ABSTRACT

Studying and identifying the impact of the macroeconomic news on the uncertainty, measured by the implied volatility index behavior in the European financial market, is the main goal of this study. The macroeconomic variables are regarded in this study are consumer price index CPI, the gross domestic product GDP, employment reports EMP, monetary policy MP, labor cost LC, and the current account for the Eurozone CA. In this study, I employ various statistical approaches to understand to what extent the uncertainty is resolved due to the macroeconomic news, namely, dummy OLS regression, GARCH (1,1), GARCH-M (1,1), and EGARCH (1,1). The reported findings uncover that only the monetary policy has a significant impact on the implied volatility index, thus, the uncertainty associated with this indicator is resolved during the announcement days. The results confirm also that the investors in the Eurozone financial market consider more than one macroeconomic variable as the viable source for the information, as the joint effect for each of CPI, GDP, LC, and MP is statically different from zero. Further, the uncertainty significantly increases prior to the CPI announcements and resolved during MP announcements.

Keywords: Macroeconomic announcements, implied volatility index VSTOXX, Dummy OLS regression, uncertainty.
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1. Introduction

The process or mechanism by which the security prices are updated due to arriving new information has been extensively researched in the finance literature over the past three decades (Smales et al., 2015, p. 710; David & Chaudary, 2000, p. 109). There seems to be approximately semi consensus, that the expected returns are always affected by the economic fluctuations and real activity in the future course, which clearly appear via the anxiety or optimism sentiment of the market participants. Acquiring good knowledge will, therefore, allow us to provide plausible explanations for the expected return changes across time. Further, the rising interest around the accurate forecasting of volatility and its importance basically comes from its critical role in asset pricing models, risk management, financial derivatives, and hedging ratios (Rai et al., 2021, p. 2; Fuss et al, 2011, p. 1571).

The mounting evidence that reveals whether the financial market is well function or not, is basically depending on the process by which they react to the new information and incorporate it into their prices. The rational foundation for this, is the accuracy and speed of the information processing, in general, is the best practical expression for the well function of the market or the effectiveness of this market in response to the new information. Given that the efficient market hypothesis implies that only the unexpected part of the information has a significant impact on the market, but the expected component should have no effect (Smales et al., 2015, p. 710).

The macroeconomic announcements are regarded as one of the most relevant sources of information in the financial markets. Its importance is clear from its close relation to sound financial planning and accurate evaluations for the available investment choices (Alexiou, 2018, p. 68; Ederington & Lee, 1993, p. 1161). These announcements yield accurate signs of policy changes in the upcoming short term, which allow investors to effectively updating for their investments in a way that enhances their profit chances and avoids further exposure to the risk (Frijns et al, 2015, p. 35). For these reasons, these announcements are closely observed by the investors due to their great impact on their financial decisions (Rai et al., 2021, p. 2; Srividya & Susana, 2019, p.322; Nikkinen & Sahlström, 2001, p. 129). However, despite the dates of macroeconomic indicator’s news are already known by the public, but their content is unknown which gives rise to a case of uncertainty and anxiety during the surrounding days of these announcements (Nikkinen & Sahlström, 2001, p. 130).
In the finance literature, there has been a sizable body of studies that investigated the impact of macroeconomic announcements on the financial markets, mainly in terms of volatility and return (Cai et al., 2020, p. 1927-1928; Frijns, 2015, p. 35; Onan et al., 2014, p. 455). However, the empirical evidence regarding the reaction of the financial variables i.e., stock prices to the macroeconomic announcements is still unclear and conflicting somewhat, this clearly appears in terms of the volatility and returns (Chen & Clements, 2007, P. 227). For instance, Schwert (1981, p.27-28) concludes that there is little evidence to support that the market reacts largely to unexpected inflation. He argues that one possible explanation for this result is that may there is leakage of information that may occur in the days prior to the announcements, which rule out the surprise element in this announcement. Hence, for this reason, the market reacts weakly to this information. Similarly, Pearce and Roley (1985, p. 66) document that non-monetary announcements such as real economic activity, has little impact on the stock price movements, whereas monetary announcements have a strong impact on the stock price reactions.

Further, the reported findings indicate also that there is some evidence supporting the claim, that expected announcements have no impact on the stock price movements. The candidate explanation for this outcome strongly aligns with the reasoning, that accurate forecasting reduces the impact of new information, therefore, there is no need to adjust the stock prices to the upcoming information. By the same token, (Hardouvelis, 1987, p. 132; Jones et al, 2005, p. 358) clarifies that there is little evidence in the literature support the impact of macroeconomic announcements on the stock price changes. The overall message confirms that the effect of this news is ambiguous particularly when decompose the macroeconomic announcements into monetary news and non-monetary news. In the same line, Backer et al., (1996, p. 145) document that the market tends to react slowly in response to the news about trade balance, whereas regarding other macroeconomic news such as CPI shocks the market appears to be insensitive originally.

On the other hand, Fleming and Remolona (1999, p. 1914) confirm that once the scheduled announcements are realized the price reacts quickly as well as the trading volume decrease. This implies that the impact of public information does not require actual trade. In the same line, David and Chaudhry (2000, p. 124) show that reported result indicates that the macroeconomic information has a significant impact on the future currency markets. In the same fashion Nikkinen and Sahlström (2004, p. 210) conclude that the US news such as employment report has a great impact on the uncertainty on the Finish and Germany stock
markets, in contrast, the domestic news has no impact on the uncertainty. Recently, Hussain and Ben Omrane (2021, p. 6) provide new light by confirming that macroeconomic news plays an important role in both the return and volatility of the Canadian equity market. In the same line, Cai et al., (2020, p. 1951) demonstrated that the unexpected part of US macroeconomic announcements exerts a significant impact on the future Chinese markets.

Together with before, Rai et al., (2021, p. 16) suggest that the efficient transparency of policymakers implies reducing the sensitivity of the financial market to scheduled macroeconomic news. As an illustration, there are two possible explanations for this point view, the first one is that the effective transparency of macroeconomic policy gives rise to accurate forecasting, therefore, the information conveyed by the macroeconomic announcements does not contain any surprise leads to a sharp reaction of financial markets. This means the financial markets become less sensitive to the scheduled macroeconomic announcements. The second explanation, which has the same reasoning, suggests that market sensitivity to any new announcements is extremely affected by unexpected components of these announcements, which are mitigated as transparency becomes more efficient. It worth mentions that this view of the point adopted the same theoretical motivation of efficient market hypothesis and assets pricing theory (Tamgac, 2021, p. 2).

Grounding on the above discussion, there is no clear consensus about the impact of macroeconomic announcements on the equity markets, in terms of volatility and return. Hence, such mixed empirical results give rise to motivate a lot of empirical studies to investigate the impact of macroeconomic announcements on the uncertainty in the hope to provide new evidence to the ongoing debate.

Lately, the implied volatility VIX, which is extracted from the options prices, has raised the eyebrow too many researchers, and it becomes the subject of keen interest for investors, portfolio managers, risk managers, and academics alike. Implied volatility is seen as best expecting for the volatility of underlying assets during the remaining life of the option. Due to the fact, that implied volatility is considered forward-looking by nature, whereas historical volatility is considered backward-looking. Hence, information consumed by implied volatility VIX is considered wider and richer in comparison to historical volatility (Pati et al., 2018, p. 2552; Dumas et al., 1998, p. 2060). As a rough generalization, the implied volatility index
(VIX) is broadly viewed as the best proxy for the realized volatility. Albeit the empirical evidence indicate that its predictive power is mixed somewhat (Simon, 2002, p.960).

Following with the practice of (Srividya & Susana, 2019, p. 33; Shaikh & Padhi, 2013, p.418; Tanha et al., 2014, p.47; Nikkinen & Sahlström, 2004, p. 202; Kearney & Lombra, 2004, p. 252; Nikkinen & Sahlström, 2001, p. 131) it is quite reasonable to utilize the implied volatility index VIX as a proxy for the uncertainty of the financial markets, which expected to change in response to arriving of new information or due to updated information about the macroeconomic circumstances in general.

The importance of this study appears basically via its various implications and expected academic contributions to the ongoing literature. To understand this, the empirical studying of the nexus between stock price movements and the macroeconomic news will show how the stock prices behave during the scheduled macroeconomic announcements (Shaikh & Padhi, 2013, p. 417). Further, the well-reporting for the sensitivity of the financial market to the macroeconomic announcements will be practically useful, as it would encourage the investors to follow sound trading behaviour. It also reveals to what extent that the financial market is well function or effective in terms of reflecting all available information (David & Chaudary, 2000, p. 110). Equally important, it will orient the policymakers to project their announcements in such a way that benefits the management of financial markets and achieve the maximum desired goals (Tamgac, 2021, p. 2).

More importantly, the literature on the relationship between macroeconomic factors and uncertainty of the financial market, for the most part, is based on the U.S economy (Jones et al., 2005, p 357). Accordingly, this study seeks to address this gap by examining the impact of the macroeconomic announcements on the uncertainty measured by the implied volatility index in the Eurozone. Hence, in this study, with sake to make our results comparable with the existing literature, I built closely on the methodology employed by (Ederington & Lee,1996, p. 520; Nikkinen & Sahlström, 2001, p. 209; Nikkinen & Sahlström, 2004, p. 209; Shaikh & Padhi, 2013, p. 425). More exactly, the Dummy OLS regression is utilized alongside GARCH (1,1); GARCH-M (1,1), and EGARCH (1,1).

The remainder of this study is organized as follows: in the next section, I review the theoretical framework and the most relevant empirical literature. Section 3 presents the used data and
describes the empirical methods to test the hypothesizes. Section 4 contains results and empirical discussion. Section 5 contains the summary of the concluded results of this study.

2. Theoretical framework and the literature review

In this section, we start by presenting the main theories and concepts that are considered the theoretical foundation for our empirical testing in such a way as to tailor the expected findings to ongoing theories. In other words, reviewing the most relevant theories and concepts that allow us to explain the expected findings.

2.1 Theoretical framework

There is sprawling literature on the relationship between security prices and information. We have only a short space to provide only the most relevant theory and concepts that are tied directly to the core subject of this study. Accordingly, we start by presenting the Efficient market hypothesis theory, then we proceed by reviewing the volatility concept and definition, and thereafter we move to present the implied volatility concept, as we will see shortly.

2.1.1 Efficient market hypothesis

It is widely believed that the country's economic performance is measured by its financial markets' ability to allocate its resources adequately via stocks as well other financial instruments. The rationale reasoning behind this is illustrated by the fact that a collapse in the financial market index is always accompanied by extensive economic disturbance, typically, induced by a sharp reduction in the household's income, drop in consumption expenditures. Further, the traders in the financial markets became more fearful and anxious about their investments, which in turn, implying a further reduction in stock issuing and the liquidity largely shrinking in the financial markets (Alamgir & Amin, 2021, p. 693).

More formally, the stock price movements and the performance of their represented index are always induced by investors updating their expectations about the expected gains and future discount rate. Since the predictive values for these elements are basically derived from the available news (Chen et al., 2013, p. 842), this indicates that the main driver for the stock price movements is the information. Consequently, the financial market is considered efficient as much as their prices reflect the available information.
Conceptually, the efficient market hypothesis (EMH) has derived its theoretical motivation based on the random walk theory. Given the random walk theory suggests that there is no feasibility to make arbitrage to earn a riskless profit (Thaker & Jitendra, 2008, p. 62). Accordingly, Fama (1970, p.383) argues that the main objective of the financial market is the efficient allocation for the holdings of real economic wealth. This means that the market is more perfect whenever its prices can give clear signs that reflect the efficient resource allocation. This fallows that, the companies can soundly invest, and the traders can accurately choose which is the best stock to invest in, accounting for the assumption, that the price in the efficient market should immediately fully reflect all the available information of the stock. Hence, the market is efficient when all the available information is entirely collapsed in their prices, in this essence, Schwartz (1970, p.421) provides another aspect to the above Fama definition for efficiency, by emphasizing that efficiency implies also that there is no monopoly control on information by traders.

Thereafter, Fama presents three versions of the efficient market, namely are: the strong form where the prices incorporate all available information containing the information that is only owned by investors; semi-strong version where prices reflect the public information; the weak version where the prices only reflect the information that is extracted from historical series for the price (Schwartz, 1970, p.421; Thaker & Jitendra, 2008, p. 62). Notably, the efficient market hypothesis (EMH) is broadly examined, and an extensive set of empirical evidence has been concluded (Narayan et al., 2015, p. 2361). Important to realize that the (EMH) requires further distinguishing between informationally efficient and operationally efficient, as the first implies rendering all available information to be fully reflected by the prices at any time of trading days. While the latter implies enabling the traders from practicing their transactions at the lowest possible costs. The driving factor behind this simply appears in the following argument, that despite the economic news are relevant and important, however, the substantial transaction costs may render the investor reaction to being worthless in comparing to its costs (Houthakker & Williamson, 1996, p. 24-25).

Furthermore, Mehla & Goyal (2012, p. 59), argue that EMH clearly appears, when the market reflects the mounting amount of information speedily and accurately. They argue that the financial market often received a huge amount of information, conveyed by economic news, political events, firm declarations, and public reports. This information is usually, quickly
assimilated by the market which reacts to it via their price changes. This intuition draws our attention to the core idea of (EMH), which is mainly means to what extent the market reacts fast and precisely to the updated information. Hence, in the finance literature, the (EMH) only cares about the nexus between the stock prices and new information in terms of the accuracy and speed of reaction and response.

2.1.2 Volatility concept and definition

Volatility in the financial markets is one of the most important aspects that caught great attention over recent decades (Gökbulut & Pekkaya, 2014, p. 23). It is widely viewed as the devise measure to capture the variations of the stock prices. (Troiano & Villa, 2020, p.199). In essence, volatility represents the variations of stock prices over time. Practically speaking, quantifying volatility is widely viewed as the best proxy for uncertainty in the financial markets. On the other side, given that the stock prices in the financial market are not carved in stone, this necessarily means that their values would change over time, and due to these changes, possible losses may result. As consequence, the risk is always associated with uncertainty, which in turn, basically results from the possible volatility of the stock prices. Volatility is a monotonic expression of risk and uncertainty in the financial markets (Valenti et al., 2018, p. 1). Volatility is the main element that gains close attention among traders, investors, academics, and portfolio managers. (Troiano & Villa, 2020, p.199). Furthermore, financial crises are widely viewed as the net outcome of the sharp increase in the volatility of assets. In consequence, the care about volatility is not only concerning the investors and risk managers, but also the policymakers who seek to conduct sound policy enhance the growth without overlooking the importance of stability of the financial markets (Gökbulut & Pekkaya, 2014, p. 24).

By accounting for the fact, the accurate measurements for the volatility are interpreted as efficient pricing models and sound risk management. For this reason, a big strand of literature has been made to develop and improve volatility models (Gökbulut & Pekkaya, 2014, p. 23). It is important to realize that, despite the uncertainty may be attributed to many factors, that are typically beyond the ability to frame or control, for instance, a trader’s sentiment, macroeconomic circumstances, prevailing expectations about the future course of the real economy, in addition to the general economic environment, however, the style that impacts the investment values and prices in the financial markets, is regarded as it is the main driver for
the risk, and is always be the focus of attention and searching (Troiano & Villa, 2020, p.199). Together with this, Hartwell (2018, p. 598), argues that uncertainty policy or what is so-called “institutional volatility” plays a vital role in creating volatility. He emphasizes that this role is not limited to creating risk but also causes pronounced effects on fragile economics. He reports that the advanced economy weakens the volatility of the financial markets.

Lastly and most importantly, it is worthwhile to mention that variations in the volatility are typically branched out into two types, namely, small volatility and harshly volatility (jumps/declines) or could be named a break structural, while the first type is induced by getting new information, the latter is triggered by unparalleled disasters and numerous fluctuations in liquidity, in addition to the unexpected changes of the macro policies (Hong et al., 2021, p. 3).

After this quick introduction about the volatility concept, let us now move to the other relevant concept, the implied volatility index, to show the meaning of the term, how to compute it, and utilized it.

### 2.1.3 Implied volatility

The implied volatility index (VIX) is an index such as any other leading index in the financial markets, for instance, index S&P 500 or OMX Stockholm 30 (OMXS30), in terms, that is calculated on the actual time foundation over the operating day in the market. However, the attention should be placed on the main point, that while the second one measures the equity, the first one measure the volatility (Whaley, 2009, p. 98). The implied volatility is basically derived by relying on the well-known Black-Scholes (BS) model for pricing the options. More precisely, the implied volatility (IV) is extracted by matching between the option price that is suggested by the BS formula and its actual value in the market. On the account of the fact that the suggested value of the option is affected by the number of the variables such as spot and strike price of the asset, remaining life of the option, the risk-free rate in the market, and the volatility of the underlying asset. This implies that inserting a high volatility value in the (BS) formula, which usually, correspond with the turmoil of the financial market will yield a high option premium and vice versa (Shaikh & Padhi, 2015, p.44). in addition, the market cannot directly observe this parameter (Eschaust, 2021, p. 1). With this in mind, the actual option prices are often implicit the true volatility that is used to gain accurate insight about the market.
expectations in the short run, or to be more precisely, over the remaining life of the potion (Canina & Figlewski, 1993, p. 660; Goncalves & Guidolin, 2006, p. 1591).

Over the last few years, the volatility index (VIX) that is introduced by (CBOE) the Chicago Broad Options Exchange has received great attention among speculators, investors, traders, risk managers, and finance scholars (Pati et al., 2018, p. 2553). VIX is initially presented in 1993 to estimate the market expectations over the next 30 days based on the volatility entailed in options prices of the S&P 100 index. The VIX shortly later has received great popularity in the financial markets. Since it has been the key reference point for the volatility over U.S stock markets. For example, Wall Street Journal has typically characterized the VIX news in their publications, hand in hand, with other key financial publications. It is regularly named VIX as “fear gauge” or fear index” (Pati et al., 2018, p. 2553; Cboe Exchange, 2019, p. 3; Shaikh & Padhi, 2015, p. 45; Whaley, 2009, p. 99; Giot, 2005, p. 93; Corrado & Miller, 2005, p. 340).

Decade thereafter, precisely, in September of 2003, the initial design of the volatility index, has been amended by CBOE by updating the compute methodology of the implied volatility index, as the new index is designed based on S&P 500 rather than S&P 100, and the volatility is estimated to cover only 30 days in the future (Pati et al, 2018, p. 2553). The implied volatility index VIX is widely viewed as an accurate measure for volatility in comparison to historical volatility. This clear in the large part, because it reflects the market expectations in the short run i.e., the remaining life of the option contract. (Chang & Tabak, 2007, p. 569; Conclaves & Guidolion, 2006, p. 1591; Canina & Figlewski, 1993, p. 670).

Uniquely, as implied volatility is regarded as a "fear gauge", it is broadly used to provide an accurate picture of the turmoil of the financial market. more precisely, the VIX index reflects high values during disturbance and anxiety periods, while their values go down during stable and prosperous times. accordingly, the investor could draw useful conclusions from VIX values regarding the market and the economy in the short term (Pati et al., 2018, p. 2553). Conventionally, there is big empirical evidence support that there is a negative relationship between implied volatility index VIX and corresponding equity index. In addition, the implied volatility index VIX responds in an asymmetric manner to the shocks. To put it differently, the VIX largely reacts in response to the bad news (negative shocks), while it showcases a relatively express weakened reaction to the good news (positive shocks). Hence, the implied
volatility index VIX is a rich source of information and widely reasonable to use it as a proxy measure to uncertainty in the financial markets (Shaikh & Padhi, 2016, p. 28).

For further illustration, Figure 2.1 exhibits the time plot of the revised VIX index from January 2, 2015, to December 31, 2020, for 1511 observations. It is clear from the plot, that the financial market has witnessed high volatility at the beginning of 2020, more precisely, during March of 2020, as the world health organization (WHO) announced that Coronavirus (Covid-19) became a global pandemic. It follows that a wide range of countries decided to lockdowns which cast additional anxiety in the economy. In consequence, real economics is profoundly affected, and most global stock market indices are sharply falling (Chundakkadan, 2021, p. 1).

![Figure 2.1 Time plot of the VIX index of Chicago Board options Exchange from January 2, 2015 to December 31, 2020.](image)

Alternatively, Figure 2.2 exhibits the time plot of the daily closing values for the well-known index S&P 500 during the period spans over five years 2015-2020. It is quite clear, as the Coronavirus news outbreak, the equity market became more volatile and turmoil. This means that investors became fearful and anxious about future stock prices and the real economy. Therefore, the investors decrease their transactions in the spot markets and convert their trades into options contracts, which are written on their equities in the spot market. the plausible explanation for this, the option contract gives the investors more choices during the market uncertainty. This, in turn, diminishes the risk during the shrinking market, and yields gains
during the recovery state. As consequence, the options contracts have been utilized as an insurance tool. This confirms that the main role of options contracts is to hedge against the risk during the uncertainty of the market, which is attributed in a main way to the Corona pandemic and the resulting case of economic lockdown (Shaikh, 2021, p.2).

![Time plot of the daily closing price S&P 500 equity index from January, 2, 2015 to December 2020.](image)

**Figure 2.** Time plot of the daily closing price S&P 500 equity index from January, 2, 2015 to December 2020.

### 2.2 Empirical litterateur review

A sizable amount of academic literature has investigated the impact of Macroeconomic Announcements on uncertainty, but the empirical results are not fully conclusive i.e., conflicted, and nonexclusive. Empirical testing of the macroeconomic news is mainly derived from studies that rely on data that reflects the U.S stock markets. this means that a large part of the findings is backed out from the American economy. For further insight into these findings, some of the relevant studies are presented here.

Firstly, among the early studies, Pearce and Roley (1985, p. 66) have empirically tested the sensitivity of security prices to economic news. The reported results are mixed given that security prices sharply reacted to the monetary policy in contrast to the inflation and real economic activity. On the other hand, Harouvelis (1987, p.131) has examined the impact of 15
macroeconomic indicators on the security prices in the U.S stock markets. The reported finding suggests great evidence to support that monetary news has a significant impact on stock prices, while other such as non-monetary indicators tend to have a weak impact on stock prices. To put it differently, this study provided mixed results varying according to the macroeconomic announcements in terms of being monetary and nonmonetary variables.

Ederington and Lee (1993, p. 1161), have studied the impact of macroeconomic news on the futures markets for interest rate and exchange rate. The findings confirm that macroeconomic news tends to have a great impact on the volatility of these markets. The study also explains why the market slowly incorporates the new information in their prices despite the market is efficient. The study argues that it might be attributable to the fact; that despite the vast amount of information that arrives in the market, but it arrives gradually, and that is why the prices slowly react with. Further, the author has examined the efficiency of the market based on the serial correlation in returns and the possibility to get gain based on the primary response of the market.

Backer et al., (a1995, p. 1193), sought to explore the nexus between equity markets for U.K and U.S. for this endeavour, they study how the traders react to the U.S macroeconomic news. the study comes to the findings confirm that the FTSE 100 volatility index in the U.K largely react to the U.S news, while this reaction is expected to be small in the case of the U.S equity market reaction to the U.K macroeconomic news. the important implications for this study, suggest that the investors in the U.S markets only care about the U.S announcements and neglect the outside information. further, this conclusion can be taken as proof for the theoretical hypothesis; the global economy is so tied to the American economy this, in turn, increase their exposure to the economic news.

Becker et al., (b1995, p.763), aimed to explore the effect of the cross-country macroeconomic news for each the U.S and the U.K on futures contracts which are written on the government bonds for the following countries U.S, U.K, Germany, and Japan. The study came to mixed evidence, as it found that U.S news has a significant impact on foreign interest rates, while in contrast, U.K news is not. the study argues that variation in results mainly comes to differences in the economic size for each of the U.S and U.K and their shares in the global economy. Since the U.K economy is relatively small in comparison to the U.S economy. By the same token, Fleming and Remolona (1999, p. 1901) have concluded that the U.S Treasury market sharply
reacted to the macroeconomic announcements, which lead to a drop in the trading volume and widens in the spread.

On further reflection, Becker et al., (1996, p. 134), tested the efficiency of Eurodollar and T Bond futures contracts by employing the money market service MMS; in terms of its speed and accuracy in translating the information contained in the macroeconomic announcements. Surprisingly, the study has provided mixed conclusions, however, the empirical evidence supports the notion that the T-Bond market exhibit a weak reaction to the CPI index, similarly, the Eurodollar market does that to the nonfarm payroll information.

David and Chaudhary (2000, p.109) have shown how the domestic news influences currency futures contracts. they provided empirical evidence that supports the notion that future contracts are affected by the macroeconomic news, despite, this effect is not the same, as it varies according to the currency that is underlying the futures contract. further, they found to their great surprise that could identify that domestic news have an impact can be still in progress for some days after their releases. In a similar manner, Nikkinen and Sahlström (2001, p. 129) confirm that uncertainty of the financial market proxied by implied volatility index VIX is significantly dropping after the macroeconomic news is reverberating through the market, while the uncertainty increases during the day prior to the announcement.

Nikkinen and Sahlström (2004, p.201), who have explored whether Domestic or global news could be regarded as a viable source for information, this could help the investors to soundly revise their investment decisions. They employed the US effective dates for each employment rate and Federal Open Market Committee (FOMC) as a proxy for world news, whereas domestic news is represented by corresponding data extracted from German and Finnish economies. The reported findings clearly confirm that global news has a significant impact on the implied volatility in both of German and Finish stock markets, while it contains little evidence to support such impact in the case of domestic news.

In contrast to above mention studies, Jones et al., (2005, 358), provide empirical evidence that the impact of the macroeconomic announcements on the equity stock markets is unclear and ambiguous. Furthermore, their study confirms that the expecting inflation data tends to have weakly effect on the long-term interest rates. Further, the study argues that as possible explanations for this contrary to previous literature, that stock market participants can interpret
the content information for each announcement, and act accordingly. In contrast, Chen and Clements (2007, p. 228), confirm that money policy announcements tend to have a great impact on the VIX.

Alternatively, Vähämaa (2009, p. 1783), who has examined the impact of scheduled US macroeconomic announcements on uncertainty measured by movements of the implied volatility index VIX, the S&P 500 options index, and the ten-years treasury future index. The reported findings appeared to confirm that VIX is greatly affected by the unexpected part of the announcements. These results cast additional doubt on the reality of the conventional theories that presume that macroeconomic announcements have an impact on the uncertainty regardless of being expected or not. Together with that, he provided empirical evidence that considers those previous mixed results can be explained in the large part to the difference in the employed methodologies. Further, he found also in the line with Nikkinen and Sahlström (2001), Shaikh and Padhi (2013, p. 417), that implied volatility index VIX notably decreases in the days that the following announcement. Despite its remarkably increased over the days prior to the announcement.

Tanha et al., (2014, p.46), have also studied how the options prices represented via VI behaviour in response to the scheduled macroeconomic news. To this end, the study has employed high-frequency data, namely, the Australian option index ASX SPI 200. The empirical evidence clearly states that options have different features in terms of being out of the money OTM or in the money ITM. Further, the investors have heterogeneous expectations. that explains why the IV react differently to macroeconomic announcements. Similarly, Smales et al., (2015, p. 716), examine the nexus between major macroeconomic news and the market activity via various aspects such as return, volatility. the results provide empirical evidence to support that market activity is highly responsive to the macroeconomic news.

In the same fashion, Frijns et al., (2015, p. 35) have shown how the price discovery reacts to the macroeconomic information in each of Canadian and American stock markets. The empirical results confirm that macroeconomic announcements play a critical role in explaining the change of price discovery. Furthermore, the study confirms that the U.S market is more responsive in terms the speed and accuracy.
A relatively new study has been conducted by Tamgac (2021, p. 2), confirms that macroeconomic news and political events have a significant impact on the exchange rate for USD/TRE. The study clearly confirms that the unexpected part "or surprise element" of the announcements has a great impact on the exchange rate.

The main inference that could be drawn from the above discussion, is that despite the literature that searched the relationship between macroeconomic news and the financial market performance is extensive, but the empirical evidence is still inconclusive. Further, the empirical research in large part is applied to the U.S economy. This leads to a potential knowledge gap in literature that requires further searching and exploring by utilizing new data and new economic context.

3. Data and Methodology

At first blush, it is clear from the previous part that empirical evidence is almost mixed accompanied with the fact that the main theatre for these studies is the U.S economy. To get around this limitation, this study is developed to explore the impact of the macroeconomic announcements on the uncertainty of the financial market, measured by movements of the implied volatility index in the Eurozone. More specifically, in this study, I try to examine the behavior of the STOXX 50 volatility index for the European zone, so-called (European VIX) in response to the European macroeconomic announcements. This index is basically designed to calculate the volatility that is backed out from the option contracts that are written on the main European equity index i.e., Euro STOXX 50. Given that STOXX 50 is widely observed by investors and traders in the European zone, as well as it is employed to draw accurate expectations about the volatility of the Euro STOXX 50 over the upcoming short term (stoxx.com).

3.1 Data

The data is employed in this study is the sample of daily closing values for the Eurozone volatility index VSTOXX for time interval spans from 2 January 2015 to 31 December 2020, containing a total of 1540 observations. Combined with, effective dates which are gathered for the main macroeconomic announcements in the European zone, namely, gross domestic product GDP, consumer prices index CPI, refinancing rate MP (monetary policy), EMP (the employment rate), LC (labour cost), CA (current account). It is important to realize that GDP,
EMP, and LC reports are disseminating on a quarterly basis, whereas reports of CPI, MP, and CA are publishing on the monthly basis. Further, all required data are obtained from the Thomson Reuters database (Eikon). Due to the practical advantages of measuring the return by geometric returns, which can be summarized mainly by providing reasonable intuition for stock price changes, together with the fact that it can be used over multiple time intervals (Jorion; 2007; p.94-95). For these reasons together, the daily percentage change for VSTOXX closing values is calculated on a compounding continuously basis as following:

\[ R_t = \ln\left(\frac{VSTOXX_t}{VSTOXX_{t-1}}\right) \]  \hspace{1cm} (1)

Where \( R_t \) denoted the rate of change of volatility index in the period \( t \), whereas \( VSTOXX_t \) and \( VSTOXX_{t-1} \) denoted the closing values for the Eurozone implied volatility index on the trading days \( t \) and \( t-1 \), respectively.

### 3.2 Preliminary data analysis

Table 1 exhibits the descriptive statistics for the daily Eurozone implied volatility index (VSTOXX) and corresponding the rate of log change over the time interval spans from 2 January 2015 to 31 December 2020. Panel A of Table 1 clearly presents the main features of the VSTOXX behaviour during the sample period. The VSTOXX index has a positive mean value of 20.45 over the sample period. More importantly, the European volatility index has greatly raised due to the uncertainty and turmoil caused by the Coronavirus, given that it is spreading across the globe, leading to adverse implications across all the world economics (Farooq et al., 2021, p. 1; Hu & Zhang, 2021, p. 365). For this reason, the VSTOXX reaches its highest value 85,62 in Mar-2020, which coincided with the clear declaration from World Health Organization (WHO) that novel coronavirus (Covid-19) has become a global pandemic (Albulescu, 2021, p.1). This implies that the financial market has become more volatile and a pessimistic look toward the future has prevailed among the investors and other participants due to the (WHO) announcement. This stressful situation has pushed the investors to sharply increase their purchases of the financial options to hedge their investment positions and decrease their uncertainty about the future.
Attention should be placed since there is an inverse relationship between the implied volatility index and the underlying equity index. Therefore, the VSTOXX spikes high values when the Eurozone equity index Euro Stoxx50 plunges and vice versa, as depicted in Figure 3.1 below.

![Figure 3.1](image_url) Daily co-movement of Eurozone Stock market index and its respective volatility index VSTOXX.

The standard deviation SD of the STOXX index series is approximately accounted for 8.3% over the sample period 2015-2020. This indicates that the volatility index has variations in its movement amount to 8.3% regardless of the nature of macroeconomic shocks in terms of being bad or good shocks. The reported results regarding the skewness and kurtosis provide clear evidence that STOXX does not comply with normal distribution. As the normal distribution implies that skewness and kurtosis should be zero and 3, respectively. However, in our case, the skewness is positive 2.54 and kurtosis is 15.01. This means that distribution positively skewed to the right compared to the left tail as well as the kurtosis that exceeds 3 implies that the STOXX distribution has heavy tails or what is well-known thicker tails which is corresponding with “leptokurtic distribution” (Rachev et al., 2007, p.55). The stationarity of the STOXX series is tested by conducting the Augmented Dicky-Fuller unit root test (Wooldridge, 2015, p. 643). The ADF statistic test confirms that daily close values of the STOXX series is stationary because the test statistic (-4.038) is more negative than the critical values (-2.860, -2.570) which are corresponding to the significance levels of 5% and 10%, respectively. Therefore, there is strong evidence against the null hypothesis.

On the other hand, Panel B presents the summary statistics for the rate of log change for the Eurozone volatility index VSTOXX. It is clear from the table, that the average value of the rate of change of the VSTOXX index over the sample period constitutes nearly 0.0076%. Further,
the VSTOXX series shows a mean-reversion phenomenon as illustrated in Figure 3.2. the figure below simply implies that the Log change of the VSTOXX series swings around the constant mean value in the long-run period. (Asteriou & Hall, 2007, p.231)

![Figure 3.2 Time series plot for the Log Change of the VSTOXX index over the sample period 2015–2020.](image)

To put it differently, the Mean reversion phenomenon that depicted in the Figure 3.2 confirms that Log change of VSTOXX series will move back to the initial mean value after facing random chock (Osman, 2021, P. 918). Additionally, the reported statistic test of ADF-test (-38,255) provides further evidence that log change of the volatility index VSTOXX is stationary given its value is smaller than of the computed critical values at both popular used significant levels i.e., 5% and 10%. The minimum value has been reached by the log change of VSTOXX was -0.434 during the sample period. Alternatively, the maximum has been reached was 0.470. Together with that, the Log change of VSTOXX series experience variability account for 0.0735 over the corresponding period. More important, the normality tests confirms that log change of VSTOXX fall short of the normal distribution requirements. As the skewness is different form zero by 0,655 and the kurtosis of the distribution is about 7,318 which implies that this destitution has fat tail or thinker tail (Leptokurtic). Further, the statistic of the Ljung Box test (LB-Q) presents strong evidence that the squared return series has autocorrelation. Given that their corresponding p. value is below all the confidence levels i.e., 1%, 5%, and 10%. On the other hand, the Lagrange multiplier LM test confirms that the log change of the VSTOXX index has heteroskedastic in the residuals, or as well-known has an arch effect.
Table 1 Summary Statistics for the Eurozone volatility index VSTOXX

Panel A: Summary Statistics for the Eurozone implied volatility index VSTOXX (1540 observations)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>20.45</td>
<td>18.70</td>
<td>10.68</td>
<td>85.62</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>8.24</td>
<td>4.032</td>
<td>2.54</td>
<td>15.01</td>
</tr>
</tbody>
</table>

Panel B: Summary Statistics for the Eurozone implied volatility index VSTOXX Log-change (1539 observations)

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>Median</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.0000756</td>
<td>-0.0049606</td>
<td>-0.4347158</td>
<td>0.4703052</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>0.0734873</td>
<td>-38.255</td>
<td>0.6515684</td>
<td>7.318905</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Test</th>
<th>Value</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>LB-Q^2</td>
<td>205.4061**</td>
<td>(0.000)</td>
</tr>
<tr>
<td>ARCH-LM (3)</td>
<td>129.960**</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

Note: The critical values of the ADF-statistics at the 5% and 10% level of significance are -2.860 and -2.570 respectively.

Figure 3. 3 Time plot of the VSTOXX index for the Eurozone from January 2, 2015 to December 2020.

From Figure 3. 3 the financial market was very turmoil at the beginning of 2020 and this turmoil is clear interpreted via the VSTOXX index movements. as the VSTOXX index spikes to its highest value over the study period. This confirms that there is a huge demand on the financial options by investors and other traders to mitigate the uncertainty and immunize their
financial positions toward risk exposure that is expected to occur owing to the Corona pandemic and its accompanying negative impact on the real economy.

Table 2 Summary Statistics surrounding Announcement and Non-announcement Days

<table>
<thead>
<tr>
<th>Statistic</th>
<th>MP</th>
<th>CPI</th>
<th>GDP</th>
<th>LC</th>
<th>EMP</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>-0.0022293</td>
<td>-0.0039372</td>
<td>-0.0071123</td>
<td>0.0042745</td>
<td>0.0006134</td>
<td>-0.0037987</td>
</tr>
<tr>
<td>Median</td>
<td>-0.0634131</td>
<td>0.0180019</td>
<td>-0.0478632</td>
<td>-0.0452442</td>
<td>-0.0660227</td>
<td>-0.0018773</td>
</tr>
<tr>
<td>Maximum</td>
<td>1.692486</td>
<td>0.6679044</td>
<td>1.252868</td>
<td>1.892418</td>
<td>1.252868</td>
<td>1.666758</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.7462468</td>
<td>-0.5158142</td>
<td>-0.59266</td>
<td>-0.7609796</td>
<td>-0.59266</td>
<td>-0.6254691</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>0.3416965</td>
<td>0.2224463</td>
<td>0.3615055</td>
<td>0.511618</td>
<td>0.3884006</td>
<td>0.3260589</td>
</tr>
<tr>
<td>Numbers</td>
<td>47</td>
<td>71</td>
<td>23</td>
<td>23</td>
<td>23</td>
<td>71</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Statistic</th>
<th>MP</th>
<th>CPI</th>
<th>GDP</th>
<th>LC</th>
<th>EMP</th>
<th>CA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>0.0010935</td>
<td>0.0004389</td>
<td>0.0004189</td>
<td>-0.0001829</td>
<td>0.000609</td>
<td>-0.0005452</td>
</tr>
<tr>
<td>Median</td>
<td>-0.0032723</td>
<td>-0.0040474</td>
<td>-0.0040474</td>
<td>-0.0049524</td>
<td>-0.0048175</td>
<td>-0.0054902</td>
</tr>
<tr>
<td>Maximum</td>
<td>0.4703052</td>
<td>0.4703052</td>
<td>0.4703052</td>
<td>0.4703052</td>
<td>0.4703052</td>
<td>0.4703052</td>
</tr>
<tr>
<td>Minimum</td>
<td>-0.4347158</td>
<td>-0.4347158</td>
<td>-0.4347158</td>
<td>-0.4347158</td>
<td>-0.4347158</td>
<td>-0.3453012</td>
</tr>
<tr>
<td>Std.Dev</td>
<td>0.0736343</td>
<td>0.0741016</td>
<td>0.0740734</td>
<td>0.0738487</td>
<td>0.0735899</td>
<td>0.0725811</td>
</tr>
<tr>
<td>Numbers</td>
<td>1,443</td>
<td>1,395</td>
<td>1,491</td>
<td>1,491</td>
<td>1,491</td>
<td>1,397</td>
</tr>
</tbody>
</table>

From the theoretical point, investors generally, tend to consider the high volatility in the financial market as the primary indicator of the fall short of the efficiency of the market. This means, the volatility represents a potential source to disturb their investments, which in turn, motivates them to reduce their spending and lose more confidence, thus, the economic growth rate further depreciating, and the unemployment rate increases more (Naik & Reddy, 2021, p. 252). In the similar context, although, there is a semi generalization in the literature that the macroeconomic announcements lead to dampening the uncertainty in the financial market, which could be explained by the downward trend of the implied volatility index regardless of the nature of the content. However, in the line with Shaikh and Padhi (2013, p. 425); Vähämaa (2009, p.1783), I argue that the surprising component of the announcement, alongside the content, have the most impact on the uncertainty of the financial market. More clearly, when the content of macroeconomic announcements is in the favour of the market, for instance, positive growth in GDP or further decline in the employment rates. Thus, it is quite reasonable to anticipate that the expected outcome will be a decline in the uncertainty in the financial market, which in turn, gives rise to low demand on the financial options and their prices fall.
more, therefore, the implied volatility goes down. In the contrast, when the content information of announcements is not in favour of the market, the expected response of the investors is to buy more options and, therefore, the implied volatility goes down.

Table 2 presents the illustrative picture of the behaviour of the Eurozone volatility VSTOXX index through presenting the main statistic values for the VSTOXX log change series during announcements days in comparison to non-announcement days. Panel A reports the statistic values for the log change for the volatility index over the only days that corresponding to effective dates for each of the macroeconomic variables i.e., MP, CPI, GDP, LC, EMP and CA. In following with (Madura & Tucker, 1992, p.499; Ederington & Lee,1996, p.514; Nikkinen & Sahlström, 2001, p. 10-11; Graham et al., 2003; p.158; Nikkinen & Sahlström, 2004, p. 209; Baber and Brandt, 2009, p.1; Shaikh & Padhi, 2013, p. 425) the implied volatility index as a reasonable proxy for the uncertainty is expected to reach maximum value prior to the macroeconomic information releases, and thereafter, the index goes back to its normal level. Additionally, the more drop of the implied volatility values, in response to the macro news, is usually interpreted as increased uncertainty regarding the macroeconomy state. On the other hand, Graham et al., (2003, p.163), argue that given macroeconomic news are usually convey information covering the economic situation on a quarterly or monthly basis. This means the significant impact of this news will be attributed to announcements in their first periods in comparison to their corresponding in the following periods.

By turning back to our study, four out of six macroeconomic announcements were in the favour of the financial market i.e., positively affected the VSTOXX index (goes down). As the average log change for the VSTOXX index were negative values during the announcement’s dates for each of the MP, CPI, GDP, and CA. More specific, the VSTOXX index fall by 0,22% due to monetary policy announcements and by 0,71% due to the GDP releases, and by 0,40% due to the inflation news and by 0,37 due to the current account news for the Eurozone. On the other hand, the log change VSTOXX index report positive values over the labour cost news and the employment rates reports over the sample period giver rise to increase in the VSTOXX log change by 0,43% and 0,06%, respectively. The candidate explanation is that this news is not in the favour of the financial market.

In panel B, the average log change for the VSTOXX index during non-announcement days was in general positive excepting to LC and CA. This implies that uncertainty measured by the
implied volatility is relatively affected by macroeconomic news in comparison to those that are corresponding to non-announcement days.

3.3 Practical Methodology

Given that this study is basically exercise to identify the impact of the macroeconomic announcements on the uncertainty in the financial market. Following with (Ederington & Lee, 1996, p. 520; Nikkinen & Sahlström, 2001, p. 209; Graham et al., 2003; p.158; Vähämäa, 2009, p. 1784; Nikkinen & Sahlström, 2004, p. 209; Shaikh & Padhi, 2013, p. 425, Tanha et al., 2014, p. 51), I started by employing the dummy OLS regression model to capture the impact of the macroeconomic announcements on the behaviour of the volatility index VSTOXX. This regression model is conducted by regressing the log change of the Eurozone implied volatility index VSTOXX (dependent variable) on the number of dummy variables that represent the corresponding date for the selected macroeconomic announcement, in more details, the dummy variable takes a value equal to one during the announcement date and zero otherwise. To get around any autocorrelation in the residuals, the best fitting autoregressive moving average (ARIMA) model is utilized in the mean model to eliminate the autocorrelation in the residuals. Further, the Lagrange multiplier (LM-test) is conducted to check the existence of the volatility clustering (ARCH effect) in the residuals. Given that the reported results confirm there is time-varying volatility. To account for that, it is widely accepted in the literature to apply generalized autoregressive conditional heteroscedastic GARCH (1,1) to model the volatility clustering and the leptokurtic feature (Li et al., 2018, p. 1-2; Pati et al., 2018, p. 2558; Gulay & Emec, 2018, p.133-134; Alexander & Lazar, 2006, p. 307; See also Engle, 1982; Bollerslev, 1986).

Grounding on the above, the following model is conducted to address the main issue of this study, namely, whether the macroeconomic news has relevant information, so the associated uncertainty is resolved, and the implied volatility index goes down. In other words, whether the investors in the European stock market consider the macroeconomic declares as an important source for information that should be regarded in their financial decisions, or not.
**Model 1:**

\[
\ln\left(\frac{VSTOXX_t}{VSTOXX_{t-1}}\right) = \alpha_0 + \beta_{MP}X_{t}^{MP} + \beta_{CPI}X_{t}^{CPI} + \\
\beta_{LC}X_{t}^{LC} + \beta_{EMP}X_{t}^{EMP} + \beta_{GDP}X_{t}^{GDP} + \\
\beta_{CA}X_{t}^{CA} + \epsilon_t^{VSTOXX}
\]

Where \(\ln\left(\frac{VSTOXX_t}{VSTOXX_{t-1}}\right)\) denoted the dependent variable, \(\alpha_0\) represent the intercept of the regression that is expected to be positive and different from zero, as the uncertainty is expected to be high during non-announcement days (Ederington & Lee, 1996, p. 521; Shaikh & Padhi, 2013, p. 426). On the other hand, \(X_{t}^{MP}\), \(X_{t}^{CPI}\), \(X_{t}^{LC}\), \(X_{t}^{EMP}\), \(X_{t}^{GDP}\), and \(X_{t}^{CA}\) represent the dummy variable for each of MP, CPI, LC, EMP, GDP, and CA, respectively. \(\epsilon_t^{VSTOXX}\) is the residual term of the model 1 at time \(t\).

Given that the investors, in practice, most likely would regard more than one announcement as a source of information, thus, it is quite reasonable to conduct an F-statistic test to check the joint impact of the announcements, in which the slope has a negative value, and similarly, for the group of the announcements that have positive slopes (Shaikh & Padhi, 2013, p. 426).

Remarkably, that one of the possible drawbacks of Model 1 is that it primarily restricted its focus to the actual announcement dates, without paying required attention to the impact of these announcements during the surrounding days. Therefore, and to get around this shortcoming, in following with (Shaikh & Padhi, 2013, p. 427; Nikkinen & Sahlström, 2004, p. 209; Nikkinen & Sahlström, 2001, p. 13) Model 2 is structured in such a way that allows capturing the behaviours VSTOXX index during the days surrounding the economic news. The purpose of this model is to test whether the uncertainty is completely resolved during the announcement days or requires more time to capture, by conducting a model contain additional dummy variables that take values 1 during the days (before, announcement days, after) and zero otherwise. Conceptually speaking, the implied volatility is initially grounded on the options prices, which usually have a short time horizon, this implies that the volatility implicit in the option prices, relatively increases as the remaining time of the option draw closer to the maturity (Chen & Clements, 2007, p. 229). This implies that volatility further increases prior
announcement days, and then goes back to its normal level (Nikkinen & Sahlström, 2004, p. 209). Hence, the \textit{Model 2} is specified as following:

\[
\ln \left( \frac{VSTOXX_t}{VSTOXX_{t-1}} \right) = \alpha_0 + \sum_{i=-1}^{+1} \beta_i^{MP} X_{i,t}^{MP} + \sum_{i=-1}^{+1} \beta_i^{CPI} X_{i,t}^{CPI} + \sum_{i=-1}^{+1} \beta_i^{LC} X_{i,t}^{LC} + \sum_{i=-1}^{+1} \beta_i^{EMP} X_{i,t}^{EMP} + \sum_{i=-1}^{+1} \beta_i^{GDP} X_{i,t}^{GDP} + \sum_{i=-1}^{+1} \beta_i^{CA} X_{i,t}^{CA} + \epsilon_t^{VSTOXX}
\]

(3)

The equation (3) is structured to capture the VSTOXX index behaviour around the announcement days, more specific, over three time points: one day before the announcement \(t=-1\), announcement day \(t=0\), one day after the announcement \(t=1\).

Short illustration for the variables of the \textit{(Model 1-2)}:

- \(\ln \left( \frac{VSTOXX_t}{VSTOXX_{t-1}} \right)\) The response variable is the long change of the implied volatility index VSTOXX over one day as time interval.
- \(\alpha_0\) denoted the intercept of the regression model, this constant describes the VSTOXX behaviour during non-announcement days. Given the uncertainty is supposed to be high based on the previous discussion, this parameter is hypothesized to be positive and different from zero (Ederington & Lee, 1996, p. 521; Shaikh & Padhi, 2013, p. 426).
- \(i\) refers to the time point is suggested to take three values, specifically, (-1) the day before the announcement, (0) the day of the announcement, and (1) the day after the announcement.
- \(\beta_i\) the slope of the regressor and it is supposed to have negative value and statistically different from zero for the \textit{Model 1}, in case the investor considers the announcement as information source (i.e., the uncertainty is resolved). On the other hand, regarding the \textit{Model 2}, it expected to take positive value prior the announcements (volatility increases) and negative value after the announcement.
- \(X_{i,t}\) denoted the dummy variable for the announcement of the macroeconomic indicator is denoted the selected announcements for this study i.e. (Monetary policy, consumer price index, labour cost, employment rate, GDP reports and the current account for...
the Eurozone trade). Regarding the Model 1, the dummy variable takes 1 value during the announcement day and zero otherwise. Alternatively, regarding the Model 2, given that there are three time points, three dummy variables are structured for each announcement, such that (take value 1 prior the announcement and zero otherwise, take value 1 during the announcement day and zero otherwise and take value 1 during the day after the announcement and zero otherwise).

- \( \varepsilon_t^{VSTOXX} \) refers to the stochastic term of Model 1-2, this term is utilized to capture the surprised part of the announcement.

Given that the Ljung-Box test, as represented in table 2, confirms that the presence of the autocorrelation problem in the squared return, as well as the Lagrange multiplier test (LM), provide strong evidence confirming that there is time-varying volatility. Therefore, following with (Nikkinen & Sahlström, 2004, p. 210; Shaikh & Padhi, 2013, p.428), the autocorrelation problem is fixed by employing the best fitting ARIMA model (Autoregressive integrated moving average model), which is fitted according to the lowest value of the Akaike information criterion (AIC). Accordingly, ARIMA (0,0,0) model specification is selected.

Thereafter, as the valid inference means accurate modelling (Li et al., 2018, p. 1; Francq & Zakoäan, 2004, p. 605) the residuals term \( \varepsilon_t^{VSTOXX} \) that is resulting from the Model 1 and 2 is modelled according to the model GARCH (1,1). This model is estimated by assuming that shocks follow the generalized error destitution, hence, the model specification as following (Pati et al., 2018, p. 2558):

\[
\varepsilon_t^{VSTOXX} | \Omega_{t-1} \sim GED(0, \sigma^2, \nu) \quad (4)
\]
\[
\sigma_t^2 = \alpha + \beta \varepsilon_{t-1}^2 + \delta \sigma_{t-1}^2 \quad (5)
\]

Where \( \nu \) is the shape parameter, and \( \sigma_t^2 \) denote the conditional variance at time \( t \), \( \varepsilon_{t-1}^2 \) is lagged squared residuals and \( \sigma_{t-1}^2 \) refers to lagged unconditional variance. Additionally, attention should be placed that \( \alpha > 0, \beta, \delta \geq 0 \) are conditions imposed to ensure that conditional variance \( \sigma_t^2 \) is still positive, in addition, the magnitude of \( (\beta + \delta) \) is less than one. This condition is imposed to confirm that the stationarity feature of the GARCH (1,1) model is met (Blazsek & Villatoro, 2015, p. 1767). Further, \( (\beta) \) the Arch coefficient measure to what extent the shock of today volatility contribute to the volatility in the future, and \( (\delta) \) the GARCH
parameter clarifies how much the past volatility chocks contribute to volatility persistency in the long run (Nugroho, 2019, p.2; Pati et al., 2018, p. 2558; Ismail et al., 2016, p. 257).

### 3.3.1 GARCH-M (1,1)

It is widely accepted in the finance literature that high-risk assets should yield a high return, and this return should be increased to compensate the investors for bearing further risk. Loosely, this relationship is obviously noted via risk-averse investors, who usually, required high returns to bear the additional risk (Park, 2009, p.93). For that reason, Engle et al., (1987) developed a model for the mean equation that accounting for the risk premium. More specifically, the conditional mean equation has been augmented by the conditional volatility or what is called the volatility effect of the asset (Brooks, 2008, p. 410; Mohammadi, 2016, p. 860). This means the GARCH-M model is employed to capture the nexus between the return and the conditional risk (Zhang et al., 2016, p. 3807).

This model (GARCH-M), however, implies estimating two equations simultaneously, namely, one equation account for the conditional mean and the second equation control for conditional volatility. As such, GARCH-M enables the conditional mean i.e., the return to get feedback from the conditional variance i.e., Conditional risk (Trypsteen, 2017, p. 15). Conceptually speaking, the GARCH-M model is like the CAPM model in terms of its role in capturing the relationship between the return and required risk premium (Li et al., 2012, p. 170). It is worth mentioning, that one of the most distinguishable features for the GARCH-M is that presenting the conditional variance or any other function form for it as an explanatory variable in the mean equation (Iglesias & Philips, 2012, p. 533). Based on this understanding, and following with (Shaikh & Padhi, 2013, 429), the GARCH-M will be estimated via augmenting mean equation by the square root of the conditional variance that denoted by $\sigma_t$. In the sake of shorting the symbols, let us denote $\Pi_1, \Pi_2$ as following:

$$\Pi_1 = \beta^{MP} x_t^{MP} + \beta^{CPI} x_t^{CPI} + \beta^{LC} x_t^{LC} + \beta^{EMP} x_t^{EMP} + \beta^{GDP} x_t^{GDP} + \beta^{CA} x_t^{CA}$$ (6)
\[ \Pi_2 = \sum_{i=-1}^{+1} \beta_i^{MP} X_{i,t}^{MP} + \sum_{i=-1}^{+1} \beta_i^{CPI} X_{i,t}^{CPI} + \sum_{i=-1}^{+1} \beta_i^{LC} X_{i,t}^{LC} + \sum_{i=-1}^{+1} \beta_i^{EMP} X_{i,t}^{EMP} + \sum_{i=-1}^{+1} \beta_i^{GDP} X_{i,t}^{GDP} + \sum_{i=-1}^{+1} \beta_i^{CA} X_{i,t}^{CA} \] (7)

Hence, the GARCH-M (1,1) has the following equations, for model 1 that accounting only for actual announcements days, and model 2 that accounting for the surrounding announcement days, in equations (8) and (9), respectively.

\[
\ln \left( \frac{VSTOXX_t}{VSTOXX_{t-1}} \right) = \alpha_0 + \Pi_1 + \sigma_t + \epsilon_t^{VSTOXX} \tag{8}
\]

\[
\ln \left( \frac{VSTOXX_t}{VSTOXX_{t-1}} \right) = \alpha_0 + \Pi_2 + \sigma_t + \epsilon_t^{VSTOXX} \tag{9}
\]

### 3.3.2 EGARCH (1,1)

Although the GARCH (1,1) has attractive characteristics based on its prominent role in modelling and forecasting the time-varying volatility, and accounting for the volatility clustering or what is called fat tail distribution. However, the practice reveals some drawbacks for this model in terms that it does not control for volatility asymmetric and leverage effect (Martinet & McAleer, 2018, p. 842). To overcome these shortcomings, an EGARCH (1,1) model which was developed by Nelson (1991) is selected to be employed in this study to control for asymmetry of volatility, a well-known phenomenon that has been often observed in the financial market. As illustration, Asymmetry in volatility is simply means that the volatility of the stock market response in unequal magnitude to bad and good shocks i.e., the bad and good news have unequal impact on the volatility of stock market despite both shocks have the same magnitude (Do et al., 2020, p. 4). On the other hand, EGARCH (1,1) can be used to capture the leverage effect, which usually refers to the stylized fact of existence negative correlation between returns and subsequent volatility chocks. It is worth mention that leverage effect is considered as a special case of the asymmetry volatility (Chang & McAleer, 2017, p. 53; Martinet & McAleer, 2018, p. 842).
Depending on the above, employing EGARCH \((1,1)\) implies gain further insight into the volatility asymmetry via differentiating between the impact of the positive and negative shocks on the stock movements (Zhang & Chen, 2011, p. 6628). Hence, in the line with Shaikh & Padhi (2013, p. 429), the EGARCH \((1,1)\) is utilized to model the conditional volatility of the resulting residuals \(\varepsilon_{t}^{VSTOXX}\) from the Model 1 and Model 2 as clarified in the following equation:

\[
\ln(\sigma_t^2) = \alpha + \beta \left| \frac{\varepsilon_t^{VSTOXX}}{\sigma_{t-1}} \right| + \gamma \frac{\varepsilon_{t-1}^{VSTOXX}}{\sigma_{t-1}} + \delta \ln \sigma_{t-1}^2
\] (10)

Where \(\beta\), \(\delta\) and \(\gamma\) refer to the coefficients of the model. As \(\gamma\) is used to capture the asymmetric impact of the shocks (bad news or good news) on the volatility of the stock market, generally, if \(\gamma\) found to be statistically different from zero and negative that means there is leverage effect i.e., the bad news has relatively stronger impact on the volatility in comparing to the good news of the same magnitude. However, here the attention should be placed that, the above analysis only applied in the case of the returns of stock prices, it is expected that bad news has a greater impact on the return in comparing to the good news. Thus, the parameter is expected to be negative and different from zero. But, as our case used the rate of the log change for the volatility as the dependent variable instead of the returns of the stock prices, it is expected the opposite, in other words, the bad news for return is good news for volatility and vice versa. Thus, this parameter is expected to be positive and different from zero. On the other side, the parameter \(\beta\) is used to measure the volatility clustering, while the parameter \(\delta\) is interpreted as the measure of the persistency of the volatility (Pati et al., 2018, p. 2558).

4. Empirical results and analysis

4.1 Model 1 analysis

To evaluate the impact of the major macroeconomic announcements on the uncertainty in the European financial market, Model 1 is designed in such a way led to testing the suggested hypotheses of the study. More specifically, Dummy OLS regression, GARCH \((1,1)\), GARCH -M \((1,1)\), and EGARCH \((1,1)\) are estimated.
By quick glance at table 3, it is evident that the first column exhibits the outcome estimated for model 1 which is extracted by regressing the dummy announcements on the log change of implied volatility (VSTOXX) according to the OLS method. The goodness of fit for this model is evaluated according to the reported value of $R^2$. As we can see, $R^2$ account for 0.0077. This means that only 0.77% of the variations of the log change of the VSTOXX can be attributed to the change of the dummy variables of the macroeconomic announcements. More evidentially, the announcements of macroeconomic variables provide little explanations of the change of the implied volatility index in the Eurozone financial market.

However, the concluded results for each of F-statistic and corresponding P-value are 2.36 and 0.03, respectively, suggest that the model can provide some meaningful interpretation for the change of the implied volatility i.e., the uncertainty of the financial market. In more detail, even though there are four dummy variables of the macroeconomic announcements that have negative slopes, namely, CPI, GDP, LC, and MP, only the MP announcements have negative slope and different from zero. As the estimated coefficient for the MP dummy variable is -0.0311 and the corresponding p-value is 0.002. This means that effective dates for the announcements of the monetary policy have a significant impact on the uncertainty. Practically speaking, the investors in the financial market of the Eurozone consider the monetary policy reports as reliable source of information for their financial planning and investment decisions. This result is in the line with Nikkinen and Sahlström (2004, p. 210); Chen and Clements (2007, p. 231) who provide strong evidence that the dates report for Federal Open Market Committee (FOMC) has significant impact on the uncertainty.
Table 3 Regression Estimation of Model 1

\[
\ln \left( \frac{VSTOXX_t}{VSTOXX_{t-1}} \right) = \alpha_0 + \beta_{MP} X_{tMP} + \beta_{CPI} X_{tCPI} + \beta_{LC} X_{tLC} + \beta_{EMP} X_{tEMP} + \beta_{GDP} X_{tGDP} + \beta_{CA} X_{tCA} + \epsilon_{t}^{VSTOXX}
\]

\[\epsilon_{t}^{VSTOXX} \sim GED(0, \sigma^2, \nu)\] the pre-assumption for each of GARCH, GARCH-M and EGARCH models.

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS Regression</th>
<th>GARCH (1,1)</th>
<th>GARCH-M (1,1)</th>
<th>EGARCH (1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
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<td>0.430</td>
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</tr>
<tr>
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<td>-0.072668</td>
<td>0.307</td>
<td>-0.0066359</td>
<td>0.481</td>
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<td>GDP report Day</td>
<td>-0.0122405</td>
<td>0.286</td>
<td>-0.078293</td>
<td>0.651</td>
</tr>
<tr>
<td>EMP report day</td>
<td>0.0015945</td>
<td>0.884</td>
<td>0.0130688</td>
<td>0.479</td>
</tr>
<tr>
<td>LC report Day</td>
<td>-0.0219288</td>
<td>0.121</td>
<td>-0.0203675</td>
<td>0.199</td>
</tr>
<tr>
<td>MP report Day</td>
<td>-0.0311084</td>
<td>0.002</td>
<td>-0.0326066</td>
<td>0.005</td>
</tr>
<tr>
<td>CA report Day</td>
<td>0.0023358</td>
<td>0.784</td>
<td>0.0020213</td>
<td>0.807</td>
</tr>
<tr>
<td>risk premium</td>
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<td>-</td>
<td>-</td>
</tr>
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<td>(\alpha)</td>
<td>-</td>
<td>-</td>
<td>0.000565</td>
<td>0.275</td>
</tr>
<tr>
<td>(\beta)</td>
<td>-</td>
<td>-</td>
<td>0.1438218</td>
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</tr>
<tr>
<td>(\delta)</td>
<td>-</td>
<td>-</td>
<td>0.7260474</td>
<td>0.000</td>
</tr>
<tr>
<td>(\gamma)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>R squared</td>
<td>0.0077</td>
<td>0.0285</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>F-statistic</td>
<td>2.36</td>
<td>0.1568</td>
<td>17.1200</td>
<td>0.1451</td>
</tr>
<tr>
<td>LB-Q(12)</td>
<td>16,81331</td>
<td>0.0072</td>
<td>10.88</td>
<td>0.028</td>
</tr>
<tr>
<td>joint effect of negative slopes</td>
<td>3.52</td>
<td>10.88</td>
<td>0.028</td>
<td>10.73</td>
</tr>
<tr>
<td>joint effect of positive slopes</td>
<td>0.05</td>
<td>0.9542</td>
<td>0.57</td>
<td>0.7529</td>
</tr>
</tbody>
</table>

Note: the table above presents the outcome estimation for the model according to OLS regression, GARCH (1,1), GARCH-M (1,1), and the GARCH (1,1) the bold values indicate that the estimated parameter is significant at both significant levels 5%, 10%.
Controversially, despite the magnitude of MP's impact on the uncertainty is relatively small (0.031), this result broadly consistent with Hardouvelis (1987, p.131), Who confirms the high sensitivity of the financial market to Monetary information. On the other hand, given that the slopes for each of the EMP and CA reports are positive, this means, theoretically speaking, that the announcements for these variables do not behave according to the hypothesis, which suggested that their slopes should be negative. Given that, their slopes have the following positive values respectively 0.0016 and 0.00233. However, practically speaking, the corresponding p-values for these coefficients 0.884 and 0.784 are larger than the significant levels 5% and 10%. This confirms that each EMP and LC has zero impact on the behaviour of the Log change of the VSTOXX index.

Further, one of the study hypotheses suggests that the uncertainty should be high during non-announcement days in comparison to the announcement’s days. This implies that the intercept or constant term in the mean equation should be positive and different from zero (Ederington & Lee, 1996, p. 521; Shaikh & Padhi, 2013, p. 426). In contrast to that, our results in the line with (Nikkinen & Sahlström, 2004, p. 2014) show that the intercept that captures the uncertainty of the financial market during non-announcement days is insignificant. Given that the reported p-value for the estimated intercept is 0.430 is above 5% and 10%. It’s worth mention that this finding has extensively support in the finance literature rather than the suggested hypothesis by the study, as the mean value of the return is always expected to be zero see (Hull, 2015, p. 210).

Moreover, as the investors are usually considering all the information available at the time of investment decision, the Wald-F test has been implemented to investigate the joint effect of the economic variables that have negative slopes, and similarly, for the variables with positive slopes. The results provide strong evidence that investors consider more than one macroeconomic variable during the investment decision. As an illustration, the Wald- F statistic for CPI, GDP, LC, and MP have a significant negative joint effect since the reported value is 3.52 and its corresponding p-value is 0.0072. Alternatively, the joint impact of the macroeconomic variables with positive slopes, namely, EMP and CA, is neglected and not different from zero, as the statistic value and its p-value are 0.05 and 0.9542, respectively.

Further, GARCH (1,1) model is presented in the second column from table 3. The reported values of the mean equation are generally in the line with Dummy regression model represented
in the first column since the VSTOXX behaviour only affected by the monetary policy announcements. In more detail, the reported value for this dummy variable is -0.0326 and its corresponding p-value is 0.005. On the other hand, five out of six indicators, namely, CPI, GDP, EMP, LC, and CA have no impact on the VSTOXX behaviour. This means that the uncertainty of the financial market is not resolved due to get new information regarding these variables. On the other side, the reported results for the modelling of residuals shows that both lagged squared residuals and lagged conditional variance have coefficient different from zero. Given that the $\beta$ has value of 0.144 and the corresponding p-value is 0.000, while the $\delta$ is 0.73 and its p-value is 0.000. Further, the sum of these two parameters is less than one. This means that the GARCH (1,1) is stationary. To put it differently, as the time horizon increases the forecasted value of the conditional volatility will coverage i.e., approach faster from the unconditional volatility (Tsay, 2013, p.201). On the other hand, the sum of $\beta + \delta$ is account for almost 0.87, that means the volatility exhibit persistency. This indicates that volatility i.e., the uncertainty caused by macroeconomic announcements will require longer time to get back to its normal level. Furthermore, the reported Ljung-Box Statistic is 17,1200 and the corresponding p-value is 0.1568 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model is appropriately fit the data.

Further, given that the return may be affected by its past volatility, the GARCH-M (1,1) is employed to account for this probability. As it demonstrated in the third column, the value of the risk Primmum is 1.003877 is positive but insignificant at 5%, since its p-value is 0.402 which is larger than 5%. This indicating that there is no feedback between the conditional volatility and conditional return. In other words, the investor in the Eurozone does not consider the risk premium i.e., conditional volatility as explanatory variable for the log change of the VSTOXX (see Tsay, 2013, p. 2013). On the other side, in the line of previous estimations, only the change of MP announcements can explain the variations of the volatility. as the estimated coefficient is negative and different from zero at usual 5% significant level. More important, the GARCH part of the model indicates that both ARCH and GARCH terms have significant coefficient. Additionally, the sum of these parameters $\beta + \delta$ is less than their values in the GARCH (1,1) model. This indicating that adding the volatility to the mean equation in the GARCH-M (1,1) improves its performance compared to the previous model, in terms of mean reversion. Moreover, the reported Ljung-Box Statistic is 18,6829 and the corresponding p-
value is 0.0965 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model is appropriately fit the data.

In the same fashion, EGARCH (1,1) is employed to account for the asymmetric effect of the nature of the content of macroeconomic news on volatility. as it is evident that parameter \( \gamma \) is positive and different from zero. Given that the reported value for this parameter is 0.130 and the corresponding p-value is 0.000. This means that the good news (i.e., bad news for returns) has a greater impact on the volatility in comparison to the negative news (i.e., good news for returns). Furthermore, as it appears from the mean equation that only MP variable has a negative and significant slope, this tells us two things: one thing the MP announcements have an impact on the uncertainty, and the second thing the uncertainty goes down which means that the nature of the content of the announcement is in the favor of the market. Moreover, the reported Ljung-Box Statistic is 17.0160 and the corresponding p-value is 0.1490 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model is appropriately fits the data.

Hence, the overall message of this analysis, only one economic variable, namely, the MP dummy variable has a significant impact on the uncertainty of the financial market. practically speaking, the investors in the Eurozone only consider the Monetary policy announcements as a source of information for their investment decisions and financial planning. Further, the other macrocosmic indicators, namely, CPI, GDP, EMP, LC, and CA have no significant impact on the uncertainty. One possible explanation for this result, the evidence shows that the market only reacts to the surprise news (Tamgac, 2021, p. 2). The transparency of the macroeconomic reports in the Eurozone reduces the surprise component in these reports. this understanding by the weak reaction of the market to the upcoming news in the scheduled macroeconomic announcements.

4.2 Model 2 analysis

To investigate the behavior of the European implied volatility index VSTOXX during the surrounding dates of the major macroeconomic announcements. Dummy OLS regression, GARCH (1,1); GARCH-M (1,1), EGARCH (1,1) models are constructed and conducted in such a way that allows us to capture the behavior of the volatility over three points of time, namely, prior to the announcement day, during the announcement day, and after the
announcement day. The theoretical motivation for these procedures is mainly based on the option pricing theory. Given that the theory suggests that announcements that are expected to convey relevant information are usually led to increasing the anxiety and sentiment of the investors in the financial market, which translated by greater purchasing of the options contract to hedge, and the implied volatility goes up. Then, after the dissemination of information via the announcements, the volatility is expected to go back to its normal level (Nikkinen & Sahlstöm, 2004, p. 209; Ederington & Lee, 1996, p. 514).

The table 4 presents the OLS regression for the selected dummy indicators variables over three points of time. The results show that reported $R^2$ is 0.0214, which means that 2.14% of the variations of the uncertainty is explained by the dummy variables included in the model. consistently, F-statistic and corresponding P-value is 2.19 and 0.0027, respectively. This means that the OLS regression can provide some valuable information to help in interpreting the changes of the uncertainty. However, estimated slopes before the announcements for four of the dummy variables, specifically, CPI, GDP, EMP, and MP are positive but insignificant. This indicates that the investors in the European financial market exhibit little response to these reports before the announcements. Surprisingly, the findings demonstrate before the day of LC announcements, investors significantly react but in opposite direction to the literature. Given that the estimated slope for the dummy of LC before the announcements, is -0.0328, and its P-value is 0.019. This implies that investors become less anxious and nervous about the information of the labour costs, thus, the associated uncertainty will go down. One plausible explanation is that the investors are highly confident that the information that will convey by LC reports will be in the line with their expectations, and in the favour of the market. as result, the investors decrease their purchase of the options to hedge.

It is worth mention that our results are consistent with Shaikh and Padhi (2013, p. 435), who present mixed evidence regarding the behavior of the Indian implied volatility index. Given that the uncertainty of the Indian market increases more before the release of EMP reports, while in contrast, the uncertainty associated with each of WPI (inflation), and GDP reports go down inconsistent to the regarded literature
Table 4 Regression Estimation of Model 2

\[
\ln \left( \frac{VSTOX_t}{VSTOX_{t-1}} \right) = \alpha_0 + \sum_{i=1}^{t} \beta_{iMP} X_{tMP} + \sum_{i=1}^{t} \beta_{iCPI} X_{tCPI} + \sum_{i=1}^{t} \beta_{iLC} X_{tLC} + \sum_{i=1}^{t} \beta_{iEMP} X_{tEMP} + \sum_{i=1}^{t} \beta_{iGDP} X_{tGDP} + \sum_{i=1}^{t} \beta_{iCA} X_{tCA} + \epsilon^{VSTOX}_t
\]

\[\epsilon^{VSTOX}_t \mid \Omega_{t-1} \sim GED(0, \sigma^2, \nu)\]

the pre-assumption for each of GARCH, GARCH-M and EGARCH models

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS Regression</th>
<th>GARCH (1,1)</th>
<th>GARCH-M (1,1)</th>
<th>EGARCH (1,1)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intercept</td>
<td>0.0012646</td>
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<td>-0.0025282</td>
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</table>
\[ \ln\left(\frac{V_{STOXX_t}}{V_{STOXX_{t-1}}}\right) = \alpha_0 + \sum_{i=1}^{\infty} \beta_i^{MP} X_{t_i}^{MP} + \sum_{i=1}^{\infty} \beta_i^{CP} X_{t_i}^{CP} + \sum_{i=1}^{\infty} \beta_i^{LC} X_{t_i}^{LC} + \sum_{i=1}^{\infty} \beta_i^{EMP} X_{t_i}^{EMP} + \sum_{i=1}^{\infty} \beta_i^{GDP} X_{t_i}^{GDP} + \sum_{i=1}^{\infty} \beta_i^{CA} X_{t_i}^{CA} + \epsilon_t^{STOXX} \]

\[ \epsilon_t^{STOXX} | \Omega_{t-1} \sim GED(0, \sigma^2, \nu) \]

The pre-assumption for each of GARCH, GARCH-M, and EGARCH models is

<table>
<thead>
<tr>
<th>Variable</th>
<th>OLS Regression</th>
<th>GARCH (1,1)</th>
<th>GARCH-M (1,1)</th>
<th>EGARCH (1,1)</th>
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<td>0.0027</td>
<td></td>
<td></td>
</tr>
<tr>
<td>F-statistic</td>
<td>16.2133</td>
<td>0.1817</td>
<td>16.0660</td>
<td>0.1882</td>
</tr>
<tr>
<td>LB-Q(12)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Note:** the table above presents the outcome estimation for the model according to OLS regression, GARCH (1,1), GARCH-M (1,1), and the GARCH (1,1) the bold values indicate that the estimated parameter is significant at both significant level 5%.
On the other side, regarding the behaviour of the VSTOXX index during the announcement days, the reported results are in the line with model 1 in terms that only MP has a significant impact on the uncertainty. Given that its estimated slope is -0.027177 and the corresponding P-value is 0.007. This means that the MP reports are in the favour of the market and investors regards the MP reports as a valuable source for information. Alternatively, the impact of the macroeconomic reports after announcements is reported to be insignificant. This means that the investors provide little reaction after the release of the macroeconomic reports. Thus, the impact on the uncertainty can be neglected. This result is largely consistent with Nikkinen and Sahlström (2004, p. 214), who provide empirical evidence that uncertainty is not affected after macroeconomic news is released. Furthermore, the reported Ljung-Box Statistic is 16.2133 and the corresponding p-value is 0.1817 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model appropriately fits the data.

Hence, according to the OLS estimators, our results are greatly in accordance with Nikkinen and Sahlström (2004) in terms that the uncertainty only resolved during the announcements days. Given that estimated slopes before and after the announcements are in most, insignificant. While only the dummy variable for the MP indicators only has a statistical impact on the uncertainty.

Regarding the non-parametric test, GARCH (1,1) model, the results show that the CPI has a statically impact on the uncertainty before the announcement day. Given that the estimated slope is 0.014919 and its P-value is 0.046. This means that the uncertainty increases before the announcement day of CPI (proxy of inflation). This result is in the line with the litterateur (option pricing theory), and with (Shaikh and Padhi, 2013, p. 437; Nikkinen & Sahlström, 2004, p. 214). In contrast, the result show also that the uncertainty tends to decrease before the announcement days for the EMP reports and the LC. Given that the estimated slopes are -0.0315477 and -0.0325444, respectively, are significant at the usual 5% significant level. A candidate explanation for this result is that despite the investor consider the LC and EMP reports as sources of information, however, they present little reaction for this information in terms of hedging and buying in the options market. It worth mention that our result slightly supports the reported finding by Shaikh and Padhi (2013, p. 435), who report similar results but for WPI, and GDP reports. Additionally, the results confirm also that the uncertainty regarding the MP reports is resolved during the announcement days. Further, after the
announcement days, only the dummy for the EMP reports is found to be statistically significant and negative. Given that the reported value is -0.0315477 and its P-value is 0.027. This indicates that the reaction to these reports continues several days after the announcements. As such, Shaikh and Padhi (2013, p. 435), show that uncertainty associated with GDP reports tends to decrease after the spread of GDP reports. On the other side, the estimated parameter for the lagged squared residuals and the lagged conditional variance is highly significant at a 5% significant level. In addition, the sum of these two parameters is less than zero. This indicates that conditional variance goes back to its mean value in the long run i.e., Mean reverts. Moreover, the reported Ljung-Box Statistic is 16.0660 and the corresponding p-value is 0.1882 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model appropriately fits the data.

Here, by GARCH-M (1,1), which is used to examine the impact of the conditional variance on the mean equation. However, the results show that risk Primum (conditional volatility) is positive and insignificant at a 5% significant level. As the reported value of the risk Premium is 0.5560295 and its P-value is 0.638. This means there is no feedback between the conditional variance and the mean equation. In other words, the investors in the European market will not consider the increase of the VSTOXX as a driving factor to demand an extra return on the underlying assets of this index. However, this finding inconsistent with Shaikh and Padhi (2013, p. 437). In addition, the results for the impact of the announcements on the uncertainty over the selected three-point of times are greatly consistent with reported results for the GARCH (1,1) model. Furthermore, the reported Ljung-Box Statistic is 17.0087 and the corresponding p-value is 0.1493 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model appropriately fits the data.

Finally, results for the EGARCH (1,1) show that the parameter $\gamma$ is found to be positive and different from zero. Given that its value is 0.1381611 and its p-value is 0.000, which means that macroeconomic reports that are not in the favour of the market (i.e., bad news for returns) have a greater impact on the volatility (i.e., increase the volatility) in comparison to those that convey information that is in the favour of the market. Furthermore, the reported Ljung-Box Statistic is 15.9830 and the corresponding p-value is 0.1920 is larger than 5%. Thus, we fail to reject the null hypothesis of this test, which states that there is no autocorrelation. This means that the model appropriately fits the data.
5. Conclusion

The main issue addressed in this study was the impact of the macroeconomic announcements on the uncertainty in the financial market. More clearly, the behavior of the implied volatility index, as a proxy for the uncertainty, in response to the macroeconomic news. To this end, the researcher chooses the European volatility index for the Eurozone i.e., the VSTOXX index alongside six of the major macroeconomic announcements, namely, CPI, GDP, EMP, LC, MP, and CA. The attention should be placed here that these announcements are carefully selected based on the previous literature.

For the sake of answering the research question, the researcher chose a sample of data comprising the daily closing values for the volatility index in the Eurozone VSTOXX over the period span from 2 January 2015 to 31 December 2020. In addition, Effective dates are gathered for the main macroeconomic announcements in the European zone i.e., CPI, GDP, EMP, LC, MP, and CA over the sample period. Here, it is important to realize that GDP, EMP, and LC reports are disseminating on a quarterly basis, whereas information regarding CPI, MP, and CA are publishing on the monthly basis.

The reported results from this study provide practical evidence to confirm that monetary policy announcements (MP) have a significant impact on uncertainty. To put it differently, the uncertainty associated with monetary policy is resolved during the announcement days. This result supports the finding by Nikkinen and Sahlström (2004, p. 214), who present great evidence that the interest rate reports for the U.S have a great impact on the uncertainty in each of Germany and Finland. Alternatively, it is incompatible with Shaikh & Padhi, 2013, p. 433), who found that the volatility index only affected by the GDP reports. Alternatively, the other five announcement variables tend to have a neglected impact on the uncertainty. As one plausible explanation for this result, I argue in the line with Ederington and Lee (1996, p. 520), if the market expectations match with the content of the announcements, the market is not expected to sharply adjust their asset prices. This means that the price of options written on these assets will not change, thus, their implied volatility will not be affected. Additionally, the transparency and good reputation of the formal EU institutions play important role in mitigating the surprising component of their announcements, which in turn, gives rise to improve the accuracy of the market expectations and lessens the chance of mismatching between the market expectations and the content of the macroeconomic announcements.
Indeed, this argument is broadly consistent with the literature that explicitly states that according to the EMH the market only significantly reacts to the surprise part of the announcements, while the expected announcements left the unaffected market (Smales et al., 2015, p. 710; Tamgac, 2021, p. 2).

On the other hand, the intercept which is assumed to capture the uncertainty during non-announcement days, thus, is expected to be positive and different from zero. However, the reported finding provides strong evidence against this hypothesis. As the estimated value of the intercept in all estimated models [i.e., OLS regression, GARCH (1,1); GARCH-M (1,1); EGARCH (1,1)] is found to be insignificant i.e., not different from zero. In this regard, this result is incompatible with Shaikh and Padhi (2013, p. 433); Ederington and Lee (1996, p. 521). Nevertheless, our reported result makes a lot of sense and consistent in general with the literature. On the understanding that the intercept statistically represents the mean value of the log change of the VSTOXX index, and the account that difference between the return (i.e., the log change) with its standard deviation over the daily basis series is assumed to be zero (Hull, 2015, p.210). in this sense, the intercept is more logical to be zero than to be positive and different from zero. Further, consistent with Shaikh and Padhi (2013, p. 433), the results show that the joint effect of the announcements that have the hypothesized sign (i.e., CPI, GDP, LC, and MP) is significant and negative. This implies that the investor in the European financial market regard more than one announcement as the source of the information when they make their investment decisions.

Regarding the behaviour of the implied volatility index VSTOXX during the days surrounding the announcements, the results demonstrate that estimated slopes before the announcements for four of the dummy variables, specifically, CPI, GDP, EMP, and MP are positive but insignificant. This indicates that the investors in the European financial market exhibit little response to these reports before the announcements. In other words, the uncertainty before the announcement days is not expected to increase as the options pricing theory suggests. Surprisingly, the findings also demonstrate that only before the day of the LC announcement, the reaction of the investors is significant, however, in opposite direction to the literature i.e., the uncertainty resolved before the announcements. One plausible explanation is that the investors are highly confident that the information that will convey by LC reports will be in the line with their expectations, and in the favour of the market. As result, the investors decrease their purchase of the options to hedge. In this regard, the finding of this study is consistent with
Shaikh and Padhi (2013, p. 435), who present mixed evidence regarding the behaviour of the Indian implied volatility index. Given that the uncertainty of the Indian market increases more before the release of EMP reports, while in contrast, the uncertainty associated with each of WPI (inflation), and GDP reports go down inconsistent to the regarded literature.

On the flip side, the impact of the macroeconomic reports after announcements is found to be insignificant. This implied that the investors provide little reaction after the macroeconomic news releases. Thus, the impact on the uncertainty can be neglected. However, this result is largely consistent with Nikkinen and Sahlström (2004, p. 214), who provide empirical evidence that uncertainty is not affected after the macroeconomic news is released.

The overall message is that, according to the OLS estimators, the findings of this study are greatly in accordance with Nikkinen and Sahlström (2004) in terms that the uncertainty only resolved during the announcement’s days. Given that estimated slopes before and after the announcements are in most, insignificant, while only the dummy variable for the MP announcements has a statistical impact on the uncertainty.

The reported results of the non-parametric tests GARCH (1,1); GARCH-M (1,1), EGARCH (1,1) support the findings of the OLS regression and largely consistent with them. The GARCH-M (1,1) results, in contrast to Shaikh and Padhi (2013, p. 437), present strong evidence that there is no feedback between the conditional variance and mean equation. In other words, the investors in the European market will not consider the increase of the VSTOXX as driving factor to demand extra return on the underlying assets of this index. The EGARCH (1,1) results clarify that macroeconomic news that are in the favour of the market (good news) have a greater impact on the volatility (i.e., dampen the volatility) in comparison to those that convey information that is not in the favour of the market.

Finally, it is worth mentioning that one of the potential limitations for this study is that ignored the nature of the content of macroeconomic information on uncertainty, as it placed its focus on the effective dates for these announcements and overlooked the content. In addition, the paper does not examine the impact of transparency of the macroeconomic reports on the uncertainty in the financial market, all of these represent research topics candidate for further studying and research in the future.
6. References


