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Impact of CPI announcements and Rate decisions on stock returns during Quantitative tightening: Evidence from the post pandemic period.

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ABSTRACT

The COVID-19 pandemic brought shocks to the economy that would have been extreme to most members of society; lockdowns, supply chain issues and disease were some of these main drivers. The present study investigates the effects of inflation surprises and monetary policy surprises on US stock prices during the post COVID-19 period of Quantitative tightening.

Inflation surprises were calculated using CPI reports and its expectations, monetary policy surprises were calculated using CBOT 30-day FED funds rate futures. The S&P500 was used a proxy for the US stock market.

Keywords: quantitative tightening, inflation surprises, monetary policy surprises, S&P500, futures.

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Table of Contents

ABSTRACT iii
LIST OF TABLES v
CHAPTER 1 Introduction 1
CHAPTER 2 Literature Review 4
2.1 Monetary policy and Interest rates 4
2.2 Monetary policy and its impact on financial markets 5
2.3 Futures rates to gauge Policy expectations 5
2.4 Monetary policy surprises and Stock market prices 6
2.5 Inflation surprises and Stock market profitability 6
CHAPTER 3 Data 8
3.1 Data Source Description 8
3.2 Sample Description 8
3.3 Variable Description 8
3.3.1 Dependent Variable 8
3.3.2 Independent Variables 9
3.3.3 Control Variable 10
3.4 Descriptive Statistics 11
3.5 Multicollinearity check 12
3.6 Normality test 14
CHAPTER 4 Methodology 15
4.1 Event window method 15
4.2 Regression analysis 16
CHAPTER 5 Results and Discussion 17
5.1 Statistical results 17
5.1.1 Hypothesis 1 17
5.1.2 Hypothesis 2 18
5.1.3 Hypothesis 3 19
5.2 Robustness check 20
CHAPTER 6 Conclusion 23
REFERENCES 25
APPENDIX A Data and Variables 30

LIST OF TABLES

Page

Table 1 Descriptive Statistics 12

Table 2 Correlation matrix of Monetary policy surprises as the independent variable 13

Table 3 Correlation matrix of Inflation surprises as the independent variable 14

Table 4 Robust regression results of Monetary policy surprises on Stock Performance 18

Table 5 Robust regression results of Inflation surprises on stock 19

Table 6 Robust regression results of Monetary policy surprises and Inflation surprises on Stock performance 20

Table 7 Robustness check of Monetary policy surprises on Stock Performance using the Nasdaq index 21

Table 8 Robustness check of Monetary policy surprises and Inflation surprises on Stock Performance using the Nasdaq index 21

CHAPTER 1 Introduction

Monetary policy today has been at the forefront of news worldwide where we have seen the United States Federal Reserve Bank (FED) and other central banks raise interest rates at a rate never seen before. This monetary policy response comes to combat high inflation numbers caused by numerous factors such as supply chain issues, expansionary fiscal and monetary policies that affected the economy before and during the pandemic period. Interest rates went to 0% at the start of the pandemic period to avoid more economic set downs and are set to 5.5% targeted by the end of 2023.

The regime switch from monetary easing to monetary tightening came for many investors still as a surprise, even though the FED had prepared the market. The surprise effect was visible in the difference between official interest rate increase priced in the FED futures and the actual FED funds rate increase. So, the first-rate hike had the largest (surprise) effect on stock values. Later FED funds rate increases came much less as a surprise.

This period of uncertainty also included some market movements that can be argued to be less then efficient. One example was game stop, a stock that got "manipulated" and surged in value before trading being restricted. In February 1994 the FOMC started explicitly announcing rate changes, which changed the functioning of the meetings and made changes in the interest rate more predictable. On the other hand, the pace the FED wants to use to achieve their target is up to them. It is known from theory the negative relationship between interest rates and stock prices as studied by Thorbecke (1997). Due to monetary policy being a huge factor in investment decisions, many finance professionals and retail investors could benefit from deeper understanding into these different types of shocks from monetary policy surprises.

Previous research has mainly been on the Federal reserve monetary policy (interest rate) and its effects on US asset prices (Rigobon & Sack, 2002). More importantly, Patelis (1997) studied the relationship between monetary policy surprises and stock returns by employing a long horizon approach as Fama and French (1988). He found that monetary policy shocks primarily affect excess returns, followed by expected dividend growth. Sekandary & Bask (2023) in their research for the period 1994-2015 found significant results that when uncertainty around monetary policy was high, positive (negative) monetary policies surprises decrease (increase) U.S stock returns for all portfolios used in the paper. They also found that positive (negative) monetary policy surprise by the FED has a larger negative (positive) effect on US stock returns when the uncertainty around monetary policy is high. On the other hand, Swanson et al. (2005) also finds significant results for the effects of monetary policy surprises on stock prices in the US but argues that other information relayed by the FOMC has more influence over these price changes.

Many studies have suggested that market efficiency has increased, with anomalies in the market shrinking or disappearing (Renshaw, 2020). However, it remains unclear if this efficiency extends to monetary policy surprises. The COVID-19 pandemic has provided a unique opportunity to explore this question, as it has demonstrated the Federal Reserve's power in controlling consumer behavior in the United States. Understanding the relationship between monetary policy surprises and stock prices during this period can provide a new perspective on market efficiency and its impact on firms' risk management strategies. The last couple of years, the COVID-19 pandemic provided a large amount of data regarding monetary policy shocks and has created new observations to deepen the study. Moreover, incorporating additional relevant variables and a different data source can provide a more nuanced understanding of this relationship. After drawing inspiration from the article by Kuttner (2004) and conducting a thorough review of related literature, the research idea behind this thesis is to replicate the traditional empirical model explored by scholars while incorporating additional data from the COVID-19 pandemic. This data is substantially different than previous as we have seen a large inflow of retail investors and less then "normal" market movements during the COVID-19 pandemic period. Finally, the objective is to investigate how the effects of US monetary policy surprises on stock prices has changed around the COVID-19 pandemic period. In summary, the study is relevant as it seeks to shed light on a timely and important topic that has implications for both theoretical and practical considerations in finance. Therefore, the research question of this thesis is stated as:

"What were the effects of monetary policy and inflation surprises during the monetary tightening cycle of the COVID-19 pandemic and post pandemic period?

In order to measure the monetary policy surprises, the daily data for the 30-day futures for the FED funds rates is going to be used as an indicator of these surprises as in the work from Kuttner (2004). The 30-day FED funds futures rates tend to move very little on a daily basis close to 0.01%. On the other hand, we can see that the largest movements are on days of meetings by the FED or days with important macroeconomic news. In order to study these effects we will run an event study that will check for short term movements in asset prices due in periods where these monetary policy surprises have happened. The event study approach has been used by many scholars that have conducted research about the effects of monetary policy surprises (Kuttner, 2001; Swanson et al, 2005). These monetary policy surprises will be identified using an event study around the monetary policy announced time as in Kuttner (2001), event study is used to avoid the stock price changes before the announcement and other macroeconomic events to affect the independent variable (FED monetary policy decision). Testing 3 different event windows will serve to check the findings in Kuttner (2001) that monetary policy changes were incorporated almost immediately into these FED fund futures.

If assumed higher market efficiency today, surprises should be less frequent and weaker so the expected effects of surprises of similar sizes should be smaller. It will be interesting to look into if markets are more efficient at assimilating the information used by the FED in their decisions. From previous similar literature such as Kuttner (2001) the results are expected to show a relationship between these different types of surprises and stock prices. On the other hand, there is also evidence from the literature that the effects of monetary policy surprises work through the change of expectations for future excess returns and expectations of future dividend growth. Therefore, assuming that information today is better incorporated into the market (higher market efficiency), the expected findings of this thesis research is that these results should be less significant with time. We believe that this research will help to complete the missing pieces of the current literature and provide insights into a significant portion of the data's variability.

The rest of this paper will be organized as follows, chapter 2 discusses the previous research done on Monetary policy and inflation surprises, and other important relevant factors for the construction and understanding of this paper. Chapter 3 presents information about the data sample and variables of interest, followed by a multicollinearity and a normality test. Chapter 4 discusses the methodology applied in this paper to empirically test the research question. Chapter 5 presents the results of the empirical research and a robustness check, lastly, Chapter 6 gives a final conclusion, discusses limitations and future research on the topic.

CHAPTER 2 Literature Review

2.1 Monetary policy and Interest rates

For the purpose of this study, firstly we should understand the concept of monetary policy. Monetary policy is a tool that the Federal Reserve (FED) can implement to control consumer behaviour and influence inflation and growth in the economy. Monetary policy, in simplified terms, works by adjusting interest rates in the economy in order to make borrowing more or less expensive. The regulators achieve this by buying or selling treasury securities, adjusting the money supply for the economy.

There are two monetary policy tools available to Central banks. The first one, quantitative easing (QE), is used when slower growth or a recession is expected in the economy. In the case for the United States (US) the FED would decrease its targeted interest rate for the economy, thus decreasing the cost of money in the economy and increasing the money available to induce growth in the economy. On the other hand, quantitative tightening (QT) works by increasing the target for interest rates in the economy. Higher interest rates in the economy relate to a more restricted money supply, making a loan taken for a business or for personal use more costly.

The first paper to study the market's reaction to monetary policy was Cook and Hahn (1989), where they examined the one-day responses of bond rates to changes in the Targeted FED Funds rate for the period between 1974 and 1979. The sample contained 75 days where the FED changed the target for the funds rate. The authors found positive and significant results for target rate increases for all bond maturities, but the effects get smaller as the bond maturity increases. Cock and Hahn (1989) also recognized that actions by the FED could be already anticipated by the markets, but they found little evidence of any anticipation on a one-to-two-day horizon.

Later studies failed to confirm the findings in Cook and Hahn (1989), Reinhart and Simin (1997) and Roley and Sellon (1995) were not able to find any significant results when studying the relationship between interest rates and Federal funds target changes. Thornton (1998) explained these results by saying that the target changes are endogenous to the model, and are expected, therefore not constituted as a surprise. Kuttner (2001) adds that the failure in Cook and Hahn's study is due the expected and surprise component of the change being grouped together.

2.2 Monetary policy and its impact on financial markets

QT and QE are monetary policies that can control price volatility in the economy. From the name of two terms, it seems that both policies are the same but in different directions. However, in practice QT has more muted effects then its counterpart.

Literature points to potential explanations as presented by Schnabel (2023) in her speech for the European central bank. Firstly, QT does not have the signalling power of QE. While balance sheet expansions (QE) signal lower-for-longer interest rate policy in the economy, balance sheet reductions provide little to no information of future short-term interest rates. Another reason is that QT is more commonly used in environments with improved market functioning. On the other hand, it is obvious to say that QE was incredibly effective at improving liquidity and reducing volatility during the breakout of the COVID- 19 pandemic.

Other papers that strengthen this relationship comes from the results of Fawley and Neely (2013), the authors found that the QE applied to the aftermaths of the 2007-2009 financial crisis was successful in increasing asset prices.

2.3 Futures rates to gauge Policy expectations

In the last decades, there are different literature that attempts to gauge expectations for policy decisions. The use of futures as a measure for monetary policy surprises comes from Kuttner (2001) that first separated the expected and unexpected part of monetary policy. He showed that the effect of the expected part of the monetary policy change had little to no effect in asset prices, and the important factor is the unexpected component. Furthermore, Swanson (2005) uses a high frequency event study to identify abnormal movements in the FED funds futures. The author uses a narrow window around FOMC announcements, and bases its works on the original work from Kuttner (2001). In a later study, Gurkaynak, Sack and Swanson (2007) show that FED funds futures arrive to the best forecasts for a horizon of up to 6 months reinforcing the futures capability to capture market expectations.

In the paper from Nakamura and Steinsson (2018), they apply the same high frequency event study method as Swanson et al (2005), in order to identify the monetary policy surprises referred to as shocks in their paper. This method is chosen with the objective of avoiding other factors affecting the dependent variable in the event window. For example, Cochrane and Piazzesi (2002) show that Vector Autoregressive (VAR) method identifies movements after 11 of September 2001 as an anticipation of a change of interest rates by the FED, instead of a terrorist attack, thus the model fails to identify a change in expectations of future output due to some exogenous event. Later, the authors Alessi and Kerssenfischer (2019) found that small scall VAR's suffer from "nonfundamentalness" as called by the authors and yield biased results. They explain this by stating that agents observe vastly more information then the VAR model is able to include.

An attractive alternative to calculate these expectations is survey data, was used by Andersen et al. (2003) where the author uses Money Market Services (MMS) survey data in their study about the effects of macroeconomic announcements on exchange rates and volatility. The authors find that in the sample period between 1992 and 1998, positive monetary policy surprises appreciate the dollar in 4 out of 5 exchange rates.

2.4 Monetary policy surprises and Stock market prices

Previous literature as Jarocinski and Karadi (2018) study the relationship between monetary policy surprises and equity ETF's. The authors find that there is an overreaction of the S&P 500 ETF (SPY) that includes the 500 largest publicly traded companies in the US, in the first 5 trading minutes after the announcement. The authors also find that after 45 minutes, an unanticipated 25 basis point cut in the federal funds rate target meant an increase of 1.2 to 1.6 percent in the SPY. They also found that the SPY (S&P 500) and MDY (Mid Cap 400 S&P ETF) react more strongly to surprise cuts then surprise increases in the Federal funds rate target. The authors also find that the market reacts stronger to monetary policy surprises during monetary tightening period.

Another author that found a significant relationship was Swanson et al (2005) who regressed the monetary policy surprises on stock prices, bond prices and output, he finds that the main effect of FOMC on financial markets does not come from changes in the federal funds rate and that the main market mover are the statements the FED releases. These results point to the surprise component being responsible for changes in asset prices.

A different method to measure this relationship was used by Alessi and Kerssenfischer (2019), the authors used forecast error variance decomposition. The results showed that in a six month horizon the forecast error variance explained by the monetary policy shocks are larger than 16%, this means that the policy surprise explains at least 16% of the difference between the expected and actual prices.

2.5 Inflation surprises and Stock market profitability

The QT seen around the globe at the start of 2022 was without a doubt a measure to combat high levels of inflation worldwide. Inflation was mentioned everywhere from bank reports to news outlets. Researchers such as Kaul (1986) have studied how inflation surprises affect stock prices with significant results. These results are more significant for countries where monetary policy changes had occurred.

Given that the sample period starts at a point of policy change and that inflation was the main indicator for policy decisions, it would be interesting to study if inflation surprises would have a stronger effect on stock prices.

Firstly, inflation has been observed to be inversely correlated with stock prices. According to the literature the most important factor is inflation expectations. Kaul (1986) took a 30-year period and investigated the relationship between inflationary expectations and stock prices in the US, UK, Canada and Germany. The author finds that there is a significant inverse relationship between stock returns and inflation expectations, and it strongly depends on the inflation target set by the authorities. The author also found that there is no change in stock returns for countries that did not shift their monetary regime during the sample period, indicating that the policy shift could be responsible for the results.

Inflation can be a positive factor for the economy and can represent increased productivity and economic growth. That is if observed in reasonable levels, high levels of inflation reduce purchasing power and anchor people's expectations of future high inflation. The US has its inflation target set to 2%, which was adopted in January 2012 under the leadership of the chair Ben Bernanke. According to the Federal Reserve (2020) inflation targets are anchored at 2% because it is the most appropriate for maximum employment and price stability. For the last 10 years inflation has ran below its target of 2%. This can be seen as positive; it is understandable that not having higher prices for essential items reduces households' burdens. On the other hand, having inflation under target can weaken the economy; households and businesses will come to expect future inflation to also come under the target in the long run, which can pull inflation even lower. It is important to note that this effect can also work with higher inflation expectations, where these expectations would lead to higher inflation.

We can derive the following hypotheses:
Hypothesis 1: Positive Monetary policy surprises affect negatively stock returns around the day of the announcement.

Hypothesis 2: Positive Inflation surprises affect negatively stock returns around the day of the cpi announcement.

Hypothesis 3: inflation surprises have a stronger absolute effect then monetary policy surprises.

CHAPTER 3 Data

In order to understand the effects of QT applied on stock prices, in the wake of the COVID-19 pandemic. In this study multiple analyses will be done to understand these effects. Firstly, we define two possible sources of surprises; the announcement of interest rate decision made by the FED and the inflation reports, namely the CPI index released by the U.S bureau of Labor statistics.

3.1 Data Source Description

The data for this analysis was retrieved from the Bloomberg terminal, which is a powerful and flexible tool for finance professionals to access to real time market data. The Bloomberg terminal was used to retrieve the historical prices of the S&P 500 Index, the CBOT 30-day FED funds rate futures, interest rate change decision, the expected and actual Consumer Price Index (CPI) for the US and the VIX index

3.2 Sample Description

The sample period for the first regression starts from the first interest rate hike done by the FED on the 16^{th} of March 2022 until the last available QT observation on the 14^{th} of July 2023. This period was chosen because it had the most rapid increases in interest rates in the US history. This was a result from a previous rapid QE policy implemented to combat the effects of the COVID-19 pandemic to the economy. The final total sample size for the monetary policy surprise is 11 observations for QT announcements and 373 for non-announcement days.

The second sample is for the inflation surprise, it includes 19 observations for CPI announcement days, 365 non announcement days.

3.3 Variable Description

3.3.1 Dependent Variable

The dependent variable used in this study is *Stock Performance* and is measured using the S&P 500 index. The S&P500 or Standard and Poor's 500 index includes the 500 largest companies in the American stock market and these stocks are weighted by market capitalization. Specifically, the index price is determined by multiplying the market prices of the assets by their share of the index. Therefore, the variable *Stock Performance* measures the return of the S&P 500 as follows:

$$Stock\ Performance_t = \sum_{t=1}^{n} \frac{Stock\ Price_t - Stock\ Price_{t-1}}{Stock\ Price_{t-1}}$$

Where Stock Performance$_t$ is the cumulative returns for the stock index for the period t = day 1 until t = day n in the event window studied.

3.3.2 Independent Variables

Monetary policy surprises

Monetary policy surprises are the independent variable that uses the CBOT 30-day FED fund futures to measure monetary policy surprises during the sample period. We assume under the efficient market theorem that the CBOT 30-day FED funds futures has priced in any available information predicting future FED fund rate decisions. The method used to calculate the surprise originates from the paper by Kuttner (2001) where monetary policy surprises are measured through FED funds rate futures.
The first complication that arrives when trying to use the CBOT 30-day FED funds rate futures comes from the fact that the price of the FED funds future is based on a calculation using the average value of the specific month's effective FED funds rate. Due to this, it is necessary to remove the time averaging to get a correct measure of the expected FED funds rate for any specific day.

Another complication that cannot be ignored is the fact that these future contracts are based on the effective market rate, instead of the target FED funds rate. It is important to note that when taken monthly averages of the effective and targeted rate, these results differ within only a few basis points. Taking the daily frequency of the futures results in a too large difference between targeted and market rate.

In order to understand what the futures rate are, we can write down what these futures rates represent. The spot futures rate representing day t of month s, is shown below:

$$Spot\ Futures_{s,t} = E_t \frac{1}{m_s} \sum r_t + \mu_t$$

Where r_t is the average Funds rate and m_s is the number of days in the month s. Assuming markets are efficient with risk neutral investors, μ_t should be zero. A non-zero error would indicate that a time varying premium may be present.

The chosen monetary policy surprise calculation has less exposure to these problems and uses the one-day change in spot prices for the CBOT 30-day FED funds rate futures. This method assumes that the day before the announcement (t-1) the futures rate already embodies the expected change at (t) and (t+1). Given that the rate change goes as expectations we will not see any movement in the spot rates. Any surprise rate change will result in a change in the futures price. This change will be relative to the amount of days left in the month. Therefore, the one-day *Monetary policy surprises* is calculated as:

$$Monetary\ policy\ surprise_t = \sum_{t=1}^{n} \frac{m_s}{m_{s-t}} \ (Spot\ Futures_{s,t} - \ Spot\ Futures_{s,t-1})$$

Where Monetary policy surprise$_t$ is the cumulative abnormal returns of the FED fund rate futures for the period t = day 1 until t = day n in the event window studied, m_s is the amount of days in that specific month, and t is the day of the month when the announcement happens. $Spot\ Futures_{s,t}$ is the spot price for the 30-day FED funds rate futures for day t and $Spot\ Futures_{s,t-1}$ for the day before the announcement.

It is important to note that this calculation works for all but the last and first day of the month. In the case where the rate decision is made in the first day of the month, the one-month futures on the last day of the previous month should be used. On the other hand, a rate change made in the last day of the month would make that it would have no effect on that months spot price, when this is the case the difference in the monthly future rates should be used.

Inflation surprises

Inflation surprises is another independent variable used to investigate Hypothesis 2. The variable *Inflation surprises* will be retrieved from the difference between the actual and expected CPI reports. The CPI is a weighted average basket of consumer goods and services bought by households. The CPI is the preferred inflation measure used by the FED Chair Jerome Powell and gives a representation of the prices that American households are paying in common goods and services. The calculation for the *Inflation surprise* works by taking the announced Year over year CPI for the specific month and subtracting the expectation for that month, as follows:

$$Inflation\ surprises_t = Actual\ CPI_t - \ Expected\ CPI_t$$

Where Inflation surprise t is the abnormal effect of the CPI on the day of the inflation announcement The expected and actual CPI are retrieved from the US bureau of labor statistics, and are used without any transformations.

3.3.3 Control Variable

VIX performance

The control variable used in the regression analysis is *Volatility performance* measured using the VIX index as a proxy. Specifically, the VIX index is the annualized implied volatility for a hypothetical S&P500 stock option with expiration in 30 days. This proxy will be used to control for changes in the volatility in order to get a measure of the 30-day expected volatility of the US stock markets. The relationship between volatility changes and stock prices is a widely studied subject; for example, Haugen, Talmor and Torous (1991) find that changes in volatility were responsible for stock prices adjustments. *VIX performance* is then calculated as follows:

$$VIX\ Performance_t = \sum_{t=1}^{n} \frac{VIX\ Price_t - VIX\ Price_{t-1}}{VIX\ Price_{t-1}}$$

Where VIX perfomance$_t$ is the cumulative returns of the volatility index for the period t = day 1 until t = day n in the event window studied.

3.4 Descriptive Statistics

Table 1 presents the descriptive statistics of the variables used in this analysis. The announcement day is equal to 1 if there was an announcement in that day, and 0 otherwise. From the table, we can observe that the *Stock performance* variable has 11 observations for announcement days, corresponding to the 11 FED rate decisions. *Stock performance* had a positive mean of 0.297% and a maximum value of 2.99%. *Monetary policy surprises* also has 11 observations during announcement days, with a mean of -0.004%, and there are 373 observations for non-announcement days with a mean of -0.0139%. The *Volatility return* variable has the same amount of observations as the previous variables; its mean for announcement days is 0.088% with a high standard deviation of 0.0575. By comparing the means of announcement and non-announcement days we can observe that announcement days have a higher volatility on average in this sample period. Finally, the *Inflation surprises* variable includes only announcement days with 19 observations corresponding to the 19 CPI reports of the sample. The *Inflation surprises* in the sample have a mean of 0 and a maximum value of 0.3%, meaning that on average the surprises went to 0 and the maximum surprise was 0.3% for the sample period.

Table 1 Descriptive Statistics

Variables	Announcement Day	Obs	Mean	Std Dev	Median	Min	Max
Panel A Monetary policy surprises							
Stock performance	1	11	0.003	0.019	0.001	-0.025	0.030
	0	373	-0.0001	0.013	-0.001	-0.043	0.055
Monetary policy surprises	1	11	-0.0002	0.001	0.00	-0.002	0.0004
	0	373	-0.0007	0.009	0.00	-0.164	0.002
VIX performance	1	11	-0.043	0.060	-0.059	-0.131	0.041
	0	373	0.002	0.064	-0.009	-0.144	0.244
Panel B Inflation surprises							
Stock performance	1	19	0.0015	0.021	0.003	-0.043	0.055
	0	365	-0.0001	0.013	-0.0008	-0.040	0.031
Inflation surprises	1	19	0.0002	0.002	0.00	-0.003	0.003
	0	365	0.00	0.00	0.00	0.00	0.00
VIX performance	1	19	-0.027	0.083	-0.044	-0.107	0.198
	0	365	0.002	0.063	-0.009	-0.144	0.244

3.5 Multicollinearity check

A multicollinearity check is an important test to conduct when hypothesis testing. A model suffers from multicollinearity when the independent variables have a high correlation with each other. Having these highly correlated independent variables in the model can lead to higher variation in the estimates, tratios can be impacted making coefficients insignificant. Thus, having multicollinearity in the model will lead to higher difficulty in interpreting individual effects from variables. The issues exists when two or more independent variables have a correlation close to 1. In Table 2 the correlation matrixes results for the monetary policy surprise study are presented. The correlation matrix shows the relationship between the three variables, and the numbers presented the correlation coefficients. Table 2 includes the three event windows. We observe that the strongest correlation is -0.78 between *Volatility return* and *Stock performance* for the event window (-1,0) in Panel A, which indicates that these two variables move in opposite directions. The highest correlation between independent variables is -0.47 for event window (1,0), which poses no issues. Thus, we can assume that no multicollinearity is detected between independent variables. We can also observe that the correlation between stock performance and monetary policy surprises is positive in all 3 event windows, with the largest one being 0.43 for the event window (0,1).

Table 2 Correlation matrix of Monetary policy surprises as the independent variable

Variables	**(1)**	**(2)**	**(3)**
Panel A Event window (-1,0)			
Stock Performance	1.00		
Monetary Policy Surprise	0.21	1.00	
Vix Performance	-0.78	0.15	1.00
Panel B Event window (0,1)			
Stock Performance	1.00		
Monetary Policy Surprise	0.43	1.00	
Vix Performance	-0.62	-0.47	1.00
Panel C Event window (-1,1)			
Stock Performance	1.00		
Monetary Policy Surprise	0.39	1.00	
Vix Performance	-0.60	0.09	1.00

In Table 3, the correlation matrix for the study about inflation surprises is presented. We can observe that the strongest correlation is -0.84, between volatility return and stock performance for the event window (-1,1). When observing the correlations between the inflation surprise and stock performance, the strongest is -0.76 indicating a strong negative correlation between the two variables. Again, we can observe that the highest correlation between the independent variable (inflation surprise) and the control variable is for the event window (0,1) and equals 0.56.

Table 3 Correlation matrix of Inflation surprises as the independent variable

Variables	**(1)**	**(2)**	**(3)**
Panel A Event window (-1,0)			
Stock Performance	1.00		
Inflation surprises	-0.69	1.00	
Vix Performance	-0.76	0.44	1.00
Panel B Event window (0,1)			
Stock Performance	1.00		
Inflation surprises	-0.76	1.00	
Vix Performance	-0.77	0.56	1.00
Panel C Event window (-1,1)			
Stock Performance	1.00		
Inflation surprises	-0.74	1.00	
Vix Performance	-0.84	0.53	1.00

3.6 Normality test

In order to conduct a statistical analysis on the variable, we need to perform a test for the normality assumption. Using the Shapiro-Wilk test for normality, where the null Hypothesis is that the distribution of the sample does not differ significantly from a normal distribution. As we can observe from Appendix A2, all three event windows for monetary policy surprises have a p-value > 0.05 so we cannot reject the null that the distribution of the variables is not significantly different from a normal distribution. From this we can assume that the sample is normally distributed.

The second normality test is run on the sample for the inflation surprises, again we observe from appendix A3 that all three event windows have a p-value > 0.05, this means that we cannot reject the null that the distribution of the variables is not significantly different from a normal distribution. From this we can assume that the sample is normally distributed

CHAPTER 4 Methodology

This study will adopt an event study analysis. the event study methodology was used in order to examine the short run effect of these surprises (monetary policy surprises and inflation surprises) on stock prices in the period post the COVID-19 pandemic, more specifically the period of monetary policy tightening used to combat high inflation.

4.1 Event window method

The event window is the length of time around a specific event that is analysed and is important to take in consideration when structuring your analyses. An event window that is too long, there is a risk that other information will be released that will affect stock performance, thus polluting the estimated effects. On the other hand, a small event window can fail to capture all the effects of the announcements on stock performance. Using high frequency data can avoid other information affecting the results in the analyses and could be used as a good robustness check. Due to this data only being available behind a paywall it will not be used in this regression.

In this study 3 event windows were looked at, the first one (-1,0) includes the day t of the announcement and the day before t-1. Not including the day after the announcement can lead to not including the whole effect of the announcement for the monetary policy surprise, on the other hand it is the event window with the least exposure to another factor affecting the results.

The second event window is (0,1), including the day t of the announcement and the day after t+1. Including the day after the announcement can help capture the full effect of the announcement, the Federal Reserve only starts making transactions such as selling and buying securities in the day after the announcement. This event window has an obvious problem, the monetary policy surprises need the day before the announcement in its calculation. Given that the data used for monetary policy surprise is made of closing prices for the futures this event window would fail to capture the effect of the announcement, this issue is exclusive to the monetary policy surprise.

The last event window is (-1,1), as the largest event window it has the largest potential to capture the full effect of the announcement. This longer event window is the most susceptible to another factor polluting the results, due to a small number of observations and a 3 day event window it is possible to cross check if there were any major economic developments/news in the specific dates around the announcements.

4.2 Regression analysis

To test for the hypothesis 1 and 2, we use the statistical method of Robust regression. The robust regression method is an alternative to the ordinary least squares (OLS) regression. This method is designed to limit the effect of violations of assumption and can be used to limit the effects of outliers and other influential data distortions on the coefficients estimates. The robust regression works by performing a screening using Cook's Distance, presented below:

$$D_i = \frac{\sum_{j=0}^{n}(Y_j - Y_{j(i)})^2}{(p+1)\sigma^2}$$

where Y_j is the jth fitted response value, $Y_{j(i)}$ is the jth fitted response value, where the fit does not reach observation i, p is the number of regression coefficients and σ is the Mean Square Error based on all available observations.

If observation have Cook's distance > 1 it is a outlier and is dropped from the data. Following this, the robust regression performs biweight changes to assign weights to each of the different observations based on their influence.

The regression equation to test for hypothesis 1 is:

$Stock\ Performance_i = a + b_i * Monetary\ policy\ surprises_i + VIX\ performance_i + e_i$

Where *Stock Performance*$_i$ is the dependent variable, b_i is the coefficient of interest, *VIX performance*$_i$ is the control variable and e_i is the error term of the regression.

The regression equation to test for hypothesis 2 is:

$Stock\ Performance_i = a + c_i * Inflation\ surprises_i + VIX\ performance_i + e_i$

Where *Stock Performance*$_i$ is the dependent variable, b_i is the coefficient of interest, *VIX performance*$_i$ is the control variable and e_i is the error term of the regression

The regression equation to test for hypothesis 3 is:

$Stock\ Performance_i = a + b_i * Monetary\ policy\ surprises_i + c_i * Inflation\ surprises_i + VIX\ performance_i + e_i$

Where *Stock Performance*$_i$ is the dependent variable, b_i is the coefficient of interest, *VIX performance*$_i$ is the control variable and e_i is the error term of the regression.

CHAPTER 5 Results and Discussion

5.1 Statistical results

5.1.1 Hypothesis 1

In Table 4 we can find the results for robust regression done on monetary policy surprises relationship with stock prices. After running a white test, we observe that homoscedasticity assumption holds, therefore normal standard errors are used. The results show that the (-1,1), the largest event window that includes the day before and after the announcement, has the most explanatory power with an R-squared of 0.77, which indicates that *Monetary policy surprises* and *Volatility return* have a good explanatory power over *Stock performance*. This event window points to a positive relationship between *Monetary policy surprises* and *Stock performance* with a significance of 1%. A one unit increase in the *Monetary policy surprise* translates to a 9.269 unit increase in the stock performance. The control variable *Volatility return* is also significant at the 1% but with a negative relationship with the dependent variable. These results strengthen the findings from the original regression using the S&P500, indicating it could be a true relationship.

For the (-1,0) event window, that includes the day of the announcement and the day before the results show a positive but weaker and insignificant effect of *Monetary policy surprises*. *Volatility return* again shows a negative and significant relationship. This event window regression also has the highest constant of 0.007. finally, the R-squared of 0.69 also indicates the model has a good explanatory power, although with insignificant results for the monetary policy surprises. These results seem to indicate that the results from the original regression using the S&P500 may not hold when using the Nasdaq instead.

The last event window (0,1) does not include the day before the announcement. Since closing prices are used in the calculation, this event window will fail to capture the change from the preannouncement to post announcement, from previous literature this event window shouldn't be able to capture the surprise component. The results show a positive coefficient but insignificant for monetary policy surprises, while a negative but significant coefficient for volatility return. These results seem to indicate that the results from the original regression using the S&P500 may not hold when using the Nasdaq instead.

Table 4 Robust regression results of Monetary policy surprises on Stock Performance

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Monetary policy surprises	3.838	6.924	9.269***
	(2.30)	(5.20)	(2.49)
Control variable			
Vix Performance	-0.181***	-0.169**	-0.193***
	(0.04)	(0.06)	(0.05)
Constant	-0.005	0.007	0.005
	(0.006)	(0.004)	(0.005)
N	11	11	11
R^2	0.69	0.69	0.77

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

5.1.2 Hypothesis 2

The second robust regression results are shown in table xx. After running a white test, we observe that homoscedasticity assumption holds, therefore normal standard errors are used. These results show that there is a negative and significant effect of *Inflation surprise* on *Stock performance* in the sample. The longest event window (-1,1) shows a R-squared of 0.75, a strong explanatory power, but lower than the same event window for the model with *Monetary policy surprises*. The coefficients for volatility and inflations surprise are significant to the 1% and both have a negative relationship with stock performance. These results indicate that 1 unit change of the inflation surprise variable will cause a -6.381 unit change in the stock performance variable, while a 1 unit change in volatility return would lead to a -0.076 unit change in stock performance.

The results for the event window (-1,0), show a negative and significant to the 5% coefficient for inflation surprise, the r-squared of 0.68 is the lowest between the 3 event windows, but still highly explanatory. The control variable, volatility return shows a negative and significant relationship to the 1% with stock performance.

Finally, the results for the (0,1) event window, this event window doesn't suffer from the same problems as its monetary policy surprise counterpart, because no closing prices are used for the determination of the surprise. The coefficient for inflation surprise shows a negative result of -6.734, while volatility return shows a coefficient of -0.105, both are significant to the 5%.

Table 5 Robust regression results of Inflation surprises on stock performance

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Inflation surprise	-5.233**	-6.734**	-6.381***
	(1.95)	(2.45)	(1.52)
Control variable			
Vix Performance	-0.125***	-0.105**	-0.076***
	(0.04)	(0.03)	(0.03)
Constant	0.004	-0.002	0.003
	(0.003)	(0.004)	(0.002)
N	19	19	19
R^2	0.68	0.72	0.75

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

5.1.3 Hypothesis 3

Table 6 shows the results for the robust regression including monetary policy and inflation surprises together. The event window (-1,0), shows a positive coefficient for monetary policy surprises of 4.254, significant to the 10%. On the other hand, inflation shows a negative coefficient of -4.737, significant to the 5%. The control variable, Volatility return shows a negative coefficient of -0.145, significant to the 1% and the overall model shows a r-squared of 0.65 indicating a good explanatory power. In this event window we can observe that inflation surprises have a larger coefficient in absolute value, indicating 1 unit change in inflation surprises has a stronger effect on the stock performance then monetary policy surprises.

The next event window (0,1) shows a positive coefficient for monetary policy surprise of 9.357, but this is not a significant result. Inflation surprises show a coefficient of -6.360, significant to the 5%. The control variable Volatility Return, again, shows a negative coefficient of -0.117, significant to the 1%. We can also observe that the r-squared is smaller than the last event window and that the coefficient of monetary policy surprises is 50% larger than the one for inflation surprises.

Finally, the third event window (-1,1) results show a positive coefficient for monetary policy surprises of 8.918, while inflation surprises coefficient is -5.687, both are significant to the 1%. The control variable, volatility return shows a negative coefficient of -5.687, also significant to the 1%. This event window has the highest explanatory power with a r-squared of 0.82. From these results we can assume that the best event window to study the effects of the surprises is (-1,1) the event window that includes the pre announcement day and post announcement.

Table 6 Robust regression results of Monetary policy surprises and Inflation surprises on Stock performance

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Monetary policy surprises	4.254*	9.357	8.918***
	(2.15)	(6.67)	(2.00)
Inflation surprises	-4.737**	-6.360**	-5.687***
	(2.03)	(2.85)	(1.97)
Control variable			
Vix Performance	-0.145***	-0.117***	-0.163***
	(0.03)	(0.04)	(0.02)
Constant	0.002	-0.003	0.002
	(0.003)	(0.004)	(0.002)
N	30	30	30
R^2	0.65	0.58	0.82

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

5.2 Robustness check

In this section a robustness check is performed to check for the validity of results. A robustness check is a test where the regression is run with different specifications with the objective to test the same hypothesis. In order to make this test another regression will be run using the Nasdaq index as the stock performance indicator.

Table 7 shows the results of a robust regression of monetary policy surprises on the Nasdaq index. The coefficients for monetary policy surprises are 4.721 for event window (-1,0), 1.188 for event window (0,1) and 7.998 for event window (-1,1), which is consistent with previous results in table 4. These coefficients have the same sign as the robust regression using the S&P500, but they are all insignificant. The control variables all show larger coefficients in absolute value, indicating a stronger effect of volatility return on the Nasdaq when compared to the S&P500.

Table 7 Robustness check of Monetary policy surprises on Stock Performance using the Nasdaq index

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Monetary policy surprise	4.721	1.188	7.998
	(3.73)	(16.40)	(5.46)
Control variable			
Vix Performance	-0.210**	-0.286	-0.460**
	(0.07)	(0.19)	(0.18)
Constant	-0.001	0.002	-0.011
	(0.009)	(0.01)	(0.01)
N	11	11	11
R^2	0.54	0.28	0.58

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

The robustness check conducted in table 8, shows the results to a robust regression of inflation surprises using the Nasdaq as the stock performance. Firstly, the inflation surprises coefficients are all negative, consistent with the previous results in table 5, the values were -5.812 for the event window (-1,0), -6.028 for the event window (0,1) and -6,860 for the event window (-1,1). From these 3 results only the one for (-1,0) and (-1,1) were significant to the 10%. All 3 event windows have negative coefficients for the volatility return, what is consistent with all previous regression, apart from the fact that the coefficient for the event window (-1,1) is insignificant and shows the smallest explanatory power out of the 3 event windows.

Table 7 Robustness check of Inflation surprises on Stock Performance using the Nasdaq index

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Inflation surprise	-5.812*	-6.028	-6.860*
	(2.80)	(4.07)	(1.52)
Control variable			
Vix Performance	-0.157***	-0.150**	-0.090
	(0.05)	(0.05)	(0.03)
Constant	0.006	-0.004	0.007
	(0.005)	(0.006)	(0.005)
N	19	19	19
R^2	0.60	0.57	0.43

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

Table 9 shows the results for the robust regression of Monetary policy surprises and inflation surprises on the Nasdaq that is used as a proxy for stock performance. The estimated coefficient results for monetary policy surprises are all positive and size similar to the regression using S&P500 as stock performance, on the other hand only the (-1,1) event window is significant.

The estimated coefficients for inflation surprises are very similar for the different event windows, varying from -5.339 to -5.793. The coefficient for the event window (-1,0) is the only significant and only to the 10%. The Vix performance show all significant results with the strongest effect on the longest event window (-1,1).

Table 8 Robustness check of Monetary policy surprises and Inflation surprises on Stock Performance using the Nasdaq index

Stock Performance	(-1,0)	(0,1)	(-1,1)
Independent variable			
Monetary policy surprises	4.568	9.408	8.639*
	(3.06)	(10.81)	(4.46)
Inflation surprise	-5.339*	-5.566	-5.793
	(2.89)	(4.62)	(4.39)
Control variable			
Vix Performance	-0.175***	-0.166***	-0.184***
	(0.04)	(0.06)	(0.05)
Constant	0.004	-0.003	0.003
	(0.004)	(0.006)	(0.005)
N	30	30	30
R^2	0.56	0.44	0.52

Note. Standard errors in parentheses, *p<01, **p<0.05, ***p < 0.01

CHAPTER 6 Conclusion

The COVID-19 pandemic brought shocks to the economy that would have been extreme to most members of society, lockdowns, supply chain issues and disease are some of these main drivers.
The importance of monetary policy for macroeconomic stabilization is widely known and has been brought to the centre of media attention in the wake of the COVID-19 pandemic. Its impact on inflation, output and employment has motivated research to better understand how these policies affect different factors of the economy.

In this analysis an event study methodology is applied in order to study the effects of Inflation and monetary policy announcement surprises on a proxy for the US markets, namely the S&P500. CPI announcements are used to calculate the effects of inflation surprises and FED funds rate futures were used in the calculation of the monetary policy surprises.

The first hypothesis is “Monetary policy surprises affect negatively stock returns around the day of the announcement”. From the results of this analysis the hypothesis is rejected. These results are in line with previous literature about the effects of monetary policy surprises on asset prices. These results conflict with the fact that standard macroeconomic models calculate asset pricing based on their discounted expected payoff, higher FED rate targets should lead to lower stock prices due to assumed higher discount rates. These results could be related to the Signalling, a negative monetary policy surprise can signal for agents that more rate increases will be needed in the future.

The second hypothesis is “Inflation surprises affect negatively stock returns around the day of the CPI announcement”. From the results of this analysis the hypothesis cannot be rejected. These results come in line with previous findings and might indicate that inflation surprises were the main negative shocks, it is important to note that the largest positive return was for an inflation surprise on the 10th of November 2022 as seen in table A1 in the appendix.

The third hypothesis is “inflation surprises have a weaker absolute effect then monetary policy surprises”. From the results of this analysis, we cannot reject the hypothesis. The results showed that inflation surprises only had a stronger effect on the (-1,0) event window, that is one out of the 3 event windows tested. This could be explained by the fact that CPI reports released in a specific month n, the inflation report will be for month n-1, agents can perceive positive monetary policy surprises as prediction for higher inflation in month n-1, this could be a relevant topic for future study.

Finally, this study has consequences for investors and policy makers, these agents should increase their focus on the financial stability consequences of these shocks. The possible risks and returns to be made from announcement shocks during periods of quantitative tightening are considerable and cannot be overlooked.

Limitations and recommendations

It is important to note that there are a number of limitations to this study, which further research can focus on. Firstly, the data could be influenced by omitted variable bias, meaning that other factors might be influencing the results. This problem could be present due to an unobservable factor that affected the stock returns during the event window. A solution to this could be to run a high frequency regression using intraday event windows. Using a higher frequency data can greatly reduce the chances of omitted variable bias as it will be possible to study the event with a more precise window.

Another limitation is the sample period. This study has a very small sample period with not many observations. Increasing the sample period to for example all quantitative easing and tightening periods since the 2000s could make the estimated results more accurate and representative, thus closer to the true values.

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APPENDIX A Data and Variables

Table A1 Announcement dates of FED monetary policy and Inflation reports

Announcement Date	Surprise	Stock Performance	VIX performance
Panel A Monetary policy surprises			
06/14/2023	0.02%	0.08%	-5.00%
05/03/2023	-0.03%	-0.70%	3.15%
03/22/2023	-0.03%	-1.65%	4.12%
02/01/2023	-0.25%	1.05%	-7.89%
12/14/2022	0.00%	-0.61%	-6.25%
11/02/2022	0.00%	-2.50%	0.19%
09/21/2022	0.03%	-1.71%	3.06%
07/27/2022	0.00%	2.62%	-5.87%
06/15/2022	-0.04%	1.46%	-9.39%
05/04/2022	0.01%	2.99%	-13.09%
03/16/2022	0.04%	2.24%	-10.59%
Panel B Inflation Surprises			
07/12/2023	-0.10%	0.74%	-8.76%
06/13/2023	-0.10%	0.69%	-2.66%
05/10/2023	-0.10%	0.45%	-4.35%
04/12/2023	-0.20%	-0.41%	-0.05%
03/14/2023	0.00%	1.68%	-10.52%
02/14/2023	0.20%	-0.03%	-7.03%
01/12/2023	0.00%	0.34%	-10.72%
12/13/2022	-0.20%	0.73%	-9.80%
11/10/2022	-0.30%	5.54%	-9.81%
10/13/2022	0.10%	2.60%	-4.86%
09/13/2022	0.20%	-4.32%	14.24%
08/10/2022	-0.20%	2.13%	-9.32%
07/13/2022	0.30%	-0.45%	-1.72%

06/10/2022	0.30%	-2.91%	6.36%
05/11/2022	0.20%	-1.65%	-1.30%
04/12/2022	0.10%	-0.34%	-0.45%
03/10/2022	0.00%	-0.43%	-6.84%
02/10/2022	0.20%	-1.81%	19.79%
01/12/2022	0.00%	0.28%	-4.29%

Dates are presented as Month/day/year.

Table A2 Shapiro-Wilk test for normality of Monetary policy surprises as the independent variable

Variable	**Z value**	**p-value**	**Decision**
Panel A Event Window (-1,0)			
Stock Performance	-0.968	0.83	Do not reject the H0
Monetary Policy Surprise	1.293	0.10	Do not reject the H0
Volatility	-1.173	0.88	Do not reject the H0
Panel B Event Window (0,1)			
Stock Performance	0.294	0.38	Do not reject the H0
Monetary Policy Surprise	0.918	0.18	Do not reject the H0
Volatility	-0.779	0.78	Do not reject the H0
Panel C Event Window (-1,1)			
Stock Performance	-0.005	0.50	Do not reject the H0
Monetary Policy Surprise	1.371	0.09	Do not reject the H0
Volatility	1.592	0.06	Do not reject the H0

Table A3 Shapiro-Wilk test for normality of Inflation surprises as the independent variable

Variable	**Z value**	**p-value**	**Decision**
	Panel A Event Window (-1,0)		
Stock Performance	1.536	0.06	Do not reject the H0
Inflation Surprise	-1.267	0.90	Do not reject the H0
VIX performance	1.500	0.07	Do not reject the H0
	Panel B Event Window (0,1)		
Stock Performance	1.032	0.15	Do not reject the H0
Inflation Surprise	-1.267	0.90	Do not reject the H0
VIX performance	1.144	0.23	Do not reject the H0
	Panel C Event Window (-1,1)		
Stock Performance	1.497	0.09	Do not reject the H0
Inflation Surprise	-1.267	0.90	Do not reject the H0
VIX performance	1.249	0.16	Do not reject the H0