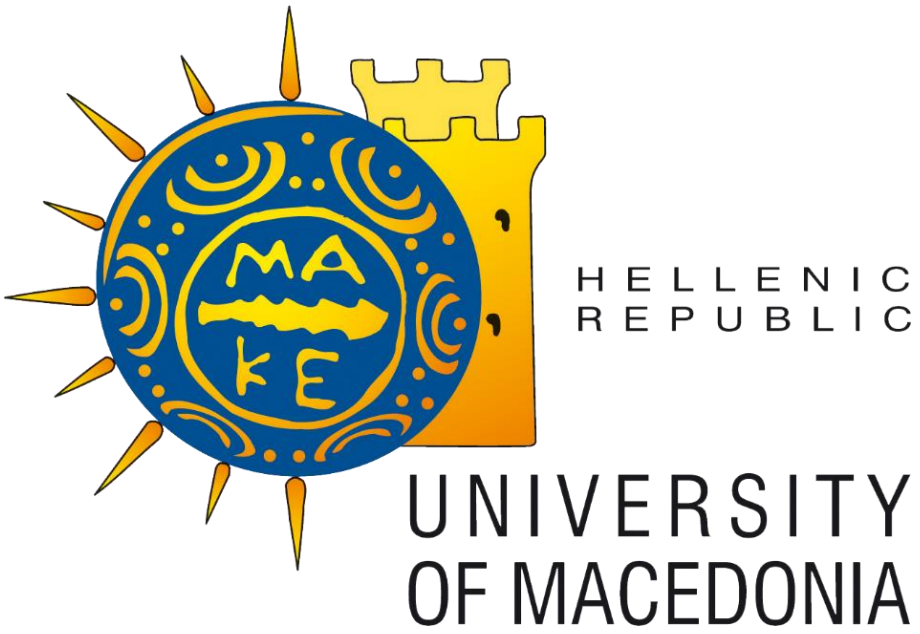

"Stock market returns and monetary policy. Identifying the effect of FED'S Forward Guidance on the stock market."

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Abstract

This paper investigates the relationship between the federal funds rate and the S&P 500 index using a vector autoregression (VAR). The VAR model with eight lags suggests that changes in the federal funds rate have a statistically significant impact on the S&P 500, with a one percentage point increase in the federal funds rate associated with a decrease in the S&P 500 of approximately 0.62%. Also 2 dummies were used to determine the effectiveness of forward guidance on the stock market. In the first dummy all the dates where forward guidance language was used, in the second dummy only dates with economic uncertainty where used. The results suggest that forward guidance only has significant effect on equity prices in times of economic uncertainty and if it manages to change GDP growth expectations.

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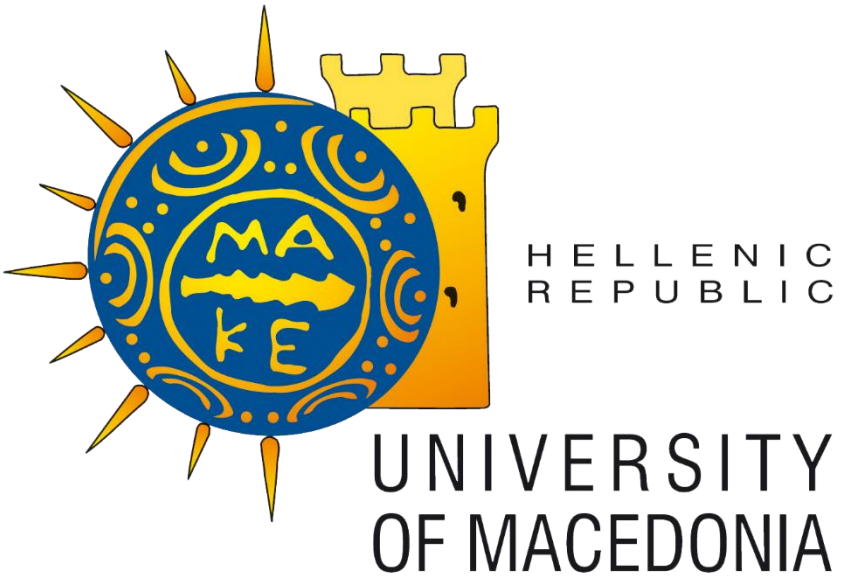


1.Introduction

The relationship between the equity prices and the Federal Funds rates has been a topic of interest for years, since the decision makers of the market could use this relationship to form their strategy. The federal funds rate target is the most important interest rate, through a finance channel it affects all other interest rates. Firstly, lets get into why was FED formed, what is the purpose of monetary policy tools and how many are there.

1.1Fed, Monetary Policy and success

So, 1913 was the year of the creation of the most important economic institution for the United states economy and probably the worlds. The Federal Reserve Bank was created after the signing of the "The Federal Reserve Act" and since then the FED uses monetary policy tools to affects and guide economy to the most desired level. The purpose of the FED is to control three variables of the economy output, inflation and unemployment. FEDS aim is to achieve minimum unemployment rate and keep inflation on low levels so that economy achieves maximum output. So, the way we evaluate the success of Federal Reserve actions is how close to the targets the bring these variables. Of course, Federal Reserve bank cannot directly affect these variables it can only use its tools and indirectly affect inflation, unemployment and output. Some of the key monetary policy tools used by the Federal Reserve include:

1. Open market operations. The Fed buys or sells government securities in the open market to influence the supply of reserves in the banking system, which in turn affects the interest rate at which banks lend to each other and to their customers.
2. Discount rate: The Fed sets the interest rate at which banks can borrow directly from the central bank, which can influence the cost and availability of credit in the broader economy.
3. Reserve requirements: The Fed requires banks to hold a certain percentage of their deposits in reserve, which affects the amount of money banks can lend and the cost of credit.
4. Forward guidance: The Fed provides explicit and transparent communication regarding future interest rates and other policy decisions, with the aim of influencing market expectations and guiding economic activity.

In this paper we are going to be focusing a bit on the fourth tool forward guidance. forward guidance was not one of the tools until recent years, I will summary what it is, when did the central banks start using and is it effective.

1.2 Forward Guidance

Forward guidance has become an increasingly popular monetary policy tool used by central banks around the world in recent years. This tool involves providing explicit and transparent communication regarding future interest rates and other policy decisions, with the aim of influencing market expectations and guiding economic activity. The effectiveness of forward guidance as a policy instrument has been widely debated in academic and policy circles, with some arguing that it can be a powerful tool for promoting economic stability and achieving policy goals, while others question its ability to impact the real economy and its potential negative effects on financial markets. This thesis aims to contribute to this ongoing debate by examining the impact of forward guidance on macroeconomic outcomes, financial markets, and the behavior of economic agents. Through an analysis of empirical evidence and theoretical models, this thesis seeks to provide a comprehensive evaluation of the strengths and weaknesses of forward guidance as a monetary policy tool, and to draw conclusions regarding its optimal use in different economic contexts.

1.3 Use of Forward Guidance

The Federal Reserve (Fed) began using forward guidance in the aftermath of the 2008 financial crisis. The first time the Fed explicitly used forward guidance was in December 2008, when it announced that it expected to keep the federal funds rate, which is the interest rate at which banks lend to each other overnight, at exceptionally low levels "for some time." This was followed by further forward guidance in the form of the so-called "extended period" language, in which the Fed stated that it expected to keep interest rates low for an "extended period" of time. The purpose of this forward guidance was to provide greater clarity and certainty to financial markets and the broader economy, and to help anchor long-term inflation expectations. By communicating its intentions regarding future monetary policy decisions, the Fed hoped to influence the behavior of borrowers, investors, and other economic agents, and to support the recovery from the crisis. Since then, the use of forward guidance has become a regular feature of the Fed's monetary policy toolkit, with varying degrees of specificity and effectiveness.

1.4Forward Guidance Effect Transition

Forward guidance can affect the stock market through several channels. One of the main mechanisms is by influencing investors' expectations of future interest rates and monetary policy decisions, which can affect the pricing of financial assets, including stocks. When the Federal Reserve provides guidance that it plans to keep interest rates low for an extended period of time, for example, investors may interpret this as a signal that monetary policy will be accommodative for longer, which can boost equity prices. Similarly, if the Fed signals that it plans to raise interest rates in the near future, investors may sell off stocks in anticipation of tighter monetary conditions, which can cause equity prices to fall.

Another channel through which forward guidance can impact the stock market is by affecting companies' access to credit and their cost of capital. If companies expect interest rates to remain low for an extended period of time, they may be more willing to invest and borrow, which can boost equity prices. Conversely, if interest rates are expected to rise, companies may be more cautious and reduce their investment and borrowing, which can lead to lower equity prices.

Overall, the impact of forward guidance on the stock market depends on the clarity, credibility, and effectiveness of the guidance, as well as the broader economic conditions and market sentiment. While forward guidance can be a powerful tool to influence market expectations, its impact on the stock market is not always straightforward or predictable, and can vary depending on a range of factors.

In this paper its examined whether the forward guidance, as FED’s monetary policy tool, influence the stock market prices.

2. Literature review

Forward guidance has been a subject of many papers, most of them tried to examine the subject with a different approach. One of the most important ones was by (Kuttner, 2001). In this paper Kuttner investigates the impact of Federal Reserve monetary policy decisions on interest rates, using data from the Fed Funds

futures market. He constructs a measure of "monetary policy surprises" - defined as changes in the federal funds target rate that are not fully anticipated by the market - using the Fed Funds futures market data, which provides a proxy for the market's expectations of future interest rates. Kuttner finds that Fed monetary policy actions often come as surprises to market participants, and these surprises can have significant effects on interest rates. Specifically, the author finds that when the Fed raises the target rate by more than expected, short-term interest rates tend to increase, while a surprise cut in the target rate leads to a decrease in short-term rates. In addition, he reports that these surprises can have a significant impact on the yield curve. Overall, Kuttner's findings suggest that monetary policy has a significant impact on the behavior of interest rates, and that this impact is not fully reflected in the expectations of market participants. The author argues that a better understanding of the impact of monetary policy surprises could help the Fed to better manage expectations and communicate its policy decisions to the market.

On the same vein, (Bernake & Kuttner, 2005) investigated the relationship between Fed policy announcements and stock market returns. The authors used an event study methodology to examine the market's reaction to Fed policy announcements from 1994 to 2001. As the “monetary policy surprises” they employed the one used by (Kuttner, 2001). They conclude that the market's reaction to Fed policy announcements is generally consistent with the expectations of market participants. However, the authors also find evidence of "excess volatility" in the market's response to some announcements, suggesting that market participants may not fully understand the implications of Fed policy decisions. In terms of the data used, the authors use a range of sources including the Wall Street Journal's "Fed Watch" survey and the Federal Reserve's "Beige Book" report to construct measures of market expectations and other economic variables.

(Ehrmann & Fratzscher, 2004) investigate the transmission of monetary policy to equity markets in the euro area. The authors use a vector autoregressive (VAR) model to examine the dynamic relationship between monetary policy, equity prices, and other macroeconomic variables. They report that monetary policy shocks can have a significant impact on equity prices, with expansionary monetary policy leading to higher equity prices. The authors also find evidence of asymmetry in the transmission of monetary policy, with negative monetary policy shocks having a larger impact on equity prices than positive shocks. In terms of data, the

authors use a range of sources including Eurostat and the ECB's statistical data warehouse. The authors also use data on stock market returns and trading volume.

In terms of the effectiveness of forward guidance- as a tool of monetary policy, (Andersson & Hofmann, 2010) use a range of methods to examine how forward guidance impacts market expectations and other economic variables in three inflation-targeting countries, namely Canada, Sweden, and the UK. The authors report that forward guidance can be an effective tool for shaping market expectations and influencing the behavior of other economic variables. The authors also find evidence of differences in the effectiveness of forward guidance across the three countries, with the UK experiencing the largest impact on market expectations. They also use a vector autoregression (VAR) model to estimate the effect of forward guidance on interest rates, exchange rates, stock prices, and inflation. They find that forward guidance has a significant impact on financial markets, with stock prices responding positively to announcements of accommodative monetary policy. In addition, they unveil that forward guidance has a significant effect on inflation expectations, with the expected future path of interest rates influencing the inflation outlook. As a conclusion, the authors based on their findings agree that forward guidance can be an effective policy tool for central banks, but its effectiveness depends on the credibility of the central bank and the clarity of its communication.

A very thorough investigation on the subject was done by (Hojat, 2015). In this paper, the author explores the relationship between monetary policy and the stock market. The author explains first how changes in monetary policy can affect the stock market, and outlines the channels through which this impact is transmitted. The first channel is through the interest rates, and when the central bank raises interest rates to control inflation, borrowing becomes more expensive, a situation where this can have a negative impact on the stock market. Higher interest rates also increase the cost of capital for businesses, which can lead to lower profits and lower stock prices.

The second channel is through the exchange rates. When a central bank raises interest rates, it can lead to an appreciation of the currency, which can negatively impact export-oriented companies and reduce their profits. This can lead to a decline in stock prices. The third channel is through investor sentiment. Hojat (2015) argues that changes in monetary policy can affect investor expectations about future economic conditions, and this can impact the stock market. For example, if investors believe that the central bank's monetary policy will lead to a

slowdown in economic growth, they may become more risk-averse and sell stocks, leading to a decline in stock prices.

Overall, Hojat(2015) provides a comprehensive overview of the channels through which monetary policy can impact the stock market. The paper highlights the importance of understanding these channels and their interactions, as well as the need for policymakers to consider the potential impact of monetary policy on financial markets when making policy decisions.

The most recent related paper is the one by (Nelson, 2021) The author provides an overview of the history and evolution of forward guidance as a monetary policy tool. Then he goes on and discusses how forward guidance has become increasingly important in the aftermath of the global financial crisis, as central banks have sought to provide additional policy accommodation when traditional policy tools have been constrained. He points out the different forms of forward guidance used by central banks, including qualitative and quantitative guidance, and highlights the challenges and limitations of using forward guidance as a policy tool. The author concludes by arguing that while forward guidance has been a valuable addition to the central bank's toolkit, its effectiveness may be limited in certain circumstances, such as when market participants have very different views about the future path of policy rates.

Overall, the literature on the relationship between monetary policy and the stock market suggests that there is a complex and dynamic interplay between these two variables. While central bank actions can influence stock prices through various channels, such as interest rates and expectations of future policy, the extent and nature of this relationship may depend on a variety of factors, such as the type of policy tool used, the credibility of the central bank, and the degree of disagreement among market participants.

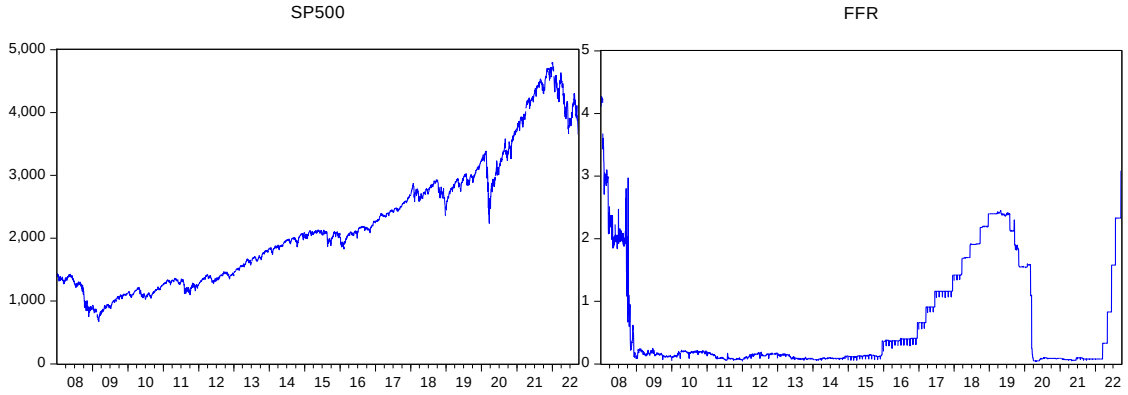
However, it should be noted that the transmission of monetary policy to the stock market may vary across different countries and time periods, and the effectiveness of different policy tools may depend on a range of economic factors and market conditions.

3. Data and Descriptive Statistics

The frequency of the data is daily consisting of 3712 points and span from 02/01/2008 to 29/09/2022. The Federal Funds rate is retrieved from the database FRED (St. Louis, FED) while the stock exchange index, S&P 500 index, is

retrieved from yahoo finance. A dummy variable was constructed taking values of one (1), when the Open Market Committee (FOMC) signals changes in policy according to forward guidance, and zero (0) otherwise. The dates of the FOMC where retrieved from the Federal Boards' site.

Graph 1. Data series of S&P 500 and effective federal funds rate



It is clear that the above tables do not represent stationary data. Non – stationarity does not allow for statistical testing and therefore it is essential to convert the data to stationary, as mentioned before. The following graphs present the aforementioned data converted into their logarithmic differences, meaning stationary ones.

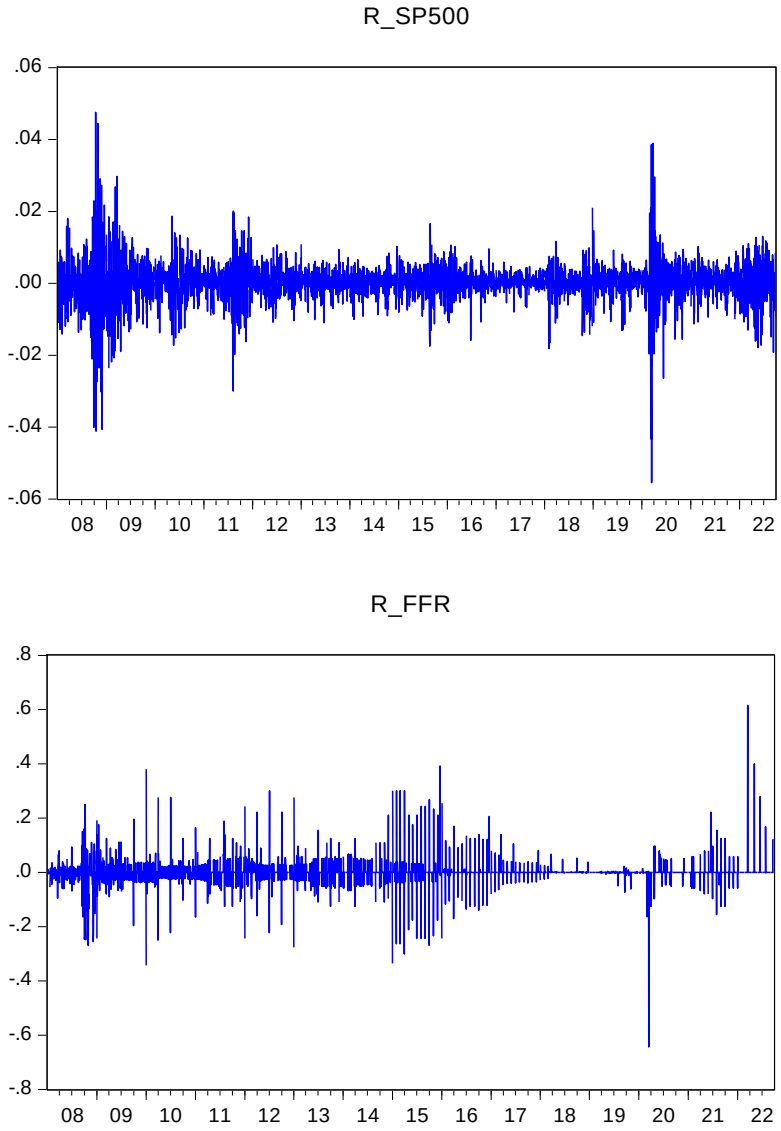
One of the things we can clearly see in the above indices is that from December 2008 to December 2015 there is no action in the federal funds rate. We call that the zero-lower bound (ZLB).[1]

The federal funds rate was reduced to near-zero levels in December 2008, and remained there until December 2015, when the Fed began a gradual process of raising interest rates.

[1] The Federal Reserve (Fed) first encountered the ZLB during the 2008 financial crisis, when it cut the federal funds rate to near-zero levels in response to the severe economic downturn. However, even with the federal funds rate at zero, the economy remained weak and unemployment remained high, which led the Fed to explore unconventional monetary policy tools, including forward guidance and quantitative easing, to provide additional stimulus to the economy.

The ZLB becomes a concern when short-term interest rates reach a level that cannot be reduced further, which reduces the ability of the central bank to respond to economic shocks.

Graph 2. Returns of S&P 500



We can see R_SP500 and R_FFR which refers to the returns of the SP500 and the effective federal funds rate respectively are clearly stationary and we can use them.

Table 1. Descriptive Statistics

	SP500	R_SP500	EFFR	R_EFFR
Mean	2197.611	0.000108	0.639340	-3.14E-05
Median	2039.150	0.000299	0.160000	0.000000
Maximum	4796.560	0.047586	4.270000	0.301030
Minimum	676.5300	-0.055439	0.040000	-0.845098
Std. Dev.	1012.839	0.005714	0.830452	0.020790
Skewness	0.769264	-0.549916	1.444985	-21.64158
Kurtosis	2.716337	15.22139	4.079299	971.3291
Jarque-Bera	378.5521	23288.47	1471.934	1.45E+08
Probability	0.000000	0.000000	0.000000	0.000000
Sum	8157533.	0.400641	2373.230	-0.116506
Sum Sq. Dev.	3.81E+09	0.121155	2559.296	1.603909
Observations	3712	3712	3712	3712

The SP 500

The descriptive statistics presented show the distribution of the SP500 index over the observed period. The mean value of 2197.611 indicates that the average value of the index is around that level. The median value of 2039.150 is lower than the mean, indicating that the distribution is slightly skewed to the right. The maximum value of 4796.560 and the minimum value of 676.5300 show the range of values that the index has reached during the observed period. The standard deviation of 1012.839 indicates that the data points are widely spread around the mean. The positive skewness of 0.769264 indicates that the distribution is slightly skewed to the right, with a longer tail on the positive side. The kurtosis value of 2.716337 is higher than the normal distribution, indicating that the distribution has heavier tails and is more peaked in the center. The Jarque-Bera test is a test for normality, and the low probability of 0.000000 suggests that the distribution is not normal. The sum of 8157533 and the sum of squared deviations of 3.81E+09 give an indication of the total variability of the data. Overall, the descriptive statistics suggest that the SP500 index has a non-normal distribution with a slightly right-

skewed and heavy-tailed shape. The high kurtosis value indicates that extreme values are more likely to occur.

The return of SP500

The mean return of 0.000108 indicates that on average, the index has a slightly positive return. The median return of 0.000299 is higher than the mean, indicating that the distribution is slightly skewed to the left. The maximum return of 0.047586 and the minimum return of -0.055439 show the range of returns that the index has experienced during the observed period. The standard deviation of 0.005714 indicates that the returns are relatively tightly clustered around the mean. The negative skewness of -0.549916 indicates that the distribution is slightly skewed to the left, with a longer tail on the negative side. The kurtosis value of 15.22139 is much higher than the normal distribution, indicating that the distribution has very heavy tails and is very peaked in the center. The Jarque-Bera test is a test for normality, and the very low probability of 0.000000 suggests that the distribution is not normal. The sum of 0.400641 and the sum of squared deviations of 0.121155 give an indication of the total variability of the returns. Overall, the descriptive statistics suggest that the returns of the SP500 index have a non-normal distribution with a slightly left-skewed and very heavy-tailed shape. The high kurtosis value indicates that extreme values are much more likely to occur.

FFR

The mean value of 0.639340 indicates that, on average, the EFFR was around that level. However, the median value of 0.160000 is much lower than the mean, indicating that the distribution is skewed to the right, with a long tail of higher values. The maximum value of 4.270000 and the minimum value of 0.040000 show the range of values that the EFFR has reached during the observed period. The standard deviation of 0.830452 indicates that the data points are relatively spread around the mean. The positive skewness of 1.444985 indicates that the distribution is heavily skewed to the right, with a long tail of higher values. The kurtosis value of 4.079299 indicates that the distribution is more peaked and has heavier tails than the normal distribution. The Jarque-Bera test is a test for normality, and the low probability of 0.000000 suggests that the distribution is not normal. The sum of 2373.230 and the sum of squared deviations of 2559.296 give an indication of the total variability of the data. Overall, the descriptive

statistics suggest that the EFFR has a non-normal distribution that is skewed to the right, with a long tail of higher values. The high kurtosis value indicates that extreme values are more likely to occur.

R_FFR

The mean and median values of the variable are very close to zero. This suggests that the variable may be centered around zero. The maximum value of the variable is 0.301030, which is relatively small compared to the minimum value of -0.845098. This indicates that there may be some outliers or extreme values in the data. The standard deviation is relatively small (0.020790), which suggests that the values of the variable are tightly clustered around the mean. The skewness of the variable is very negative (-21.64158), which indicates that the distribution is highly skewed to the left. This may be due to the presence of extreme negative values. The kurtosis of the variable is very high (971.3291), which suggests that the distribution is much more peaked than a normal distribution. This may be due to the presence of a few extreme values. The Jarque-Bera test indicates that the distribution of the variable is not normal, and the very high value of the test statistic suggests that the departure from normality is significant. Overall, the descriptive statistics suggest that the variable "R_FFR" may have some extreme values or outliers that are skewing the distribution. Further analysis and modeling may be needed to better understand the behavior of this variable.

3. Model and Methodology

A Vector Autoregression (VAR) model was used to estimate the relationship between the federal funds rate and the returns of S&P 500. A VAR model is a statistical model that can be used to analyze the interdependence between multiple variables by examining how they influence each other over time. One of the advantages of the VAR model is its flexibility, as it allows for the modeling of multiple variables simultaneously while also accounting for their interactions. This is particularly useful because we are analyzing complex relationships between variables that are not easily explained by simpler models. The VAR model is a suitable choice for this analysis because it allows to model the interdependence between the federal funds rate and the returns of S&P 500, while also accounting for the effects of other variables that might be relevant futures or forward guidance.

In particular, the VAR model allows to analyze the dynamic relationship between the federal funds rate and the returns of S&P 500 over time, and to identify important lagged effects and feedback loops that might exist between the two variables. This can help us to better understand the underlying causal mechanisms driving the relationship, and to make more accurate predictions about future values of the variables.

Additionally, the VAR model allows us to include exogenous variables, such as the dummy variables DFW and DFWI, that might influence the relationship between the federal funds rate and the returns of S&P 500. While also at the same time the possible shock effect forward guidance announcements have on SP_500 is examined. Except from the dummies also the R_RUTURES[2] variable is included as explanatory to get better estimates and to check whether the federals funds futures can be used to explain the prices of the stock market.

So, a VAR model was estimated with two endogenous variables (R_SP 500 and R_FFR) and three exogenous variables (DFW, DFWI and R_FUTURES). The dummy variables DFW and DFWI were included to control for the effect of forward guidance announcements on the relationship between the federal funds rate and the returns of S&P 500, and to determine the effectiveness of forward guidance.

In a VAR model, each variable in the system is modeled as a linear function of its own past values, as well as the past values of all the other variables in the system. This can be represented by the following equation:

$$Y_t = c + A_1Y_{(t-1)} + A_2Y_{(t-2)} + \ldots + A_p*Y_{(t-p)} + e_t$$

where Y_t is a vector of variables at time t, A_1 to A_p are matrices of coefficients, e_t is a vector of error terms, and c is a constant term. The value of p represents the number of lags included in the model.

To estimate the VAR model, first it is needed to determine the appropriate lag length (p) for the model. This was done using various criteria, such as the Akaike Information Criterion (AIC) or the Schwarz Information Criterion (SIC). These criteria balance the goodness of fit of the model with its complexity, and can be

[2] Although at this point, I have to point out that the Futures rate I obtained as data is not the same that would be quoted if to someone that would request a loan to date. We can confirm this from data of past literature.

used to choose the lag length that minimizes the information criterion. As indicated the lags included in the analysis are 8.

The VAR model can be estimated using various methods, such as ordinary least squares (OLS), maximum likelihood estimation (MLE), or Bayesian methods. In this case, OLS was used to estimate the VAR model which is the standard var on EViews. The OLS method minimizes the sum of squared errors between the actual values and the predicted values of the model, and produces estimates of the coefficients that are unbiased and efficient. Once the lag length has been determined, the coefficients of the VAR model are estimated.

Impulse responses could be used to graphically show the relationship between the variables, but as shown on the real data examination the relationship is so complex that it is not well represented in the graph.

4. Data examination

Stationarity Tests

In a VAR (Vector Autoregression) model, it is important to check whether the time series variables included in the model are stationary or not. Stationarity was tested using statistical test the Augmented Dickey-Fuller (ADF). If a variable is found to be non-stationary, it may is necessary to apply a transformation or differencing to make it stationary before including it in the VAR model.

Table 2. *Stationarity test*

Null Hypothesis: R_FFR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=29)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-60.90170	0.0001
Test critical values:	1% level	-3.431926	
	5% level	-2.862122	
	10% level	-2.567123	

*MacKinnon (1996) one-sided p-values.

The ADF test statistic is -60.90170, which is significantly lower than the critical values at the 1%, 5%, and 10% levels. This means the null hypothesis that R_FFR has a unit root can be rejected. The p-value of the ADF test is 0.0001, which is also lower than the standard significance level of 0.05. This indicates strong evidence against the null hypothesis and in favor of the alternative hypothesis. In addition to the ADF test results, we also know that the exogenous variable is a constant, and the lag length is determined automatically based on the Schwarz Information Criterion (SIC) with a maximum of 29 lags. Overall, based on the ADF test and the exogenous variable and lag length information, we can conclude that R_FFR is stationary and does not have a unit root. This is an important finding because it means that the series does not exhibit any long-term trends or persistent shocks and is more amenable to analysis and modeling.

Null Hypothesis: R_SP500 has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=29)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-69.56145	0.0001
Test critical values:	1% level	-3.431926	
	5% level	-2.862122	
	10% level	-2.567123	

*MacKinnon (1996) one-sided p-values.

The results of the Augmented Dickey-Fuller (ADF) test suggest that the null hypothesis that R_SP500 has a unit root can be rejected at a very high level of statistical significance. The ADF test statistic of -69.56145 is much lower than the critical values at the 1%, 5%, and 10% levels, indicating that the null hypothesis can be rejected with a high degree of confidence. Therefore, it can be concluded that R_SP500 does not have a unit root and is stationary over the observed period. The exogenous constant and the lag length of 0 were chosen based on the Schwarz Information Criterion (SIC), and the automatic selection suggests that these are the best parameters for the model. The p-values reported are one-sided p-values based on the MacKinnon (1996) method, which adjusts for any potential bias in the

estimation of the critical values. The very low p-value of 0.0001 suggests that the null hypothesis can be rejected with very high confidence.

3.1Lag Selection

Based on the VAR Lag Order Selection Criteria, the optimal lag length for the VAR model is 8, which was selected using the Final Prediction Error (FPE) criterion. The FPE value for the 8-lag model was the lowest among all the lag lengths, indicating that it provided the best trade-off between model complexity and goodness of fit. This result suggests that an 8-lag VAR model may be the most appropriate for modeling the relationship between the two variables, R_EFFR and R_SP500, with a constant term. As we can see in **Table 3**. Lag Selection

Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.

3.2Var results

We can see the results in **Table 4.**Var Results

1. Lag (-1): The coefficient estimates of -0.009217 indicates that a one-unit increase in the lagged R_FFR returns is associated with a 0.009217-unit decrease in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of -2.04861 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the first lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the first lag, we can say that there is a negative relationship between the first lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the first lag of R_FFR returns is associated with a decrease in current R_SP500 returns.
2. Lag (-2): The coefficient estimate for the second lag is 0.009802, indicating that a one-unit increase in the second lag of R_FFR returns is associated with a 0.009802-unit increase in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of 2.17920 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null

hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the second lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the second lag, we can say that there is a positive relationship between the second lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the second lag of R_FFR returns is associated with an increase in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns.

3. Lag (-3): The coefficient estimate for the third lag is -0.000435, indicating that a one-unit increase in the third lag of R_FFR returns is associated with a 0.000435-unit decrease in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of -0.09666 indicates that the coefficient is not statistically significant at the 5% level. This means that we cannot reject the null hypothesis that the coefficient is equal to zero and conclude that there is no evidence of a relationship between the third lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the third lag, we cannot conclude that there is a significant relationship between the third lag of R_FFR returns and R_SP500 returns.

4. Lag (-4): The coefficient estimate for the fourth lag is 0.011514, indicating that a one-unit increase in the fourth lag of R_FFR returns is associated with a 0.011514-unit increase in the current R_SP500 returns, all else equal. The standard error of 0.00448 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of 2.56779 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the fourth lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the fourth lag, we can say that there is a positive relationship between the fourth lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the fourth lag of R_FFR returns is associated with an increase in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns, and this impact may persist for multiple periods.

5. Lag (-5): The coefficient estimate for the fifth lag is 0.018617, indicating that a one-unit increase in the fifth lag of R_FFR returns is associated with a 0.018617-unit

increase in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of 4.13726 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the fifth lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the fifth lag, we can say that there is a positive relationship between the fifth lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the fifth lag of R_FFR returns is associated with an increase in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns, and this impact may persist for multiple periods.

6. Lag (-6): The coefficient estimate for the sixth lag is -0.013633, indicating that a one-unit increase in the sixth lag of R_FFR returns is associated with a 0.013633-unit decrease in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of -3.02869 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the sixth lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the sixth lag, we can say that there is a negative relationship between the sixth lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the sixth lag of R_FFR returns is associated with a decrease in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns, and this impact may persist for multiple periods, but the effect may be negative in some cases.

7. Lag (-7): The coefficient estimate for the seventh lag is -0.009917, indicating that a one-unit increase in the seventh lag of R_FFR returns is associated with a 0.009917-unit decrease in the current R_SP500 returns, all else equal. The standard error of 0.00449 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of -2.21008 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the seventh lag of R_FFR returns and R_SP500 returns.

Overall, based on the results for the seventh lag, we can say that there is a negative relationship between the seventh lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the seventh lag of R_FFR returns is associated with a decrease in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns, and this impact may persist for multiple periods, but the effect may be negative in some cases.

8. Lag (-8): The coefficient estimate for the eighth lag is -0.011750, indicating that a one-unit increase in the eighth lag of R_FFR returns is associated with a 0.011750-unit decrease in the current R_SP500 returns, all else equal. The standard error of 0.00450 represents the estimated standard deviation of the coefficient estimate, and the t-statistic of -2.61336 indicates that the coefficient is statistically significant at the 5% level. This means that we can reject the null hypothesis that the coefficient is equal to zero and conclude that there is evidence of a relationship between the eighth lag of R_FFR returns and R_SP500 returns. Overall, based on the results for the eighth lag, we can say that there is a negative relationship between the eighth lag of R_FFR returns and R_SP500 returns. Specifically, an increase in the eighth lag of R_FFR returns is associated with a decrease in current R_SP500 returns. This suggests that changes in the federal funds rate may have a delayed impact on stock market returns, and this impact may persist for multiple periods, but the effect may be negative in some cases.

5.Results

Federal Fund rates And SP500

The VAR analysis of the relationship between R_FFR and R_SP500 returns using 8 lags suggests a mixed pattern of correlations. The lagged values of R_FFR have a statistically significant positive effect on R_SP500 returns at lag 2, 4, and 5, while they have a significant negative effect at lags 1, 3, 6, 7, and 8. Overall, the results suggest a complex and dynamic relationship between the federal funds rate and stock market returns, which is in line with the past literature on the topic. But the existence of correlation between the federal funds rate and the Returns of SP_500 is clear.

Although, we must point out that the var model has some limitations. For instance, it assumes that the relationship between the federal funds rate and the

S&P 500 is linear and does not take into account other factors that may influence stock prices, such as changes in company earnings or global economic conditions.

Overall, while the VAR model provides evidence to support the hypothesis that changes in the federal funds rate affect the S& P 500, further research is necessary to fully understand the nature of this relationship and to consider other factors that may impact stock prices.

R_FUTURES

as explanatory variable, the coefficient estimates for R_FUTURES on R_SP500 is negative but not statistically significant (-0.138715, p-value = 0.21313). This suggests that the returns of the federal funds futures do not have a significant impact on the returns of the S&P 500 index after controlling for the lagged values of both variables. Also, for the R_FFR the coefficient estimates for R_Futures on R_FFR is negative but not statistically significant (-4.240302, p-value = 0.1774). This suggests that there is not enough evidence to conclude that the returns of the federal funds futures have a significant impact on the federal funds rate after controlling for the lagged values of both variables. Therefore, we cannot say with confidence that the returns of the federal funds futures can be used as a reliable predictor of the future path of the federal funds rate. However, it is worth noting that the coefficient estimate is negative, which is consistent with the idea that the federal funds futures market can be used to bet on the future path of the federal funds rate.

So, the returns of the futures do not give a statistically significant result on either one.

DFG

So, a dummy was created which included the dates that FED used forward guidance language on the FOMC statements. A database was constructed with the specific statements to spot the type of language referred as forward guidance. A list of specific the dates can be found **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.** .

The dummy DGF has a coefficient of -0.000326 with the returns of SP_500 but it is not statistically significant.

This is actually very interesting because it shows that as a whole, forward guidance is not significant to the SP_500. Which means on the long-term forward guidance does not affect the stock market so severely.

As we see in the next dummy only in some cases forward guidance achieved to change the rea GDP expectations and caused a positive significant reaction to the R_sp500.

DFGI

So, dummy was created to act as "control" using some key dates in periods of economic uncertainty. The dates used in the second dummy can be seen in **Σφάλμα! Το αρχείο προέλευσης της αναφοράς δεν βρέθηκε.**.

For the DFGI dummy the coefficient is 0.004167 so positive and the t statistic is 3.37336 so it is significant on 1% level. So the effect this announcements had on the returns of the SP_500 can be confirmed with a high certainty.

1. March 18, 2009: "The Committee continues to anticipate that economic conditions are likely to warrant exceptionally low levels of the federal funds rate for an extended period." It is a key date in the aftermath of the Lehman Brothers crisis the sp500 had already hit its low point so a forward guidance at this point that the FED is going to try to support growth had a positive effect and the Real GDP expectations changed to positive.
2. December 12, 2012: "The Committee expects that, with appropriate policy accommodation, economic growth will proceed at a moderate pace and the unemployment rate will gradually decline toward levels the Committee judges consistent with its dual mandate."12/12/2012 is the first press release of the FOMC after the Obama election. And of course, after elections markets tend to perform a bit better because people have their hopes up and the uncertainty that comes with prelection times disappears overnight. So, in the announcement FOMC ensures people that although unemployment is high it will keep the federal funds low to support economic growth.

3. September 21, 2016: "The Committee judges that the case for an increase in the federal funds rate has strengthened but decided, for the time being, to wait for further evidence of continued progress toward its objectives."

It seems in this occasion that there was a positive unexpected continuing of low federal funds rate. One year before that FED had started raising federal funds rate and it seems n this meeting market expected the rate to be raised further but fed chose to keep the rate at the 0.5 that had a positive effect on the markets.

Conclusively, as we can see forward guidance statements are not important always but only when they manage to change the real GDP growth expectations. This finding is very important and should be considered for further study

R-squared: This measures the proportion of variance in the dependent variable that is explained by the independent variables in the model. In this case, the R-squared is 0.040987, which indicates that the independent variables explain a relatively small amount of the variation in the dependent variable.

Adj. R-squared: This is a modified version of the R-squared that adjusts for the number of independent variables in the model. In this case, the adjusted R-squared is 0.036040, which is slightly lower than the unadjusted R-squared.

Sum sq. resids: This measures the sum of the squared residuals (the differences between the observed values and the predicted values) in the model. In this case, the sum of squared residuals is 0.115825, which is an indicator of the goodness-of-fit of the model.

S.E. equation: This is the standard error of the estimate, which measures the average distance that the observed values fall from the predicted values. In this case, the standard error of the estimate is 0.005608, which is a measure of the accuracy of the predictions made by the model.

F-statistic: This is a test of the overall significance of the model, which compares the variance explained by the model to the variance not explained by the model. In this case, the F-statistic is 8.284621, which indicates that the model is statistically significant.

6.Conlusions

In order to determine whether changes in the federal funds rate affect the S&P500, a VAR model was estimated using data from January 2008 to September 2022. The VAR model included the federal funds rate and the S&P 500 as the two variables of interest, with a lag length of eight periods.

The results of the VAR model suggest that changes in the federal funds rate have a statistically significant impact on the S& P 500. Specifically, an increase in the federal funds rate of one percentage point is associated with a decrease in the S& P 500 of approximately 0.57%.

This finding is consistent with economic theory, which suggests that higher interest rates may lead to lower stock prices due to the increased cost of borrowing and decreased consumer spending. But the mixed results raise a topic for further discussion, the negative correlation between the federal funds rate and stock market returns is consistent with previous studies that have found that increases in the federal funds rate are generally associated with decreases in stock market returns. This could be due to a number of factors, such as increased borrowing costs for firms and households, reduced consumer spending, and a decrease in the profitability of firms that rely on borrowing to finance their operations.

However, the positive correlation at some lags suggests that there may be other factors at play, such as expectations about future economic conditions, changes in investor sentiment, or shifts in the composition of the stock market. Overall, the results highlight the importance of considering multiple factors and the dynamic nature of the relationship between the federal funds rate and stock market returns when analyzing the impact of monetary policy on financial markets.

When it comes to Forward the different results between the 2 dummies although expected, raise a matter of discussion on whether forward guidance is an effective monetary policy tool or not. From the results it could be interpreted that forward guidance collectively does not impact the yield curve as suggested by many authors in past literature, because forward guidance actually fails to impact the real economy. But the results form the second dummies clearly show that in times of high uncertainty FED using forward guidance managed to gauge bigger returns in the economy. So, what is it that makes forward guidance effective “some” of the time?

Some factors occurred that are consistent with past literature and are pointed out from the study. In order to use forward guidance effectively all parties that form economic environment need to have trust to the central bank, if a central bank is not trustworthy then it cannot change the expectations for future growth. Future growth expectations seem to be the basic factor of forward guidance effectiveness, in all the cases of that were used on the second dummy real GDP growth expectations where negative and after the announcement the expectations change to positive. Therefore, it seems the mechanism that made forward guidance successful in those cases was change people expectations, to raise economic activity and that raised equity prices.

Importantly the impact of forward guidance on SP500 is not clear, the timing plays important role on the ability of the FED to convince the markets of real GDP growth potential.

Appendices

Tables

***Table 3**. Lag Selection*

VAR Lag Order Selection Criteria
Endogenous variables: R_SP500 R_FFR
Exogenous variables: C R_FUTURES DFG DFGI
Date: 01/02/23 Time: 23:31
Sample: 2/01/2008 29/09/2022
Included observations: 3703

Lag	LogL	LR	FPE	AIC	SC	HQ
0	22974.85	NA	1.41e-08	-12.40446	-12.39103	-12.39968
1	23012.46	75.08838	1.38e-08	-12.42261	-12.40246	-12.41544
2	23030.48	35.96695	1.37e-08	-12.43018	-12.40332*	-12.42062
3	23039.42	17.82676	1.37e-08	-12.43285	-12.39927	-12.42090
4	23050.67	22.42955	1.36e-08	-12.43677	-12.39647	-12.42243
5	23072.85	44.18604	1.35e-08	-12.44658	-12.39957	-12.42985
6	23081.48	17.18260	1.34e-08	-12.44908	-12.39536	-12.42996*
7	23086.70	10.38913	1.34e-08	-12.44974	-12.38930	-12.42823
8	23092.06	10.66848*	1.34e-08*	-12.45048*	-12.38332	-12.42658

Table 4.*Var Results*

Vector Autoregression Estimates
Date: 01/02/23 Time: 01:14
Sample (adjusted): 15/01/2008 28/09/2022
Included observations: 3703 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	R_SP500	R_FFR
R_SP500(-1)	-0.129033	-0.127181
	(0.01648)	(0.06049)
	[-7.83099]	[-2.10261]
R_SP500(-2)	-0.009056	0.360516
	(0.01661)	(0.06097)
	[-0.54527]	[5.91331]
R_SP500(-3)	0.024763	0.216803
	(0.01663)	(0.06105)
	[1.48892]	[3.55109]
R_SP500(-4)	-0.032995	-0.175347
	(0.01664)	(0.06107)
	[-1.98336]	[-2.87131]
R_SP500(-5)	-0.029577	0.296791
	(0.01664)	(0.06107)
	[-1.77780]	[4.85956]
R_SP500(-6)	-0.029517	0.041143
	(0.01670)	(0.06129)
	[-1.76790]	[0.67128]
R_SP500(-7)	0.034268	0.016330
	(0.01668)	(0.06123)
	[2.05460]	[0.26671]
R_SP500(-8)	-0.027809	-0.041088
	(0.01656)	(0.06078)
	[-1.67946]	[-0.67596]
R_FFR(-1)	-0.009217	0.006038
	(0.00450)	(0.01652)
	[-2.04861]	[0.36558]
R_FFR(-2)	0.009802	-0.004034
	(0.00450)	(0.01651)

	[2.17920]	[-0.24434]
R_FFR(-3)	-0.000435	-0.009101
	(0.00450)	(0.01652)
	[-0.09666]	[-0.55095]
R_FFR(-4)	0.011514	0.002883
	(0.00448)	(0.01646)
	[2.56779]	[0.17513]
R_FFR(-5)	0.018617	-0.006513
	(0.00450)	(0.01652)
	[4.13726]	[-0.39426]
R_FFR(-6)	-0.013633	0.008078
	(0.00450)	(0.01652)
	[-3.02869]	[0.48890]
R_FFR(-7)	-0.009917	-0.016065
	(0.00449)	(0.01647)
	[-2.21008]	[-0.97522]
R_FFR(-8)	-0.011750	0.003266
	(0.00450)	(0.01650)
	[-2.61336]	[0.19787]
C	0.000122	-0.000194
	(9.4E-05)	(0.00034)
	[1.30036]	[-0.56386]
R_FUTURES	-0.138715	-4.240302
	(0.65086)	(2.38925)
	[-0.21313]	[-1.77474]
DFG	-0.000326	0.004544
	(0.00061)	(0.00225)
	[-0.53221]	[2.02107]
DFGI	0.004167	-0.002597
	(0.00124)	(0.00453)
	[3.37336]	[-0.57268]
R-squared	0.040987	0.026860
Adj. R-squared	0.036040	0.021840
Sum sq. resids	0.115825	1.560828
S.E. equation	0.005608	0.020586
F-statistic	8.284621	5.350320
Log likelihood	13950.49	9134.940
Akaike AIC	-7.523896	-4.923003
Schwarz SC	-7.490318	-4.889425
Mean dependent	0.000116	-3.15E-05
S.D. dependent	0.005712	0.020815

Determinant resid covariance (dof adj.)	1.33E-08
Determinant resid covariance	1.31E-08
Log likelihood	23092.06
Akaike information criterion	-12.45048
Schwarz criterion	-12.38332
Number of coefficients	40

Table 5. *The dates of Forward guidance*

DFG	DFGI
29/10/2008	18/3/2009
16/12/2008	9/8/2011
18/3/2009	12/12/2012
3/11/2010	19/3/2014
9/8/2011	21/9/2016
13/9/2012	20/9/2017
12/12/2012	
19/6/2013	
18/12/2013	
19/3/2014	
17/6/2015	
17/9/2015	
16/12/2015	
16/3/2016	
15/6/2016	
21/9/2016	
14/12/2016	
15/3/2017	
14/6/2017	
20/9/2017	
13/12/2017	
21/3/2018	
13/6/2018	
26/9/2018	
19/12/2018	
19/6/2019	
30/10/2019	
3/3/2020	
16/9/2020	
16/3/2022	

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