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The Fed policy announcement effect on the equity market

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A project carried out on the financial market area, with the supervision of:

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Abstract

Fed Policy announcements have always created controversy when analyzing its effects on asset prices. This project analyzes the relationship between the Fed announcements and the stock market's return. We use an econometric methodology suggested by Kenneth Kuttner (2000) that uses the futures market to divide the announcement in two parts the expected and unexpected component.

The relationship between the equity market reaction and the Fed policy announcements has shown to be statistically significant. A considerably negative reaction of the equity market has been observed in response to an unexpected announcement by the Federal Reserve while the expected part of the announcement revealed to have no effect on the equity market. This relation was also tested for the existence of asymmetries and cross industry effect.

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1. Project purpose

Commercial Banks are responsible for providing credit conditions to the economy. However, it is frequent that banks borrow money from other banks (usually overnight loans) to meet their reserves requirements. These operations are performed on the Federal Funds market that reallocates the reserves in the economy, the rate paid on those loans is the Federal Funds rate (Nosal, 2001). In order to control money circulation the Federal Reserve (Fed) attempts to manipulate the rate paid on these loans. However, this rate is dependent on the reserve transactions set by each Commercial Bank. In order to control the rate paid on the Federal Funds market and subsequently the money in circulation the Fed sets a benchmark rate: the target rate. This rate changes every time the Federal Reserve performs an announcement.

Even though the target rate changes aim is to control macroeconomic variables, financial markets are the first to react indicating that relevant information is released to the market whenever the Federal Open Market Committee (FOMC) performs a policy announcement. The transmission effect in theory can be summarized by an increase in the target Federal Funds rate that leads to a decrease in the demand for money by Commercial Banks, since money becomes more expensive. Monetary circulation decreases and an immediate increase in the market interest rate is observed. The credit conditions provided to firms and individuals deteriorate reducing future wealth perspectives. As so, if investors are rational they are expected to react positively to a policy easing and negatively to a tight policy action.

The aim of this project is to measure and analyze the stock market return when exposed to Federal policy actions. Although there is significant literature about monetary policy and its effects, little research has focused on the cross sector and industry effect. This

project will assess this question by testing the relationship for the existence of asymmetries and by improving past research through the addition of a new relevant dependent variable. To avoid any bias related to the Subprime crises, results will be first analysed from data collected before the Subprime (1994-2007) and subsequently including the Subprime observation (1994-2009) in order to understand if there are significant changes on the behaviour. If results prove to be significant, the relationship between the monetary policy shocks and the equity market will be better estimated.

As Rigobon and Sack (2002) point out a good estimate is in the interest of all market players. This estimation is important not only for the investors in order to build strategies to obtain return from the market but also for the policy makers to perform more efficient policy decisions.

This study follows the methodology developed by Kenneth Kuttner (2000). This author focuses on the anticipation effect, suggesting that if markets are efficient, as it is assumed, they can anticipate the outcome of the announcement leading to no effect on the financial market. Only the unanticipated changes on the target rate should influence the equity market return. This view is in line with the Efficient Market Hypothesis. This might explain why past literature as estimated a week relationship between policy announcements and asset prices.

To assess the unanticipated component Kuttner (2000) proposes to use the Federal Funds futures market to calculate the unexpected component of the surprise. The project will focus on the observation of the change in the Federal Funds future implied rate and from this findings analyse the market expectations of the announcement outcome. Although this financial instrument is traded since 1989, it is only in 1994 that the changes in the funds rate target became announced. To have some stability in the

way financial markets receive the news from the FOMC announcements this work will introduce a new data set, starting from February 1994 until June of 2007 just before the beginning of the subprime crisis.

2. Literature review

During the last century many authors tried to study monetary policy shocks on other variables. However, a lot of controversy has been discussed on which variables should be used to assess this effect. In this section a broad overview of the area of interest will be analysed based on past research.

Before 1994 different targeting approaches were used to control monetary circulation. In 1979 Federal Fund rate target was abandoned to start targeting no borrowed reserves until 1982, from 1982 – 1987 it focused on a borrowing guideline. It was only in 1987 with the appointment of Alan Greenspan that the funds rate became re-used to determine shifts on policy actions (Jones, 1994)[1]. It is important to remark that before 1994 the Fed didn't make announcements for shifts on the targeting approach, as today. In this sense, it was more difficult for market participants to understand changes on the monetary policy since the only tool they had was the following day actions of the open market committee.

Facing with this problem of an accurate identification of the monetary policy actions, Perez-Quiros and Timmermann (1999) used the changes in interest rates to identify the monetary policy. However, this methodology might be biased since interest rates changes usually coincide with changes on the macroeconomics conditions. More complex analysis was used by Christiano, Eichenbaum and Evans (1996) that defined

[1] In Thorbecke, Willem. 1997." On stock Market Returns and Monetary Policy", The Journal of Finance, LII (2): 635-654.

the monetary policy by using a VAR model which uses macroeconomic variables as a proxy for monetary policy.

Cook and Hahn (1988) were the pioneers of using an event study approach to measure the relationship between the stock market and the Fed policy actions. Their basic assumption was that the Fed controlled the funds rate so rigorously during the 1974 - 1979 period that market participants were able to detect a change in the target funds rate on the day it occurred. If market participants were able to assess and process the new monetary information on the same day of the announcement then it could be used daily data to regress the change in the bill notes and bond rates on the target rate change. Results revealed a positive correlation between the target rate response and the bond rate, but less significant for longer maturities. This could indicate that some Fed actions may have been anticipated. Roley and Sellon (1995) used the same approach but for a more recent period (1987 - 1995) and got a much weaker relationship between target rate changes and other interest rates which could indicate that financial markets improved their capacity to anticipate changes in the target rate.

Kenneth Kuttner (2000) however took special attention in what concerns the anticipation effect and separated the announcement into two different components: expected and unexpected. According to him, the financial market reacts only to the unanticipated component of the FOMC policy announcements. Some controversy appeared when estimating the market expectations about the FOMC announcements. What Kuttner suggested was to use the Federal Funds futures implied rate to assess the policy surprise. His argument was based under the assumption that "Fed Funds futures prices are a natural, market-based proxy for policy actions expectations".

Others authors have used different market-based instruments to assess the surprise. For instance, Michel Ehrmann and Marcel Fratzscher (2004) measured the surprise using Reuter's survey performed on the Fridays just before the announcements. Roberto Rigobon and Brian Sack (2002) used the three-month Eurodollar rate to assess the surprise component of the announcement suggesting that the Eurodollar is better to estimate expectations of the market about the target rate for near-term maturities while the Future Federal Funds rate are better for shorter maturities. To dissipate any doubt about which financial instrument work better to assess the market expectations about the future target rate Gürkaynak, Sack, and Swanson (2006) have performed an evaluation of the most relevant financial instruments that can serve as a tool to calculate the surprise component, suggesting that Federal Funds Futures dominate other market-based measures for policy expectations since the predictive power was higher, evidenced by a smaller risk premium when compared to other marked-based instruments but only up to six months horizons, for long term perspective results showed to be similar.

Monika Piazzesi and Eric Swanson (2006) explained why it is appealing to use this future financial instrument. "First, producing the forecast is simple (given that) rates on various contracts can be obtained (...) at any time during the day. Second, the forecasts work well (since) Federal Funds futures outperform forecasts based on alternative methods (...). Third, previous studies have failed to find significant risk premia in Fed Funds futures".

However a lot of controversy regarding the methodology with the Federal Funds Futures rate has also been evidenced. Glenn Rudebusch (1998) also uses the Federal Fund Futures to assess the surprise component however its methodology is different

from the one introduced by Kuttner. He defines the surprise as the difference between the realized Federal Funds rate target and the expected Federal Funds rate derived from the futures market. On the other hand, Kenneth Kuttner (2000) defines the surprise component as the daily change in the current-month or one month maturity Federal Funds Futures rate on the event day in order to assess the surprise component. After analysing the robustness of the two monetary surprises series, Piazzesi and Swanson (2006) found that on the first approach the presence of risk premium will negatively bias the final results for market expectations. While the second one revealed to be more solid for the presence of risk premium.

More recently, Refet S. Gürkaynak, Brian Sack and Eric T. Swanson (2004) have improved the Kenneth Kuttner approach to measure the stock market response to monetary policy actions by looking at intra-day data in narrow windows around the announcement time. This procedure attenuates the "noise" from other financial market news that took place throughout the day allowing to better isolate the effect of the surprise component on the asset prices. In the end they got similar results but much more precise.

Although a lot of research has been conducted on monetary policy and its effects, little literature has focused on the sector and industry effect. Gert Peersman and Frank Smets (2002) found strong evidence of cross industry effect on the response to policy announcements. The results revealed that different industries have different sensibilities to policy announcements accordingly to the durability of the goods produced, suggesting that the monetary policy effect on industries producing durable goods was almost the triple than those producing less durable goods. Moreover the capital intensity and the degree of openness appear also to influence the response across industries. This

demonstrates the importance and relevance of assessing the cross industry effect for policy analyze.

3. Methodology

In order to have a good estimation of the relationship between the FOMC announcements and the stock market it will be assessed the stock market expectation of the FOMC committee actions through the future market. After a good estimation of the market expectations it is possible to use the following regression using the Ordinary Least Squares (OLS) method:

$$R_t = \beta_0 + \beta_1 . e^{\exp} + \beta_2 . e^{un} + \varepsilon$$

R_t is the equity market response measured by the daily return of the S&P 500 stock index on day t, $e^{\exp}$ and e^{un} are the expected and unexpected components of the announcement and ε is the error term (all the other factors that influence the stock market return beside the FOMC announcement) (Bernanke et al, 2005).

Beside this equation this project will innovate by introducing an extra explainable variable that accounts the equity market volatility on FOMC announcement days. To measure the equity market volatility it will be used the VIX index. This new variable will consists on an interactive dummy, which multiplies the unexpected component by the VIX dummy variable. To calculate the dummy variable it is necessary to first calculate the average of the VIX index prices. The dummy variable will be accounted as "1" each time its value is 25% higher to the average of the VIX prices. The new regression turns into:

$$R_t = \beta_0 + \beta_1 . e^{\exp} + \beta_2 . e^{un} + \beta_3 . (VIX . e^{un}) + \varepsilon$$

The logic is that on days of high market volatility the "noise" associated with other news around the policy announcement will be higher dispersing the normal stock market response from its normal reaction decreasing the quality of these observations.

To reduce the error term, Gurkaynak Sack and Swanson (2004) approach should be used. This model focuses on the intraday data in narrow windows around the announcement time which gives similar but more precise results than previous studies that used daily data. However because of data limitations this project cannot use intraday data. After consulting Kenneth Kuttner by e-mail on how to reduce "the noise" associated with news arriving "after hours" he suggested calculating the stock market return by

$$\frac{Closing.Price_t - OpenPrice_t}{OpenPrice_t}$$

Data will be collected from the Bloomberg software. Two observations (03 January 2001 and 17 September 2001) will be excluded because on those days the volatility on the stock market is heavily explained by other factors.

3.1 Federal Funds Future Market

The Federal Funds Future contract is an interest rate future traded in CBOT, its underlying asset is the average Federal Funds rate over a particular month. These contracts can be viewed as the right for one bank to receive an overnight loan by another bank at some future date at a predetermined rate, the Federal Funds Future rate. The Bloomberg screen quotes this financial instrument as $100-r$ where r is the average Effective Federal Funds rate over the expiry month.

The logic behind the use of Federal Funds Futures to assess target rate expectations is that possible deviations of the actual overnight rate from the desired target rate tend to be averaged out on the remaining part of the month, allowing the implied rate in the future contract to be essentially the market´s expectation of the intended target rate.

Appendix 1 demonstrates the relationship between the implied rate by the contracts and the expectations of target Federal rates, revealing a strong correlation. In a research conducted by Gürkaynak, Sack and Swanson (2006) it was demonstrated that on horizons up to six months, using Federal Funds future rate, showed to do better than all other market based measures in predicting actual future funds rate.

When using Federal Funds futures to extrapolate the surprise component it is important to formulate some assumptions (Refet Gürkaynak, 2005). First the model assumes that on "policy dates future intermeeting rate changes are seen as a zero probability events" which if we look to their frequency since 1994 is a very reasonable assumption. Second, when calculating the policy surprise it is assumed that the Effective Funds rate is equal to the target rate. Finally, but not least, it is assumed that the change in the term premium around the policy dates is insignificant. However, it is important to highlight that it is not the term premium that is negligible but the change during the day of the announcement.

This work is only going to focus on the surprise component of the current policy decision, as so the spot future rate denoted by f_t will be used for the event occurred on day t. As Gürkaynak (2005) explains on the day before the FOMC meeting the arbitrage-free price of the spot-month Federal Funds future contract will satisfy:

(1) $$f_{t-1} = \frac{d_o}{m_0} r_{-1} + \frac{m_0 - d_0}{m_0} E_{t-1}(r_0) + u_{t-1}$$

Where d_j stand for the day in the month when the event takes place and m_j the number of days on that month. In this equation, r_{-1} and r_0 are, respectively, the target rate prevailing before and after the FOMC announcement. u_{t-1} is the term premium for the spot month contract which, as it will be demonstrated, it will not interfere in the calculations of the surprise component. After the policy decision is known the implied futures rate is:

(2) $$f_t = \frac{d_o}{m_0} r_{-1} + \frac{m_0 - d_0}{m_0} r_0 + u_t$$

For the purpose of this model it is assumed that Effective Funds rates are equal to the target rate. Using equation (1) and (2) to measure the surprise component, denoted by e^{un}:

(3) $$e^{un} = r_0 - E_{t-1}(r_0) = \left[\left(f_t - f_{t-1}\right) - \left(u_t - u_{t-1}\right)\right] \frac{m_0}{m_0 - d_0}$$

As it was previously mentioned, the model assumes that the daily risk premium change on FOMC announcement days is insignificant and therefore ignored. This assumption leads to the final equation for calculations of the surprise component:

$$e^{un} = \left(f_t - f_{t-1}\right) \frac{m_0}{m_0 - d_0}$$

This equation explains how it is possible to use the future market to calculate the surprise component of the announcement. The second part of the equation is required because the surprise will only matter to the remaining part of the month. After having

calculated the unexpected component it is possible to assess what the market already expected: $e^{\exp} = \tilde{r} - e^{un}$ where $\tilde{r}$ is the new target rate.

For some observations the way to calculate the surprise component is slightly different:

- If the announcement is on the first day of the month the appropriate future rate at t-1 is going to be the future rate on the last day of the previous month with one month to maturity (instead of the spot rate). The policy surprise will be calculated as $e^{un} = \left(f_t - f_{t-1}^1\right)\frac{m_0}{m_0 - d_0}$. From 1994 to June 2007 there is only one observation on the 1st day of the month, in September 2005.
- When the announcement is done on the last days of the month the scale factor amplifies too much the noise in the measurement of the surprise component. Refet Gürkaynak (2005) suggests that whenever the scale factor is greater than 4 it should be used the one month maturity future rate and no scale factor is used because the policy action affects the expected rate in the entire subsequent month. The formula becomes, $e^{un} = f_t^1 - f_{t-1}^1$
- In 15 October 1998 the 0, 25% rate cut was announced after the close of the future market. In this case, the difference between the Opening rate on the 16th and the closing rate on the 15th is used.

3.2 The Error term

The Least Squared Regression relies on some assumptions, when they are not verified error estimations might occur and hence bias the hypothesis tested.

The first violation would be if the independent variable (policy action) responded endogenously to the dependent variable (stock market return). According to Rigobon and Sack (2003) there is empirical evidence that sustain such argument, they assert that a 5% rise in the S&P500 increases the probability of a policy tightening on the next FOMC meeting by 25 basis points. Other authors contradict this theory by finding little evidence that the FOMC responds to stock prices (Jeff Fuhrer and Geoff Tootell, 2004). "There are, however, no clear examples of instances in which a drop in equity prices led the FOMC to cut rates, or the inverse" (Bernanke and Kuttner 2005). This project will assume no endogenous response from policy actions to movements on the stock market.

Secondly, other type of endogeneity would be a response from the stock market and from policy actions to new information. However, after consulting Kenneth Kuttner by e-mail his suggestion was unequivocal: "I don't think that's a big issue post-1994, if you're using daily data. It was really only in the early 1990s that the Fed reacted on the same day to employment releases".

4. Results

From February 1994 to June 2006 there are 111 valid observations. During this period there were 63 announcements with no target rate change, 17 cuts and 31 increases. Appendix 2 illustrates the evolution of the target rate, starting at 3.25% on February 94 and reaching 6, 5% on May 2000 during the Dot-com euphoric times. In response to the bubble burst, the target rate declined until the 1 per cent level in June 2003, finally with the economic recovery in 2004 the target rate reached the 5.25% level. The equity market has completely anticipated the outcome of the announcement in 42 occasions which corresponds to 38% of the observations and the equity market had an average daily return of 0. 27% on those 111 days that composes the project data set. The

correlation between the stock market and target rate change is -0, 07 but if the surprise component of the target change is used the correlation becomes -0, 42 a much more significant value.

These statistics give a general perspective of how the stock market and the Fed behave on the announcement days from 1994 to 2007.

4.1 Equity Market reaction to Policy Announcements

The estimated reaction of equity prices to monetary policy actions are reported on Appendix 3. All variables are expressed in percentage terms. The threshold level for all the tests was assumed at a significance of 5%. The column a) reports the results for the Original regression while column b) reports the regression with the VIX Index.

Regression (a) indicate that an expected change of 1% will induce the equity market to an increase of 0.85% while a 1% unexpected change will bring a decrease of -7.479% on the stock market. The adjusted R^2 indicates that on days of policy actions 20.4% of the equity market variance is associated with monetary policy news. Regression (b) suggest that an 1% change on the target rate that was already expected by the market will induce the equity market to increase by 0.96% while the unexpected change of 1% will bring down the equity market by -5.71% . Finally the additional variable tells that when there is a 1% surprise action on days of high market volatility, the equity market will decrease by -7.61%. The R^2 indicate that policy announcements account for 24.47% of the daily reported variance on the equity market. This result suggests that observations associated with days of high equity market volatility inflate the negative response of the stock market to a policy surprise change.

After looking to both R^2 it is possible to conclude that the second regression is better to estimate the market response to policy announcements. However, it is necessary to test the significance of those values and see if the assumptions behind the construction of the Least Square Model are valid.

4.2 Hypothesis testing

First it will be tested the sustainability of the OLS assumptions and ensure the no existence of serial correlation and heteroskedasticity. Subsequently, it will be preformed significance tests on the variables and on the regression.

To investigate the existence of serial correlation it was used the Breusch-Godfrey serial correlation Lagrange Multiplier test for (Appendix 4). This consists in testing the null hypothesis H_0 of no serial correlation against the alternative hypothesis H_1 that the errors are serial correlated. The test consists "in regressing the residuals on all regressors and lagged residuals and then obtains the R^2 of this regression". The test statistic is given by $(Obs) \times R^{2'} \sim \chi_k^2$. For a 5% significance level and two degrees of freedom the critical value is 5.99946. The test statistic for regression (a) and (b) are respectively 1.910448 and 2.542301 which allow to no rejection of the null hypothesis in both cases and accept the assumption of no serial correlation.

Once both regressions have passed the serial correlation test it is possible to test them for the presence of heteroskedasticity. To see if regression (a) and (b) are homoscedastic it will be used the white`s test (Appendix 5). This test defines the null hypothesis as the existence of homocedasticity or $H_0 : \sigma_i^2 = \sigma^2$ against the alternative hypothesis defined as the existence of heteroskedasticity or $H_1 : \sigma_i^2 = \sigma_i^2$. The test statistic is computed from an auxiliary regression where the squared residuals are regressed on all possible

cross products of the regressors. Then it is necessary to multiply the number of observation by the R^2 of the auxiliary regression. This statistic follows a χ_k^2 distribution with the degree of freedom equal to the number of slope coefficients of the auxiliary regression. In regression (a) for a 5% significance level and five degrees of freedom the critical value is 11.07050 while in regression (b) for a 5% significance level and 6 degrees of freedom the critical value is 12.59159. The test statistics for regression (a) is 3.030426 while in (b) is 11.74615 leading to the no rejection of the null hypothesis concluding the existence of homocedasticity.

To test if the single estimators have effect on the stock market it must be used the two tailed t-student test (Appendix 6). The null hypothesis is that $\beta_j = 0$ meaning that if it is accepted the independent variable associated with that parameter does not have any effect on the dependent variable. The t statistic is equal to $\frac{\hat{\beta}_j}{\sigma_j}$ and it follows a two tailed T-student distribution with n-k-1 degrees of freedom. The results for this test are reported in Appendix 6. For regression (a) it is obtained a significant value for the unexpected value but an insignificant one for the expected component which demonstrate the no relationship between the expected component of the announcement and the equity market return. In regression (b), curiously, each one of the three independent variables with 95% of confidence is relevant to explain the equity market return.

To see if the independent variables together are useful to explain the daily equity market return, the F –test was preformed. The null hypothesis is that the expected and the unexpected component of the announcement do not help to explain the daily equity market return or: $H_0: e^{\exp} = e^{un} = 0$ and the alternative hypothesis is that at least one

variable is different from 0. The F-statistic is used to execute the test. Results are reported in Appendix 7. In both regressions the null hypothesis is rejecting, concluding that at least one of the predictors is linearly associated to the daily stock market return.

Both regressions are valid and significant. The results are in accordance with the general theory that a cut on the target rate will lead to an increase on the stock market, and vice versa. Both unexpected parameters are statistically relevant at a 1% significance value revealing the importance of this factor to explain the equity market return on days of policy action. The VIX Interactive dummy variable revealed to be very useful to explain the stock market response to policy actions, the results suggest that a 1% surprise associated with days of high market volatility will induce the stock market to decrease by -7.6% while in "quiet" days the response is -5.7%. This result might suggest that news arriving "after hours" are distorting the equity market reaction to policy announcements in previous literature.

4.3 Asymmetries

Asymmetries are defined as "the possibility that the equity prices response to monetary policy depends on the direction of the action" (Bernanke and Kuttner, 2005). Little research has explored the existence of asymmetries when measuring the relationship between the equity market and Fed policy announcements. This project has verified the effect of three different asymmetries. The VIX index variable will continue to stay on the regression since it was demonstrated the importance of such variable.

Appendix 8 report the results for three different types of asymmetries, first it verifies if the equity market reacts differently accordingly to the sign of the surprise change. The second and third column analyze if the equity market reacts asymmetrically to a positive

rate change or to a no change by the FOMC. The results for the interactive dummy variable revealed not significant for the first two types of asymmetry however it was evidenced that equity markets react differently to a no movement on the target rate. For the dummy "Rate change = 0" it is possible to say with a 95% confidence that when there is a 1% surprise change associated with a zero target rate change the return on equity market will increase by more 8. 66% in comparison with a surprise associated with a movement on the target rate by the FOMC. This result is very significant since it shows that investors are more hysterical when the policy surprise is associated with a no movement by the Fed on the target rate. In the end of the table it is possible to observe the no existence of serial correlation or heteroskedasticity.

4.4 Industries

In the cross industry regressions (Appendix 9), an analysis of the R^2 revealed that in an observation of 10 industries, 5 of them revealed that it is possible to construct a relationship between its daily return and the Fed policy announcements. Namely, Consumer Discretionary (R^2 =0, 28), Information technology (R^2=0,267), Industrials (R^2=0, 24), Financials (R^2=0, 17) and Materials (R^2=0, 14). It is important to highlight that the unexpected coefficient in the Information technology sector reveals that policy actions have tremendous effect in this Industry, evidenced by the decrease of the return in this Industry by -16, 2% when there is a surprise policy change of 1%. In 2009 the total weight of those industries in the market was approximately 50%, as so the size of the Industry does not help to explain the heterogeneous cross Industry response.

To investigate this problem, the correlation between this industries return and the overall economy performance was observed. In lack of a measure for the overall economy performance the S&P 500 was used since this measure is intended to measure

performance of the broad USA economy. In this sense, when measuring the correlation between S&P 500 and the sector indices, results revealed that from the 5 industries with high correlation with the economy, 4 of them observed a strong relationship to the FOMC announcements and their daily return. A possible justification for the cross industry effect would be that the industries where the return varies more with the economic condition were also the ones that reacted more strongly to policy announcements.

The results are in accordance with the ones obtained by Gert Peersman and Frank Smets (2002) for the European market. The durability of the goods produced seem to be an important factor when analyzing the relationship between the FOMC announcement and the stock market. Higher durability sectors (Consumer Discretionary, Industrial, information and technology and Materials) revealed a stronger relationship with the FOMC announcements when compared with lower durability sectors (Consumer Staples, Utilities).

4.5 **Subprime effect**

Since the subprime there are 14 observations. However, two outliers have been excluded for policy analyses: 22nd of January 2008 when the Fed made the first unscheduled rate cut announcement since 2001 leading to the biggest surprise component observed in the data collection, surprisingly the equity market went down by -0.18%. The second outlier occurred in the 8th of October 2008 observation when global Central Banks cut the rates in a synchronized effort to fight global turn down that lead to a surprise of -0.14% however the equity market responded negatively to global cooperation news and came down by -0.40%.

Appendix 10 illustrates the effect of the twelve observations in the original regression. Results revealed that for both cases: accounting and not accounting for equity market volatility, the quality of the regression decreases. Both regressions showed to be free of serial correlation, however both regressions revealed to be contaminated by the presence of heteroskedasticity. The white test analysis rejected the null hypothesis of homoscedasticity. Under heteroskedasticity the model still produce unbiased coefficients nevertheless they are no longer Best Linear Unbiased Estimators (BLUE) and the estimated squared error showed to be incorrect. In this sense, confidence intervals and hypotheses tests were assumed to be not reliable.

Though results revealed the presence of heteroskedasticity, the analysis proceeded. In order to isolate the subprime effect an interaction term involving a dummy variable equal to 1 for those observations since the subprime and the surprise component has been included on the original regression (Appendix 11). Although the value of this dummy is only significant at the 10% significance level the sign and magnitude of the coefficient clearly report a change on the equity market behavior since the subprime. Those regressions tell us that a 1% positive policy surprise since the subprime will induce the market to rise around 8% more when compared to the observations before the subprime, indicating a change in the behavior by the market investors.

A possible explanation for this change of behavior is that the subprime crises lead to an unprecedented confidence crisis on the credit market which almost stagnate the interbank credit market. As so investors who associated target rate cuts with future improving credit conditions may now see the transference of this better conditions to the business market has more doubtful. A more reasonable explanation might be inherent to the VIX index. The average price of the index before the subprime was 19 and the

average after appeared to be 32. As so, “the noise” associated with other news on announcement days appeared to be higher since the subprime crisis turning the use of daily data old-fashioned. Using intraday data would probably lead to much more precise and significant values.

5. Conclusion

After using a more stable data set and including one more explainable variable on the model to study the relationship between the stock market and Fed policy action, results revealed a good estimation of the relation analyzed: equity market goes down by 5.7% whenever there is a surprise of 1% on the market. This regression obtained a R^2 of 24.4% which is a superior value in comparison to previous researches.

Moreover, the financial markets seem to react differently if the policy surprise is associated with a no change on the target rate by the Federal Reserve. On the other hand the sign of the policy surprise itself do not seem to influence the relationship between the stock market and the Federal announcements.

A significant heterogeneous cross industry response to policy announcements was verified. This can be explained by the way industry returns are related with the domestic economic situation. The durability of the goods produced seems also to have different sensibilities to policy announcements among economic sectors. Further research however should be conducted to assess which specific industry characteristics are related with policy announcement response.

Lastly, it was verified a significant change on the behavior from the stock market as a reaction to policy announcements after the recent subprime crisis. Results however revealed to be severely contaminated by the presence of heteroskedasticity. Even so, it

is possible to conclude that since the subprime market investors have clearly changed the behavior when responding to a policy surprise. This outcome may be biased by the limitation of using daily data instead of intraday data. It would be interesting to perform using intraday data to assess the subprime effect more accurately.

The results of this study may help equity investors making more efficient decisions, assuming that estimations of the market response to policy announcements has been improved by the technique hereby presented.

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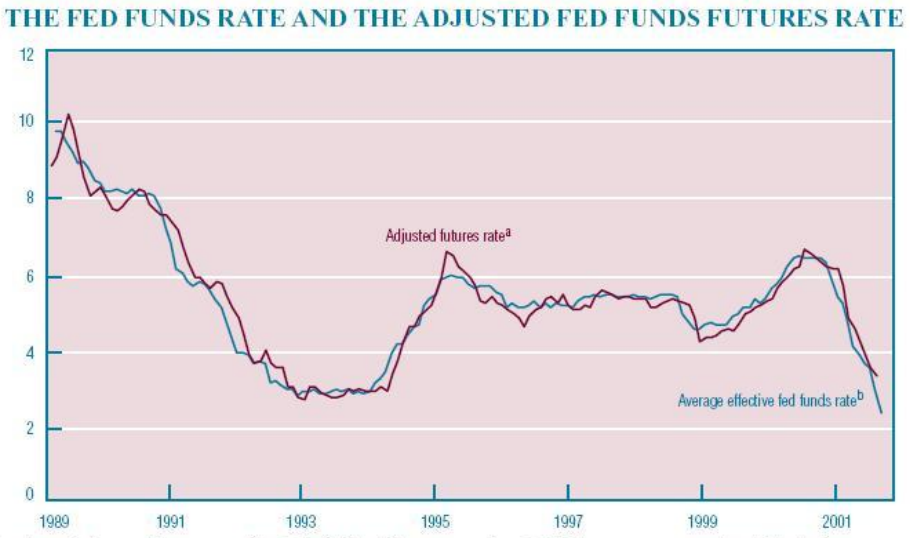
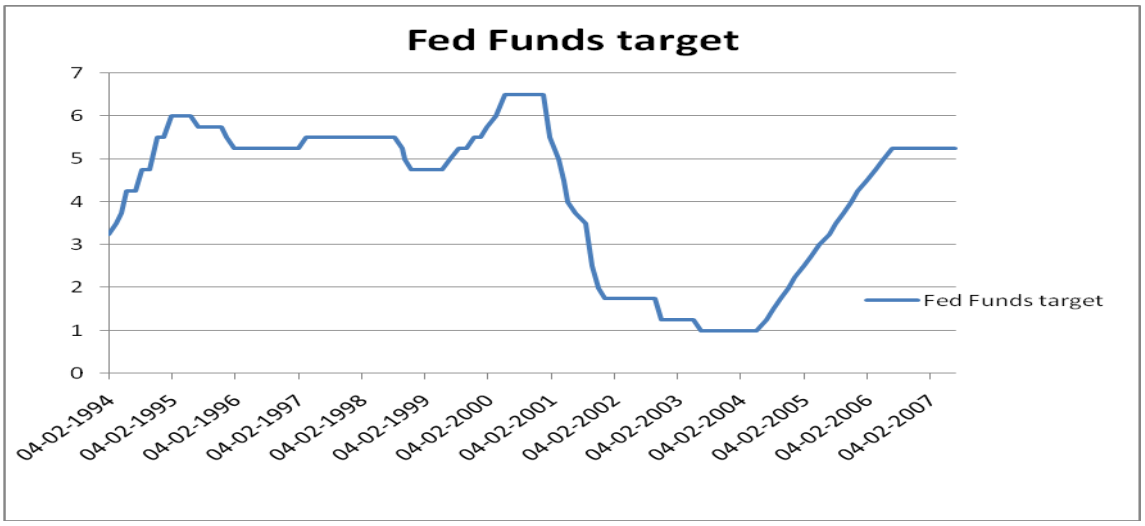
Appendices

Appendix 1: Relationship between the implied rate and the expectations of target federal rates.



a. The adjusted rate is the monthly average of the daily fed funds futures rate minus 0.187, the average amount by which the futures rate overpredicted the fed funds rate from April 1989 to October 2001.
b. Daily fed funds rates were averaged for each month.
SOURCES: Board of Governors of the Federal Reserve System, *Federal Reserve Statistical Releases*, "Selected Interest Rates," H.15; Chicago Board of Trade; and Bloomberg Financial Information Services.

Appendix 2: Evolution of the target rate



Appendix 3: Equity prices reaction to monetary policy actions

	(a) Original Regression		(b) Accounting for VIX	
regressor	Coefficient	Std. Error	Coefficient	Std. Error
Intercept	0.175633	(0.0929)	0.155077	(0.091326)
Expected	0.853926	(0.464582)	0.957991	(0.456761)
Unexpected	-7.479132	(-1.433604)	-5.712104	(1.584885)
Unexpected x Vix_dummy	-	-	-7.616310	(3.176709)
R-squared	0.204164		0.244738	

Appendix 4: The Breusch-Godfrey serial correlation Lagrange Multiplier test for serial correlation (Eviews Software)

For Regression(a)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.928171	Prob. F(2,106)	0.398464
Obs*R-squared	1.910448	Prob. Chi-Square(2)	0.384726

For Regression (b)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.230625	Prob. F(2,105)	0.296288
Obs*R-squared	2.542301	Prob. Chi-Square(2)	0.280509

Appendix 5: The white`s test (Eviews Software)

For Regression (a)

White Heteroskedasticity Test:

F-statistic	0.589416	Prob. F(5,105)	0.708053
Obs*R-squared	3.030426	Prob. Chi-Square(5)	0.695295

For Regression (b)

White Heteroskedasticity Test:

F-statistic	1.554789	Prob. F(8,102)	0.147864
Obs*R-squared	12.06460	Prob. Chi-Square(8)	0.148345

Appendix 6: The t-test statistic

t - statistic

Regression (a)				
Variable	Std. Error	t-Statistic	Critical value	
INTERCEPT	0.092900	1.890570	1.95996	Accept
EXPECTED	0.464582	1.838051	1.95996	Accept
UNEXPECTED	1.433604	-5.217013	1.95996	Reject
Regression (b)				
Variable	Std. Error	t-Statistic	Critical value	
INTERCEPT	0.091326	1.698063	1.95996	Accept
EXPECTED	0.456761	2.097357	1.95996	Reject
UNEXPECTED	1.584885	-3.604113	1.95996	Reject
UNEXPECTED x VIX_dummy	3.176709	-2.397547	1.95996	Reject

Appendix 7: The F-statistic

F - statistic

Regression (a)		
F-Statistic	Critical value	
13.85315	3.949	Reject
Regression (b)		
F-Statistic	Critical value	
11.55755	3.480	Reject

Appendix 8: Results for three different types of asymmetries

	(c)	(d)	(e)
Intercept	0.071694	0.135021	0.172403
	(0.106052)	(0.094175)	(0.090109)
Expected	0.942522	0.878607	1.138986
	(0.454101)	(0.465905)	(0.456515)
Unexpected	-7.380373	-6.531946	-7.174540
	(1.919737)	(1.836323)	(1.695591)
Unexpected x Vix_dummy	-6.816729	-6.795899	-6.898574
	(3.200912)	(3.311810)	(3.139474)
Surprise >0	5.900831	-	-
	(3.881066)	-	-
Rate change>0	-	3.439931	-
	-	(3.880166)	-
Rate change=0	-	-	8.665164
	-	-	(3.968545)
R2	0.260857	0.250297	0.277245
No serial Correlation	Yes	yes	yes
No Heteroskedasticity	Yes	no	yes

Appendix 9: The cross industry regression.

Sector	Least Squares Regressor Intercept	Expected	Unexpected	Adjusted R^2
Consumer Discretionary	0.209930 (-0,109582)	0.809262 (0.548007)	-10.96771 (1.691037)	0.280322
Inf.Technolo	0.319924 (0.169374)	2.041316 (0.847022)	-16.15257 (2.613734)	0.266949
Industrials	0.181092 (0.099767)	0.589010 (0.498923)	-9.077150 (1.539575)	0.243581
Financials	0.223574 (0.125304)	0.781787 (0.626633)	-9.191154 (1.933659)	0.173257
Materials	0.259223 (0.116073)	-0.277591 (0.580470)	-7.101629 (1.791211)	0.140503
Telec.Services	-0.136997 (0.132133)	0.623555 (0.660786)	-2.578563 (2.039049)	0.018735
Health Care	0.185839 (0.105325)	0.521286 (0.526720)	-1.283520 (1.625350)	0.012089
Energy	0.200777 (0.123580)	-0.398106 (0.618009)	-1.325453 (1.907048)	0.010564
Utilities	0.056789 (0.099397)	-0.352842 (0.497076)	-0.639019 (1.533874)	0.007811
Consumer Staples	0.066879 (0.087073)	0.363220 (0.435441)	-0.480611 (1.343682)	0.006688

Appendix 10: Sub prime effect

	(a) Original Regression		(b) Accounting for VIX	
regressor	Coefficient	Std. Error	Coefficient	Std. Error
Intercept	0.337843	(0.108964)	0.334112	(0.111149)
Expected	-0.480170	(0.480010)	-0.462585	(0.490735)
Unexpected	-5.238854	(1.663884)	-5.258348	(1.673696)
Unexpected x Vix_dummy	-	-	-0.281013	(1.478585)
R-squared	0.092754		0.093027	

Appendix 11: Subprime effect (With Dummy)

	(a) Original Regression		(b) Accounting for VIX	
regressor	Coefficient	Std. Error	Coefficient	Std. Error
Intercept	0.341767	(0.108161)	0.335265	(0.110274)
Expected	-0.467546	(0.476422)	-0.436374	(0.487108)
Unexpected	-6.362059	(1.779817)	-6.415490	(1.793496)
Unexpected x Vix_dummy	-	-	-0.494710	(1.472258)
Subprime dummy	7.728587	(4.570191)	7.860107	(4.603846)
R-squared	0.113872		0.114712	