authorities and eventually discuss its implementation to other countries across the European Union. So that local guidelines decided by local governments will converge to a common European legislation. Facing fast financial flows across countries and borders from financial institutions to another, the regulation will try to propose common rules to all European members so that no discrimination would rise from one country to another.

[1] As from 6th of May, stated in the ESMA Report.

To convince investors and market participants to implement the rules conducted by the European parliament, some administrative sanctions should be applicable to anyone not fulfilling the law. In Belgium, the Article 28 has amended the law concerning the supervision of the financial sector in July 30 2013, so that the new regulation takes the new European directives into account. The FSMA (2013) states, “Non-complying with the law concerning the short sell regulation will induce a penalty ranging between 250 and 50,000 per day”. Moreover, an administrative fine “should not be less than 2500 and not more than 2,500,000.” In case the offender has made a financial gain through the short sell operation, the maximum fine he can encounter is fixed at the double of its gain.

Finally it’s the European Union’s role to insure smooth functioning of the internal market and improve the conditions of its functioning, especially in terms of financial markets, and to ensure a high level of protection for consumers and investors.

To put an end to the past dispersion situation in which some Member States had taken divergent measures and to limit the possibility for competent authorities to take such measures, it was essential to harmonize the means to fight against the risks that may include short selling and contracts trade on credit risk. Nevertheless, the requirements to be met should not alter the short selling benefits, in terms of market efficiency and quality if any.

1.3. Theories of impact of short selling regulation on the financial market

"I don't think it (short-selling) is malicious. It's people acting in their self interest which is what Wall Street does," said Martin Sklar, an attorney representing hedge funds, which typically engage in short selling. This chapter will try to detail potential market consequence due to short sell regulation. After this chapter, we will be able to emit an opinion concerning SSR and see if this financial product is non-malicious, as stated by M. Sklar.

1.3.1. Liquidity theories

Market liquidity represents the ability to buy or sell securities on the market without affecting its price. Following Reuters (2010), a liquid market is a place where one can make a transaction with very low transaction costs. In opposite, a market with high transaction cost is said to be illiquid. The liquidity is defined by the Banque de France (2006) as “a bundle of properties rather than a one-dimensional characteristic of asset and markets where they are traded”. Moreover, liquidity is a relative concept, an active being all the more liquid it is exchanged easily against “liquidity by excellence”, which is money. So a perfectly liquid market therefore ensures at all times a single price for buying and selling, regardless of the amounts involved. The financial markets as we know them, even those renowned the most liquid, do not comply perfectly with this ideal configuration. As transaction costs are difficult to calculate, different measures of liquidity need to be used. The Banque de France (2006) and Baker (2006) both argue that the degree of liquidity of a market is mostly determined by three different dimensions: the “breadth”, “depth” and “resilience” (Rapidity to which markets come back to its initial position after random choc in transaction flow).

- The breadth could be explained as the range between the bid and ask (also called the bid-ask spread) and measures the position’s cost in a short turnaround time for a standard amount. The bid is de facto always lower than the ask. On the sell-side, the bid is the purchase price and the ask represents the sale price. On the buy-side, for an investor wishing to purchase shares in a company A, the bid corresponds to the

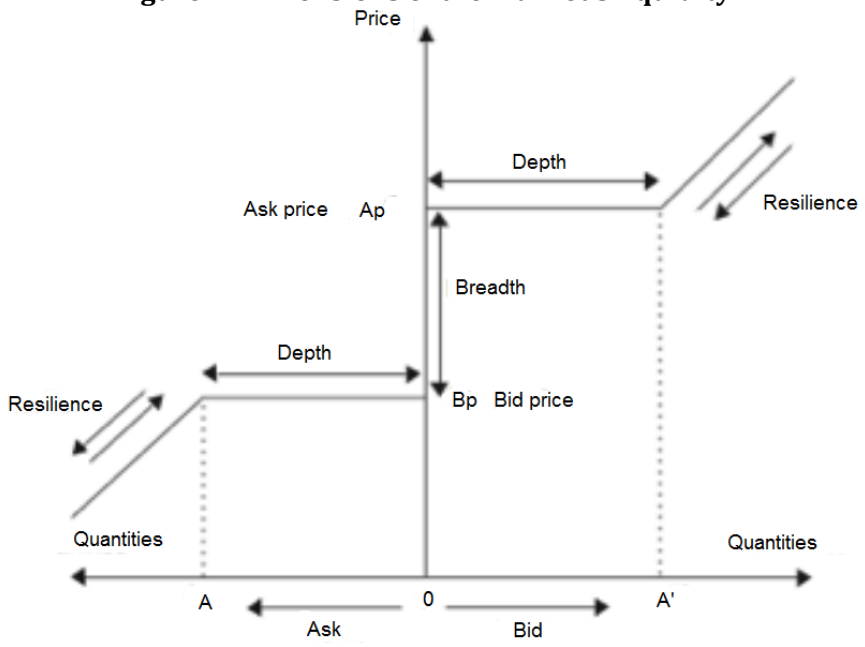
selling price and the ask will be the purchase price. A bid-ask spread of zero means that we evolve in a frictionless market, a theoretical environment where no transaction cost applies, hypothesis used in various models, such as the Black-Scholes model.

- The market is deep if there is a sufficient amount of trading volume both on the up and down side of a specific asset.

- We can qualify a market to be resilient if the stock course finds its equilibrium level quickly after a random shock in the transaction flow. Following the IMF (2002), "it is a characteristic in which new orders flow quickly to correct order imbalances, which tend to move prices away from what is warranted by fundamentals."

In the following figure (Figure 1), the three dimensions of liquidity are graphically explained. Bid prices Bp and ask prices Ap are defined for standard amounts OA and OA'. The gap between Ap and Bp represents the "breadth" of the market. OA and OA' amounts are those that can be processed without being offset: they reflect the "depth" of the market. Beyond the points A and A', we visualize the negative impact of high amounts of transactions execution price. Resilience refers to the time dimension of liquidity and corresponds to the speed of price adjustment to their equilibrium value following a shock in the transaction flow.

Figure 1: Dimensions of the market's liquidity



Bank of France

Some literatures in the field of financial market are devoted to identifying the determinants of liquidity. But in addition to that, some academicians were particularly interested by the role of the market liquidity in period of crisis and its impact on it. The crisis the world just came trough was an opportunity to test significative role of market liquidity and its implication in the crisis.

Different works on multiple financial crises identify the scarcity of liquidity as an ever-present element during major crises (currency crises, banking crises, bursting of speculative bubbles, blockages in the payment systems, etc.). Direct evidence of negative liquidity impact comes from Boehmer, Jones and Zhang (2009): after analyzing bid-ask spread of stocks (not-) targeted by short-term ban introduced in the United States at the worst crisis moment in October 2008, they found that "liquidity of stocks subjected to ban was significantly reduced". Those previous findings were confirmed by two other studies: a one conducted by Kolasinski, Reed and Thornock (2010) and a second one by Marsh and Payne (2011). On one side Kolasinski et Al. found out that "emergency restrictions on naked short selling decided in 2008 have similar negative effect on liquidity." On the other side, Marsh and Payne conducted a study on a transaction level with daily data of U.K stocks and concluded, "The bid-ask spread was widening as soon as the ban has been in place. Moreover, the market depth declined much more than for other non-financial stocks". Charoenrook and Daouk (2005) also investigated the consequences of market-wide short selling restrictions. They found out that "when short-selling is possible, aggregate stock returns are less volatile and there is greater liquidity". In addition to that, Beber and Pagano (2011) found that liquidity was negatively impacted by short-selling short terms bans during the 2007-09 crisis. Small-capitalized stocks were more impacted by the ban. This observation is easily understandable: indeed, interestingly, Beber and Pagano integrated the Amihud's liquidity ratio in their study. The Amihud's ratio gives an illiquidity measure of a stock. Intuitively, it says a security is illiquid if its price varies widely following low volume transactions. This concept developed by Amihud will be used in a later stage of the paper in order to test significant increase/decrease of the European stock market's liquidity.

It is important to note that not all financial studies identify negative correlation between market liquidity and short sell constrains. Indeed, Jones (2012) revisited the short-term ban in the United States after the Great depression of 1929 after what the American Government imposed an uptick rule[1], in the mid 30's, to frame short sell operations. Jones concluded that the "market liquidity increased during the period in which the uptick rule was in place."

Previous study conducted only 5 months after the SSR date by ESMA (2013) provides some indication concerning the impact of the new short selling regulation on the European market's liquidity. ESMA indicates, "European stocks bid-ask spread tends to decrease after the date the regulation came into force". In opposite, "daily share volume of transactions and Amihud's illiquidity ratio didn't give conclusive results". But ESMA (2013) suggests that the "delay between the dates the regulation came into force and their analysis was not broad enough to be pertinent".

1.3.2. Volatility Theories

Volatility is a key feature of a good-functioning financial market. A stagnating market is a market with very low volatility. The term volatility concerns the short, the medium and the long term. It does not characterize indecision of the market at a given time, but the magnitude of price fluctuations, upwards or downwards, which notably reflects changes in expectations. Betting on future volatility, traders are sometimes called the "risk players". According to financial theory, an investor only agrees to acquire financial assets with high volatility (and therefore a significant risk) if the yield is high. High volatility in the financial markets does not appear in one and only scenario. Periods of high volatility often result in low prices, which enable the buyer to anticipate higher profitability. The opposite is also true: in all periods of speculative bubble, volatility increased also sharply. For most of academicians, such as Pedro and Leclair, the volatility is rather a consequence than a cause of a crisis. Following the same Pardo and Leclair (2004) "volatility is *raw material* for much of market activities, provides a

[1] The SEC (2008) defines the Uptick rule as the following: "a stock may be sold short at a prize above the price at which the immediately preceding sale was effected (plus tick), or at the last sale price if it is higher than the last different price (zero-plus tick)."

matching function to cover the growing risks of the real economy." So a decrease in volatility should not constitute in any way an exclusive goal, or even a priority for the regulator. It is important to recall that establishing and maintaining a climate of confidence are the best antidotes against excessive market volatility. During the 2008 crisis some governments, such as the United States, were concerned about the market drop and the high volatility of the financial markets. So one of the reason short sell constraints had been introduced, for short or long term (depending on the country), was to reduce the volatility and slow down the downward behavior of the market as much as possible through confidence injection.

Contrarily to what people and government think, theoretical documentations affirm short sell constrains worsen market's volatility during chocks. Indeed, following Anufriev and Tuinstra (2009) who studied global price dynamics, "introduce a short selling constrain into a volatile market price dynamic can lead to an increase of the market volatility". Chen and Zheng (2006) are going in the same direction: they studied the Hong Kong stock market and showed that "when short-sell constrains exist, aggregate stock returns are more volatile". Hong Kong has introduced a regulation back in early nineties[1] and has inspired many economist and financial professionals. Indeed, Hong Kong stock exchange has restricted the short sell activity to 17 financial stocks only. In line with Chen and Zheng, Wu and Liao (2007) used a co-integration methodology to study the Honk Kong and Taiwan financial markets to conclude, "Short selling activity plays an essential buffer role in the market". This idea is contradicting the governments' ones, sustaining the fact that limiting short sell activity would reduce market volatility. Other academicians developed the topic in different countries where temporal or definitive short sell has been applied, and the majority of them end up with the same conclusion. Indeed, more documentation from Robin and Kraus (2002) over the market volatility in Israel also suggests that the volatility increased significantly after the restriction imposed on short market participants.

In opposition to those studies ending up with all the same conclusion that short sell constrains affecting negatively the volatility of the market, Bohl, Reher and Wifling do not drew up the same conclusions than their colleagues but still give mitigated opinion

[1] https://www.hkex.com.hk/eng/market/sec_tradinfo/regshortsell.htm

over possible constrains imposed on unconventional market participants. They indicate the following three observations:

- First they argue that the "volatility regimes' switches arises rather from the financial crisis and tremendous period than from the short sell limitation in itself". This indicates that potential bias in conducting analysis occurred, and specifically in period of high market turmoil, where price volatility do not behave in a normal way.

- Secondly, they only see "very weak evidence that constrains imposed by governments to particular market participant have a diminishing effect".

- Finally, the authors suggest that "short selling constrains and regulations do not have a stabilizing effect on the market". This last indication says that the reason why governments want to control short selling should not be based on the willingness to reduce volatility of returns. In other words, SSR have only poor incidences on the observed volatility on the markets, or at least do not stabilize it.

Besides the idea that short sell impacts positively market volatility, one could also think that betting "against" a particular stock should participate in, influence and enhance market crashes. But relating to crash consideration, Charoenrook and Daouk (2005) persist developing, "allowing for short selling does not have any correlation with the probability of market burst".

On its time-scope limited report, the ESMA (2013) concludes, "there was a diminishing volatility of returns on European stocks by approximating 0,12% after the 1st of November 2012", date that the SSR came into effect in the European zone. This means that by limiting short selling, the volatility of returns was reduced, which is contradicting the previous studies held by academicians around the world. This interesting "countercurrent" result will be re-examined in the finding part of this work, as it is the core aim of this study.

1.3.3. Price formation theories

As described in their book, *Equity Markets in Action: The Fundamentals of Liquidity, Market Structure & Trading*, Schwartz et al. (2004) define Price Discovery as "the process of determining the price of an asset in the marketplace through the interactions of buyers and sellers." The price of a stock reflects therefore a value found by matching the supply and demand of different markets participants. By constraining investors to sell short securities, market regulators reduce voluntary the number of sellers on the markets. Back in 1977, Miller studied the implication of short selling constrains on the stock pricing formation. He argued that "the price of a security subjected to short sell constrains were not taking all investors' opinion into account." Indeed, "by only integrating the optimistic investors into a stock price, this last one could be overvalued; as short selling restriction prevents some pessimists from shorting a stock they believe to be overvalued". In the same direction of Miller's studies, Cahn, Kot and Yang (2010) argue, "Short selling slows bubble formation on rising stocks". They study the share prices of Chinese companies listed in both Shanghai and Hong Kong stock exchanges, and concluded stocks tend to be higher in Shanghai, where short selling is prohibited, than in Hong Kong, where it is permitted. To stress on the fact that short sell constrains may have a price formation impact, it is useful to note that following two past studies run by Boehmer et al. (2008) and Asquith et al. (2005) "short sellers are high skilled informed traders". Therefore, their presence on the market represents a precious information source for price discovery process. The source of information advantage is difficult to analyze but Engelberg et al. (2011) consider "public news only as a valuable trading source" for those skilled markets participants.

In the observation and conclusions the ESMA drew up early 2013, the prize formation process has been "significantly modified and deteriorated after the SRR came into effect." Indeed, the European stocks prize discovery process "has been reduced by 3% more than for American stocks".

1.4. Conclusion

To conclude the literature review, let's sum up the general ideas worldwide academicians have over short selling. Despite the negative view one could have facing short sell instrument, numerous financial analyst and observers have debated and demonstrated, for the majority, the legitimacy of this financial instrument. Indeed, short selling is far more than speculating on a future downward trend of a stock, it plays a crucial role in the stock market.

Major modern financial authors we discussed so far indicate:

- A clear positive correlation between market liquidity and short selling, as short sell participates in a major role in the research of a perfectly liquid market; knowing that this characteristic is a core quality of a financial market.

- In addition to that, short selling activity has an impact on the volatility of returns. Its implication is clear for the major part of the authors; they indicate a clear negative impact of recent regulation of short selling on the market volatility. Moreover, some argue that recent regulations do not have any effect on the stabilization of the volatility.

- Finally, short sell plays a crucial role in the price formation process. This market characteristic is not as intuitive as the two previous ones but is meanwhile very important in good functioning financial market. One more time, authors mainly agree on the fact that short sell constrains has negative effect on Price Discovery.

We have seen that European governments' reactions to the recent market crash were not very well coordinated and some few regulations emerged. Meanwhile regulations were not very restrictive, as constrains were only settled for a few stocks only. Facing that situation, the European Parliament decided to vote a short sell regulation applicable in all European countries, so that investors across the continent would have to follow the same legal frame, which is the goal of the European Union. The goal of the regulation in the European Union is not to totally block or ban all short sell transactions, it is

settled to put a frame on this financial instrument. Meanwhile, by restraining naked short selling and push investors to declare their short position from a certain amount, the European Parliament has restrained the short sell activity in the financial market.

Following previous studies on short selling restrictions, these ones have impacts in opposite to the goals of the EU's regulations, so it could be important to study the market implication of this recent regulation, voted by the European Parliament the 1st of November 2012. This is on what we will work on for the rest of the paper.

2. Quantitative Analysis

This section explains the methodology used in order to identify potential market effect of recent short sell regulation in Europe. The aim of the study is to evaluate potential liquidity, return volatility and price formation process impact due to the SSR. First, measures of market liquidity, volatility and price discovery will be enunciated and described. Secondly, the main methodology, "the difference-in-difference" method, used in the context of the analysis will also be defined. Thirdly, the way the measures are integrated into the difference-in-difference approach will be discussed. Two different approaches will be used, in order to have a better idea of potential SSR effects on the European market. Indeed, a "graphical approach" will complete a "regression approach". Finally, the data used for the study will also be described in order to fully understand where numbers used in next "Findings" section are coming from.

2.1. Measures of market liquidity, volatility and price discovery

This chapter presents the different measures taken for the study of market's liquidity, volatility and price formation process. Each measure will be described mathematically and literally.

2.1.1. Liquidity measure

To analyze the liquidity impact of the SSR in the European Union, it is interesting to see the impact of this last one on three different measures. Indeed, as stated previously, market liquidity is defined by multiple characteristics and can be seen under different spectrums. The liquidity analysis following in this study is using three globally recognized measures: the bid-ask spread and the transaction's volume respectively used as proxy for the breadth and the depth of the financial market. Both the breadth and the depth of the market represent major market's characteristics. Moreover, they are easily available as they are public data's and also easy to calculate and interpret. A third

measure is complementary with the two first, and is seen as an "illiquidity measure" by academicians: the Amihud ratio. Those three (il-)liquidity measures and their usefulness in the context of this study are explained hereafter.

By previous academic and empirical studies, it is expected that the European stock market should be less liquid after the first of November 2012, date at which the SSR came into force. This conclusion would be in line with previous studies if, after the 1/11/2012, the bid-ask spreads significantly increases, the trading volume decreases and the Amihud's ratio increases.

Let's now have a look at the properties of those three measures and the way they will help us to study the market's liquidity difference before and after the SSR application.

2.1.1.1. Bid Ask Spread

As stated before, the bid-ask spread of a financial stock is defined by the difference between the lowest price a stock holder is willing to sell his security (ask) and the highest price a market participant is ready to pay for the similar security (bid).

Let rename "$BidAskSpread_t$", the absolute spread, A_t the Ask Price and B_t the Bid Price in time t. The definition of the Bid-Ask Spread would be the following:

$$BidAskSpread_t = A_t - B_t$$

This absolute bid ask spread as liquidity measure is the easiest to interpret. The higher the spreads, the larger the gaps between ask and bid prices, and the lower the liquidity of the financial security.

However, this simple absolute spread measure is not the most relevant measure in the frame of our liquidity analysis.
Reshaping the absolute bid-ask spread leads toward another globally recognized index used to examine and model the liquidity in the market: the Percentage Bid-Ask Spread.

In the continuation of our previous formula, lets rename A_t the Ask, B_t the Bid and P-S_t the Percentage Bid-Ask Spread in time t.

$$P - S_t = \frac{A_t - B_t}{(A_t + B_t)/2}$$

This spread expressed in percentage is one of the liquidity measures used by the ESMA in order to capture the difference in market's liquidity before and after the 1st of November 2012. But the percentage Bid-Ask Spread represents more than a liquidity measure. Indeed, academicians such as Gabrielson, Marzo and Zagaglia argue that the percentage spread represents more "a transaction cost rather than a liquidity index in a pure sense".

2.1.1.2. Volume of Transactions

The volume of transactions occurred on a daily basis is used as a proxy for studying the difference in market's depth of European market before and after the SSR came into force. We use the daily share volume of transactions taken as a natural logarithm, in order to harmonize scales.

$$Volume_{ti} = \ln(DailyVolume_{ti})$$

With "$Volume_{it}$" measure as daily volume of stock i on day t, equaling the natural logarithm of daily volume of stock i on day t.

2.1.1.3. Amihud Ratio

The Amihud's Ratio is an illiquidity measure studied and elaborated by Amihud. The ratio is defined as « the stock absolute return to its daily dollar volume, averaged over some period. »

$$Amihud_{it} = \frac{1}{D_{it}} \sum_{t=1}^{D_{it}} \frac{|R_{it}|}{VolD_{it}}$$

With D_{it} the number of days with ratio available of stock I on day t, R_{it} the daily return and $VolD_{it}$ as the dollar trading volume of stock i on day t.

The ratio is interpreted by Amihud (2002) as "the daily stock price's reaction to a dollar of trading volume". But for calculations facilities, an illiquidity ("Illiquidity") proxy for the Amihud ratio is used in the context of this analysis:

$$Illiquidity_{it} = \frac{|R_{it}|}{P_{it}Volume_{it}}$$

With, on a daily basis, "$|R_{it}|$" the absolute stock return of stock i on day t, "P_{it}" the stock i closed on t price and "$Volume_{it}$" the Volume of transactions on t for the stock i.

2.1.2. Volatility measure

Mathematically, the historical volatility of returns is calculated as the annualized standard deviation of returns, which is represented by the symbol σ. Literally, the standard deviation is found by computing "*the square root of the average of the squared deviations of the values from their average value*"[1].

The mathematical expression for the standard deviation σ is the following:

$$\sigma = \sqrt{E\left[(X-\mu)^2\right]}$$

With $E[X] = \mu$ where X is a random variable with a mean equals to μ.

The first step to be performed is the computing of the standard deviation of stocks with daily returns that have been computed for the liquidity analysis. Those returns will be useful in this new research. But computing the standard deviation using daily return data gives us the daily standard deviation of a particular stock. However the objective

[1] https://en.wikipedia.org/?title=Standard_deviation

here is to compute the annualized volatility. A slight rearrangement needs to be made: *"the standard deviation needs to be multiplied by an annualisation factor, which is the square root of how ever many of your periods are in a year."*[1] As there are 262 trading days in a calendar year and that the standard deviations are computed on a daily basis, the factor of annualization in this case is √262. The annualized volatility is then computed as the following:

$$AnnualizedVolatility_{it} = \sigma_{it}\sqrt{262}$$

With σ_{it} the standard deviation of stock i on day t.

2.1.3. Price formation measure

To study possible market reaction to SSR and its inference to the prize formation measure, Boehmer and Wu utilize the prize lag/delay to integrate information as a proxy to evaluate the rapidity of the prize discovery process. They found out (2013) that "prices are more accurate when short sellers are more active." Indeed, their conclusion was based on the fact that the higher was the shorting flow; the better was the efficiency of prize information. The ESMA (2013), summaries the Boehmer and Wu idea as, "extent to which previous market information accounts for the formation of prize". To evaluate and measure the price delay of a stock, Boehmer and Wu as well as the ESMA identify the following procedure to be applied:

The idea is to compare two models to see if past market returns help to better explain current market returns.

The first step is to regress the stocks' weekly return with indices' current return and returns of the previous 4 weeks. A first mathematical expression applies:

[1] http://adamhgrimes.com/blog/how-do-you-calculate-volatility-in-excel/

$$r_{i,t} = c + \beta_t R_{m,t} + \sum_{n=1}^{4} \delta_{t-n} R_{m,t-n} + \varepsilon_{i,t}$$

With r_{it} the stock's "i" returns on week t, c a constant, R_{mt} the week return of the corresponding equity index m on week t and $R_{m,t-n}$ the index return delayed of n week (-s). ε represents the residuals of the regression. The last equation will further be called as the unrestricted model.

A second mathematical expression needs to be evaluated by regressing the weekly stock returns with the weekly return of the corresponding index only. The regression is described as the following:

$$r_{i,t} = c + \beta_t R_{m,t}$$

With r_{it} the stock's "i" returns on week t, c a constant, R_{mt} the week return of the corresponding equity index m on week t. ε represents the residuals of the regression. The last regression will further be called the restricted model.

Now that both the restricted and unrestricted models have been described and enunciated, let's express the price delay measure as the following:

$$\Pr izeDelay = 1 - \frac{R^2(\mathrm{Re}strictedModel)}{R^2(UnrestrictedModel)}$$

In statistics, R^2 is the coefficient of determination and reveals how well the data's fit the model. The coefficient of determination ranges from 0 to 1 and is defined by Steel and Torrie (1960) as "the proportion of total variation of outcomes explained by the model". Please refer to annex 4 for further development and explanations over the way the coefficient is calculated.

In an ideal world where financial markets would be perfectly efficient, the price delay as described before should be equal to zero. Indeed, there is no reason that the incorporation of returns from the preceding four weeks would better explain current

returns. Intuitively, the SSR applied in Europe would reduce the price formation process and de facto, generate higher prices delays after the first of November 2012 regulation.

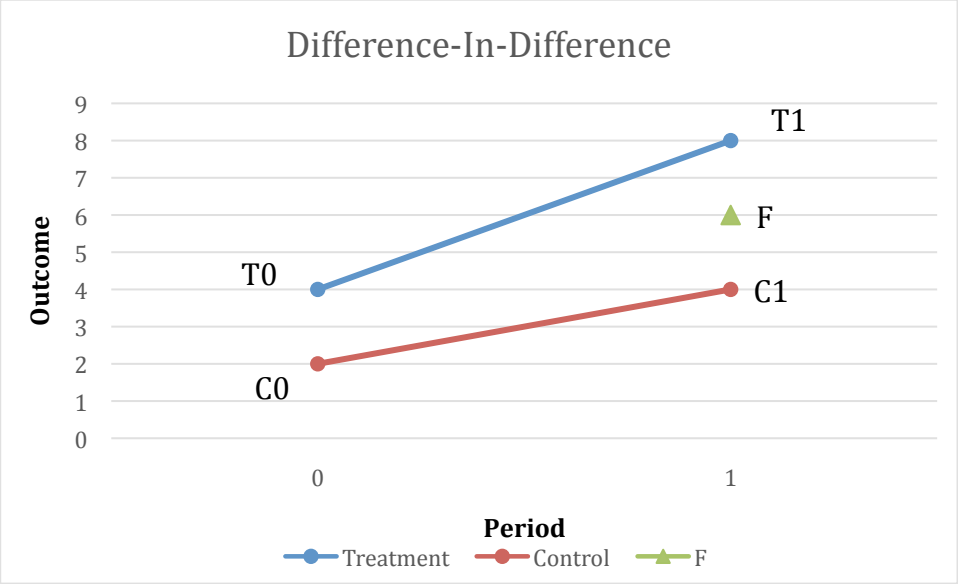
2.2. The Difference in Difference methodology

In order to make a study in line with the one made by the ESMA, only three months after the SSR and in order to make right comparisons between the two times lapse, the methodology used in this study is quite similar to the one operated by the study done by the ESMA. The main methodology used to study the impact of the SSR on the European market is a difference in difference methodology (DD). Before reviewing the DD applied in the case of the regulation adopted in the EU in 2012, let's explain and develop the foundation of the methodology.

2.2.1. The Model

The Difference in Difference ("DD") methodology is a statistical technique used in multiple econometrics studies, and tries to imitate an experimental research by using observed data. The point of the DD technique is to evaluate potential impact of an event on a treatment group compared to a control group, by using a set of data's of at least two time periods: before and after the event. The DD is often used by practitioners' and academicians in orders to evaluate particular event such as law's enforcement; which is the case of this study. The study over short selling integrates many time periods as daily data have been used; meanwhile, let's illustrate the definition with a picture integrating only a 2-time period:

Figure 2: The Difference-in-Difference methodology on a two-period basis.



Source: Danni Rythvan

The simple picture above can be explained as the following: the Treatment Group is considered to be T and the Control Group to be C. Time 0 corresponds to the period before any group receives the treatment, defined by the independent variables. Time 1 corresponds to the second measure, after the Treatment Group has been experiencing a treatment. C_0 and T_0 represent the outcome variables at time 0, in opposite with C_1 and T_1, representing the dependent variables after the treatment effect impacting T only, on time 1. So lines C and T show the evolution of the outcome (the dependent variable) from Time 0 to Time 1. Note that the point "F" at time 1 corresponds to the outcome of the Treatment Group without the observed treatment effect: it is the hypothetical Treatment Group outcome without treatment (a law in our case). The difference in difference statistical technique is acting like a double difference methodology: comparing a first difference between T_1 and C_1 with a second difference, between F and C_1. To sum up, the DD methodology calculates the difference between the effective Treatment Group outcome T_1 and its hypothetical one, "F".

Mathematically speaking, the model is defined as the following regression estimated using the OLS method[1]:

$$y_{it} = \beta_t + \delta D_{it} + \varepsilon_{it}$$

[1] OLS method assumptions are detailed in annex 2.

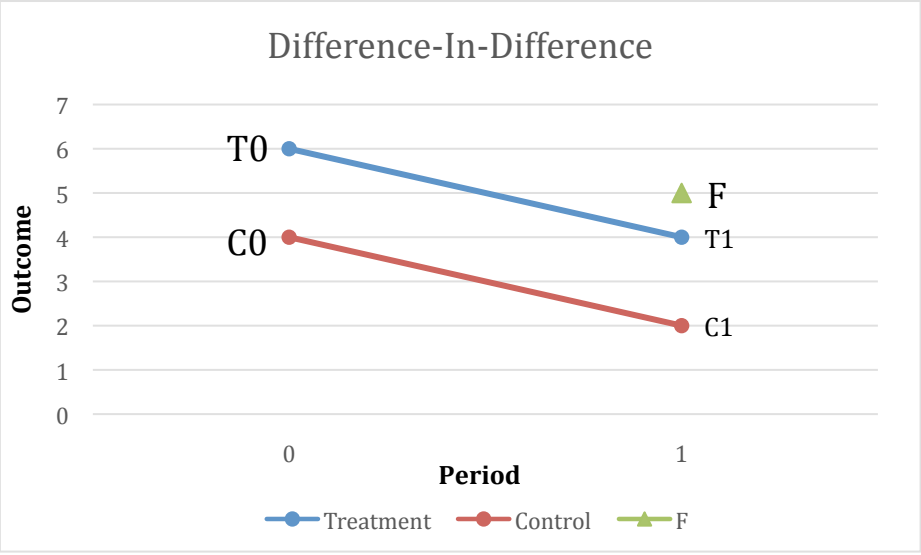
With the dependent variable y_{ist}, as the outcome of interest of the stock "i" for a given time "t". β corresponds to intercept and D_{st} is a dummy variable: in one hand the dummy variable takes the value of "0" if the variable is not subject to the treatment and on the other hand a value of "1". The effect of the treatment is indicated by "δ". ε_{it} are the residuals for given i and t

The DD model has many positive points: it is an easy methodology to put in place and it permits to avoid and reduce selection bias. On the other side, it also includes some negative characteristics such as serial correlation. Some limitations of the model will be discussed in the final part of the study: "limitations of the study".

2.2.2. Assumptions of the model

In addition to all the OLS assumptions[1], a "parallel trend assumption" applies to the DD model. Assuming the treatment group T and the control group C, theoretical outcomes differences in time 0 (T0-C0) and time 1 (T1-C1) need to be equal, without any treatment applied to the treatment group.

Figure 3: Difference-In-Difference graphical assumption



Source: Mathieu Parijs

[1] OLS assumptions are detailed with the OLS method in Annex 2.

The low point of the DD methodology is a possible violation of the parallel trend assumption due to possible other than treatment - change in one group only, without affecting the other group. Indeed, this scenario would shift the parallel outcome and violate the parallel trend assumption. One way to reduce that kind of scenario would be to use the same individual data's before and after the treatment, but this does not completely guarantee the DD model. Another way to reduce such problem would be to use control variable when using DD applied through the regression method.

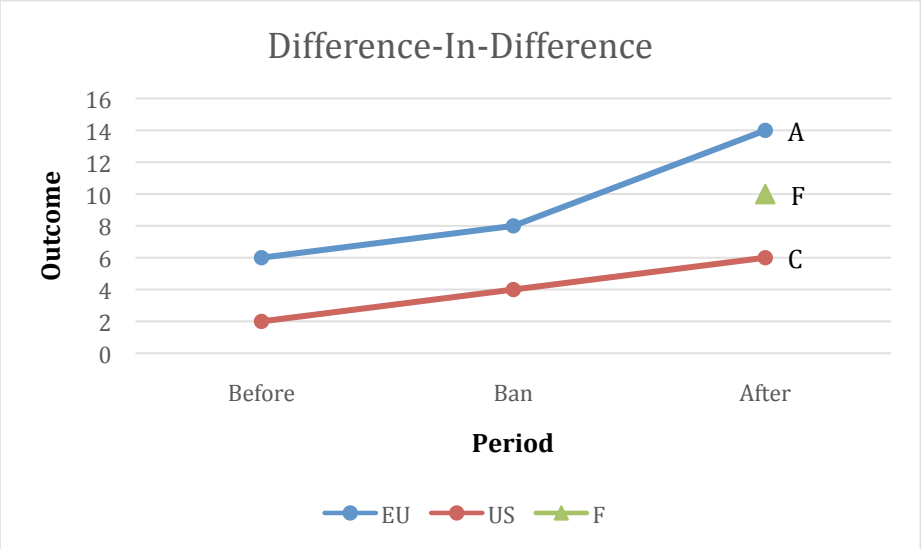
2.3. Graphical and Regression approach

The first step to be achieved in the implementation of a DD model is to choose the two groups: one of control and another of treatment. As the regulation aims to regulate the European stock market, the treatment group will be composed of European stocks only. On the other hand, the control group needs to be a financial market with similar core characteristics. The most relevant and the one that is the closest of the treatment group is defined as the US financial market by the ESMA. It is important to note that no regulation occurred in the US concerning short sell regulation since 2010.[1] In addition to that, what is interesting in the DD methodology is the fact that it can be approached on two different ways: indeed, a graphical approach can be completed by an eventual regression one. Let's now explain the two approaches:

2.3.1. Graphical approach

To understand the graphical approach, it is easy to explain it by a short illustration:

Figure 4: Difference-In-Difference methodology applied in a 3 period basis, model used to evaluate potential event effect.



Source: ESMA (2013)

On the previous chart there is three outcomes for each group, on different time period: before, on and after the regulation introduction. The difference-in-difference estimates

[1] http://www.sec.gov/answers/shortrestrict.htm

between the two groups of interest correspond simply to the difference between A and F. This result is only true if we take the hypothesis that the unobserved difference (F-C) remains constant over time, meaning that unobserved variables impact the two groups in a same way.

A practical way to evaluate potential effect in the frame of our study is to compute the means of the relevant proxies before, on the ban date, and after the date of interest, which is the first of November 2012. The results of this approach will be developed in the next section: Findings. As stated in the assumptions of the Difference-in-Difference model, the parallel outcomes and shift of those ones are the principal limitations of the model. Indeed, real data's of 2 different groups of actions will nearly never follow parallel outcomes. Moreover, the value represented in the different chart will only be average of a specific group measurement. For those reasons, this approach is very limited but will nonetheless give a first approach and global view of each pertinent proxy. Those themes will be discussed in the "findings" part of the study.

2.3.2. Regression approach

To avoid problems linked with unobserved differences between groups, control variables should be included in the difference in difference model. To integrate such variables, a regression model is applicable. In this study, the regression is inspired from the DD methodology in order to measure possible market's liquidity, return volatility and prize formation impact after the short sell regulation decided by the European Parliament in November 2012.

To analyze the SSR with the DD model a new regression of interest is defined as following by the ESMA:

$$y_{it} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{it}$$

With y_{it}, the dependent variable and outcome of the measure of interest on time "t" for the stock "i". "C" a constant, dummies dependent variable "Group", "SSR" an "Effect" and

ε the residuals of the regression. Dummies variables take values of either 0 or 1, depending of the stock and the time t. Let's now explain the three Dummy variable and the values they will adopt depending of the stock and the time scope:

- Group independent variable indicates to which group the stock belongs. It will indicate common features for both groups. For all European stocks, the place where the treatment is applied, the variable will take a value of 1. For all shares belonging to the U.S market, the variable will adopt a value of 0. Note here that Group variable is only settled to define in which group the stock are belonging to. The dummy variable does not depend of any time scope.

- SSR indicates time tendency for both treatment and control group. The SSR was adopted by the European Parliament in March 2012 but only applicable by the first of November of the same year. So by definition, the date of interest of our study is settled as the 1st November 2012. The independent dummy variable of all stocks' data's take a value of 1after the 1st of November 2012, and a value of 0 before the SSR implementation date.

- Effect dummy variable is the most relevant variable, as its estimated coefficient will indicate possible European market's reaction post 1st November 2012. The dummy variable will take a value of one for all European stocks after the SSR implementation and 0 otherwise.

The way different measurement proxies used to assess the market impact occurred by the European Regulation on the European markets will know be explained.

2.3.2.1. Bid ask regression

Let's use the Percentage Bid-Ask Spread as dependent variable in the general regression derived from the DD method expressed at the beginning of the methodology. It is then possible to write the following regression that will be used in order to study the first liquidity measure: Let the dependent variable (Percentage Bid Ask Spread of stock "t" on day "i") be $S\text{-}P_{ti}$ and c a constant variable:

$$S\text{-}P_{ti} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{ti}$$

Please recall that independent variables "Group", "SSR" and "Effect" are dummies variables. Indeed, they can take only the value of "0" or "1", depending of the continent the stock "i" is quoted and the date of interest "t".

As theories summarized in the literature review, it is expected that the bid ask spread increased after the European regulation, end of year 2012. Contrary to these studies made by academicians, the ESMA related in its limited time scope report that the European market has seen its percentage bid ask spread decreased after the SSR. Those conclusions will be confirmed or invalidated in the "findings" part of the study.

2.3.2.2. Volume regression

Using the same working method as for the percentage Bid-Ask Spread, let's use the daily Log Volume of transactions as the dependent variable in the general regression inspired form the DD method. The following regression will be used in order to study the evolution of the stock trade volume in Europe.

$$Volume_{ti} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{ti}$$

With $Volume_{ti}$ the trading volume in a natural logarithmic scale, c a constant, ε_{ti} the residuals and the dummy independent variables "Group", "SSR" and "Effect".

As theories discussed in the literature review, a slight decrease in transaction volume is expected after the SSR date, in November 2012. Indeed, as short sell is limited, fewer stocks are supposed to change from hand. The ESMA related in its limited time scope report that the size of the European market's volume has not been impacted by the regulation. The study will enunciate results we obtain with previous method in the "findings" part of the thesis.

2.3.2.3. Illiquidity regression

Rearranging the general regression derived from the DD methodology with the proxy inspired from the Amihud illiquidity measure, gives the following regression, with "c" a constant, ε_{ti} the residuals and the illiquidity measure "$Illiquidity_{ti}$" as the dependant variable of stock "i" on time "t":

$$Illiquidity_{ti} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{ti}$$

As theories summarized in the literature review, it is expected that the illiquidity measure increased after the European regulation, end of year 2012. In opposite to this global observation made by academicians throughout the world, the ESMA has detected a slight decrease in the illiquidity ratio after the SSR came into effect in November 2012. Results founds using the previous methodology will be discussed in the third part of this study, in complement to bid ask spread and volume findings to complete the liquidity analysis.

To avoid bias in the estimates of the parameter of interest**,** control variables will be added in the previous regressions. Indeed, the Frisch-Waugh theorem explains the importance and the interest of including control variables in the regressions. Indeed, the theorem shows that "the coefficient linking one of the explanatory variables to the dependent variable will inevitably be biased if the other significant variables are not included in the regression." In fact, when a variable able to explain the dependent variable is not specified in the model, this last one is found in the residuals of the regression. To prevent such residuals bias, control variable will be integrated into the

different liquidity regression explained here above. Transaction volume and volatility will serve as control variable in the percentage bid-ask spread regression. Furthermore, percentage bid ask spread and volatility will be used as control for the two other regressions on transaction volume and volatility.

The introduction of such control variables in the different regressions describing liquidity effect will also have a capturing effect on different unobserved variables. As result, we hope getting more appropriate result than by applying the graphical method. This will also allow us to check the robustness of the simple regressions analysis.

2.3.2.4. Volatility regression

After reviewing of the regressions used to approach the liquidity measure and the impact of the SSR on the European market, let's move on to the second part of this study: the description of the analysis of the volatility of returns. As stated before, market volatility is a key determinant of financial markets: it is a measure of prize variation over time.

In this case, the idea is to determine if the SSR adopted by the European Parliament had an impact on the European stock market. By using the same methodology as for the liquidity measurement, the following regression has to be performed:

$$AnnualizedVolatility_{ti} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{ti}$$

The daily standard deviation will be determined on a 20 and 10 days look back basis. Perfect look back period are difficult to define: a good period is considered as a one close to the one considered by markets participants.

Based on previous studies, we could argue that the volatility of returns of European stocks is expected to increase after the European regulation. Previous empirical studies demonstrated that an introduction of any short sell constrains is followed by an increase in market volatility. Indeed, researches made by Chen and Zheng (2006) in Hong Kong indicates that local constraints enhanced local volatility of returns. In the ESMA report

(2013), it was notified, “volatility decreased by around 0,12% after the regulation implementation". This result is also an opposite result than the one exposed to main academicians’ results.

2.3.2.5. Prize formation regression

Once the Price delays have been measured for both the European and American zone, it is possible to evaluate the effective impact of the SSR to the European stock market’s prize formation by using the DD approach, one more time. By using the PriceDelay as the new dependent variable of the model previously developed, a mathematical expression comes up:

$$\Pr izeDelay_{it} = c + \alpha Group + \beta SSR + \chi Effect + \varepsilon_{it}$$

By assessing the previous equation, it will be possible to announce potential effect of the European SSR on the price discovery process of the European stock market.

Following previous studies recalled in the literature review, by deleting a part of short seller activity, regulator might have affected the prize discovery process. Indeed, by only taking a part of investors’ information, stocks’ prizes might not be as efficient as it should be. By definition, the prize discovery process should be reduced by the limitation of short selling activity. In that direction, the ESMA (2013) also reported a slight decrease in the European prize discovery process. Following their study, the prize discovery process “decreased by 3% more in Europe compared to the US.”

2.3.3. Regression estimations

All previous regressions concerning measurements of liquidity, volatility and prize formation will be estimated through the White's standard errors and covariance matrix for work facilitation. In large sample as it is the case in this study, heteroskedasticity[1] of the regressions errors will probably appear. The source of heteroskedasticity will also be a cause of concern, as it will not be easily identifiable. As stated in the Gauss-Markov theorem, "not dealing with heteroskedasticity cannot produce biased coefficient estimates but their variance will not be the lowest and therefore, the estimators will not be the BLUE." Not producing BLUE estimators leads to biased variance, confidence intervals and, by definition, all future statistical inference. To get around this problem, White introduced a methodology that "fixes" the regression errors, also called later "robust errors". The White's robust standard errors methodology is explained in details in Annex 7. In short, the use of this methodology deals with major issues statisticians have to deal with: following the University of California Los Angeles, "the robust option copes with heteroskedasticity and lack of normality issues."

Following the White's procedure (1980): "appropriate inference will be possible even if the type of heteroskedasticity has not been previously defined". Indeed, the White robust errors offer a wide range of advantages in the case of this study, focus will be made on two of its advantages.

The first and the most important one is without any doubt the possibility to use the coefficient estimated for further statistic inference, such as the T-Test and the F-Test. Wooldridge (2009) argues "T-Statistics distributions obtained from robust standard errors will follow the same exact t-distribution in case of very large sample". Please note that in the case of this SSR study, daily data have been uploaded from DataStream to form data set that extends more than a thousands data per share. It is important to note here that this is only with the hypothesis that we have a wide data set that it will be possible to make some later inference, as the F and T test will tend to their true

[1] Heteroskedasticity of errors appears when the variances of the errors are not constant over time. This issue can be a source of problem when inferences are made with regressions results. Indeed, no test (as the t-test) can be performed when errors are heteroskedastics.

distribution. In small sample, the robust errors will still produce unbiased coefficient, but inference will not be feasible. Andrews and Monahan (1992) and Kiefer et al. (2000) pointed out two possible error misstatements, they argue, “The size of distortion is proportional to the heteroskedasticity error” and that in most of the times, errors are biased upward, so that significance level will be higher than expected in theory.

The second advantage of the White procedure is as important as the first one in the context of the study: the White “heteroskedasticity-consistent-errors” is applicable to homoskedastics errors as well.

In addition to this robust option, cluster option has also been used: this option deals with serial correlation within each stocks measure. As stated by the University of California, “cluster options are often used to show that regression’s observations are correlated within clusters. In the frame of this study, stocks represent the clusters, so that we have 200 clusters in our regression: as we start from the assumption that stocks returns, volatility and liquidity measures can be serially correlated through time within each cluster. In opposite to that, no correlation is assumed between stocks.

2.4. Data

As stated by the European Entity, a too small time lapse was used to study the liquidity, trade volume and prize formation process. That is why, for the purpose of the current study, information was uploaded from Reuters DataStream for the time lapse ranging from the first of November 2010 to the thirtieth of April 2015. The time period of study is then two years before and two and a half-year after the regulation date. This large period is crucial for the good conduct of the study. It will allow it to stand out from the one made by the ESMA three months only after the SSR. Indeed, the collection of data on a broader time frame reduces the selection bias and particularly of time interval bias: by only collecting information till the end of March 2013 (which was the sole available information at that time), the ESMA's conclusion may have been considerably distorted.

In the previous ESMA study, 100 stocks were randomly picked for each group (US Market and EU group). Stocks were picked in a pool of major European and US stock markets. The stock's pools were divided in four in order to have relevant data concerning different companies' capitalizations. 25 stocks were randomly picked up in each pool. In order to work in the continuity of the previous study, it has been decided to retake the same companies that the ones chosen by the ESMA, for two main reasons. First, the data selection has been done properly by the European agency and the far longer time scope this study takes into account will not be biased by taking the same data as the one selected by the ESMA. Secondly, we could better compare the studies at the end of the work, by stressing the fact that time scope was the major issue of the study held by the ESMA.

For liquidity and volatility measures, daily close stock prizes, volumes of transaction, bid and ask prizes need to be collected. In addition to that, indices' data from corresponding stock need to be gathered for the elaboration of the market prize formation measure. As stated by Gabrielsen, Marzo and Zagag (2011), "Intra-day measures of liquidity appear to be relevant to capture core features of the market". So confirming that daily measurement of information is pertinent.

After collection, all information's has been treated using Microsoft Excel for chart elaboration as well as for simple ratios calculations such as liquidity, volatility and prize formation measures. Once the data treatment was accomplished, the regressions and all statistical work have been performed with StatPlus, Stata and SPSS statistical tool, depending of the work performed. In one hand, StatPlus is easy-to-use integrated software that can be appended to Microsoft Excel. In the other hand, many characteristics of the Stata and SPSS software can be activated with an easy programming interface. They both have the advantage of reproducibility and handling of complex data.

Table figuring in annex 3 resumes the 200 companies selected to evaluate the market impact of the SSR regulation. Note that companies' subgroups are classified by market capitalization. Taking companies of different capitalization is crucial for the analysis of liquidity, volatility and prize formation process: it is obvious that small capitalizations do not offer the same characteristics than large capitalization.

3. Findings

After enunciating and describing the different steps of the study, useful data and methodologies to describe the market's impact of the SSR on the European markets, let's now interpret the results measure per measure following the two approaches mentioned above: the graphical one and the regression one. The objective of the study is to identify potential effect of the SSR, which took place in Europe as from the first of November 2012, on the market's liquidity, volatility and stock prize formation using the DD methodology, explained in the previous section.

Please note that for each measurement, different time lapses have been taken. Indeed, the impact of the short sell regulation on the markets might only be observable on a short time frame. In order to make our study more relevant, two time frames have been settled: a long period (consisting of daily data's from November 2010 and April 2015) and a shorter time period, which takes daily data's between November 2011 and April 2014 into account. These two scenarios will be discussed for market liquidity and volatility.

The different findings on each measurement proxy will be explained gradually for each measure of interest for the study. Indeed, explanations of the results will be divided in two (graphical & regression) for each measure of liquidity, volatility and prize formation process. This will be verified on a second step of the findings section. Please note that through the different regression, the coefficient of the dummy variable "Effect" represents the net impact of the SSR on the measure of interest.

3.1. Liquidity impact

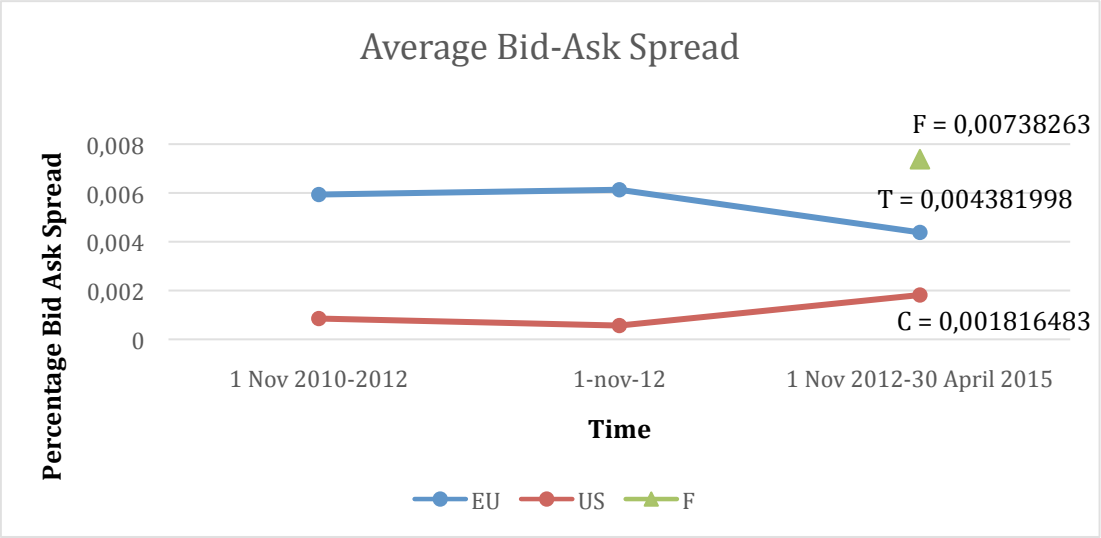
As stated in previous section, the liquidity impact of the European regulation is evaluated using three different liquidity proxies: Percentage bid ask spread, volumes of transactions and finally with a non-well known but also pertinent illiquidity ratio: the Amihud ratio.

3.1.1. Bid Ask Spread

To assess an eventual bid ask spread change in Europe after the SSR, let's first have a look at the DD graph next page, showing average Bid Ask spread of the 100 stocks of each group: EU and US, before and after the short sell ban. After a quick look at the chart, it is observable that the bid ask spread is higher for European than American stocks. This observation is valid both before and after the European ban. But when the chart is tested more closely, a significative difference between before and after SSR is observable. In one hand, the control group (U.S stocks) has experienced an increase in its bid ask spread between the period before and after the European SSR. On the other hand, the treatment group's (E.U stocks) average bid ask spread has significantly decreased compared to the period before the SSR.

On a difference in difference point of view, it is assumed that the two groups would behave the same way before and after the regulation if no regulation occurred. By hypothesis, if no regulation occurred in Europe, the EU stocks' spread would have taken the same direction than the American one and would have reached the "F" point in the graph next page. In opposite to that, the European spread reached the "T" point in the same chart. So the graphical difference in difference methodology highlights here a significative decreased in the European bid ask spread compared to the group of reference, the US market. The DD between the point T, where the spread actually is and the point F, where the spread should have gone in reference to the US market is also quantifiable using this method. As stated in the theory in previous section, the DD is the difference between the point F and the point T, which is: 0,00738-0,00438 and equals to 0,003. So we can conclude that the bid ask spread suffered of a decrease by approximately 0,3% after the SSR compared to the U.S. This first approach gave us a first idea of the reaction of the European bid ask spread after the SSR.

Figure 5: Graphical DD method showing the SSR effect on the E.U. stocks' Bid-Ask Spread, using U.S. stocks as control group.



Sources: DataStream, Mathieu Parijs calculations.

To complete the simple graphical method described here before, let's now use the regression method in order to confirm and precise our first approach. The regression has been approached using five different models. The two first regressions use the only three independent variables Group, SSR and Effect in order to study SSR impact on the bid ask spread. On the one hand the Model 1 uses daily data from November 2010 and April 2015, and on the other hand, the Model 2 uses daily data from a shorter time period: from November 2011 and April 2014. The three latter models integrate two control variables: return's volatility and prize volume on a full time basis (November 2010-April 2015). Please note that the variable of interest is the "Effect" independent variable. This variable shows how the measure of interest behaved after the SSR date in Europe.

The following table groups the two first model: Model 1 and Model 2. The Model 1, integrating daily data's from November 2010 to 2015, shows significant coefficient of interest. Indeed, following the computing made on Stata, the bid ask spread has decreased by 0,26% after the SSR date. This result is significant at a 1% confidence level, which indicates high confidence on the estimator of the coefficient of interest.

To evaluate if the SSR had the same effect on shorter time period, the effect is evaluated through the Model 2. This Model integrates data from November 2011 to April 2014, and shows significant coefficient of interest as well. Indeed, following the Model 2, the

bid ask spread decreased by approximately 0,34%. This coefficient is also significant at a 1% level of confidence.

Through the two first Models, it is observable that the bid ask spread significantly decreased by 0,26% at a full time frame and 0,34% on a shorter time period. These measurements confirm the graphical methods used in previous section. However, comparing the two first Models' results, the bid ask spread decreased more significantly using shorter time periods. This could indicate that the SSR impacted the spread in a more important way on a shorter time frame.

Table 1: Bid Ask Spread coefficients of the two first models.

Bid Ask Spread		
Variable	Model 1 (Nov 10'-Apr 15')	Model 2 (Nov 11'-Apr 14')
Constant (Std. Error)	0,00077 (0,00005)*	0,00055 (0,00004)*
Group (Std. Error)	0,00516 (0,00065)*	0,00619 (0,00074)*
SSR (Std. Error)	0,00103 (0,00013)*	0,00165 (0,00019)*
Effect (Std. Error)	-0,00260 (0,00053)*	-0,00349 (0,00056)*
R-Squared	0,0236	0,0342

* Significant at 1% confidence level
Sources: DataStream, Mathieu Parijs calculations.

To take unobserved effect into account when computing potential SSR effect on the bid ask spread, it is interesting to add control variables in the model. The adjustments on the initial regression through the adding of control variables will also allow having a better-fitted regression. The Model 3 integrates both volatility and volume control variable, Model 4 takes only the volatility control variable and finally the Model 5 takes the volume as control variable on a full period basis.

Following the table next page, the adding of control variables confirms the results found using the two first regression's Models and the graphical method. Indeed, the variables of interest found via the three Models are significant and range between -0,27% and -0,28%. Interestingly, the Model 3, which adds volatility and volume control variable into account, has a higher coefficient of determination compared to other ones. This result indicates that the Model 3 have a better model fit than the other ones. Nevertheless, the Model 3 also indicates a decrease of the bid ask spread of 0,27%, which strengthens our previous results.

Table 2: Bid Ask Spread coefficients of the three last models, integrating control variables.

Bid Ask Spread			
Variable	Model 3 (Volatility + Volume)	Model 4 (Volatility)	Model 5 (Volume)
Constant	0,00480 *	-0,00251 *	0,00680 *
Group	0,00382 *	0,00484 *	0,00438 *
SSR	0,00204 *	0,00202 *	0,00122 *
Effect	-0,00279 *	-0,00281 *	-0,02746 *
Volatility	0,18167 *	0,16490 *	-
Volume	-0,00053 *	-	-0,00043 *
R-Squared	0,0474	0,0387	0,01241

* Significant at 1% confidence level
Sources: DataStream, Mathieu Parijs calculations.

To conclude the bid ask spread study, we can state that the spread has been significantly impacted by the SSR. Indeed, the first impression found through the graphical method where the bid ask spread decreased by 0,3% has been verified through regressions. The Model 1 indicated a bid ask spread decrease of 0,26% and was confirmed with shorter time frame around the SRR date via Model 2. The introduction of control variable also confirmed the previous models.

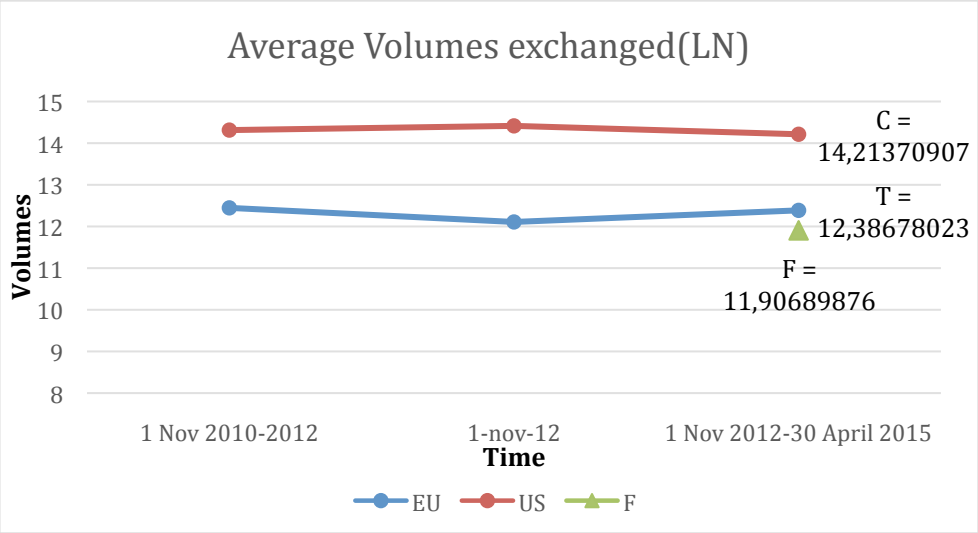
So unlike expectations we would have thought before making the analysis, those results indicate a significant increase in European market liquidity since November 2012, date that came the SSR into effect.

3.1.2. Volume of Transactions

The volume of transaction represents the second flap of our analysis concerning the markets' liquidity. To assess an eventual volume of transaction change in Europe after the SSR, let's first have a look at the DD graph next page, showing average volume of transaction of the 100 stocks of each group: EU and US, before and after the short sell ban. After a quick look at the chart, it is observable that the volumes of transactions are higher for the American than for the European stocks market: more transaction occurred on the whole data period. But on a DD point of view, no clear observation can be drawn concerning any potential SSR impact on a volume point of view. In fact, using the DD graphical approach, we could argue that the average volume of transaction of our global European stock sample increased after the SSR date, but this increase seems very small. If we take the assumption, one more time, that the European stocks should have

behaved the same way than American stocks if no regulation occurred, then the average volume of transaction would have reached the F point of the chart below. Instead of this scenario, the volume of transaction of our sample reached point T. The value "T-F" represents the DD between the effective European sample average volume of transaction and the one if it would have perfectly follow the American tendency, zone where no regulation occurred. The value indicates a potential small increase of average volume exchanged in Europe after the regulation.

Figure 6: Graphical DD method showing the SSR effect on the E.U. stocks' Average Volumes exchanged, using U.S. stocks as control group.



Sources: DataStream, Mathieu Parijs calculations.

To try to detect more relevant findings concerning trading volumes, some regressions have been performed. For the volumes of transactions analysis, the two first Models are made with three independent variables: Group, SSR and Effect, but on different time frames: Model 1 takes on daily data's from November 2010 till April 2015, whereas the Model 2 integrates data's from November 2011 till April 2014. The three latter Models takes on control variables in order to cope with some unobserved market reaction.

The following table shows the results of the first two models performed with Stata. The full time scope regression described by Model 1 indicates that the volumes of transaction have not been significatively impacted by the SSR. Indeed, the Effect's negative coefficient in not significant. This results hold also for the Model 2, where the coefficient is positive but also insignificant. Therefore we can state through first

regressions that there was no significant volume impact after the SSR date in November 2012 using only the first two Models.

Table 3: Volumes coefficients of the two first models.

Volumes (Ln)		
Variable	Model 1 (Nov 10'-Apr 15')	Model 2 (Nov 11'-Apr 14')
Constant (Std. Error)	14,31333 (0,13185)*	14,30592 (0,12674)*
Group (Std. Error)	-1,86227 (0,30773)*	-1,91089 (0,30538)*
SSR (Std. Error)	-0,09932 (0,04412)*	-0,06987 (0,03295)*
Effect (Std. Error)	-0,03592 (0,077104)	0,04434 (0,05769)
R-Squared	0,1462	0,1538

* Significant at 5% confidence level
Sources: DataStream, Mathieu Parijs calculations.

To complete the previous regressions, it is important to add some control variables into the model. In the case of the volumes exchanged, bid ask spread and return volatility are added to the previous regression, name Model 1. Model 3 adds the two control variable, whereas Model 4 and 5 respectively add Bid ask and volatility control variables on a full period basis (November 2010-April 2015).

By adding the control variables, the fit of the model increased by a few percent, but the overall significance of the variable of interest has not changed since the two first Models. Indeed, following the table below, the coefficient of interest is negative for Model 3 and 4 but positive for Model 5. As the coefficients of interest are not significative across the three regressions completed with control variables, it is not possible to state that the SSR regulation had an effect on the volume of transaction of the European sample's stocks of those three models.

Table 4: Volumes coefficients of the three last models integrating control variables.

Volumes (Ln)			
Variable	Model 3 (Bid Ask + Volatility)	Model 4 (Bid Ask)	Model 5 (Volatility)
Constant	13,68493 *	14,33055 *	13,72793 *
Group	-1,82803 *	-1,77365 *	-1,91079 *
SSR	0,07965	-0,08158	0,04505
Effect	-0,01171	-0,00730	0,03640
Bid Ask Spread	-17,09089 *	-13,9091 *	-
Volatility	34,27186 *	-	31,45345 *
R-Squared	0,1653	0,1480	0,1577

* Significant at 5% confidence level
Sources: DataStream, Mathieu Parijs calculations.

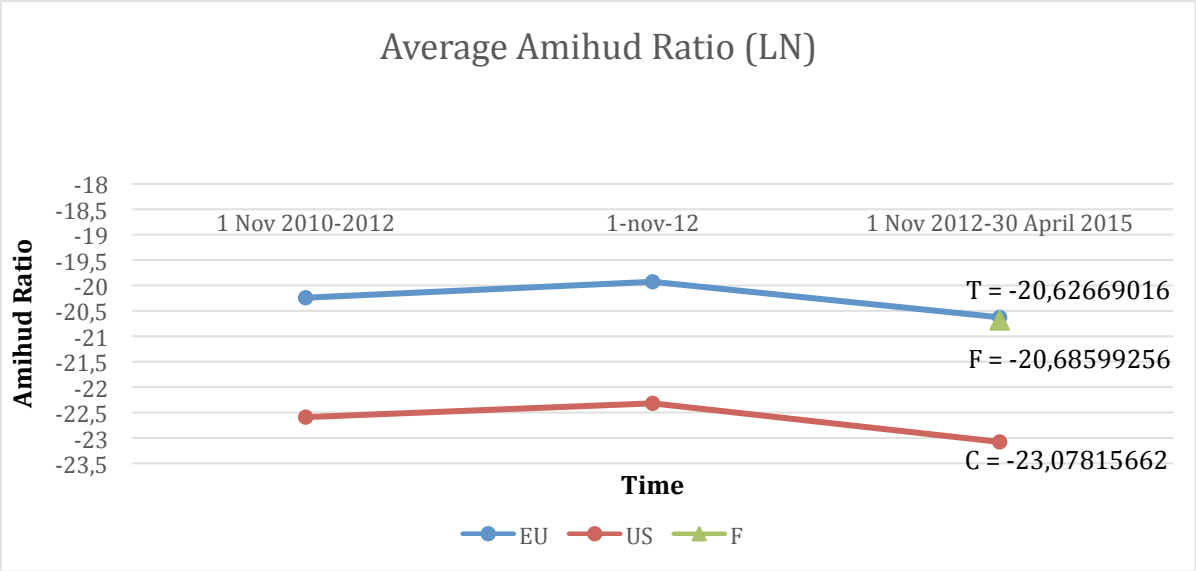
Finally, it is possible to draw the conclusion that the SSR did not have significant negative effect on the volume of transaction in the European market, following our five models. None of the coefficients has been statistically significant and they were once positive, once negative. These results are in line with the previous graph made in this section, where only small impact has been notified. So, in line with liquidity theories, it is not possible to conclude that the SSR did have impacted the liquidity of the market, using this spectrum of market liquidity.

3.1.3. Amihud Ratio

To complete the liquidity impact of the short sell regulation on the European stock market, let's now discuss and describe the results of the third and final liquidity measurement: the Amihud ratio. Please remember that, unlike the two first market measurements, the Amihud ratio is an illiquidity measure. So an increase in the Amihud ratio indicates potential market liquidity impoverishment.

In the chart next page, it is observable that the illiquidity measure of both the treatment and control group behave in the same way through time. Meanwhile a big difference clearly appears: the Amihud ratio is far smaller for the control group compared to the European group, also called the treatment group; indicating higher liquidity on the U.S. stock market compared to the European ones. This liquidity specificity was also noted via the two first measures. On a graphical point of view, the difference in difference measurement is not as direct as for the bid ask spread measurement. Indeed, the difference between the effective average Amihud ratio after November 2012 (T) and the point where it should have been if no regulation occurred (F), in comparison with the American illiquidity ratio is very small. This DD, computed as T-F is very small and this implies that no clear impact on liquidity could be induced using that chart.

Figure 7: Graphical DD method showing the SSR effect on the E.U. stocks' Average Amihud's Ratio, using U.S. stocks as control group.



Sources: DataStream, Mathieu Parijs calculations.

As for the two previous liquidity measurements, five different Models have been computed to approach the illiquidity regression. The two first Models are made with three independent variables: Group, SSR and Effect, but on different time frames: Model 1 takes on daily data from November 2010 till April 2015, whereas the Model 2 integrates data from November 2011 till April 2014. The three latter Models takes on control variables in order to cope with some unobserved market reaction.

In the first table below, the Model 1 indicates that the variable of interest (Effect) is positive but statistically non-significant. This implies that on a full time frame basis, it is not possible to state that the SSR has affected the illiquidity measure. But in comparison to that, the Model 2 indicates that the variable of interest is negative and statistically significant. In fact, the coefficient yields -0,12; implying that the market illiquidity decreased by approximately 12%. This relative difference between the two first models lets us thinking that the SSR would only have a short-term (one and half year) impact on the illiquidity ratio.

Table 5: Illiquidity coefficient of the two first models.

Illiquidity (Ln)		
Variable	Model 1 (Nov 10'-Apr 15')	Model 2 (Nov 11'-Apr 14')
Constant (Std. Error)	-22,59095 (0,12310)*	-22,66193 (0,11828)*
Group (Std. Error)	2,35364 (0,33070)*	2,59151 (0,33371)*
SSR (Std. Error)	-0,48432 (0,05529)*	-0,35298 (0,04501)*
Effect (Std. Error)	0,10062 (0,09053)	-0,12771 (0,06863)*
R-Squared	0,1875	0,2026

* Significant at 5% confidence level
Sources: DataStream, Mathieu Parijs calculations.

To complete the first two Models, let's now have a look at the table below which summarizes the effect of the SSR on the Amihud ratio, taking some control variables into account. Following all three Models below, the effect of the SSR is positive, but only two of them are statistically significant. Model 3, which add bid ask spread and volatility control variables, has a significative coefficient yielding 0,15, signifying a relative positive effect on the illiquidity measure. Moreover, the overall fit of the Model 3 is better than the two first Models. Indeed, through the R-Squared in the table below, 23,65% of the variance can be explained through this model, so it is possible to state that this model better explains the reality than the other ones. Model 4, which takes only a bid ask control variable, shows the same result as the Model 3: the regression indicates positive effect, of approximately 0,17.

Table 6: Illiquidity coefficients of the three last models, integrating control variables.

Illiquidity (Ln)			
Variable	Model 3 (Bid Ask + Volatility)	Model 4 (Bid Ask)	Model 5 (Volatility)
Constant	-23,59201 *	-22,61764 *	-23,65897 *
Group	2,08689 *	2,17160 *	2,23125 *
SSR	-0,27807 *	-0,51956 *	-0,22124 *
Effect	0,15380**	0,17771 **	0,07036
Bid Ask Spread	29,94138 *	34,40385 *	-
Volatility	51,78127 *	-	56,28337 *
R-Squared	0,2365	0,2080	0,2199

* Significant at 5% confidence level
* *Significant at 10% confidence level
Sources: DataStream, Mathieu Parijs calculations.

Nevertheless, it is important to note that the significances of the coefficients of interest are not high enough to state that the SSR had a positive impact on the Amihud ratio on a long time frame basis. Indeed, significance level amount to 10% and does not give enough assurance concerning the precision of the estimate. Meanwhile it was observed

that short time frame analysis gave significative result, indeed the short period data gave a coefficient of interest of -0,12 at a 5% confidence interval. Using this illiquidity measure as proxy for market liquidity, it might be possible to state that the SSR did only have probable significant impact on market liquidity on a short term around the SSR date. But all in all, the impacts on the illiquidity measure are not clear and it is not possible to state that the SSR have significant impact on the illiquidity of the European stock markets.

After the interpretation of the results concerning the three markets liquidity measures, it is possible to draw global conclusion on the impact of the SSR on the European stock market liquidity. First, the bid ask spread measure showed an improvement of the market liquidity, this result was robust and supported by the five models used to approach the regression. Secondly, the volume of stocks exchanged has not been significatively impacted by the SSR in Europe. The short time scope model and models integrating control variables as well confirmed these results. Finally, the illiquidity measure represented by the Amihud ratio was only significative on a short time period. Indeed, the Model 2 indicated a probable reduction of the illiquidity measure by 12%. The four other Models did not give enough significant results. That is why the outcome and impact of the SSR on liquidity are not obvious and manifest.

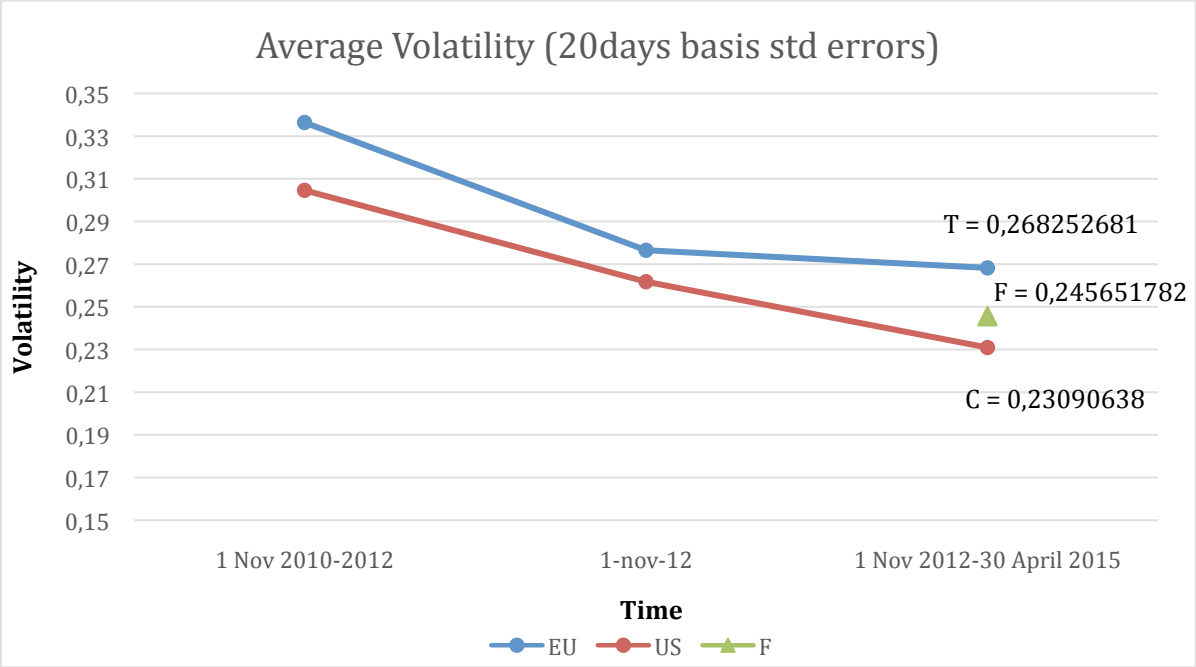
3.2. Volatility impact

After reviewing the liquidity impact of the SSR in Europe, let's now complete our analysis of the market impact through our second market characteristic with stocks' volatility of returns. As stated in previous section, remind that the returns' volatility is approached using standard errors of weekly stocks returns. This market measure will be first approached graphically, using a 20days basis standard error. It will be then approached by regressions using 20 and 10days look back period's standard errors on a short and long time frame.

The following chart represents the evolution of the average volatility of weekly returns of our two samples composed by 100 stocks each. Standard errors on 20 days basis are used as proxy for return volatility to draw the chart. It is observable that the European

stock sample is more volatile than the American one. This characteristic goes for the whole time period. However a common character arises from the two groups: both see their return's volatility decreasing through time. The DD model applied on this graph indicates that the European volatility has experienced a lower decrease compared to the American group after the introduction of the SSR. On a DD point of view, it is assumed that the two groups would behave the same way before and after the regulation if no regulation occurred in the EU. With the assumption that the European stocks would have followed the same trend than the American ones after the SSR date, their volatility would have reached point "F". Instead, the group reached point "T" in the same chart. This positive difference between point T and F represents the positive impact of the SSR on the volatility of return in Europe. Note here that the difference is also very small: it represents only a difference of 0,02. The following regressions analysis would allow us to develop this difference deeper and find if this difference is significant on this time frame basis.

Figure 8: Graphical DD method showing the SSR effect on the E.U. stocks' Average Volatility, using U.S. stocks as control group.



Sources: DataStream, Mathieu Parijs calculations.

To test previous chart, let's use different regressions. The first regressions uses the volatility of the weekly stock return using the standard errors on 20 previous days, on both short (November 2011-April 2014) and long time (November 2010-April 2015)

period. Results are summarized in the table below. The Model 1 in this table shows that, on the long time period, the SSR had positive net impact on the stocks volatility. Indeed the coefficient of interest yields 0,00029. This result confirmed our first graphical model. Meanwhile this result is not statistical significant, therefore we cannot conclude the SSR had a significative net impact on the European market using this regression. With the same standard error look back period but on shorter time frame, it is observable that the regulation had a negative impact on the market's volatility. This result yields -0,0036 and is significant at a 10% level. As the coefficient is only significant at 10%, it is not reliable to state that the SSR had significative negative impact on the market' volatility. Even if this coefficient of interest is only confident at a 90% level, this result indicates us that the regulation might have an opposite effect on the market on a shorter time frame around the SSR.

Table 7: Volatility coefficients of the two first models, taking 20-days look back period.

Volatility (20days basis)		
Variable	Model 1 (Nov 10'-Apr 15')	Model 2 (Nov 11'-Apr 14')
Constant (Std. Error)	0,01879 (0,00065)*	0,01800 (0,00067)*
Group (Std. Error)	0,00200 (0,00096)*	0,00322 (0,00105)*
SSR (Std. Error)	-0,00452 (0,00041)*	-0,00360 (0,00041)*
Effect (Std. Error)	0,00029 (0,00064)	-0,00115 (0,00067)**
R-Squared	0,0617	0,0644

* Significant at 5% confidence level
** Significant at 10% confidence level
Sources: DataStream, Mathieu Parijs calculations.

Testing the first regressions cited previously, let's study the impact of the regulation on market's volatility using standard error on a 10 days basis. With this look back period in the following table, Model 3 uses weekly data on a long time frame, whereas Model 4 integrates data on a shorter time scope. Using Model 3, we can see that the regulation did not significatively impact the market volatility. Indeed, the coefficient of interest (Effect) yields approximately 0,0002238 but is not significant. Therefore, this model does not add information, compared to the two previous regressions, approached via Model 1 and Model 2. However, Model 4 gives us some pertinent information: since the coefficient of interest yields negative and is also significant (at 5% level). That's why it is possible to tell that the regulation could have a negative effect on the market volatility on a short time period after the regulation. This impact turns around -0,12%.

Table 8: Volatility coefficients of the two last models, taking 10-days look back period.

Volatility (10days basis)		
Variable	Model 3 (Nov 10'-Apr 15')	Model 4 (Nov 11'-Apr 14')
Constant (Std. Error)	0,01826 (0,00063)*	0,01734 (0,00064)*
Group (Std. Error)	0,00199 (0,00093)*	0,00328 (0,00102)*
SSR (Std. Error)	-0,00445 (0,00040)*	-0,00340 (0,00038)*
Effect (Std. Error)	0,00022 (0,00062)	-0,00127 (0,00063)*
R-Squared	0,01037	0,0518

* Significant at 5% confidence
Sources: DataStream, Mathieu Parijs calculations.

After the interpretation of the results of the previous chart and regressions, it is pertinent to conclude about the global impact of the SSR on the European stock market's volatility. Using long time period around the date the regulation came into effect, it was not possible to see any significant relevant market volatility reaction to the SSR. In fact positive effect was observed but the coefficient were not significant. This observation is valid using standard error on 20 and 10 days look back period. However, conclusive observations were made using shorter time frame around the SSR date, November 2012. In fact, using this shorter period, significative negative effect was observed on the volatility of the European markets. In one hand, using the 20 days look back standard errors gave significant (at 90%) decrease in volatility of around 0,11%. In the other hand, the 10 days look back standard error period indicated a 0,12% decrease in volatility, but in this case at 5% significative level.

So it is reasonable to conclude that, following the DD model and using data described here above, the SSR might have negatively impacted the market's volatility of return on a short time period. Meanwhile, this result has to be taken with a grain of salt, as this result is the only one significative throughout the whole return's volatility analysis. Using larger time scope, it is possible to state that the SSR did not have significant impact on the volatility of returns.

3.3. Prize formation impact

After reviewing the liquidity and volatility impact of the SSR in Europe, let's now complete and finalize our analysis of the market impact through our last market characteristic: the stocks' prize formation process. As discussed in previous section,

recall that the prize formation process elaborated by Boehmer and Wu is defined as the "extent to which previous market information accounts for the formation of prize". Therefore, the PriceDelay compares how information is taken into account in models using short-run past information to models integrating short and long run past information. As stated in the theoretical part of the study, in a perfectly working market, the stock price should not be better explained by integrating more past market information. In this latter case, R-Squared of the Restricted Model should equal the Unrestricted Model cited in the theoretical part, and therefore the PrizeDelay should be equal to 0. A PrizeDelay over 0 would mean that current stock prize is better explained with the addition of past market information.

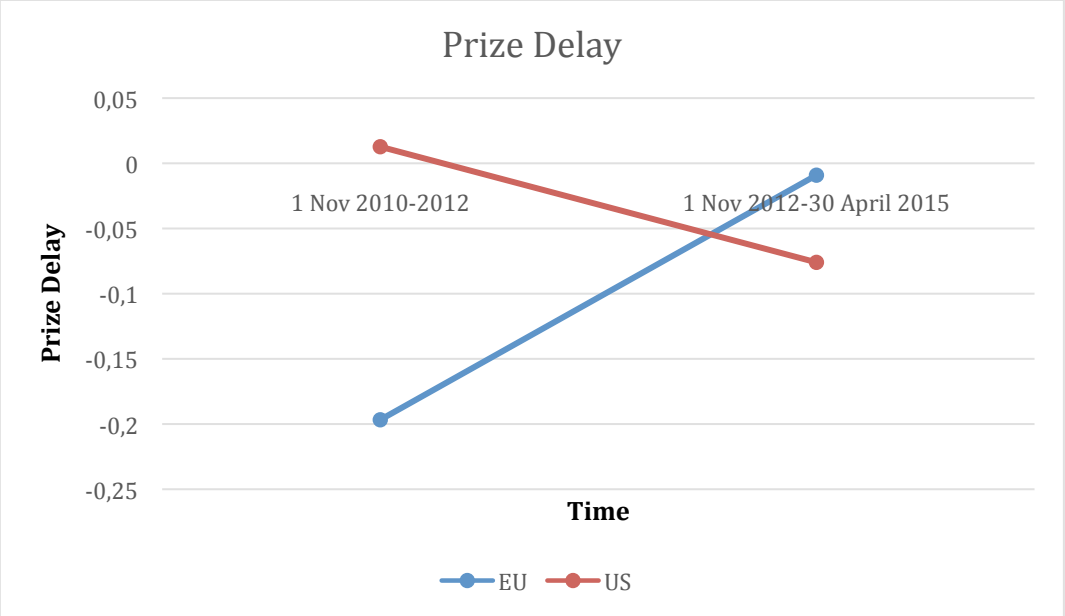
As for the two first market measurements, prize formation will be first approached graphically, with prize formation means of American and European stocks on two different time frames: with a first period lagging from November 2010 till November 2012 and a second period from the regulation date in 2012 till April 2015.

In the chart next page, it is observable that, whereas the US stocks have seen a large deterioration of their PrizeDelay, the EU stocks have seen their PrizeDelay improved through time. Indeed, compared to previous period (November 2010-November 2012), the PrizeDelay of the European stocks' sample showed a PrizeDelay average converging to zero. This is a near-perfect situation where the introduction of past information into the model does no help to better explain current stock prizes. So by only analyzing this chart we could argue that prize formation process has been improved through the introduction of the SSR in November 2012.
On a DD point of view, this conclusion could also be put forward. If we take the assumption that the European would have followed the American PrizeDelay trend if no regulation impacted the EU market, then even larger positive PrizeDelay impact can be observed. The impact can be numerated as of approximately 0,25. This number can be formed by adding the American PrizeDelay drop (which is rounding as 0,7) with the European PrizeDelay increase (which is nearly approaching 0,18). As this result is very high and evolution of European and American PrizeDelay diverge by many percent, there is a large probability that the "parallel hypothesis" of the DD model does not hold

through this exercise. That is why previous short computing should be taken with a grain of salt.

After having compared both groups' PrizeDelays, let's move forward the analysis of this measure through the regression difference in difference methodology.

Figure 9: Graphical DD method showing the SSR effect on the E.U. stocks' Prize Delay, using U.S. stocks as control group.



Sources: DataStream, Mathieu Parijs calculations.

To complete previous chart analysis, let's now try to see if the SSR had as many impact as it was stated in the previous methodology. The following table summarizes core characteristics of the regression described in the theoretical part of the study. As it is quickly observable, the SSR had positive effect on the PrizeDelay of the European stocks' sample. This effect is rounding 0,27. This value was also observed through the graphical method cited above. But in this case, the coefficient of interest is not significant. This lack of significance of our coefficient will not allow us to state that the SSR affected positively the price formation process of our Europeans stocks.

Table 9: PriceDelay coefficients on the full time period (November 2010-April 2015).

PriceDelay	
Variable	Model 1 (Nov 10'-Apr 15')
Constant (Std. Error)	0,01283 (0,01373)
Group (Std. Error)	0,20957 (0,17570)
SSR (Std. Error)	-0,08881 (0,11640)
Effect (Std. Error)	0,27643 (0,20684)
R-Squared	0,0068

Sources: DataStream, Mathieu Parijs calculations.

Therefore, despite some graphical expectation, the only conclusion we could draw up with this last regression is that there is not enough significative results to state that the SSR impacted the price formation process of the European stocks. This last regression is the most difficult one to estimate, as many hypotheses and computing were needed in order to approach the coefficient of interest of the stocks' samples.

3.4. Comparison with the study held by the ESMA

After reviewing the impact of the SSR on different measures of interest on relative short and large time scope, it is timely to compare the results we obtained and the result the ESMA get 3 months only after the regulation came into effect: this comparison is one of the mains objectives of this study. Indeed, as the study made by the ESMA was only made 3 months after the regulation came into effect, data was not available to correctly conduct and evaluate potential change in market liquidity, volatility and prize formation on a longer time frame. In its early study, the ESMA (2013) "invites the European Commission to reassess the SSR at a later date". That is why the ESMA study had to be taken with a grain of salt. So using broader time frame and data of longer time scope, we are able to detect if the SSR voted by the European Parliament had negative effect on core essentials market characteristics: this is the final objective of the study we need to cover so far.

Using the bid ask spread as first liquidity proxy, the ESMA (2013) stated that this measure "decreased by 0,31% after the SSR came into effect". Following the study we conducted, we are able confirm that the bid ask spread of the market was also reduced by 0,26% using data from 2010 till April 2015. So that the liquidity of the European

market has not been negatively impacted after the regulation, better: it has been increased.

To continue the comparison between this study and the one held by the ESMA, let's now compare the impact of the SSR on the volumes exchanged in Europe after the regulation date. Similarly to the ESMA (2013) who suggested "no effect on this measure", the result found in this present study indicates no significative volume impact in Europe due to the SSR. This result was supported on different time period basis.

To finish with liquidity comparison between the two studies, let's now compare deeper the illiquidity measures across the two researches. In the ESMA report (2013), it is said, "the illiquidity measure has been negatively impacted by around 11% after the regulation date." This means that the liquidity was improved across Europe. In our research, using data from broader time period, mitigated results have been drawn. On one hand, large time frame (November 2010-April 2015) indicates no significative impact on the illiquidity measure after the SSR date. Those results were comforted with robust checking with implementation of control variables. On the other hand, reduced time frame (November 2011-April 2014) indicated a reduction of the illiquidity measure of approximately 12%. Combined with the ESMA observation, this drives us to conclude that the regulation might only had significant effect on limited time scope around the regulation date.

To conclude the liquidity analysis, it is not possible to draw up the conclusion that the regulation voted by the European Parliament negatively affect key market characteristic, which is the liquidity. As the Bid Ask Spread measure showed manifest positive liquidity impact, other measures did not give enough significative results. No significative impact has been found using volumes and the illiquidity ratio only have short period significant result.

The second measure that the SSR could have impacted is the volatility of returns in Europe. On a short time frame basis, the ESMA (2013) concluded "the volatility decreased by 0,12% after the regulation date". In this research, using data from longer time period around the date the regulation came into effect, it was not possible to see any significant market volatility reaction to the SSR. In fact positive effect was observed but the coefficients were not significant. However, conclusive observations were made

using shorter time frame around the SSR date. In fact, using this shorter period, significative negative effect was observed on the volatility of the European markets. So it is possible to conclude that the SSR might only have negatively impacted the market's volatility of return on a short time period only.

The third market measure we analyzed with the DD model is the prize formation impact of the SSR. With limited data on which the ESMA worked on, it was observed that the prize discovery process has been deteriorated since the regulation date in November 2012. Following the ESMA's report finished in May 2013, a numerical abstract showed, "a 3% deceleration of the prize discovery process on European stocks compared to the American stocks." In opposite with ESMA's work, it was graphically observed that the Price formation has been improved after the short sell regulation voted by the European Parliament. But on the other side, regression analysis demonstrated the coefficient of interest was not significant. So by the analysis, the SSR adopted in November did not significatively impact the price formation process of European stocks, following our samples and computing at a given level of confidence. This observation relatively contradicts what major academicians have developed about prize discovery process and short sell limitation. Meanwhile, it is important to note that academicians made their studies on short sell bans essentially. The regulation made in Europe is not a ban per se, it is in place in order to have more transparent short sell activity and coordinate European countries on this subject.

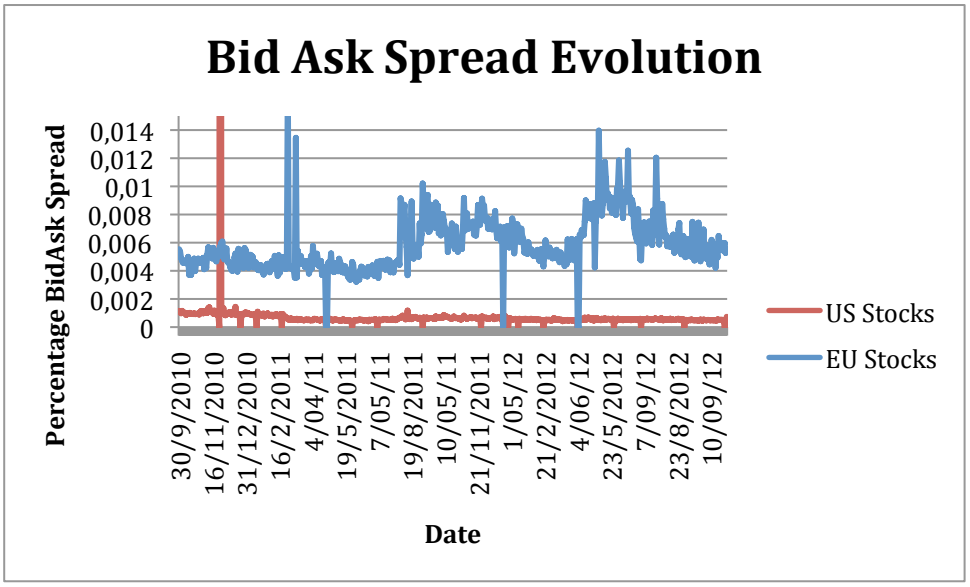
3.5. Limitations of the study

The main limitation of this study comes from the model itself. Indeed, European and American financial markets are not perfectly similar to one another. The DD offers a nice and wide way to study the impact of the SSR into Europe but with the assumption that the European and American market would behave in the same manner in the case of no regulation. This so-called "parallel trend" assumption has been covered in details in the presentation of the DD model. But mixing theory with practice is very difficult and this assumption is very hard to hold using real financial data.

It would then be interesting to graphically compare the stock market liquidity and volatility of the zone of interest, Europe, with the zone of comparison used in the difference in difference methodology: the United States before the introduction of the short sell regulation.

For doing so, let's use the percentage bid ask spread as the representative measure of liquidity. In the following chart, it is observable that the bid ask spread differs widely between the two groups. The fact that the European bid ask spread is higher for European stocks than the American ones is not an issue of concern. The only concern we have to be interested in is the volatility of this measure. The spread evolutions of the two zones of interest are not really parallel, condition that should normally be fulfilled in the difference in difference assumption.

Figure 10: The evolution of the Bid-Ask Spread of the stocks' sample of the two zones of interest: U.S. and E.U. from November 2010 till November 2012.

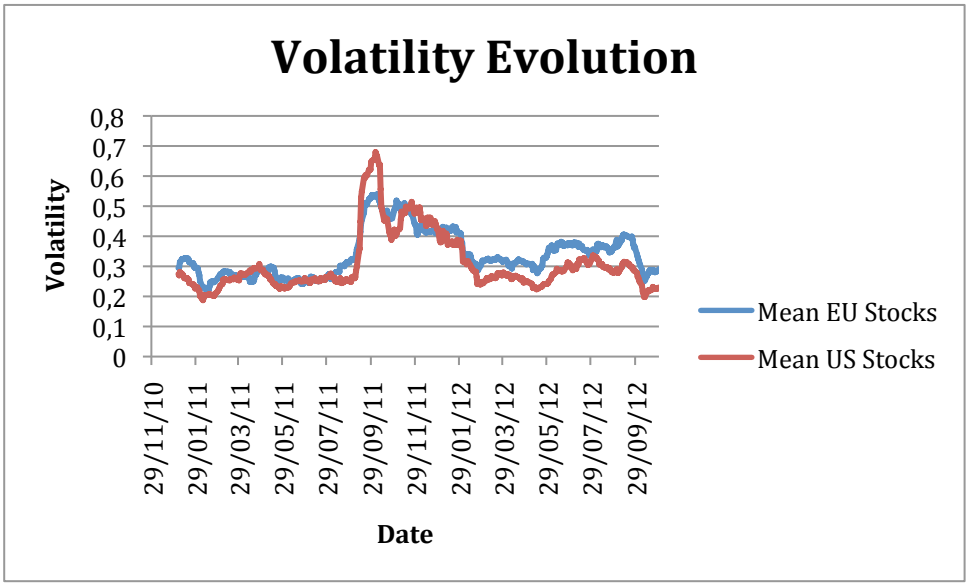


Sources: DataStream, Mathieu Parijs calculations.

On a volatility point of view, the difference in difference methodology also assumes similar reaction on both sides of the Atlantic. The chart here under illustrates the volatility difference across the two groups of stocks between November 2010 and November 2012.

Even if it is observable that European stocks generally experience higher volatility than the American one, it seems that both market's volatilities have the same trend in the period prior the European SSR. Compared to the bid ask spread chart discussed here above, it is possible to state that the volatility of returns better fulfills the "parallel trend" assumption of the DD methodology.

Figure 11: The evolution of the volatility of the stocks' sample of the two zones of interest: U.S. and E.U. from November 2010 till November 2012.



Sources: DataStream, Mathieu Parijs calculations.

But one specification has to be noted: the volatility of both markets ranged between 0,2 and 0,4 for the two-year period except for a period in 2011. This period coincides with the so-called "sovereign crisis". Markets participants were facing huge drops of financials stock markets: As the BEL20 dropped by 25% from July to November 2011, the S&P 500 saw its value decreasing by 15% on the same period. In period of quick market decrease, it is not surprising to face such volatility increase. But what is surprising here is the fact that the volatility of returns of the US market increased far more than its European sister. Naturally, modern financial markets are closely inter-related, but the main zone of concern of the sovereign crisis was Europe. That is why it would have been more intuitive to see the European market facing higher volatility of returns during that period. This observation has been done using a sample of representative stock from the US and EU markets, so no fast conclusions can be drawn from this chart so far. But, as this observation is not in the center of our study and will

not be further debated. Meanwhile it would be interesting to further investigate this observation in future studies.

The second big limitation comes from the use of the White's cluster robust standard errors. This option has been used in order to cope with potential residuals' errors disturbance across the data. The coefficients' estimates found using this regression methodology are the same as the one using normal OLS regressions technique. However, the standard errors are modified and are taking potential heteroskedasticity and normality issues into account. Indeed, as stated by the University of California, "the errors found using robust option give generally larger value than the one found using non-robust errors." In the same direction than previous robust-errors characteristics, p-values and significance level of coefficients will differ from non-robust standard errors. So it is important to notify significative level of coefficients' estimators are probably biased compared to non-robust standard errors.

4. Conclusion

The objective of the European Parliament by adopting the SSR was to achieve its goals of good functioning markets by introduction short selling notification system or European coordination facing exceptional economic situation, without affecting the core essential characteristics of the market. As we have discussed it through this paper, liquidity, volatility and prize formation process are primary characteristics required for a well behaving stock market.

This paper did not discussed about the achievement of the Parliament's objectives; instead, it was dedicated to discover if those regulations did not negatively affect essential characteristics of European stock markets for its well behavior.

By the elaboration of this study, we are able to share an opinion over the SSR voted by the European Parliament. Please recall the questioning of this study: "Did the regulation voted by the European Parliament have impacted the market, and if yes did it worsen or improved it?" The markets' impacts of the regulation have been discussed on a 3-measures basis using a difference in difference methodology (with U.S stocks as control group and E.U stocks as treatment group): market liquidity, volatility and price formation process.

By this paper, it was exposed that the SSR did not have clear significant negative impact on the European stock markets. This finding was true for market liquidity, volatility and price formation process. So we can state there is no reason and indices showing clear negative market impact due to European Parliament law "Regulation (EU) 236/2012 of the European Parliament and of the Council on short selling and certain aspect of credit default swaps."

We could argue that the limitations of short selling in Europe are not very restrictive: the European regulator has not introduced a complete ban of short activity. Instead, the UE Parliament just banned naked short selling and wanted the market to be more transparent through the required notification system. But as stated in the paper, some market makers and primary dealers can be exempted of such regulation.

For the time being, no modification to such exemption is on the European agenda. Market makers and primary dealers represent the biggest banks in the world and their short activities are therefore wider than banks required to notify their net short positions. As stated by the FSA, “market makers play an important role in the liquidity of the stock markets.” If stricter regulations will be adopted by the European parliament concerning market makers, then a new study concerning the impact of short sell regulation on the market would be pertinent to be held, since the scope of the regulation would be extended to all market participants and have a bigger impact on the liquidity, volatility and price formation process of stock markets than the 2012 SSR.

Bibliography

- Acharya V., Pedersen L. (2005). Asset pricing with liquidity risk. *Journal of Financial Economics 77* (2), 375-410. Online http://pages.stern.nyu.edu/~lpederse/papers/liquidity_risk.pdf

- Amihud Y. (2002). Illiquidity and stock returns: cross-section and time-series effects. *Journal of Financial Markets 5* (1), 31-56. Online http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.145.9505&rep=rep1&type=pdf

- Andrews, D., Monahan J., (1992). *An improved heteroskedasticity and autocorrelation consistent covariance matrix estimator.* Econometrica.

- Anufriev M., Tuinstra J. (2013), The impact of short-selling constraints on financial market stability in a heterogeneous agents model. *Journal of Economic Dynamics and Control 37* (8), 1523-1543. Online http://www.uts.edu.au/sites/default/files/PaperAnufrievMikhail.pdf

- Bai Y., Chang E., Wang J. (2006). *Asset prices under short-sale constraints.* Online http://web.mit.edu/wangj/www/pap/BCW_061112.pdf

- Beber A., Pagano M. (2013). Short-selling bans around the world: evidence from the 2007-09 Crisis. *The Journal of Finance, 68*(1), 343-381. Online http://www.eief.it/files/2013/01/pagano_beber_joff_2013.pdf

- Bertrand M., Duflo E., Mullainathan S. (2004). How much should we trust difference-in-difference estimates? *The Quarterly Journal of Economics 119* (1), 249-275. Online http://economics.mit.edu/files/750

- Boehmer E., Wu J. (2013). Short selling and the price discovery process. *The Review of Financial Studies 26* (2), 287-322. Online http://www.hec.unil.ch/documents/sem_ibf/Boehmer.pdf

- Bris A., Goetzmann W., Zhu N. (2007). Efficiency and the bear: short sales and markets around the world. *The Journal of Finance 62*(3), 1029-1079. Online http://www.sec.gov/spotlight/hedgefunds/hedge-efficiency.pdf

- Business Insider. (2010). *Here's why it's the Germans pushing for the Euro-wide short-selling ban.* Online http://www.businessinsider.com/heres-why-its-the-germans-pushing-for-the-euro-wide-short-selling-ban-2010-6

- Cameron A., Miller D. (2013). *A practitioner's guide to cluster-robust inference.* University of California. Online http://cameron.econ.ucdavis.edu/research/Cameron_Miller_Cluster_Robust_October152013.pdf

- Chan K., Kot H., Yang Z. (2010). *Effects of short-sale constraints on stock prices and trading activity: evidence from Hong Kong and mainland China.* Online http://www.apjfs.org/conference/2010/cafm2010/3-1.pdf

- Charoenrook A., Daouk H. (2009), *A study of market-wide short-selling sestrictions*. Cornell University, Department of Applied Economics and Management. Online http://dyson.cornell.edu/research/researchpdf/wp/2009/Cornell_Dyson_wp0921.pdf

- Chen M., Zheng Z. (2008). The impact of short selling on the volatility and liquidity of stock markets: evidences from Hong Kong Market. *Advances in Business Intelligence and Financial Engineering.* Atlantis Press, Paris. Online *http://efinance.org.cn/cn/aboutme/cmx3.pdf*

- Engelberg J., Reed A., Ringgenberg M. (2012). How are shorts informated?: Short sellers, news, and information processing. *Journal of Financial Economics 105* (2), 260-278. Online http://rady.ucsd.edu/faculty/directory/engelberg/pub/portfolios/SHORT_NEWS.pdf

- European Securities and Markets Authority (2013). *ESMA's technical advice on the evaluation of the Regulation (EU) 236/2012 of the European Parliament and of the Council on short selling and certain aspects of credit default swaps.* Online http://www.esma.europa.eu/system/files/2013-614_final_report_on_ssr_evaluation.pdf

- European Securities and Markets Authority (2013). *Links to national websites for the purpose of the notification of net shorts positions.* Online http://www.esma.europa.eu/system/files/2012_epsc_680_short_selling_-_nca_weblinks_for_notification_30092013.pdf

- Goyenko R., Holden C., Trzcinka C. (2009). Do liquidity measures measure liquidity? *Journal of Financial Economics 92* (2), 153-181. Online http://kelley.iu.edu/cholden/Goyenko%20Holden%20and%20Trzcinka%20%282009%29.pdf

- Grimes A. (2011). *How to calculate volatility in Excel?* Online http://adamhgrimes.com/blog/how-do-you-calculate-volatility-in-excel/

- Hayes A., Cai L. (2007). Using heteroskedasticity-consistent standard error estimators in OLS regression: An introduction and software implementation. *Behavior Research Methods 39* (4), 709-722. Online http://www.afhayes.com/public/BRM2007.pdf

- Healthcare economist. (2006). *Difference in difference estimation.* Online http://healthcare-economist.com/2006/02/11/difference-in-difference-estimation/

- Hedgeweek. (2013). *ESMA publishes review on impact of short selling regulation*. Online http://www.hedgeweek.com/2013/06/03/185252/esma-publishes-review-

impact-short-selling-regulation

- Hong Kong Exchanges and Clearing Limited (2012). *Regulated short selling.* Online https://www.hkex.com.hk/eng/market/sec_tradinfo/regshortsell.htm, consulted the 3rd of July 2015.

- Hou K., Moskowitz J. (2005). Market frictions, price delay, and the cross-section of expected returns*. The Review of Financial Studies 18* (3): 981-1020. Online http://faculty.chicagobooth.edu/tobias.moskowitz/research/khtm_RFS.pdf

- IMF (2013). Global financial stability report, old risks, new challenges. *World Economic and Financial Surveys.* Online http://www.imf.org/External/Pubs/FT/GFSR/2013/01/pdf/text.pdf

- Institute for digital research and education, (s.d). *Analyzing Correlated (Clustered) data.* University of California Los Angeles. Online http://www.ats.ucla.edu/stat/stata/library/cpsu.htm

- Institute for digital research and education, (s.d.). *Stata annotated output.* University of California Los Angeles. Online http://www.ats.ucla.edu/stat/stata/output/reg_output.htm

- Investopedia. (s.d.). *Bid ask spread.* Online http://www.investopedia.com/ask/answers/06/bidaskspread.asp, consulted the 2nd of May 2015

- Investopedia. (s.d.). *Short interest: What it tells us*. Online http://www.investopedia.com/articles/01/082201.asp, consulted on the 27th of April 2015

- Investopedia. (s.d.). *Short selling*. Online http://www.investopedia.com/terms/s/shortselling.asp, consulted the 15th of April 2015

- IVolatility (s.d.). *Ways to estimate volatility*. Online http://www.ivolatility.com/help/2.html, consulted the 15th of May 2015.

- Kiefer N., Vogelsang T., Bunzel H. (2000). *Simple robust testing of regression hypotheses.* Econometrica.

- Kraus A., Rubin A. (2005). The effect of short sale constraints removal on volatility in the presence of heterogeneous beliefs. *International Review of Finance 4* (3-4), 171-188. Online http://papers.ssrn.com/sol3/papers.cfm?abstract_id=302003

- London Stock Exchange Group. (2013). *What is the short selling regulation?* Online http://www.lseg.com/markets-products-and-services/post-trade-services/unavista/regulation/short-selling-regulation

- Lybek T., Sarr A. (2012). Measuring liquidity in financial markets. *IMF Working Paper*. Online http://www.imf.org/external/pubs/ft/wp/2002/wp02232.pdf

- Massachusetts Institute of Technology (s.d.). *Reading and using STATA output*. Online http://web.mit.edu/course/17/17.846/OldFiles/www/Readout.html

- Mora R., Reggio I. (2012). *Treatment effect identification using alternative parallel assumptions.* Universidad Carlos III De Madrid. Online http://e-archivo.uc3m.es/bitstream/handle/10016/16065/we1233.pdf?sequence=1

- Ouellet E. (2005). *Guide d'econometrie appliquée pour Stata.* Université de Montréal. Online http://sceco.umontreal.ca/fileadmin/Documents/FAS/sciences-economiques/Documents/3-Ressources-services/Ressources-formulaires/GuideEconometrieStata.pdf

- Petersen M. (s.d). *Programming advice.* Kellogg School of Management. Online http://www.kellogg.northwestern.edu/faculty/petersen/htm/papers/se/se_programming.htm

- Reuters. (2012). *EU watchdog should not have power to ban short-selling.* Online http://www.reuters.com/article/2013/09/12/us-eu-shortselling-court-idUSBRE98B0FP20130912

- Reuters. (2011). *Europe curbs short-selling as credit markets swoon.* Online http://www.reuters.com/article/2011/08/12/europe-banks-idUSLDE77A05U20110812

- Rhee G. (2003), Short-sale constraints: good or bad news for the stock market?, *Fifth OECD Round Table on Capital Market Reform in Asia, Tokyo*. Online http://www.oecd.org/finance/financial-markets/18454115.pdf

- Schwartz A., Francioni R. (2004). *Equity markets in action: the fundamentals of liquidity, market structure & trading*. Wiley.

- Thomson Reuters. (2012). *Europe's naked short selling ban leaves investors with skin in the game.* Online http://blog.thomsonreuters.com/index.php/europes-naked-short-selling-ban-leaves-investors-with-skin-in-the-game/

- Thomson Reuters. (2012). *Short-selling and CDS regulation in EU: Less to nakedness than meets the eye, funds and firms argue*. Online http://blogs.reuters.com/financial-regulatory-forum/2012/03/05/short-selling-and-cds-regulation-in-eu-less-to-nakedness-than-meets-the-eye-funds-and-firms-argue/

- U.S. Commodity Futures Trading Commission. (s.d.). *Net position changes data.* Online http://www.cftc.gov/MarketReports/NetPositionChangesData/index.htm

- U.S. Securities and Exchange Commission (2008). *Amendments to exchange act rule 10a-1 and Rules 201 and 200(g) of regulation SHO.* Online

http://www.sec.gov/divisions/marketreg/tmcompliance/rules10a-200g-201-secg.htm. Consulted the 4th of July 2015.

- U.S. Securities and Exchange Commission, (2015). *Short sale restrictions.* Online http://www.sec.gov/answers/shortrestrict.htm, consulted the 7th of June 2015.

- Varian H. (1985). Divergence of opinion in complete markets: a note. *The Journal of Finance 40* (1), 309-317. Online http://people.ischool.berkeley.edu/~hal/Papers/Opinion/divergence-of-opinion-in-complete-markets.pdf

- Wikipedia. (s.d.). *Naked short selling.* Online http://en.wikipedia.org/wiki/Naked_short_selling, consulted the 22nd of April 2015

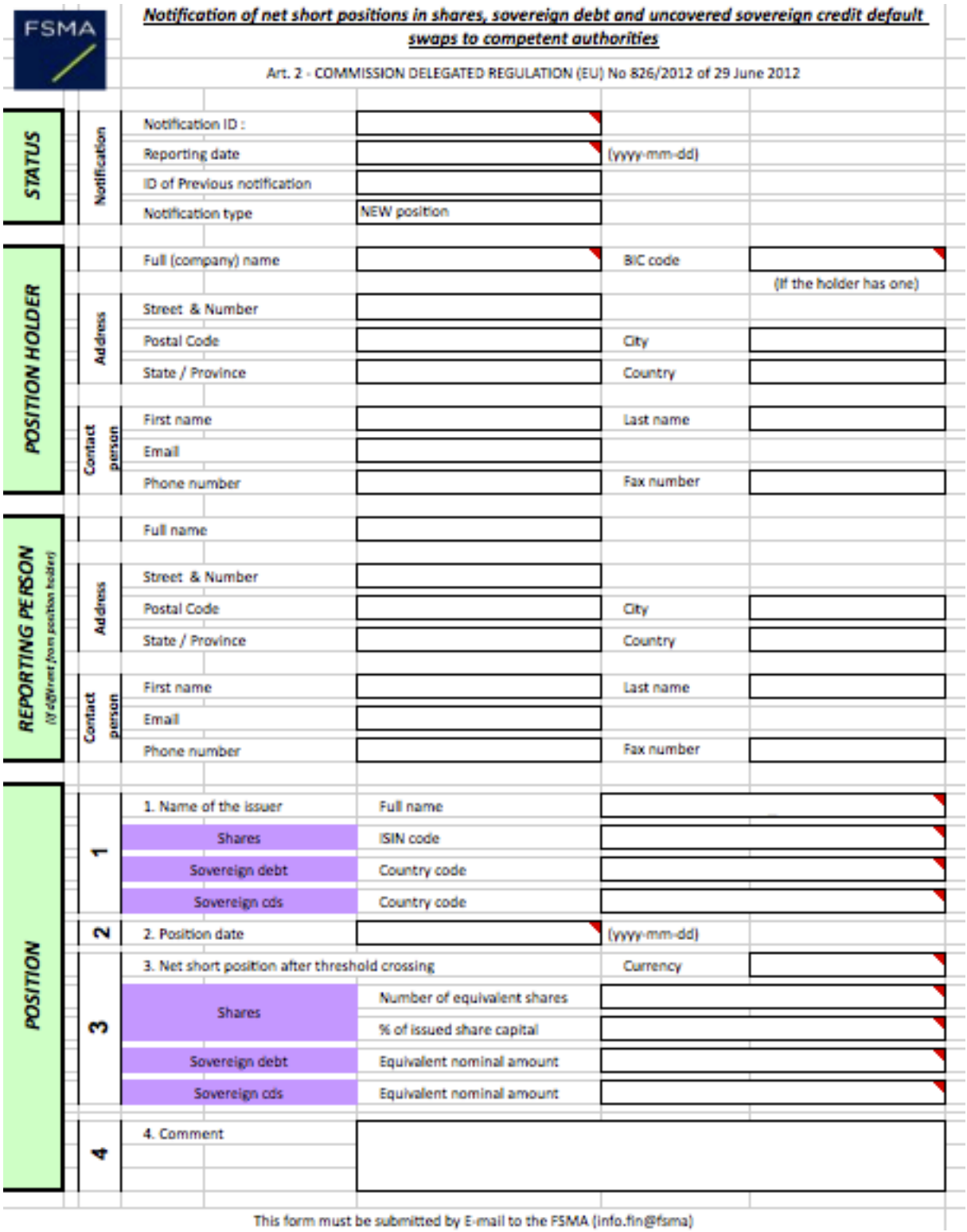
- Wikipedia. (s.d.). *Short (Finance).* Online http://en.wikipedia.org/wiki/Short_%28finance%29, consulted the 15th of April 2015

- Wikipedia. (s.d.). *Uptick rule.* Online http://fr.wikipedia.org/wiki/R%C3%A8gle_de_l%27uptick, consulted the 5th of May 2015.

- Wikipedia. (s.d). *Standard Deviation.* Online https://en.wikipedia.org/?title=Standard_deviation, consulted the 15th of April 2015.

Annexes

Annex 1: Document used to notify net short position in shares.



Notification of net short positions in shares, sovereign debt and uncovered sovereign credit default swaps to competent authorities

Art. 2 - COMMISSION DELEGATED REGULATION (EU) No 826/2012 of 29 June 2012

STATUS	Notification	Notification ID :			
		Reporting date		(yyyy-mm-dd)	
		ID of Previous notification			
		Notification type	NEW position		
POSITION HOLDER		Full (company) name		BIC code	(If the holder has one)
	Address	Street & Number			
		Postal Code		City	
		State / Province		Country	
	Contact person	First name		Last name	
		Email			
		Phone number		Fax number	
REPORTING PERSON (if different from position holder)		Full name			
	Address	Street & Number			
		Postal Code		City	
		State / Province		Country	
	Contact person	First name		Last name	
		Email			
		Phone number		Fax number	
POSITION	1	1. Name of the issuer	Full name		
		Shares	ISIN code		
		Sovereign debt	Country code		
		Sovereign cds	Country code		
	2	2. Position date		(yyyy-mm-dd)	
	3	3. Net short position after threshold crossing		Currency	
		Shares	Number of equivalent shares		
			% of issued share capital		
		Sovereign debt	Equivalent nominal amount		
		Sovereign cds	Equivalent nominal amount		
	4	4. Comment			

This form must be submitted by E-mail to the FSMA (info.fin@fsma)

Annex 2: The OLS assumptions.

Following Brooks (2008), the OLS estimators are BLUE if their fulfill the following four assumptions:

- "The errors have a mean of zero".

$$E(u_t) = 0$$

- "Constant errors' variance and finite over all values of x".

$$Var(u_t) = \sigma^2 < \infty$$

- "Linear independence of errors".

$$Cov(u_i, u_j) = 0$$

- "No relation between errors and the x variable".

$$Cov(u_t, x_t) = 0$$

Annex 3: Composition of the selected companies of the ESMA (2013).

Treatment Group: EU Stocks			
Subgroup 1	**Subgroup 2**	**Subgroup 3**	**Subgroup 4**
Barco	Xing	Banco Popolare	Bankinter
Bekaert	Carl Zeiss Meditec	Enel Green Power	M Set Esp Comunicacion
Ageas	Baywa	Enel	ACS Activ. Constr. Y Serv.
UCB	Fuchs Petrolub Pref	Assicurazioni Generali	Grifols
AB Inbev	Tag Immobilien	Nieuwe Steen Inv.	Enagas
Solvay	Axel Springer	BinckBank	Abertis Ingraestructuras
Trigano	Rational	Vastened Retail	Caixa Bank
Sc. Fonfnc. Et De Paris	Kabel Deutschland Hldg.	Arcadis	Repsol YPF
Altran	Wacker Chemie	CSM Certs	BBV. Argentaria
Pierre & Vacances	Suedzucker	Aperam	Go-Ahead Group
Ipsos	Deutsche Postbank	Ziggo	Cranswick
Rubis	Deutsche Post	Boskalis Westminster	Shanks Group
Nexans	Siemens	Randstad Holding	Beazley
Air France-KLM	Independent News&Media	Unilever Certs.	KPN Con
Wendel	Kingspan Group	Robeco	Cookson Group
Areva	Bank of Ireland	Reed Elsevier	Domino's Pizza Group
Arkema	Paddy Power	DSM Koninklijke	Schroders
Eiffage	Kerry Group	Banco Comr Portugues	Derwent London
Klepierre	Italmobiliare	Cimentos de Portl SGPS	Permission
Sodexo	Reply	Portugal Telacom SGPS	Whitbread
Vivendi	Geox	Jeronimo Martins	Smith
BNP Paribas	DeLonghi	EDP Energias De Portugal	Aggreko
RIB Softxare	Recordati Indua.Chemica	Sacyr Valleherm OSO	Royal Deutch Shell
KHD HM B. WDG. Intl	Banca Ppo.EM Ilia Rom.	Gamesa Corpn. Tegc.	Shire
Norma Group	Parmalat	Obrascon Huarte Lain	Reed Elsevier
Treatment Group: US Stocks			
Subgroup 1	**Subgroup 2**	**Subgroup 3**	**Subgroup 4**
Dominion Res.	Hollyfrontier	Allegany	Fresh Market
Hess	Dover	Willis Group Holding	Tanger Fac. Outlet Cntrs
Xcel Energy	NXP Semiconductors	Micron Technology	Wpx Energy
Capital One Finl	Republica SVS	Oceaneering	CVR Energy
Coviden	Forest Labs	Mohawk Inds.	Rollins
Bristol Myers Squibb	Chack Point Sftw Techs	Resmed	Apollo GP
Ebay	Michael Kors Holding	Trw Autv. Hdg	Landstar System
Google	Oneok Partners	Comerica	Two Harbors Investment
Mondelez International Cl	Discovery Comms	Cbre Group Classa	Energen
Philips 66	Delta Airlines	PinnacleWest Cap.	Smithfield Foods
CME Group	Cerner	Ashland	Teledyne Techs
Air Prds & Chems.	Royal Carribean Cruises	Quanta Services	Sotheby's
Public Storage	Cincinnati Finl	Masco	Assurant
Walmart Stores	Pultegroup	Hertz Global Hdg	Credit Accep.
General Gw. Props.	Paychex	Oge En	Chico's Fas
Intuit	Wynn Resorts	HIS A	Highwoods Props.
Century Link	Ansys	Fossil	Babcock & Wilcox
Dell	Trimble Navigation	Constellation Brands	Sandridge Energy
Coca cola	NYSE Euronext	Everest Regp	Superior Energy Svs
United Parcel Man.	Humana	Royal Gold	Madison Sq. Garden CLA
Annaly Capital Man	Regions FinlNew	Unum Group	Athnahealth
Williams Partner	Energy Transfer Ptns.	Windstream	Douglas Emmett
State Street	Adv. AutoParts	Leucadia National	Atmel
PPL	Coventry Healthcare	Toll Bros	Atwood Oceanics
PPG Industries	Consolen	Autoliv	Kar Auction Services

Annex 4: The Coefficient of Determination (R^2)

Brooks (2008) defines the coefficient of determination as "how well the sample regression fits the data". In other words, it is a kind of model's fit measurement. Let's briefly explain the R Squared as stated in the Brooks book: Introductory econometrics for finance (2008):

"Taking a regression as followed: $y_t = \beta_1 + u_t$, the total variation across observations of dependent variable about its mean is the Total Sum of Squares (TSS)."

$$TSS = \sum \left(y_t - \bar{y} \right)^2$$

"The TSS could be divided in 2: the Explained (ESS) and the Restricted Sum of Squares (RSS)."

$$TSS = \sum \left(\hat{y}t - \bar{y} \right)^2 + \sum_t \hat{u}_t^{\,2}$$

Please recall that the residuals are computed as "difference between actual and fitted values. So that the R square is defined as the ratio of the ESS to the TSS":

$$R^2 = \frac{ESS}{TSS}$$

Annex 5: The Summarized SSR by the ESMA (2013), applied in Europe:

- *All those entering into short sales of shares must be covered by either having borrowed the instruments concerned, have arranged to borrow them; or have an arrangement with a third party who has confirmed that the share has been located i.e. naked short selling in shares is now banned;*
- *All those entering into short sales of sovereign debt instruments must have borrowed the instruments concerned, have an agreement to borrow them, or have an arrangement with a third party who has confirmed that the share has been located or expects that the trade can be settled when due i.e. naked short selling in sovereign debt is now banned.*
- *All those entering into credit default swaps positions related to a sovereign issuer must have an underlying exposure to the risk of default of that sovereign issuer or of a decline in the value of the sovereign debt of that issuer i.e. naked sovereign CDS are now banned.*
- *Central counterparties providing clearing services must ensure that there are adequate arrangements in place for buy-in of shares as well as fines where there is a settlement failure.*
- *Mandatory transparency of net short positions:*
    - *Significant net short positions in shares must be*
        - *Reported to the relevant competent authorities when they at least equal to 0.2% of company issued share capital and every 0.1% above that;*
        - *Disclosed to the public when they at least equal to 0.5% of company issued share capital and every 0.1% above that.*
    - *Significant net short positions in sovereign debt should be reported to the relevant competent authorities when reaching or crossing one of the thresholds published by ESMA for sovereign issuers– notification thresholds,*

- *Exemptions are available for market making activities and authorized primary dealers; we will detail more in dept that exception later.*

According to the provisions of the Regulation, ESMA will have to provide for public access to certain types of information:

1st.Significant net short position notification thresholds for each sovereign issuer (Article 7(2));

2nd. Links to central websites operated or supervised by competent authorities where the public disclosure of net short positions is posted (Article 9(4));

3rd. The list of shares for which the principal trading venue is located in the third country (Article 16(2));

4th. A list of market makers and authorized primary dealers (Article 17(3));

5th. A list of existing penalties and administrative measures applicable in Member States (Article 41).

ESMA's coordination role in exceptional circumstances

ESMA has been given the role of coordinating the scope and implementation of any proposed emergency measures by national competent authorities (NCA). In addition, ESMA will have the power to coordinate the actions of NCAs by assessing the emergency measures one NCA is proposing to take and considering whether it should be

expanded to other jurisdictions.

ESMA powers of intervention in exceptional circumstances
In exceptional circumstances ESMA can also decide to use its intervention powers directly and take the following emergency measures:

- *Prohibition or conditions on entering*
  - *Into a short sale*
  - *Into other transaction in a financial instrument that confers a financial advantage in case of decrease in value of another financial instrument (does not apply to sovereign debt and sovereign CDS)*

For sovereign debt and sovereign CDS, in case of an emergency declared by the European Council, ESMA could take individual decision requiring NCA's to take actions.

Annex 6: Market makers for which public disclosure is not mandatory in Belgium, following the FSMA:

Authorized Market Makers

FSMA	BNP Paribas FORTIS BANQUE SA	GEBABEBB
FSMA	ING Bank NV/SA	BBRUBEBB
FSMA	KBC Securities NV	KBSEBE22

Authorized Primary Dealers

FSMA	BANCO SANTANDER SA	BSCHDEFF
FSMA	BARCLAYS BANK PLC	BARCGB2
FSMA	BNP Paribas FORTIS BANQUE SA	GEBABEBB
FSMA	CITIGROUP GLOBAL MARKETS LIMITED	SBILGLB2L
FSMA	CREDIT AGRICOLE CIB	BSUIFRPPXXX
FSMA	DEUTSCHE BANK AG	DEUTDEFFXXX
FSMA	HSBC France	CCFRFRPPXXX
FSMA	ING Bank NV	INGBNL2A
FSMA	J.P. MORGAN Securities Ltd	JPMSGB2LMOS
FSMA	KBC BANK	KREDBEBB
FSMA	MORGAN STANLEY & Co Int. Plc	MSLNGB2X
FSMA	NATIXIS	NATXFRPPXXX
FSMA	Nomura International PLC	NOMAGB2L
FSMA	RBC Europe Ltd	ROYCGB22
FSMA	ROYAL BANK OF SCOTLAND Plc	RBOSGB2RTCM
FSMA	SOCIETE GENERALE SA	SOGEFRPP

Annex 7: White's robust standard errors.

Following White (1980), heteroskedastics-consistent estimators is found by the following:

$$V_{HCE}\left[\hat{\beta}_{OLS}\right] = \frac{1}{n}\left(\frac{1}{n}\sum_i X_i X_i'\right)^{-1}\left(\frac{1}{n}\sum_i X_i X_i' \hat{u}^2{}_i\right)\left(\frac{1}{n}\sum_i X_i X'{}_i\right)^{-1}$$

With V_{HCE} the OLS variance estimator and X_i' matrix from data.

This is true if errors of the regression are independent but distinct variances σ_I and $\sum = diag(\sigma_I^2,..,\sigma_n^2)$ estimated with $\hat{\sigma}_i^2 = \hat{u}_i^2$