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Master Thesis

Excess stock returns during monetary policy announcement days in the euro area and the US

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Abstract

We investigate the excess stock return performance during the ECB monetary policy decision (MPD) and the FOMC days. In particular, why on average there are a high excess return during the FOMC days but not during the ECB. We compare the average conventional, unconventional and the uncertainty shock levels as well as reaction to them in the euro area and the US during the ECB MPD and the FOMC days. The main finding is that the difference between the excess return on the ECB MPD and the FOMC days comes from the ability of central banks to move down uncertainty and not from monetary easing.

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1. Introduction

Multiple studies have found that the stock markets enjoy high returns during the monetary policy announcement days (Savor & Wilson, 2013; Cieslak, Morse & Vissing-Jorgensen, 2016). However, the results are mixed. The recent study by Brusa, Savor & Wilson (2016) showed that the stock markets in the United States, as well as abroad, experience high excess returns only on the days of scheduled FOMC meetings, but not during the ECB monetary policy decision (MPD) dates. At the same time, Kroencke, Schmeling & Schrimpf (2017) demonstrated that monetary policy announcement shocks around FOMC meetings are driven by three type of shocks: Short rate shock (conventional), long rate shock (unconventional) and so-called "risk appetite" shock. The "risk appetite" shock in this study is defined as the principal component which is mostly loaded on stock and long-term government bonds implied volatility indices (VIX and TYVIX). Our study aims to investigate why there is high excess return during FOMC days, but not during ECB MPD dates. Specifically, whether the difference in excess stock returns is driven by the different shock levels of different reactions to these shocks, or the combination of both. Conventional and unconventional monetary policy shocks represent unexpected monetary accommodating (tightening), while uncertainty shock - change in risk aversion and uncertainty.

Conventional monetary policy shocks represent an unexpected change in the short rates during monetary policy announcement. In one of the prominent studies, Kuttner & Bernanke (2005) showed that a 25-basis-point cut in the federal funds' target rate leads to a 1% increase in the broad stock index in the US. Several theoretical explanations exist in the literature. First, the cut in short rates could make stronger the balance sheet position as a result of a decreased interest expenses on a short-term or a floating-rate debt (balance sheet channel) (Bernanke & Gertler, 1995). Second, the increase in the supply of credit would lead to lower costs associated with borrowing either through lower equilibrium price or through lower transactional costs to find new counterparties (credit channel; Bernanke & Gertler, 1995). Both effects make firms less risky, so the stock prices increase.

Unconventional monetary policy shock is defined as a surprise change in the long end of the yield curve. Central banks in the period of low-interest rates faced with limited opportunity to move down short rates. Thus, central banks introduced unconventional measures which were aimed to move down the long end of the yield curve. Nevertheless, unconventional measures were different in each of the countries, moving down the long end of the yield curve is a common feature (Lenza, Pill & Reichlin, 2010). The effect of unconventional shocks was investigated in numerous studies and was found to be important in explaining stock returns during monetary policy days (Rogers, Scotti & Wright 2014; Haitsma, Unalmis & Haan, 2016; Unalmis & Unalmis, 2015).

The last shock which we account for is the *uncertainty shock*, which is measured as a change in the uncertainty during ECB monetary policy announcements. We use the implied volatility index as an uncertainty proxy since it shows a market-based risk-neutral expectation of volatility (uncertainty). Sever papers study implied volatility performance during monetary policy announcements (Nikkinen & Sahlström, 2004; Chen & Clements, 2007). For example, Chen & Clements (2007) found that S&P 500 implied volatility index falls significantly during FOMC days. At the same time, Nikkinen & Sahlström (2004) concluded that implied volatility increases prior to the scheduled and drops after FOMC announcements. During monetary policy announcement days, there is a large inflow of information. Firstly, it is the monetary policy decision itself. Secondly, monetary policy announcements are followed by press conferences. During the press conferences, central banks explain its decision and the reasoning, which usually includes an overview of current and projected macroeconomic conditions. Altogether, it impacts the market perception of uncertainty. The variation in uncertainty moves stock prices since investors demand a higher premium for higher uncertainty and vise versa (Unalmis & Unalmis, 2015).

The shocks described above signify unexpected expansionary or contractionary monetary policy and also show the influence of central bank's announcements on market expectations about uncertainty and risk aversion.

In our study, we replicate Brusa, Savor & Wilson (2015) findings of the excess returns during FOMC meetings and further extend it to the ECB MPD. We compare the average shock levels in the euro area during ECB MPD and in the US during FOMC days. Then, we conduct an event study, proposed by Kuttner (2001), on the dates of ECB and FOMC monetary policy announcements during the 2000 - 2017 period and check how different is the reaction to three shocks in the euro area and the US. Besides that, we further analyze the reaction to the shocks in the euro area and the US considering the asymmetry of monetary policy and uncertainty shock issue.

This master thesis is structured as follows. First, the relevant academic literature is reviewed, providing a detailed theoretical explanation of the influence of the mentioned shocks on the excess stock return. Further, the methodology and the approaches to measuring shocks are described. This is followed by the data description and overview of the empirical findings. Next, the results are discussed, and theoretical & managerial implications are presented. Finally, the discussion of the results is presented, and conclusions are drawn.

2. Theoretical Background

Around monetary policy meetings, the market experiences multiple shocks, including short rate shock (conventional), long rate shock (unconventional), and uncertainty shocks. We will separate the uncertainty shock and the monetary policy shocks, and will look at them in greater detail.

2.1. Monetary Policy Shocks

The impact of monetary policy on the stock market was a debatable topic for many decades. In general, the view on the influence of monetary policy on the real economy and the stock market was derived under assumptions of specific economic schools (Devereux & Engel, 2003). The three main economic schools that proposed their vision on this question include Classical School, Monetarism School, and Keynesian School.

2.1.1. Money Neutrality

When it comes to monetary policy, one of the most controversial topics is the money neutrality theory, which states that the change in money supply only affects nominal variables, such as nominal interest rate and nominal growth rate, while real variables remain the same (Coe & Nason, 2002; Olekalns, 1996). Proponents of this theory belonged to the Neoclassical School of Economics. Conservative neoclassicists claimed the following: Provided that all people are fully-rational, we live in a world of perfect competition, perfect knowledge (both from the consumer and the producer side), and no transaction costs - where people consider real variables, adjusted for an inflation, rather than nominal variables (Banks & Weintraub, 1995). Thus, following this perfect knowledge assumption, neoclassicists argued that no monetary policy interventions are required since markets are fully rational, even in the short-run (Cerny, 1991).

Expectedly, neoclassicists support the theory of money neutrality, since, from their perspective, the amount of money that entered the economy can trigger only short-term deviation of the real interest rate from its true equilibrium. In contrast, the only factors which can influence the interest rate are "the supply and

demand ratio of the loan capital. In the neoclassical theory, the demand for loan capital is equal to the investments, while the supply equals savings". (Sedova & Ratzlaf, 2014, p.2).

Overall, there are multiple papers in the literature that prove the existence of money neutrality in different countries, including Australia (Olekalns, 1996), Brazil (Nogueira, 2009), the euro area (Gerlach & Svensson, 2002). Besides that, multiple studies have examined both developed and developing countries throughout the world and came to similar conclusions about money-neutrality (Lucas, 1980; Kormendi & Meguire, 1985; Barro, 1997).

Based on the statements above, it can be concluded that classical school of economics does not support the idea that monetary policy decisions affect the stock market. Even if it is the case, it should not persist long and suppose to vanish in the short run.

2.1.2. Money Non-Neutrality

Another school of thought, which shares quite the opposite view to that of the Neoclassical ones, stems from Keynesian Economics (Stein, 2014). It argues that monetary policy decisions not only affect inflation, but also have an influence over real economic outputs, such as real income, employment level, and production (Stein, 2014). Furthermore, Keynes (1936), as a founder of this theory, argued that market economies do not self-correct quickly since prices and wages take time to adjust, meaning that they are sticky. This leads to a conclusion that during the recession it is necessary for the government to be proactive and fully utilize the power of monetary policy since, with an increase in the money supply, the interest rate falls and investment and income rise (Keynes, 1936; Alavinasab, 2016). Keynesians further conclude that since economic developments are path dependent, regulatory bodies have to actively manage and use monetary policies by either straightening or loosening them, depending on the current economic situation (Blanchard & Summers, 1986; Romer & Romer, 1989).

When analyzing money neutrality from a neoclassical point of view, Keynesian noticed a discrepancy (Keynes, 1936). On the one hand, Keynesians

suggest that interest rate is only influenced by the supply and demand. On the other hand, if there is an increase in the quantity of money, it can lead to the shift from the true point of the equilibrium between savings and investments. This implies that interest rate is also influenced by the balance of savings and investments, which is in contradiction with the neoclassical point of view (Sedova & Ratzlaf, 2014).

In support of the Keynesian theory, researchers had proven many cases of inconsistency not only with short-run money neutrality but also with the long-run money neutrality theory (Friedman, 1968; Niehans, 1978). For example, Sprinkel (1964) was one of the early researchers who discovered that US stock prices are informationally inefficient with respect to the money supply. Later, Cooper (1974) stated that stock returns lead money supply changes and no time lag money supply changes have been observed in the United States, further proving Sprinkel's theory. Besides that, money non-neutrality provided robust conclusions for the developed and the developing countries (Urama, Oduh, Nwosu & Odo, 2013; Puah, Habibullah, Mansor & Shazali 2008). For example, Wongbangpo & Sharma (2002) noticed that the ASEAN markets (Indonesia, Malesia, Philippines, Singapore, and Thailand) are inefficient not only in the long-run but also partially inefficient in the short-run, demonstrating inconsistency with the theory.

These findings further imply that since monetary policies can influence the market in the long run, there is great importance in the monetary policy announcements. Thus, the information, released during the statements may change the expectation of the investors about the future. It implies that investors demand the risk premium since they are uncertain how the information, released by the central banks, may influence their expectations about prospects. If further leads to the increase in stock returns.

2.1.3. Money Neutrality in the Long-Run

Despite a broad coverage of neoclassical money neutrality position, virtually no empirical research could prove that money is neutral in the short-run. At the same time, many scientists provide evidence of money neutrality in the long-run, disagreeing with a Keynesian point of view. One of the prominent advocates for an

idea that money can be, but not always is neutral in the long run, belongs to the monetarist school of economists. Monetarists argue that the most crucial aspect for the economy is the carefully-crafted growth rate of the money supply, which ensures price stability and steady growth of the economy. They advocate that the supply side of money should be regulated by the central banks and continuously grow at the same speed as the economy itself, in order to avoid high inflation (deflation).   In addition to this, the monetarist school maintains that since prices and wages are sticky, money is not neutral in the short-run and may have long-term effects. Friedman (1968), the most influential scholar in this field, alleged that monetary policy should be "long-run oriented and long[er] term effects that will make any monetary growth path it follows ultimately consistent with the rule of policy" - in line with most of the monetarists (Friedman, 1968, p.11). Besides that, Friedman (1968, p.5) stated that "monetary policy cannot peg interest rates except for limited periods" since the economy would no be in the equilibrium and it would lead to sustained inflation.

In contrast to Keynesians, arguing that change in money supply may affect the level of the interest rate and investment, monetarists hold a view that change in money supply may affect real variables in the short-run and nominal variables in the long-run (Alavinasab, 2016).

From an empirical point of view, mixed results had been presented when it comes to money neutrality in the long run. On the one hand, Serletis (1993), analyzing the United States stock market, discovered that money and the stock market, having a unit root in all of the variables do not cointegrate, which is aligned with the market efficiency hypothesis. Furthermore, Malliaropolus (1995), using the bivariate framework developed by Fisher & Seather (1993), draw a similar conclusion concerning the United Kingdom. Thus, changes in money supply create a proportional increase in money level and nominal GDP, while actual prices are still intact (Fisher & Seather, 1993). More recently, Alatiqi & Fazel (2008), analysing S&P 500 for 50 years span concluded that "lack of a stable negative causal relation from money supply to interest rates, and from interest rates to stock prices, results in no significant long-term causal relation from money supply to stock

prices", further supporting the theory of money neutrality in the long-run (Sarletis & Koustas, 1998; Bernanke & Mihov, 1998). On the other hand, there is some evidence strictly against some aspects of money neutrality theory, proposed by the neoclassical school. First, transactional costs do exist in the real world (Grossmann & Weiss, 1983). Besides that, there is asymmetry information (Ui, 2003) which in return allows insider trading (Lucas, 1972). Finally, firms are unable to adjust prices every day, since it would be too costly to perform (Calvo, 1983). With this in mind, it is expected that numerous papers exist, supporting an idea of money non-neutrality (Mishkin, 1982; Motolese, 2001; Motolese, 2003).

Based on that, it is important to note that the topic of money neutrality is quite controversial and has many aspects, which have to be considered. For example, the effects of monetary policy in a developed or a developing country would have the magnitude of a different scale (Kormendi & Meguire, 1985). Besides that, it is necessary to observe the current economic situation, since expansionary and contractionary monetary policy actions may have a different effect on the money neutrality. Finally, the current level of the uncertainty about the monetary policy (as well as future monetary policies) may have varying influence on the neutrality of money (Caplin & Spulber, 1987). However, no matter what economic school of thought one supports, it is indisputable that the transmission mechanisms of monetary policy affect the stock market (Bernanke & Kuttner, 2004; Brusa et.al., 2015; Lucca & Moench, 2012). The uncertainty about the central bank's decisions of key interest rates, the nominal money and the overall view on the economy create a risk premium for the investors (Bernanke & Kuttner, 2004; Mishkin, 1995). Since this uncertainty exists, the market becomes riskier, and investors require a risk-return tradeoff (Bernanke & Kuttner, 2004). Thus, monetary policy shock is persistent and can be observed around monetary policy meetings.

2.2. The Uncertainty Shock

The Uncertainty shock is the second type of shock, which arises from the uncertainty, or insecurity, in the actions that can be taken by the central banks (Pástor & Veronesi, 2012). Right before the monetary policy announcements, stock prices are relatively high (Bollerslev, Tauchen & Zhou2009). Once the information about

the interest rate is announced, and the statement of further economic outlook is released, uncertainty about governing body's decision is significantly reduced, which in turn stimulates the price fall (Pástor & Veronesi, 2012). The decline of prices will be substantial in the moments when the uncertainty about the central bank's decisions is high or when the policy change is followed by a short economic downturn (Pástor & Veronesi, 2012). Besides that, the more information is released, in particular, the forward-looking statements and the Quantitative Easing programs announcements, the larger drop in implied volatility indices will be (Bauer & Neely, 2012; Chang & Feunou, 2013).

This further implies that one of the main uncertainty indicators – the volatility index, is influenced by the monetary policy announcements and investors will demand higher returns in order to hold the asset (Unalmis & Unalmis, 2015). The main volatility index in the euro area is the Euro Stoxx 50 Volatility Index (VSTOXX) and in the United States is the stock market option-based implied volatility index (VIX). If these volatility indexes are high prior to the announcement, it is a general indicator of the expansionary monetary policy and visa versa (Bekaert et.al., 2013). High volatility indexes indicate the uncertainty about the future. Once the central banks hold its meetings, more clarity about the future of the economy is revealed (Bernanke & Kuttner, 2004). Since investors become more knowledgeable about the future, they in return require not as high-risk premium as before. Thus, decomposing this uncertainty shock from the other shocks can unveil the nature of the excess return around the monetary policy announcements.

3. Literature Review

3.1. Stock Market Reaction to Monetary Policy Announcements

For many decades researchers have tried to explain how monetary policy affects the stock return, with more attention being paid to the *monetary news announcement* (Lucca & Moench, 2015; Cieslak et.al., 2016). Dating back to 1997, Thorbecke was able to identify the adverse effect on the percentage change in Dow Johns Industrial Average from changes in federal fund interest rate. Further supporting Thorbecke's findings, Bernanke & Kuttner (2005) discovered that 25-basis-points cut in the federal fund target rate are associated with 1 percent increase in the US stock market, further proving the importance and value of the Federal Open Market Committee (FOMC)[1] has on the equity market. More recently, Brusa et.al. (2015) have identified that the FOMC meetings have a significant influence not only on the domestic stock market but also on the numerous international stock markets.

Besides that, an extensive literature has covered the topic of the market *return* around monetary policy announcements. The general concept is that the stock prices move in response to the information, released during the meetings (Bernanke & Kuttner, 2005). In Support of this idea, Lucca & Moench (2012) demonstrated during the 1994-2011 period, when policy decisions had been released by the FOMC, the US stock return on average was *thirty times larger during the announcement day*, in comparison to any other day of the year. Cieslak et.al. (2016) went further and observed that the excess return in the US, starting from 1994 until 2015, was earned entirely in weeks 0, 2, 4 and 6 in FOMC cycle time. Only 531 even-week Fed put days since 1994 are responsible for 157 percentage points out of a total 191 percentage points of cumulative log stock returns (Cieslak et.al., 2016). The author argues that even-weeks excess return is explained by the fact that every two weeks the release regarding monetary policy is made, which is accommodating on average (Cieslak et.al., 2016). Based on these findings, the authors highlight the

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[1] The part of the Federal Reserve, which is responsible for determining "discount rates and reserve requirements" (Federal Reserve, n.d)

types of monetary policies, which could lead to these outcomes as an interesting direction for further research.

3.2. Conventional and Unconventional Monetary Policies

The primary goal for the most central banks is to maintain inflation at a stable rate, while trying to keep the unemployment low, and closely monitor the interest rate, adjusting on the need (European Central Bank, n.a.). Under these conditions, the conventional monetary policy can be implemented, which leads to the *conventional shocks* on the monetary policy announcements, in case if investors are unable to anticipate central banks' changes in policies.

However, within the past decade, multiple countries experienced a short-term nominal interest-rate being close to zero (Honkapohja, 2016). This phenomenon is called the *zero-level bound* (zlb). Zero level bound is an economic situation when short-term interest rates are close to zero (European Central Bank, n.a.). During this period *unconventional monetary policy* actions have to be taken since the central bank is unable to decrease the interest rate any further (Rogers, Scotti & Wright 2014). Even though there is no one unified way of applying the unconventional monetary policies, some parallels can be drawn between the actions taken by the Federal Reserve and the European Central Bank (Lenza et.al., 2010). Thus, during the zero-level bound period, central banks have widely used unconventional monetary policies, among which one of the most popular ones is the repurchase of government bonds (European Central Bank, n.a.). Both the United States and the euro area have used it after the 2007 and 2013 crises respectively (European Central Bank, n.a.; Board of Governors of the Federal Reserve System, n.a.). During the announcement of the program, Mario Drage – the president of the ECB, had famously said - "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro. And believe me, it will be enough" (European Central Bank, n.d.). Following this statement, the ECB has spent roughly EUR 2.5 trillion, stimulating and supporting the economy (Kisham, 2018). Similarly, during the 2008-2015 period, the Federal Reserve has purchased Mortgage Backed Securities and long-term debt securities, adding over USD 4.5 trillion to the balance sheet (Cox, 2017).

Since both conventional and unconventional policies play a significant role in the economy, it is essential to further look at how investors react to the different announcements, made by the central banks.

3.3. Monetary Policy Shocks Structure

Kroencke et.al.(2017) has identified three distinct shocks, which are accountable for nearly 90% of all the stock returns around monetary policy announcements, by applying orthogonal factor rotation. The three components are able to explain the absolute majority of the of the stock variation during the monetary policy meetings and include: 1) A shock to the short-term rates of up to 2 years (conventional shocks), 2) a shock to the long-term rates, between 5 and 10 years (unconventional shocks) and, 3) a shock to the 'risk appetite', which is triggered by the FOMC's meetings uncertainty (Kroencke et.al., 2017; Miranda-Aggripino, 2015).

The first shock comes from the conventional surprises, made by the central banks. This shock concentrates on the front of the yield curve, capturing immediate interest rate reacting to the monetary policy announcements (Kroencke et.al., 2017). The second shock can be noticeable during the unconventional monetary policy announcements and is applied to the end of the yield curve. It captures the effects of quantitative easing and other long-lasting implications disclosed by the central banks, which are embedded in the long-term rate premia (Kroencke et.al., 2017; Miranda-Aggripino, 2015). Finally, the "risk appetite" is the principal component, which is mostly loaded on stock and long-term government bonds implied volatility indices (VIX and TYVIX).

It should be noted that since risk appetite is uncorrelated with the first two shocks, Kroencke et.al. (2017) separates it from the term structure of safe interest rates [2]. The author identified that a one-standard-deviation "risk appetite" is responsible for a daily equity excess return of 0.82%, with a t-statistics equals 7.4, which by itself explained over 50% of all the stock return during the FOMC's meetings (Kroencke et.al., 2017). In addition, short-term and long-term policy shocks were insignificant drivers of the stock market returns during FOMC

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[2] Including both short-term and long-term rates

announcements. This leads to a conclusion that "risk appetite" plays an important role in explaining excess stock return during monetary policy meetings (Kroencke et.al., 2017; Miranda-Aggripino, 2015).

3.4. FOMC vs Other Central Banks

It is indisputable that FOMC meetings have great influence on the world economy. Brusa et.al. (2015) have identified that almost all the world stocks experience excess return during FOMC announcements. For example, the value of "FOMC-day premia", which is the difference between the average market excess returns on FOMC announcement and non-announcement days, is 28.6 basis points (bps) in Japan, 28.1bps in South Africa, 43.8bps in Brazil[3]. At the same time, "FOMC-day premia" in the United States is significantly lower, being at 23.5bps (Brusa et.al., 2015). In addition to this, Brusa et.al. (2015) have found that other central banks (in both developed and developing countries) do not possess any excess returns not only in the United States but also in the respective home countries. This leads to the conclusion that investors do not demand as high of a risk premium for the risks that come from their home central banks. This discovery leads to the question of what makes FOMC and its meetings so unique? In order to answer this question, we will investigate the European Central Banks (ECB) as a main counter-party for the FOMC.

First, the United States economy is the largest in the world, and multiple domestic companies may have a tight relationship with American multinational corporations (Rogers et.al. 2014). It is partially correct, yet there are no grounds to assume that the Eurozone would be so influenced by the FOMC meetings and not ECB meetings, especially considering the fact that the economy of the Eurozone area in 2013 was larger than that of the US (Janse, 2015). The other explanation may lie in the monetary policy actions. Specifically, the fact that other central banks do not pursue active monetary policy (Brusa et.al., 2015). However, with the recent quantitative easing (QE) program that ECB introduced in 2015, amounting to over EUR 30 billion per month (ECB, 2018), as well as the spread of the interest being

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[3] With the world average for the FOMC-day premia being 27.6 bps

between 0.25% and 4.75% during the 1999-2018 period, the authors do not have any doubt that ECB percusses an active monetary policy. The third possible reason is the fact that ECB decisions, unlike FOMC meetings, can be widely anticipated (Wilhelmsen & Zaghini, 2011). However, this theory does not have any grounds either and European Central Bank "surprises investors reasonably frequently" (Brusa et.al., 2015).

The authors are perplexed by the fact that FOMC meetings have such a significant influence on the international markets and can persistently demonstrate FOMC-day premia, while domestic central banks are unable to do so (Kroencke et.al., 2017). Being motivated by this dilemma, as well as inspired by the Kroencke et.al. (2017) paper, this thesis aims to explore the nature of the short-term shock, the long-term shock, and the "risk appetite", taking European Central Bank as the central area of concentration. Therefore, we analyze why the FOMC announcements facilitate excess return for the stock market, while the European Central Bank's monetary policy decisions do not.

4. Methodology

First, it is necessary to estimate excess stock return performance during ECB MPD and FOMC days. In order to do that, we estimate simple time-series model, where the dependent variable is excess stock return, and the only independent variable is the dummy variable, which equals to 1 in days of monetary policy meetings (ECB MPD or FOMC) and 0 in all other dates.

$$Excess\ Return = \ b_0 + b_1 * MPD + \varepsilon \qquad (1)$$

where *Excess Return* is measured as the daily log return on the market index risk free rate; *MPD* denotes a *monetary policy date*, while ε is an error term.

In order to find how excess return during ECB MPD and FOMC days is explained by the variation in the conventional and unconventional monetary policy as well as the uncertainty shocks, we estimate the following model:

$$Excess\ Return\ during\ MPD\ days = \ a + b * CMPS + c * UMPS + \qquad (2)$$
$$d * US + \varepsilon$$

where excess return during MPD and the FOMC days is measured as a daily log-return on the market index minus risk-free rate. *CMPS*, *UMPS*, and *US* are conventional and unconventional monetary policy and uncertainty shock respectively; *CMPS* reflects the shock in the short-end of the yield curve during monetary policy meeting day; *UMPS* reflects the shock in the long-end of the yield curve during monetary policy meeting day; *US* reflects the shock in the uncertainty during monetary policy meeting day. Measuring *CMPS*, *UMPS*, and *US* will be presented below. Finally, ε is an error term.

4.1 Measuring Uncertainty Shock

There are two common ways to measure uncertainty, the first of which is based on historical measures and the second is based on the volatility implied by option prices (Chang & Feunou, 2013). The main difference between the two is that historical measures are backward looking, whereas implied volatility is forward-looking. Historical measures show uncertainty as it was on the market some time ago,

whether implied volatility shows market expectation about volatility in the future. At the same time, implied volatility is a risk-neutral measure of uncertainty, meaning that real-world uncertainty is adjusted for the variance premium. Thus, implied volatility is a biased measure of uncertainty and could lead to the wrong conclusions (Chang & Feunou, 2013).

Despite the bias caused by the variance premium, implied volatility approach is superior over the historical measures of uncertainty. First, it is market-based measure and incorporates all the new information flowing into the market since it is traded (indices like VIX, VSTOXX). Second, it was proved that implied volatility does a better job of forecasting the real-world volatility than historical measures (Christoffersen et.al., 2013; Poon & Granger, 2003). Third, uncertainty with a variance premium could be better, since it considers the economic significance of uncertainty which varies during the business cycle. In other words, the same amount of uncertainty has different importance during the crisis and normal times (Chang & Feunou, 2013).

Taking all the evidence discussed, we will use implied volatility as a measure of market uncertainty. We define uncertainty shock (US) on a day t as a return on volatility index, or:

$$Uncertainty\ shock = \ log\frac{Volatility\ Index_t}{Volatility\ Index_{t-1}} \qquad (3)$$

4.2. Measuring Monetary Policy Shocks

There are two main methods to measure monetary policy shocks, which received broad support in the literature. In general, the surprise is defined as the difference between actual change and the expected change. Thus, the main difference is in calculating expectations. The first method to measure market expectations is survey-based, whereas the second one is market-based.

Comparing survey-based and market-based measures of expectations we should consider several important issues. First, market-based measures incorporate information faster and react to available market leaks faster, similar to the stock

market reaction (Lloyd, 2018). Second, it could be used to measure surprises during zero level bound to account for unconventional monetary policy surprise effect through changes in long-term instruments yields. It is an important feature for data series after 2009. At the same time, survey-based measures answer purely what is the conventional monetary policy, not accounting for risks, liquidity and market imperfections (Lloyd, 2018).

In this study, we will use market-based methods to measure monetary policy shocks. This decision is primarily motivated by the fact that the big part of the time series data is associated with zero level bound and the use of the unconventional monetary policy (Lloyd, 2018).

Among the market-based measures of monetary policy surprise before the zero-level bound, the widest coverage was obtained by the method, proposed by Kuttner (2001). In his study monetary policy surprise is defined as the difference between the short-term rate (Federal funds) futures on days after monetary policy announcement and before, adjusted for time to maturity, or:

$$CMPS = \frac{D}{D - d} * (f_{d,m} - f_{d-1,m}) \tag{4}$$

where *CMPS* is the *conventional monetary policy shock*; f_m is the current-month futures; *d* is the current date and *D* is the number of days in the month.

This method is widely used in order to measure conventional monetary policy shock in the US and will be used in our study. However, this method has several implications for the euro area. First, there are no comparable instruments, similar to those of the Federal fund's futures for the euro area. In order to overcome this issue, we use EURIBOR futures, since EURIBOR futures are considered as unbiased predictors of the euro area short rates (Bernoth & Hagen, 2004; Lloyd, 2018). The second important matter is that adjusting of Federal funds futures in the US is required by the futures design. Federal funds futures payoff depends on the average monthly Federal funds rate and its scaling incorporates the number of days that are affected by the one-day change (Abad & Soler, 2013). Thus, for the euro

area, the surprise change could be simply defined as the difference between the EURIBOR futures implied rates:

$$CMPS = f_{d,m} - f_{d-1,m} \qquad (5)$$

where *CMPS* is the *conventional monetary policy shock*; f_m is the current-month futures; d is the current date.

The futures implied rate we define as a 100 minus futures settlement prices (Wang & Mayes, 2012). After interest rates dropped to almost zero level, central banks started to use unconventional methods of monetary policy, among which are asset repurchases and forward guidance. Since these instruments are difficult to measure (for example, compare to changing in the refinancing rate), several new methods were proposed. These are measuring unconventional monetary surprises as changes in the long-term yields or using principal component analysis (PCA) or factor analysis in order to find unconventional shocks (Rogers et al., 2014; Swanson, 2017; Gurkaynak et.al., 2005).

The first method defines unconventional shock as a simple change in the long-term government bond yields:

$$UMPS = b_d - b_{d-1} \qquad (6)$$

where *UMPS* is the *unconventional monetary policy shock*; b_d is the current yield to maturity on the generic bond, and d is the current date.

This way of measuring reflects a central bank's policy to move down long-term yields during zlb. At the same time, it is intuitive in explaining the effect of unconventional policy measures similar to the one, proposed by Kuttner (2001). This way, we compute unconventional shock for the US. Specifically, we calculate unconventional monetary policy shock for the US as the daily change in 10 years US government yields.

Measuring unconventional monetary policy surprises through PCA or factor analysis could provide a better picture of monetary policy shocks since the factors (or components) are extracted from the number of securities and, thus, are superior

over single yield change in explaining unconventional surprises. However, factor interpretation makes this approach less intuitive in explaining marginal effects of monetary policy. Furthermore, it requires additional assumptions about factor characteristics which need to be justified.

In this thesis, we follow Rogers et.al. (2014), measuring unconventional monetary shocks of the US through changes in long-term yields. However, we do not measure unconventional monetary surprise directly as the difference in long-term yields, since ECB unconventional monetary policy aimed to reduce spread between yields on government bonds of Germany and some peripheral countries, such as Italy and Spain (Haitsma et.al., 2016; Rogers et.al., 2014). Thus, unconventional monetary surprise in the euro area is defined as:

$$UMPS = s_d - s_{d-1} \tag{7}$$

where *UMPS* is the *unconventional surprise change*; *s* is the yield spread between the German and the Italian 10 years bonds, and *d* is the current date.

4.3. Checking for the Asymmetry Reaction

Market reaction to monetary policy surprises could be non-symmetrical, meaning that the reaction to positive and negative surprises could vary. The overall market tends to react more to negative news (positive surprises) and less to positive news (negative surprises) (Wang & Mayes, 2012).

Thus, the authors aim to investigate the asymmetry of market responses to monetary policy shock by estimating the model:

$$\begin{aligned} Excess\ return_{t|MPD} = {} & a + b_1 * CMPS_{t|MPD}^{PLUS} + b_2 * CMPS_{t|MPD}^{MINUS} + \\ & c_1 * UMPS_{t|MPD}^{PLUS} + c_2 * UMPS_{t|MPD}^{MINUS} + d_1 * US_{t|MPD}^{PLUS} + d_2 * \\ & US_{t|MPD}^{MINUS} + \varepsilon_{t|MPD} \end{aligned} \tag{8}$$

where *PLUS* and *MINUS* indicate whether the shock is positive or negative; *CMPS* reflects the shock in the short-end of the yield curve during monetary policy meeting day; *UMPS* reflects the shock in the long-end of the yield curve during monetary

policy meeting day; *US* reflects the shock in the uncertainty during monetary policy meeting day.

In this setup, b_1 (c_1, d_1) would represent the excess return reaction to a 1% *positive* conventional monetary (unconventional, uncertainty) shock and b_2 (c_2, d_2) would represent the excess return reaction to a 1% *negative* conventional monetary policy (unconventional, uncertainty) shock.

4.4. Testing for the Difference in the Shock Levels and the Difference in the Reaction to Shocks

In order to explain the difference between excess return in the euro area during the ECB MPD and in the US during FOMC days, we compare the shocks and the reaction to it.

To investigate whether the shocks in the euro area are different during the ECB MPD from the shocks in the US during FOMC, we use the t-test for independent samples, also known as the Welch's test. It tests whether a mean of one sample is equal to a mean of another sample. One of the assumptions of this test is that data is normally distributed. However, as it was shown by Chen & Chen (2017), as long as the sample is greater than 11, the distribution of Welch's test is well approximated by the theoretical distribution.

In order to compare the reaction to the shocks in the euro area and the US, we check whether the estimated coefficients for the euro area are different from the estimated coefficients for the US. Since the estimated coefficients from the OLS are normally distributed, we can compare the two coefficients from different models by conducting a simple Z-test. Specifically, the Z-statistic is calculated in the following way:

$$Z = \frac{b_1 - b_2}{([SE(b_1)]^2 + [SE(b_2)]^2)^{1/2}} \quad (9)$$

where b_1 is the coefficient from the euro area model; b_2 is the coefficient from the US model; $SE(b_1)$ is the standard error of the coefficient for the euro area model, and $SE(b_2)$ is the standard error of the coefficient for the US model. This formula

provides an unbiased test of the null hypothesis that b_1 is equal to b_2. Test statistic approximates a normal distribution under the null hypothesis. Thus, the critical values for the two-sided test are 1.282, 1.645, 1.96 and 2.576 for 80%, 90%, 95% and 99% (or 90%, 95%, 99% and 99.5% for one-sided test) (Paternoster et.al., 1998).

5. Data

In order to estimate the excess return around monetary policy meetings, we collected the dates of the ECB monetary policy meetings and the FOMC meetings from their official websites. As a market proxy for the euro area, we used the blue-chip Eurozone index - Euro Stoxx 50. We further measure excess return as a daily log-return on the Euro Stoxx 50 minus daily EONIA rate. Excess return for the US is extracted from Kenneth R. French website, measured as "the excess return on the market, value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ" (French, n.a.).

Uncertainty shock is defined as the daily log-return on the implied volatility index –VSTOXX for the euro area, and VIX – for the US. Conventional shock for the euro area is measured as the three months EURIBOR rate futures daily change on the next day[4]. Similarly, conventional shock for the US is measured as the daily change in 30 days Federal funds futures, adjusted following Kuttner's (2001) methodology. Besides that, the unconventional shock is defined as the daily change in 10 years government bond yields spread between Italy and Germany for the euro area and daily change in 10 years government bond yield for the US.

Overall, we concentrate on the period between 2000 – 2017, since during this time the data is available for all the required variables. During this period there were 229 ECB monetary policy meetings and 144 FOMC meetings.

Summary statistics for excess returns, monetary policy and the uncertainty shocks for the euro area and the US in ECB MPD and FOMC days are presented in Table 1. During ECB MPD days all the variables are negative on average, yet close to zero. Only uncertainty shock is statistically different from zero (lower than zero at a 99% confidence interval) during the ECB MPD days and is equal to -1.053. During the FOMC days in the US, the excess return was statistically different from zero, at a 99% confidence interval. On average excess return during the FOMC days is equal to 32.2 basis points. Furthermore, the uncertainty shock in the US was also

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[4] EURIBOR rate is determined at 11:00 CET, which is before ECB monetary policy decision announcement (13:45 CET)

different from zero (at a 99% confidence interval) and is equal to -2.767%. Finally, conventional and unconventional monetary policy shocks in the US during FOMC days are not statistically different from zero.

Table 1: Summary statistics for the Excess Returns, Monetary Policy Shocks, and the Uncertainty Shock during the ECB monetary policy decision days and the FOMC days

This table reports summary statistics for the daily excess return and the monetary policy shocks on the dates of the ECB monetary policy meetings and the FOMC days. Excess return represents the euro area excess return during ECB MPD days, but US excess return during FOMC days (similarly for the rest of the variables). Excess returns and shocks are measured in percent. CMPS is the conventional monetary policy shock, while UMPS is the unconventional monetary policy shock, and the US is the uncertainty shock. The 't-test' row presents t-statistic of whether a particular variable is equal to zero. The last row of the Welcher's test presents the result of whether a shock in the euro area during ECB MPD days and in the US during FOMC days are equal.

	Excess Return	Shocks		
		CMPS	UMPS	US
The ECB MPD days				
Count	229	229	229	229
Mean	-0.043	-0.002	-0.0005	-1.053
S.D.	1.731	0.048	0.084	6.251
t-test	-0.375	-0.677	-0.085	-2.544
The FOMC days				
Count	144	144	144	144
Mean	0.322	0.001	-0.006	-2.767
S.D.	1.226	0.047	0.081	6.925
t-test	3.137	0.211	-0.901	-4.779
Do shocks during the ECB MPD differ from the ones in the FOMC days?				
Welch's test	-2.371	-0.589	0.64	2.408

To compare shocks in monetary policy days in the euro area and the US we conducted a t-test for an independent sample, the result of which is presented in the last row of Table 1. We can conclude that only excess return and the uncertainty shock in the euro area are statistically different (95% confidence interval) and lower from the ones in the US.

Correlation matrices for excess return and shocks during the monetary policy days in the euro area and the US are presented in Appendix A, Table A1.

From Appendix A, Table A1, it can be observed that shocks are negatively correlated with the excess return since negative shock represents positive news. Furthermore, uncertainty shock has the highest correlation coefficient with the excess return (in absolute terms), being equal to -0.777. Correlation of excess return

and unconventional monetary policy shock is lower and is equal to -0.348. Correlation with conventional monetary policy shock is pretty low, being at -0.086. Finally, the correlation between the shocks is low (not higher than 0.269); hence it indicates that there is no issue of multicollinearity.

Correlation matrix for the excess return, monetary policy and the uncertainty shocks in the FOMC days is presented in Appendix A, Table A2. Similar to the euro area, uncertainty shock has the highest (in the absolute terms) correlation coefficient with an excess return and is equal to -0.777. The correlation of the excess return with the conventional and unconventional monetary policy shocks is lower, while with unconventional shock is almost zero. Finally, the correlation between the shocks is not higher than 0.11, which further indicates that there is no issue of multicollinearity.

Additionally, we compared excess returns, monetary policy and uncertainty shocks in days of monetary policy meetings and all other days. The summary statistics and correlation matrices for the euro area and the US are presented in (Tables 2 and Appendix A, Table A3).

From the Table 2, it could be observed that during non-ECB MPD days none of the variables is statistically different from zero. We further conducted Welch's test to compare average excess returns and shocks during monetary policy meeting days and all other days. The results show that only uncertainty shock is statistically different (99% confidence interval) on days of ECB MPD in comparison to all other days. This is consistent with the summary from the Table 1, where only uncertainty shock is different from zero in ECB MPD days.

Correlation matrix for the euro area variables in non-ECB MPD days is similar to the one in ECB MPD days (Appendix A, Table A3).

Table 2: Summary Statistics for Excess Returns, Monetary Policy Shocks and Uncertainty Shock during the ECB MPD monetary policy decision days and all the other days

This table reports the summary statistics for the monetary policy and the uncertainty shocks on the date of the ECB MPD meetings as well as during all the other days. *CMPS* is the conventional monetary policy shock; *UMPS* is the unconventional monetary policy shock; *US* is the uncertainty shock. The 't-test' row presents t-statistic of whether a particular variable is equal to zero. The last row ('Welch's test') presents the result of whether the average shocks in the euro area during the ECB MPD days and during all the other days are equal.

	Excess Return	Shocks		
		CMPS	UMPS	US
		ECB MPD days		
Count	229	229	229	229
Mean	-0.043	-0.002	-0.0	-1.053
S.D.	1.731	0.048	0.084	6.251
t-test	-0.375	-0.677	-0.085	-2.544
		All the other days		
Count	4377	4377	4377	4377
Mean	-0.013	-0.001	0.0	0.013
S.D.	1.461	0.034	0.06	5.793
t-test	-0.586	-1.533	0.348	0.151
		Do shocks during the ECB MPD differ from the ones in all the other days?		
Welch's test	-0.257	-0.426	-0.14	-2.521

Summary statistics and correlation matrix for excess return and shocks in non-FOMC days are presented in Table 3 and Appendix A, Table A4. Similarly to the euro area, none of the variables is statistically different from zero during the non-FOMC days. Excess return and uncertainty shock during the FOMC days are statistically different during the FOMC days, compare to all other days. Specifically, excess return is significantly higher and uncertainty shock is significantly lower during FOMC days.

Correlation between excess return, conventional monetary policy, and uncertainty shocks is similar during FOMC and all other days. However, the correlation between excess return and unconventional monetary policy shock is different during FOMC days and all other days, almost zero in the first case and 0.412 in the latter case.

Table 3: Summary statistics for Excess Returns, Monetary Policy Shocks and Uncertainty Shock during the FOMC monetary policy decision days and all the other days

This table reports the summary statistics for the monetary policy and the uncertainty shocks on the date of the FOMC meetings as well as during all the other days. *CMPS* is the conventional monetary policy shock; *UMPS* is the unconventional monetary policy shock; *US* is the uncertainty shock. The 't-test' row presents t-statistic of whether a particular variable is equal to zero. The last row ('Welch's test') presents the result of whether the average shocks in the US during the FOMC days and during all the other days are equal.

	Excess Return	Shocks		
		CMPS	**UMPS**	**US**
	The FOMC days			
Count	144	144	144	144
Mean	0.322	0.001	-0.006	-2.767
S.D.	1.226	0.047	0.081	6.925
t-test	3.137	0.211	-0.901	-4.779
	All the other days			
Count	4462	4462	4462	4462
Mean	0.012	-0.001	-0.001	-0.028
S.D.	1.212	0.045	0.059	6.438
t-test	0.639	-1.523	-0.93	-0.286
	Do shocks during the FOMC days differ from the ones in all the other days?			
Welch's test	2.978	0.465	-0.773	-4.667

Overall, summary statistics several important aspects. Firstly, excess return is significantly higher during the FOMC days compare to the non-FOMC days and the ECB MPD days. Secondly, uncertainty shock is significantly lower during the FOMC days compare to the non-FOMC days. Furthermore, it is significantly lower than uncertainty shock during the ECB MPD days in the euro area. Conventional and unconventional monetary policy shocks are not statistically different from zero both during the (non-)ECB MPD and the (non-)FOMC days.

6. Empirical Findings

This thesis aims to investigate why on average there is a high excess return during the FOMC days than during the ECB MPD days. Specifically, we explore whether the difference in the conventional and unconventional monetary policies, and the uncertainty shocks, as well as the reaction to these shocks, can explain this evidence.

Our findings are presented in the following way. Firstly, we check the excess stock return performance in the ECB MPD and the FOMC days using time-series study, following Brusa et.al. (2015) paper. Then, we conduct an event-study in the spirit of Kuttner (2001) and investigate how the excess return is explained by a specific shock separately in the euro area and the US during the monetary policy announcement days. After that, we proceed to the multi-shock event study, when we check how excess return is explained by *all* the shock types. Next, we will account for possible asymmetry in reaction to the shocks and check whether results are different. On each step, we run Z-test to compare the reactions to conventional and unconventional monetary policy, as well as the uncertainty shocks during the ECB MPD and the FOMC announcements. Finally, we compute the total effects implied by the average shock level and the reaction to the shocks. We finish by computing the difference between the euro area and the US excess returns, which results from the particular shock (shock level and the reaction to it).

6.1. Excess Stock Return Reaction to ECB MPD and FOMC Days

In order to estimate the excess return performance on the ECB MPD (FOMC days), we conduct a simple study, where the only independent variable is the dummy variable, which is equal to 1 during the ECB MPD (FOMC) dates and 0 otherwise.

The results are presented in Table 4. It can be observed that the excess return is not statistically significantly different from zero on days of the ECB MPD. At the same time, excess return is statistically (99% confidence interval) different from zero. Excess return during the FOMC days is on average by 31 basis points higher than during any other day of the year. The b coefficients are statistically different for the euro area and the US at a 95% confidence interval. Furthermore, adjusted R-squared is close to 0, which means that the ECB MPD and the FOMC dates by itself

do not explain much of the variance of the excess return. The results are comparable to the ones obtained by Brusa et.al. (2015). In their sample period between 1973-2013, the average excess return during the FOMC days is 23.61 basis points higher than in non-FOMC days (1.28 basis point). At the same time, excess return during the ECB MPD meetings (1999-2013 sample) is not statistically different from zero for all the euro area countries, except Finland.

Table 4: Excess stock return reaction to the ECB MPD and the FOMC days

This table reports the effect of the monetary policy (CMPS, UMPS) and the uncertainty (US) shocks on the excess return in the euro area during the ECB MPD days and in the US during the FOMC days. Excess returns and all the shocks are measured in percent. MPD (monetary policy date) is a dummy variable which equals to 1 on the ECB monetary policy dates and 0 otherwise for the euro area and 1 on the FOMC days and 0 otherwise for the US. Columns represent whether an event study is estimated for the euro area or the US. The Newey-West standard error is presented in parentheses. Data period is between 2000 – 2017. Column 'Z-test' gives the test statistic under the null hypothesis that the two coefficients are identical.

Dependent variable:	Excess Return, %		Z-test
Dummy	The ECB MPD	The FOMC days	
$Excess\ Return_t = a + b * Dummy_t + \varepsilon_t$			
a S.E. (*a*)	-0.013 (0.022)	0.012 (0.018)	
b S.E. (*b*)	-0.030 (0.100)	0.310*** (0.104)	-2.357
Adjusted R-squared	-0.00	0.00	
N (days)	4606	4606	

6.2. Excess Return Reaction to Monetary Policy and Uncertainty Shocks during ECB MPD and FOMC Days

This subsection presents an event-study, which shows how variation in the monetary policy and the uncertainty shocks during the ECB MPD and the FOMC days explains the variation of the excess returns in the euro area and the US and how the reaction to these shocks is different.

From 2000 to 2017, the effect of the conventional monetary policy shock was not statistically significantly different from zero in both the euro area and the US (Table 5). Even though the coefficient values are -3,135 and -3.513 respectively and are comparable to the Kuttner & Bernanke (2004) findings, we are unable to conclude that the conventional monetary policy shock affects excess return in the

euro area and the US on days of the ECB MPD and the FOMC days respectively. Meanwhile, adjusted R-squared is close to zero, meaning that the variation in the conventional monetary policy shock poorly explains variation in the excess return both in the euro area and the US.

Table 5: The reaction of the Excess Return to the Monetary Policy and the Uncertainty Shocks on days of the ECB and the FOMC monetary policy meetings

This table reports the effect of the monetary policy (CMPS, UMPS) and the uncertainty (US) shocks on the excess return in the euro area during the ECB MPD days and in the US during the FOMC days. Excess returns and all the shocks are measured in percent. MPD (monetary policy date) is a dummy variable which equals to 1 on the ECB monetary policy dates and 0 otherwise for the euro area and 1 on FOMC days and 0 otherwise for the US. Columns represent whether an event study is estimated for the euro area or the US. The Newey-West standard error is presented in parentheses. Data period is between 2000 – 2017. Column 'Z-test' gives the test statistic under the null hypothesis that the two coefficients are identical.

Dependent variable:	Excess Return, %						Z-test
	ECB MPD			FOMC			
$Excess\ Return_{t|MPD} = a + b * CMPS_{t|MPD} + c * UMPS_{t|MPD} + d * US_{t|MPD} + \varepsilon_{t|MPD}$							
	(1)	(2)	(3)	(4)	(5)	(6)	
a S.E. (a)	-0.050 (0.113)	-0.046 (0.108)	-0.272*** (0.078)	0.325*** (0.100)	0.322*** (0.099)	-0.059 (0.072)	
b S.E. (b)	-3.135 (2.421)			-3.513 (2.907)			0.099
c S.E. (c)		-7.138*** (1.199)			0.008 (1.833)		-3.263
d S.E. (d)			-0.215*** (0.018)			-0.137*** (0.010)	3.788
Adjusted R-squared	0.00	0.12	0.60	0.01	-0.01	0.60	
N (days)	229	229	229	144	144	144	

From Table 5 it is possible to observe that the unconventional monetary policy shock is significant at a 99% confidence interval and explains the excess return in the euro area during the ECB monetary policy decision dates, but not in the US during the FOMC days. The decrease in the unconventional monetary policy shock by 1% leads to an increase in the excess return by 7.138%. At the same time, the unconventional monetary policy shock explains 12% of the variation in the excess return in the euro area during the ECB MPD dates, while this number is virtually zero in the US during the FOMC days.

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It is important to note that *the influence of the uncertainty shock* is the most pronounced. The coefficient is statistically significant at a 99% confidence level both in the euro area and the US, but the reaction to it is different. A 1% increase in the uncertainty shock would lead to a 0.215% decrease in excess return in the euro area and would lead to only 0.137% decrease in the US. Given that the average value of the uncertainty shock was -1.03 for the euro area and -2.767 for the US (Table 1), the uncertainty shock on average leads to an increase in excess return by 0.221% in the euro area during the ECB MPD days and 0.379% in the US during the FOMC days. This implies that the 0.158% difference in excess stock returns the ECB MPD and the FOMC days is *associated with the uncertainty shock* during the ECB MPD and the FOMC days. Besides that, adjusted R-squared is equal to 60% in both models, meaning that the biggest part of the excess return variation during the ECB MPD and the FOMC days is explained by the variation in the uncertainty shock.

Looking at the reaction to the shocks in the euro area and the US (Table 5), it can further be observed that the reaction to unconventional monetary policy and the uncertainty shock in the euro area is statistically different (at 99% confidence interval) from the one in the US.

In Table 6 the results of multivariate regressions are reported. The estimated coefficients for the conventional monetary policy shock and the unconventional monetary policy shock for the US are still insignificant. The coefficient for the unconventional monetary policy shock in the euro area is statistically significant at a 99% confidence interval and is equal to -3.084, which substantially lower (in absolute terms) than -7.138 (Appendix A, Table A3). Such a decrease could be explained by the correlation uncertainty shock, which is equal to 0.269 (Appendix A, Table A1). It could be the case that the unconventional shocks are partially accounted for the uncertainty. The uncertainty shock coefficient is equal to -0.203 in the euro area and -0.138 in the US, which is comparable to the results in Appendix A, Table A3. These results are also statistically significant at a 99% confidence interval. Finally, the adjusted R-squared are equal to 62% and 61% respectively.

Table 6: The Reaction of the Excess Return to the Monetary Policy and the Uncertainty Shocks on days of the ECB and the FOMC monetary policy meetings

This table reports the effect of the monetary policy (CMPS, UMPS) and the uncertainty (US) shocks on excess return in the euro area during the ECB MPD days and in the US during the FOMC days. Excess returns and all the shocks are measured in percent. MPD (monetary policy date) is a dummy variable which equals to 1 on the ECB monetary policy dates and 0 otherwise for the euro area and 1 on the FOMC days and 0 otherwise for the US. Columns represent whether an event study is estimated for the euro area or the US. The Newey-West standard error is presented in parentheses. Data period is between 2000 – 2017. Column 'Z-test' gives the test statistic under the null hypothesis that the two coefficients are identical.

Dependent variable:	Excess Return, %		Z-test
	The ECB MPD	The FOMC	
$Excess\ Return_{t|MPD} = a + b * CMPS_{t|MPD} + c * UMPS_{t|MPD} + d * US_{t|MPD} + \varepsilon_{t|MPD}$			
a S.E. (*a*)	-0.262*** (0.078)	-0.062 (0.065)	
b S.E. (*b*)	-1.601 (1.052)	-2.687 (1.747)	0.533
c S.E. (*c*)	-3.084*** (1.052)	-0.909 (1.111)	-1.421
d S.E. (*d*)	-0.203*** (0.020)	-0.138*** (0.011)	-2.848
Adjusted R-squared	0.62	0.61	
N (days)	229	144	

The reaction to the unconventional and uncertainty shocks is different in the euro area and the US. However, it is not as well-pronounced as in Table 5. Specifically, the reaction to the unconventional shock in the euro area is statistically lower (at a 90% confidence interval for one-tailed Z-test) than in the US. The reaction to the uncertainty shock is also lower in the euro area (at 99% confidence interval) than in the US.

Overall, the reaction of the excess returns to the monetary policy and the uncertainty shocks is consistent with the previous findings (Kroencke et.al., 2017). The variation in the uncertainty shock explains more than the half of the variation in the excess stock returns. Finally, it is important to note that the reaction to the shocks is more pronounced in the euro area than in the US.

6.3. Excess Return Reaction to the Monetary Policy and the Uncertainty Shocks during the ECB MPD and the FOMC Days. Asymmetry Effects

In this subsection, we aim to extend the analysis and account for the asymmetry effects. Furthermore, if the reaction to shocks is indeed asymmetrical, it may explain the difference in the excess stock returns during FOMC days, but not during the ECB MPD days.

Table 7 reports the summary statistics of the shocks. New variables are constructed in such a way that the variable is either equal to the original value or is equal to zero. For example, $CMPS^{PLUS}$ s equal to CMPS if it is positive, and to zero if it is not. All other variables are constructed following the same logic. We have further conducted the t-test for the independent samples, the results of which are presented in the last row. It examines whether specific shock in the euro area during the ECB MPD is different from the one in the US during the FOMC days. As it can be observed, only the positive unconventional monetary policy and both positive and negative uncertainty shocks are different for the euro area and the US. All the other shocks are not statistically different. Besides that, the unconventional monetary policy shock is statistically larger in the US. At the same time, both positive and negative uncertainty shocks are statistically lower in the US rather than in the euro area.

Table 7: Summary statistics for Excess Returns and Monetary Policy Shocks and Uncertainty Shock during the ECB monetary policy decision days and the FOMC days

This table reports the summary statistics for the monetary policy and the uncertainty shocks on the date of the ECB monetary policy meetings and the FOMC days. *CMPS* is the conventional monetary policy shock, *UMPS* is the unconventional monetary policy shock, and *US* is the uncertainty shock. *PLUS* and *MINUS* indicates whether the variable is positive or negative. The last row of the Welch's test presents the result of whether the average shocks in the euro area during the ECB MPD days and in the US during the FOMC days are equal.

	Shocks					
	$CMPS^{PLUS}$	$CMPS^{MINUS}$	$UMPS^{PLUS}$	$UMPS^{MINUS}$	US^{PLUS}	US^{MINUS}
	The ECB MPD days					
Count	229	229	229	229	229	229
Mean	0.008	-0.01	0.019	-0.02	1.852	-2.914
S.D.	0.014	0.044	0.064	0.047	3.803	3.715
	The FOMC days					
Count	144	144	144	144	144	144
Mean	0.01	-0.009	0.026	-0.032	1.273	-4.046
S.D.	0.033	0.03	0.041	0.057	2.893	5.412
	Do shocks during the ECB MPD differ from the ones in the FOMC days?					
Welch's test	-0.811	-1.311	1.66*	-0.149	2.257	2.198

Correlations between the new shocks are presented in Appendix A, Tables A5 and A6. The correlation coefficients are similar to the ones reported in T Appendix A, Table A1 and A2. However, there are minor differences. Firstly, the negative convention of the monetary policy shock in the euro area correlates with an excess return, which equals to -0.275, in comparison to 0.014. Secondly, correlation coefficients between unconventional monetary policy shocks and the excess return for the US have different signs - 0.114 while positive and -0.081 while negative. Overall, the stock correlation is not higher than 0.392 for the euro area and 0.367 for the US. This indicates that there is no issue of multicollinearity.

Table 8 presents the estimated regressions for the asymmetrical monetary policy and the uncertainty shocks. Overall, the models perform better, in comparison to the Table 6. In this case, we observe that the negative conventional monetary policy shocks are statistically significant (99% and 95% confidence interval) for both the euro area and the US. However, the coefficients for the US model is lower and is equal to -4.625 while only -2.628 for the euro area. The unconventional monetary policy shocks (both positive and negative) are significant in explaining the variance of the excess returns in the euro area and the US. However, the reaction to

these shocks is different. In the euro area market reacts more to the positive shocks (which represent negative news), even though the reaction is negative in both cases. In the US the reaction to positive unconventional shocks is opposite to the reaction to the negative unconventional shocks, with the coefficients being 4.285 and -4.029 respectively. Finally, we observe that there is an asymmetric reaction in the euro area to the uncertainty shocks. The market reacts more to the positive shocks than to the negative, -0.222 and -0.183. Moreover, the reaction to the positive and negative uncertainty shocks in the US is almost identical.

Table 8: The Reaction of the Excess Return to the Monetary Policy and the Uncertainty of the positive and negative Shocks on days of the ECB and the FOMC monetary policy meetings

This table reports the effect of the monetary policy (*CMPS*, *UMPS*) and the uncertainty (*US*) shocks on the excess return in the euro area during the ECB MPD days and in the US during the FOMC days. Excess returns and all the shocks are measured in percent. *MPD* (monetary policy date) is a dummy variable which equals to 1 on the ECB monetary policy dates and 0 otherwise for the euro area and 1 on the FOMC days and 0 otherwise for the US. Columns represent whether an event study is estimated for the euro area or the US. The Newey-West standard error is presented in parentheses. Data period is between $2000 - 2017$. Column 'Z-test' gives the test statistic under the null hypothesis that the two coefficients are identical.

Dependent variable:	Excess Return, %		Z-test
	The ECB MPD	**The FOMC**	
$Excess\ Return_{t|MPD} = a + b_1 * CMPS_{t|MPD}^{PLUS} + b_2 * CMPS_{t|MPD}^{MINUS} + c_1 * UMPS_{t|MPD}^{PLUS} + c_2 * UMPS_{t|MPD}^{MINUS} + d_1 * US_{t|MPD}^{PLUS} + d_2 * US_{t|MPD}^{MINUS} + \varepsilon_{t|MPD}$			
a	-0.216*	-0.315***	
S.E. (a)	(0.122)	(0.113)	
b_1	5.209	-2.162	1.664
S.E. (b_1)	(4.098)	(1.680)	
b_2	-2.634***	-4.628**	0.883
S.E. (b_2)	(0.637)	(2.166)	
c_1	-3.450**	4.279*	-2.792
S.E. (c_1)	(1.519)	(2.314)	
c_2	-2.784**	-4.027**	0.542
S.E. (c_2)	(1.300)	(1.891)	
d_1	-0.222***	-0.137***	-1.702
S.E. (d_1)	(0.042)	(0.027)	
d_2	-0.183***	-0.136***	-1.812
S.E. (d_2)	(0.023)	(0.012)	
Adjusted R-squared	0.62	0.63	
N (days)	229	144	

The result of the Z-test shows the reaction to the positive conventional shocks is different in the euro area while comparing to the US. However, the coefficient is not significant neither for the euro area nor the US. At the same time, positive unconventional and both positive and negative uncertainty shocks are statistically different and also statistically significant for the euro area and the US.

Finally, the summary of the total effects, measured as the average shock (Table 7) multiplied by the reaction to it (Table 8), are presented in Table 9. By construction, the sum of the total effects is also equal to the average excess returns presented in Table 1. The most significant difference between the total effects could be observed for the positive uncertainty shock. It implies that the euro area excess return during the ECB MPD days is lower by 0.237% (99% confidence interval) in comparison to the US excess return during the FOMC, which is due to the different average level and reactions to the positive uncertainty shock. At the same time, the difference between the excess return during the ECB MPD and the FOMC days could be attributed to the difference in the total effects for the positive unconventional monetary policy shock (99% confidence interval). In particular, due to the different reaction and the average level of the positive unconventional monetary policy shock, the euro area excess return during the ECB MPD days is 0.176% lower than the US excess return during the FOMC announcements. Besides that, the effect of other shocks is lower. The difference between the excess return during the ECB MPD and the FOMC days could also be associated with the different reaction to the negative unconventional monetary policy shock -0.073% (the average shock level itself in the euro area is not statistically different from the one in the US, Table 7). Different reactions to the positive conventional monetary policy shock -0.016% (the average shock level the euro area is also not statistically different from the one in the US, Table 7) and the average level of the positive uncertainty shock – 0.025. Since the positive conventional shock is not statistically different from zero, we cannot argue that the excess return during the ECB MPD and the FOMC days could also be associated with the difference in the reaction or level of the positive conventional monetary policy shock.

Table 9: Total effects of the asymmetrical shocks on excess returns

In this table, the total effect of the shocks is presented. Mean excess return is from Table 1. The total effect is calculated as the regression coefficient for the shock from Table 6 (if statistically different from zero) multiplied by the average shock value from Appendix A, Table A4. Column 'sum' presents the sum of all the total effects. All values are in percent.

	Mean Excess Return (SUM)	Intercept	CMPS^PLUS	CMPS^MINUS	UMPS^PLUS	UMPS^MINUS	US^PLUS	US^MINUS
ECB MPD	-0.043	-0.218	0.042	0.026	-0.065	0.056	-0.411	0.525
FOMC	0.322	-0.316	-0.022	0.042	0.111	0.129	-0.174	0.55
Difference	-0.365	0.098	0.064	-0.016	-0.176	-0.073	-0.237	-0.025
Welch's test			7.812	-1.211	-8.582	-3.614	-3.65	-0.227

7. Discussion

The number of studies demonstrated that the FOMC monetary policy announcement days are associated with high stock returns (Lucca & Moench, 2015; Savor & Wilson, 2013; Cieslak et.al., 2016). In this study, we found that absence of high excess returns during the ECB MPD days is associated both with different *magnitude of uncertainty shock* and the *different reaction to monetary policy and uncertainty shocks*.

Between 2000-2017, excess returns were 31 basis points higher during the FOMC days in comparison to any other days of the year. During the ECB MPD days excess return was not statistically different from the one in all the other days. This is in line with findings of Brusa et.al. (2016). They pointed out four possible explanations of this evidence (Brusa et.al., 2016). In particular, that: 1) domestic economy more depends on foreign markets; 2) the central bank does not pursue an active monetary policy; 3) the central bank pursues an active monetary policy, but monetary policy decisions are widely anticipated; 4) stock market experiences high excess returns during FOMC because of unique Fed's role in setting the global price of money. However, the authors conclude that none of these explanations seems reasonable in the case of the euro area.

In our study monetary policy shocks represent unexpected monetary easing or tightening. We showed that both conventional and unconventional monetary policy shocks during the ECB MPD and the FOMC are not different from the ones in all the other days. It seems that both in the euro area and the US, the central bank's monetary policy is highly anticipated by market participants. Moreover, the average conventional and unconventional monetary policy shocks are not statistically different in the euro area compare to the US. This result rules out that the Fed monetary policy was more accommodating compared to the ECB. Thus, it is unlikely that high excess returns during the FOMC days in the US result from more unexpectedly aggressive monetary policy, as it was suggested by Cieslak et.al. (2016).

Uncertainty shock represents a risk-neutral measure of uncertainty. During the ECB MPD and the FOMC days markets experience statistically significant negative uncertainty shocks. Uncertainty is statistically lower during monetary policy announcement days both in the euro area and the US. This is similar to the findings of Nikkinen & Sahlström (2004) and Chen & Clements (2007). They found that implied volatility in the US declines after monetary announcements. Chang & Feunou (2013) showed that uncertainty declines after the Bank of Canada's policy rate announcements. Our results show that on average uncertainty shock is statistically lower during the FOMC days in comparison to the ECB MPD days. While distinguishing between positive and negative uncertainty shocks, we found that on average both positive and negative uncertainty shocks are lower in the US during monetary policy announcements. Changes in uncertainty are closely related to changes in central bank announcement's tone (Schmeling & Wagner, 2016). This means that the central bank's tone and information policy plays important role in the underliyng uncertainty shocks.

Bernanke & Kuttner (2005) suggested that excess returns could be affected by changes in the riskiness of the stock market or the attitude toward risk. Kroencke et.al. (2017) showed that changes in 'risk appetite' shock (which is significantly related to uncertainty) lead to a reallocation of funds between bond and stock markets. Increase in uncertainty leads to funds flow from risky assets to risk-free (or less risky) assets. Given the fact, that uncertainty shocks are on average negative in the US and are lower than in the euro area during monetary policy announcements, it implies that there is a larger reallocation of funds in the US during FOMC days. This further could explain high excess returns during FOMC days in the US as well as the difference between the US and the euro area.

The difference in excess returns during monetary policy announcement days could come from the different reactions to the same shock levels. In our analysis, we do not check for causality between shocks and excess returns. However, previous studies showed that (Granger) causality goes from conventional and unconventional monetary policy surprises to stock prices (Khan, Qingyang & Khurshid, 2017).

Furthermore, Dufour, Garcia & Taamouti (2011) found that changes in uncertainty (implied volatility) leads to changes in stock returns, not vice versa.

The reactions to the monetary policy and uncertainty shocks are different for the US and the euro area. Firstly, positive unconventional monetary policy shocks are associated with opposite reactions in the euro area and the US. Secondly, uncertainty shocks are associated with a much more aggressive reaction in the euro area. Why the difference in the coefficients exist? One of the possible explanations lies in the thesis limitations. Unconventional monetary policy surprises are measured differently for the euro area and the US (change in yield spread between Germany and Italy and daily yields change). While the increase in yield spread is negative news, increase in yield for the US could mean either monetary tightening or expectation of economic recovery. Moreover, the difference may come from variables selection. We use "value-weight return of all CRSP firms incorporated in the US and listed on the NYSE, AMEX, or NASDAQ" (Kenneth, n.a.) for the US and EURO STOXX 50 index for the euro area. The first one better represents the stock market, while the last one incorporates only blue-chip companies. Another reason could come from the fact that the reaction to unconventional monetary policy surprises is different in crisis and non-crisis times (Gregoriou et.al., 2009). In our sample, the euro area faced with the sovereign debt crisis which was not as important in the US. Lastly, the reaction could be different because of different economic structures, different sensitivities to the shocks. Overall, the difference in the reaction to the shocks requires additional investigation and further analysis.

The difference in average shock levels and the reaction to these shocks could compensate the total effect. Thus, we calculated the total effect for each shock. The biggest statistically significant difference in excess returns is caused by the difference in total effect for positive uncertainty shock and positive unconventional monetary policy shock. The difference in the total effect for positive uncertainty shock results from the average shock level being more negative in the US. It means that the ability of central bank's announcements to decrease market uncertainty plays the major role in explaining the difference between excess returns during FOMC and ECB MPD days. On average it implies the excess return during FOMC

days to be higher by 23.7 b.p. compare to ECB MPD days. The total effect of positive unconventional shock causes the difference in 17.6 b.p. between excess returns during FOMC and ECB MPD days. It is driven by the different reaction to the shock (since the average shock levels are not statistically different). The difference in reaction requires additional tests to discover whether it comes from the different economic structure, different sensitivities to the shock or study limitations.

8. Conclusion

In the paper, we investigate why there is high excess return during the FOMC days, but not during the ECB MPD dates. In particular, we look at whether the difference in the reaction to the monetary policy announcement days could be explained by the different average levels of shocks (conventional, unconventional and uncertainty) during these days in the euro area and the US. Alternatively, we check whether it could be explained by the different reaction to the shock of the same level in the euro area and the US. These shocks represent unexpected easing or tightening monetary policy and how central bank's announcements move market expectations about uncertainty and risk aversion.

The most prominent part of the difference in excess returns during the FOMC in the US and the euro area during the ECB monetary policy announcement days could be attributed to the positive uncertainty shock, which means negative news. According to the recent studies, it could mean that the tone of the ECB or its information signals were on average more negative compared to the Fed.

At the same time, we rule out that the difference in the excess returns caused by more accommodating monetary policy in the US compare to the euro area, as it was suggested in previous studies. Indeed, the monetary policy of both the Fed and the ECB was well anticipated by the market, and surprising component in the euro area is not statistically different from the one in the US.

The reaction to the monetary policy and uncertainty shocks is different in the euro area and the US. This difference in response partially compensates for the difference in uncertainty shock levels, but not for the unconventional monetary policy shock. Further analysis of why there is a difference in the reaction to the shocks is required.

Overall, the results of the thesis show that the difference in the reaction to the monetary policy announcement days could be explained by both the more positive shocks (negative news) during the ECB MPD days and more negative reaction to them. We found that the main difference in excess returns comes from

the ability of central banks to move down uncertainty and not from more aggressive monetary easing.

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Appendices

Appendix A – Correlation Matrixes

Appendix B – Preliminary Thesis

Appendix A – Correlation Matrixes

Table A1: Correlation matrix of Excess Return and shocks during ECB monetary policy days

	Excess Return	CMPS	UMPS	US
Excess Return	1	-0.086	-0.348	-0.777
CMPS	-0.086	1	0.0004	0.057
UMPS	-0.348	0.0004	1	0.269
US	-0.777	0.057	0.269	1

Table A2: Correlation matrix Excess Return and Shocks during FOMC monetary policy days

	Excess Return	CMPS	UMPS	US
Excess Return	1	-0.134	0.001	-0.774
CMPS	-0.134	1	0.11	0.032
UMPS	0.001	0.11	1	-0.093
US	-0.774	0.032	-0.093	1

Table A3: Correlation matrix of the shocks and excess return during the non-monetary policy days in the euro area

	Excess Return	CMPS	UMPS	US
Excess Return	1	0.031	-0.350	-0.739
CMPS	0.031	1	-0.016	-0.037
UMPS	-0.350	-0.016	1	0.306
US	-0.739	-0.037	0.306	1

Table A4: Correlation matrix of the shocks and excess return during the non-monetary policy days in the US

	Excess Return	CMPS	UMPS	US
Excess Return	1	0.034	0.412	-0.721
CMPS	0.034	1	0.047	-0.016
UMPS	0.412	0.047	1	-0.320
US	-0.721	-0.016	-0.320	1

Table A5: Correlation matrix of the asymmetrical shocks during the ECB monetary policy days

	Excess Return	CMPS^PLUS	CMPS^MINUS	UMPS^PLUS	UMPS^MINUS	US^PLUS	US^MINUS
Excess Return	1	0.014	-0.275	-0.156	-0.104	-0.595	-0.603
CMPS^PLUS	0.014	1	0.173	-0.039	0.041	0.107	-0.025
CMPS^MINUS	-0.275	0.173	1	-0.011	0.184	0.02	0.075
UMPS^PLUS	-0.156	-0.039	-0.011	1	0.177	0.199	0.054
UMPS^MINUS	-0.104	0.041	0.184	0.177	1	0.041	0.094
US^PLUS	-0.595	0.107	0.02	0.199	0.041	1	0.392
US^MINUS	-0.603	-0.025	0.075	0.054	0.094	0.392	1

Table A6: Correlation matrix of the asymmetrical shocks during the FOMC days

	Excess Return	CMPS^PLUS	CMPS^MINUS	UMPS^PLUS	UMPS^MINUS	US^PLUS	US^MINUS
Excess Return	1	0.0	-0.21	0.114	-0.081	-0.506	-0.72
CMPS^PLUS	0.0	1	0.092	0.132	-0.008	-0.046	-0.058
CMPS^MINUS	-0.21	0.092	1	-0.105	0.073	0.058	0.125
UMPS^PLUS	0.114	0.132	0.105	1	0.367	-0.047	-0.073
UMPS^MINUS	-0.081	-0.008	0.073	0.367	1	-0.132	-0.028
US^PLUS	-0.506	-0.046	0.058	-0.047	-0.132	1	0.329
US^MINUS	-0.72	-0.058	0.125	-0.073	-0.028	0.329	1

Appendix B – Preliminary Thesis

BI Norwegian Business School - campus Oslo

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Master Thesis

Component of continuous assessment: Forprosjekt, Thesis MSc

Preliminary Thesis

Navn:	Oleh Korop, Nikita Kotelnikov

Start: 01.01.2018 09.00

Finish: 15.01.2018 12.00

BI NORWEGIAN BUSINESS SCHOOL

How does equity premium affected by the monetary news announcements across different countries?

BI

Authors:
Oleh Korop
Nikita Kotelnikov

Supervisor:
Costas Xiouros

A Preliminary thesis is submitted in fulfillment of the requirements
for the degree of Master in Finance

January 14, 2018

Table of Contents

Abstract

This study examines the pattern of the market behaviour and its returns on the respective central bank scheduled meetings, including such countries as United States, Norway, Japan, and also the Eurozone as the main areas of concentration.

The hypothesis states that there is a strong influence on the market by the central bank's monetary policy announcement, once the information is released. In particular, we will concentrate on the equity premium behaviour, during central banks' announcements and will conduct a research on the exact patterns that can arise, based our hypothesis on Cieslak's et. al. (2016) findings.

1 Introduction

Numerous literatures that had been published for the past few decades stated the importance of the central banks and their influence on the stock market in its own jurisdictions (Rigobon & Sack, 2003; Lucca & Moench, 2015). Interestingly, some countries' central banks have a further influence not only on their own stock performance, but also on the performance of other countries' stocks.

This could possibly be explained by the recent globalization movement, where countries become more interconnected and interdependent on each other. Furthermore, in the case of the United States, being one of the biggest and most influential economies in the world, its central bank, known as Federal Reserve, has a great influence not only on the US market itself, but also on many foreign markets, including Germany, France, Switzerland and Spain (Cieslak, 2016).

This paper is triggered by the findings of Cieslak et. al. (2016) and Lucca & Moench (2012), who found that there is a pattern of the US market return with relation to the Federal Open Market Committee (FOMC) releases. The aim of this paper is to observe effects shown by Cieslak et. al. (2016) and further conduct a similar study for the Norwegian, Japan, and Eurozone's central banks respectively.

To the author's knowledge, no comparable study was ever conducted for these countries, thus making the paper original.

The remaining four chapters of this paper are structured as follows. In chapter 2, the literature review will be presented. In chapter 3, design and methodology of the diploma will be reviewed. In chapter 4, further project management of the thesis will be established.

2 Literature Review

Today, we observe a boom in the stock market, which last time was seen before the housing crisis in 2008. Stock is inexplicably outperforming most of the other asset classes, including fixed income, cash, and real estates. Thus, in 1978 Robert Lucas in his paper "Asset Prices in an Exchange Economy" raised a question of the magnitude of the equity premium. This equity premium model was developed by Mehra and Prescott, showing that with a reasonable risk aversions, true equity premium should be much lower than in reality (Mehra&Prescott, 1982; Mehra&Prescott, 1985). The equity premium, also known as risk premium, is a difference between the return on the stock and the risk-free rate (Mehra&Prescott, 2008). This inability of explaining an excess return on stocks, known as the *equity puzzle*, has confounded many researchers for several decades (Mehra&Prescott, 2008).

The aim of this paper is to partially explain the equity premium puzzle by looking at the influence of central banks on the stock markets.

2.1 Pre – Announcement drift

The role of the central bank in the United States is taken by Federal Reserve. The part of the Federal Reserve, which is responsible for determining "discount rates and reserve requirements" is called Federal Open Market Committee (FOMC) (Federal Reserve, n.d.). Antulio Bomfim, taking the United States as an example, performed early research on pre-announcement drifts of the central banks. The paper documents an evidence of the "quiet – before – the – storm" effect on the days before an FOMC announcement. In particular, it states that conditional volatility tends to be lower on the days before FOMC announcements – the "quiet" part, and then sharply increases on the day of the announcement – "the storm" part (Jones et. al., 1998; Bomfim, 2003; Li & Engle 1998).

Andersson further conducted a study of market volume and volatility reactions in the United States and the European Union, after "respective economies' monetary decisions" had been announced to the public. Even though a significant intraday volatility rise had been identified for both parties, US financial market has much stronger impact (Andersson, 2007). Some of the explanations for this finding will be presented below.

First, as Andersson (2007) point out, possibly "more" information becomes available when FOMC releases its statements, in comparison to European Central Bank. Thus, the tone of the Federal fund may play a great role and influence the market, even though investors might predict the actual decision and the direction of the FOMC (Andersson, 2007). Cieslak (2016) further states that the Fed uses the announcement not only as a way of communicating with investors, but FOMC is also engaged in an informal communication, which gives more flexibility for the authorities, while adding an extra channel of communication for Fed fund.

Further, Fleming and Piazzesi (2005) proposed another reason for the magnitude of the volume and volatility, related to the time of the announcement. Thus, while ECB has a set time when it announces its monetary policy decision, which is exactly at 13:45 ECT, FOMC time fluctuates. From September 1994 to March 2011, FOMC statements were regularly released at or after 14:15 (Lucca & Moench, 2015).[1] From April 2011 to present, the release time varied between 12:30 and 14:00. Thus, Fleming and Piazzesi (2005) identified that if the announcement is released minutes after 13:15, liquidity tends to be lower, and the more time passes the higher liquidity would be on aggregate (Fleming & Piazzesi, 2005).

The third reason relates to the argument that United States is perceived to be a main economic driving force in the world, which implies that the Fed releases not only affect the US market, but also impacts other markets, including that of the European Union (Andersson et.al., 2006).

Finally, an increase in volume can be connected to the variety of opinions among traders in the US (Harris & Raviv, 1993). Gropp and Kadareja (2006) further proved the theory aligned with this reasoning, showing that if the information is "poorly aligned due to stale publicly available information, the impact on volatility of an unanticipated stock is larger than if the publicly available information is fresh".

2.2 Lucca and Moench study

In a more recent study, related to central banks' announcements, Lucca & Moench (2012), in its paper "The Pre-FOMC Announcement Drift" conclude that

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[1]   The only exception was on March 26, 1996, when FOMC released its statement in the morning, due to the fact that Alan Greenspan, the Chairman of Fed fund, had to testify later that day.

between 1980 and 2011 roughly a half of the realized excess return had been earned during the pre-FOMC announcements, while within 24 hours before the FOMC meeting, the return of S&P 500 on average was 49 basis points. In contrast, average return on S&P 500 between the announcements until market closes is not significantly different from zero (Lucca & Moench, 2012). The paper further documents that the returns tend to be higher when the slope of Treasury yield curve is lower (Lucca & Moench, 2015). The researchers show that holding an S&P 500 portfolio within 24 hours before the announcement leads to an annualized Sharp ratio of 1.14, which is statistically significant (Lucca & Moench, 2015).

Besides that, Lucca found a similar "quiet – before – the – storm" effect, when the volatility and liquidity of stocks is lower *on* the pre-FOMC meeting and spikes right *after* the announcement.

Finally, the paper found similar patterns of index behavior of other developed countries after FOMC announcement. Thus, the German DAX, the British FTSE 100, the French CAC 40, the Spanish IBEX, as well as the Swiss SMI all show an excess return earned, with Swiss' IBEX earning the least a 29 basis point on average and French's CAC 40 earning the most – 52 basis points on average.

With regards to explaining pre-announcement drift, several reasons have been identified.

First is the risk-based explanation, since a lot of information with regards to non-diversifiable and political risks are released and FOMC's opinion about the future state of the economy is announced (Pástor & Veronesi, 2013). Due to the fact that extra risk is buried before the announcement, investors demand a higher return. However, it is difficult to explain why exactly the return is earned 24 hours *before* the announcement and not *at* the time when FOMC makes an announcement.

Another explanation, which has a stronger support among researches was proposed by Duffie (2010). He argues that there are two types of investors – inattentive and specialists. Thus, inattentive investors, due to its inexperience and fear that professional investors are better informed, are unwilling to hold a position before the FOMC makes a statement. This situation, in return, creates fewer participants on the market who have to bury the risk. The participants, specialists, are not willing to take this risk unless they are compensated for it, which leads to pre – announcement drift.

2.3 Cieslak's study

The most recent study made by Cieslak et. al. (2016) found an unusual pattern in the stock behavior. Thus, the author argues that equity premium in the US, starting from 1994 until 2015, was earned entirely in weeks 0, 2, 4 and 6 in FOMC cycle time (Cieslak et. al., 2016). Only 531 even-week Fed put days since 1994 are responsible for 157 percentage points out of a total 191 percentage points of cumulative log stock returns (Cieslak et. al., 2016). Further, Cieslak demonstrates that one dollar invested in 1994 would give a return of only \$1.40 without these 531 days, versus \$6.75 when these days are included.

Finally, similar pattern of persistent announcement effect for the fixed income around macroeconomic releases, such as labor market and inflation rate had been observed (Jones et. al, 1998). However, the paper will not concentrate on this aspect since this paper is concerned with the stock market, rather than fixed incomes.

Overall, this paper is aiming to check Cieslak's results using the latest data for the US market, as well as to find patterns for other markets, including Eurozone, Norway and Japan, with a further aim to discover new regularities.

The remaining part of the literature review will concentrate on four hypotheses, which this paper examines.

2.4 Research hypothesizes

In this Master Thesis the author's aim is to answer on the question how does equity premium affected by the monetary news announcements across different countries? In order to do that the next hypothesis will be tested.

1. Monetary news announcement is a significant factor explaining equity premium over long run.

2. Monetary news announcement in an economically strong country is a significant factor explaining equity premium in a less economically strong country over long run (international effect).

3. There are unofficial information channels which leads to equity premium patterns during the announcement cycle.

4. The tone of an announcement moves market expectations.

3 Design and Methods

3.1 Methodology and data collection

3.1.1 Research strategy

The research is oriented to find empirical links between monetary news announcements and market performance. Thus, to test the hypotheses mainly quantitative methods will be used to accept or reject them based on the data.

In order to check the influence of monetary news announcements on equity premium across different countries, the data for monetary policy meetings and announcements, risk-free rates, exchange rates and market proxies will be gathered. This is the first step in the research methodology.

The second step is graphical observation of possible patterns of market premium during the monetary announcements cycle. Cieslak's model, for example, is based on bi-weekly pattern around FOMC announcements. In Eurozone, Norway and other countries, due to local specifics, there could be different regularities or their absence. In order to explore them in this stage the data will be visualized in order to make suggestions of possible regularities.

During third stage, based on graphical observation, regression models and statistical tests will be used to check our hypotheses and get evidence of monetary policy effects on equity premium.

Finally, conclusions and suggestions for further research will be made.

3.1.2 Data collection

In order to produce quality research, the data for monetary policy announcements, risk-free rates and market proxies needs to be collected. Simultaneously, the data will be gathered for several countries.

With regards to monetary news announcements, the data will be obtained from central banks' official websites. However, solely using central banks' website can create a limitation in the data points available. Thus, further research will be made in order to identify other reliable sources to extract information from.

Moreover, the aim is to collect the text of this news, with a further analysis of the announcements. Due to the fact that this kind of data is unstructured, Python code will be written for collecting and processing the data. Generally, each source of

information is unique, and the way to collect the data will be purposefully developed for this source. Thus, due to its fundamentality, the process may be time –consuming, yet absolutely essential for the study.

Collected monetary news announcements includes both scheduled and unscheduled ones. Therefore, it is important to notice that all the unscheduled meetings will be erased from the data, since the prime interest of this study lies in observing the reaction of the market on the anticipated central banks meetings only.

When it comes to the market indexes, collecting data will not be an issue. For example, STOXX index history will be obtained from the official website (Table 1). This information could also be found on Bloomberg or Thomson Reuters. Furthermore, authors believe that several indices should be analysed for testing the hypothesis, in order to accurately asses the results.

With regards to risk-free rates, generally accepted views in research area will be used. Thus, yields on US Treasury Bills, yields for government bonds with triple A rating for Eurozone provided by ECB 3 months to maturity, Norway Treasury Bills 3 months to maturity, yields on Japan governmental bonds 3 months to maturity are considered the primary risk – free rates.

	US	Eurozone	Japan	Norway
Monetary news	Federal Open Market Committee	European Central Bank website	Bank of Japan website	Norges Bank website
Market proxies	Ken French's website	STOXX Japan 600	EURO STOXX	STOXX Norway Total Market
Risk –free rate	Ken French's website	European Central Bank website	BOJ Time Series Data search	Norges Bank website

Table 1: Data Sources

3.1.3 Data preparation

After collecting raw information, the data should be prepared and organized into one database. Unification using the same market conventions for risk-free rate and market indices will have to be performed. Moreover, a series of boolean variables for monetary announcements, such as for days and weeks cycles will have to be developed. For this purpose, the application in Python will be created, in order to create multiple variables for monetary news from raw data.

During the data preparation, there is one important point already mentioned in the literature review that is relevant to measure international effects: FOMC, ECB, Norges Bank and Bank of Japan have a different approach concerning the exact time when the announcement will be made.

For example European Central Bank has a set time – 13:45 – when it makes its announcement. However, Federal Open Market Committee had been varying its announcement time. Between September 1994 and May 1999 statements were released only if the change the interest rate had been changed. From April 1999 until March 2011, all the statements of FOMC had been released, at or after 14:15 on the day of the meeting. From April 2011, the announcement occurred between 12:30 and 14:00, "while the press conference by the FOMC Chairman is held at 14:15" (Lucca & Moench, 2012, p.5).

This information is important for the study, since when the pre – announcement effects are observed, 24 hours window has to be taken, which should lie outside of the announcement time. This leads to the conclusion that for ECB the window will start at 13:30 the day before the announcement and will end at 13:30 on the day of the announcement.

In comparison, for the United States market, the window between 14:00 on the day before the announcement and 14:00 on the day of the announcement will be taken, in order to make sure that the FOMC statement will fall outside the pre - announcement window.

Bank of Japan has meetings during two consequent days from the 14:00 till 16:00 of the first day and from the 9:00 till 11:45 the following day. At the same time Norges Bank meets typically at 10:00, local time.

These local nuances will be used to create the variables and measure effects properly.

3.1.4 Data analysis

In order to check the hypothesizes mentioned earlier, statistical analysis to the collected data is required.

As a main model, linear regression with boolean variables for monetary announcements and monetary announcement's cycles indicator will be used to check for the first and second hypothesizes.

$$MP_i = \alpha + \beta * MNA_i$$

where:

MP_i - market premium

MNA_i - monetary news announcement at day i (1 or 0)

To check the third hypothesis, graphical observation of possible regularities in equity premium around monetary announcements will be conducted with a further development of the model to explain these patterns.

For the last hypothesis, semantic analysis of monetary announcements will be conducted and time series of central bank's tone by counting the number of positive, negative and neutral words, describing their decisions will be build. Furthermore, 'central bank's tone time series' will be build and analysed. After that, multinomial linear regression and vector autoregressive (VAR) models will be used to find the answer for the last hypothesis.

$$MP_i = \alpha + \beta * CBA_{i-1} + \gamma * MP_{i-1}$$
$$CBA_i = \alpha + \beta * CBA_{i-1} + \gamma * MP_{i-1}$$

where:

MP_i - market premium

CBA_i - monetary news announcement's tone at day i

The last point in the analysis will be economic significance analysis. Here building trading strategy will be established, based on the models and test their profitability, comparing with appropriate benchmark. Significant overperformance of benchmark index will be sign of high economic importance for this paper.

3.1.5 Other considerations

3.1.5.1 Sub-sample robustness
To check the robustness of the results data will be split into several subsamples and the results of model based on different time horizons will be compared. Robust results should be persistent independently of sub-sample.

3.1.5.2 Sub-sample robustness

In order to avoid misspecification of variables several market proxies and several alternatives for risk-free rate will be used.

3.1.5.3 Reliability

All the data used in this paper had been retrieved from the reliable sources, thus 1) all the central banks meetings had been taken from the official websites, 2) US market premium and STOXX indices are taken from Kenneth French's website, Bloomberg or official STOXX indices' website. Data for risk free rate could be found on appropriate central bank's web-page.

Furthermore, in order to keep a high standard and reliability of the paper, numerous statistical checks, including, but not limited to robustness, autocorrelation and heteroskedasticity, will be performed once the model is built.

4 Project Management

In order to insure timely delivery of a high-quality paper, further development of this thesis will have the following path, consisting of four parts. (Figure 1)

First phase is a thorough and complete research and reading of all the material available regarding this topic. By completing this stage, minor changes regarding the hypothesis can take place, since new discoveries can be made. Furthermore, a complete and final draft of a literature review will be made at that time. Expected period of completing phase one is eight weeks.

Second phase consists of collecting the data and completing numerous regressions, described in design and methods section. Five weeks is an adequate amount for completing this stage, before moving to the next step.

The third phase is a milestone of this paper, where empirical findings and results will be presented. Due to the fact that this part has to be carefully crafted, at least six weeks' time is a reasonable amount of time for completing this part.

Finally, in the *fourth phase* the paper will be polished, in order to have high research standards, established by BI Norwegian Business School.

Thus, the final draft of the thesis is planned to be delivered by the middle of the summer.
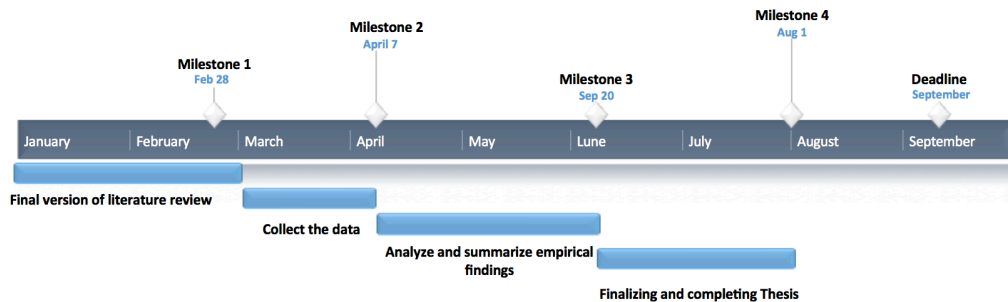

Figure 1: Further progress of the paper

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