

The Impact of Unanticipated Monetary Policy Changes on Stock Prices

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## Abstract

This paper explores the relationship between monetary policy and the stock market. Using U.S. data for the period 1989- 2006, we find that an unexpected 25-basis-point cut in the Federal Funds rate would lead to an average increase in the S&P 500 stock return of about 1.35%. A vector autoregression (VAR) model is then used to investigate the impact of monetary policy on equity prices through the channels of expected future excess equity returns and the real interest rate.

## 1. Introduction

Monetary policy decisions play an important role in affecting stock market movements. Institutional investors operating in the stock markets pay close attention to any information released by the central bank, and adjust their expectations and actions in response to this information. As a consequence, expected monetary policy decisions will be timely incorporated in the prices of stocks, while unexpected policy changes might generate significant stock market fluctuations.

In this paper, we analyze the relationship between monetary policy and the stock market, and in particular we focus on two research questions. First, we study the magnitude of the changes in the stock market in response to an unexpected change in the Federal Funds rate. Second, we investigate the channels thorough which unanticipated monetary policy changes can affect stock prices.

The results presented in the paper show that the markets reacts strongly to unexpected Federal funds rate changes. More specifically, using U.S. data for the

period 1989-2006, we find that an unexpected 25-basis-point Federal funds rate cut will lead to an average increase in the S&P 500 stock return of 1.35%. We provide an analysis of the robustness of our original results to alternative definitions of the stock index and different sample period. We also investigate the extent to which our results are affected by stock market crash in the data, we find that if the periods of stock market crash are excluded from the sample, the estimated effect of surprise Federal funds rate changes on stock prices will be much smaller than the baseline result. However, we don't include the period of the recent financial crisis in 2008 because the Federal funds rate has been cut to zero by Federal Reserve during this period. So there is no surprise Federal funds rate changes, which this paper tries to investigate.

In the second part of the paper, we employ a VAR model to explore the questions of why monetary policies can affect stock prices. In more detail, we follow the approach used by Bernanke and Kuttner (2005), which is an adaptation of the model proposed by Campbell (1991) and Campbell and Ammer (1993), to study the dynamic effects of unexpected changes in monetary policy on two channels through which policy is assumed to affect stock prices: expected future excess equity returns and the real interest rate. Using this VAR model, we are also able to analyze the response of several macroeconomic variables to surprise Federal funds rate changes.

The remainder of the paper is organized as follows. Section 2 presents the literature review. Section 3 describes the empirical regression model and reports the main findings for the baseline sample. Section 4 discusses the robustness of the results to changes in the index used to measure stock prices and in the sample period under

analysis. Section 5 presents the VAR model which is used to explore the channel through which monetary policy can affect stock prices. Section 6 concludes.

## 2. Literature Review

A large number of contributions in the Economic literature have analyzed the relationship between monetary policy and the stock market. Early research used the event-study approach to study how the stock market reacts to monetary policy. These studies suggest that there is a negative relationship between stock returns and the Federal funds rate (Cook and Hahn, 1989; Jensen, Johnson and Mercer, 1996; Thorbecke, 1997).

In subsequent work, Kuttner (2001) introduced a different approach, based on isolating unanticipated Federal funds rate changes from total changes. While the works of Thorbecke (1997) and Jensen, Johnson and Mercer (1996) focused on the impact of overall Federal funds rate changes on stock prices, Kuttner (2001) distinguished the effects of surprise Federal funds rate changes from those of expected Federal funds rate changes. This author found that the response of market interest rates to anticipated funds rate changes is limited, but their response to the surprise components is significantly larger. Kuttner (2001) focused on the impact of monetary policy on bond markets and market interest rates, while a later contribution by Bernanke and Kuttner (2005) studied the impact of monetary policy on the stock market. In more detail, Bernanke and Kuttner (2005) followed the approach proposed by Kuttner (2001) to study the impact of unanticipated Federal funds rate changes on

equity prices. Using U.S. data for the period 1989- 2002, they found that an unexpected 25-basis-point rate cut would lead in average to an increase in stock prices of about 1%.

Both Kuttner (2001) and Bernanke and Kuttner (2005) used an overall stock index to study the relationship between stock returns and monetary policy. Some later studies focused on the cross section of stock returns rather than on the overall stock returns. An example of this literature is provided by Maio (2014), who distinguished the returns of “small and value” stocks from the returns of “large and growth” stocks.<sup>1</sup> Maio (2014) estimated a negative relationship between Federal funds rate changes and stock returns, which is greater for the “small and value” stocks than for the “large and growth” stocks. By using a VAR approach, this author also showed that such negative effect comes mainly from the impact of Federal funds rate changes on expected cash flows, rather than on future stock risk premiums. A second example of the literature studying the impact of surprise monetary policy changes on the returns of different types of stocks is Kontonikas and Kostakis (2013). Similarly to Maio (2014), this paper finds that “value”, small capitalization, and “past loser” stocks are more susceptible to unexpected Federal funds rate changes than “growth”, big capitalization, and “past winner” stocks.<sup>2</sup> While we believe that the analysis of the impact of monetary policy on different typologies of stocks is interesting, in this paper we decided to focus on the more general question of its effects on the overall stock

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<sup>1</sup> The “small and value” stock refers to the stocks of companies that have a small market capitalization, and whose stock prices are currently trading at or lower than the book value. The “large and growth” stock refers to the shares in a company whose earnings are expected to grow at an above-average rate relative to the market.

<sup>2</sup> A “past loser” stock is a stock that experienced a bad performance in some defined prior time period. Similarly, a “past winner” stock refers to a stock with good performance in some defined prior time period.

index. For this reason, our analysis will follow the approach of Bernanke and Kuttner (2005) rather than the one of Maio (2014) and Kontonikas and Kostakis (2013).

An important strand of the literature in this area has focused on separating the impact of monetary policy on stock prices from the possible response of the central bank to the behavior of the stock market. Rigobon and Sack (2003) suggested using an identification technique based on the heteroskedasticity of equity returns, which allows to obtain a measure the simultaneous reaction of monetary policy to developments in the stock market. Using this approach, Rigobon and Sack (2003) found that the Federal Reserve tightens the monetary policy in response to an increase in stock prices. D'Amico and Farka (2012) employed high frequency data from the futures market (specifically, intraday futures data around Fed announcements times), to obtain a measure of the effects of Federal Reserve's announcements on stock prices that is clear of the contemporaneous response of monetary policy to the stock market. As in Rigobon and Sack (2003), D'Amico and Farka (2012) found that a tightening policy action has a negative impact on stock prices. Fuhrer and Tootell (2008) used the "Greenbook" forecasts to separate the FOMC's (Federal Open Market Committee) reaction to traditional macroeconomic variables (output, inflation,...) from the independent response to fluctuations in stock prices. This paper claims that the FOMC reacts directly only to forecasts of traditional Fed goal variables, which however might be affected by changes in equity prices. Thus, while the Federal Reserve will not react directly to stock market movements, it will respond to the effects of these movements on its goal variables. In this paper, we only focus on the impact of

changes in the Federal funds rate on stock prices, and we disregard the analysis of the response of the central bank to stock market developments. We are aware that not accounting for this response might introduce endogeneity problems in our empirical study, and a further discussion of this issue will be provided in Section 3.

A recent line of research takes from the area of Behavioral Economics, and incorporates psychological factors into the analysis of the effects of monetary policy on the stock market. Kurov (2010) suggested that “investor sentiment” can affect the stock market’s reaction to monetary policy changes. He isolated bear market periods from bull market periods, and found that monetary policy has a significant impact on investor sentiment and stock returns during bear market periods, but has a little impact on these variables during bull market periods. Compared to Kurov (2010), both Bernanke and Kuttner (2005) and this paper don’t explicitly account for possible differences in the impact of monetary policy during the alternating phases of the business cycle. However, we do incorporate Kurov’s (2010) idea that changes in monetary policy might have different effects on stock prices based on market conditions, and in the robustness analysis, we investigate how our baseline results change when we consider financial crisis rather than non-financial crisis periods.

In addition to the literature investigating the magnitude of the impact of monetary policy on stock prices, several contributions have analyzed the channels through which monetary policy can potentially affect the stock market. Campbell (1991) and Campbell and Ammer (1993) used a VAR framework to study the sources of stock market fluctuations. Campbell (1991) focused on the stock market alone,

while Campbell and Ammer (1993) studied the stock and bond markets together. Both papers decomposed excess equity returns into real interest rate, dividends and future excess returns. By using monthly data for the US stock market over the period 1952 - 1987, they found that a large proportion of the variance of excess equity returns can be attributed to changes of future excess stock returns, while there is only a limited effect of the real interest rate on equity returns. The VAR framework proposed by Campbell (1991) and Campbell and Ammer (1993) was also employed by Bernanke and Kuttner (2005), who found results similar to those of the two original contributions using US monthly data for the period 1973 - 2002. In Section 5 of this paper, we will adopt the same VAR model to study the channels through which changes in monetary policy can affect the stock market using a more recent sample period (May 1989 – December 2006) and a different stock market index.

This paper contributes to the existing literature by providing a study of the extent to which estimates of the impact of monetary policy on stock prices are affected by the specific sample period used in the empirical estimation, and by the choice of the stock prices measure. The analysis performed in this work is closely related to Bernanke and Kuttner (2005). However, the CRSP value-weighted index employed by these authors is replaced here by the S&P 500 index. In addition, the sample period is extended from May 1989 - December 2002 to May 1989 - December 2006. We find that if the period 2003 - 2006 is included in the sample, then the estimated effects of unexpected Federal funds rate changes on stock prices are smaller, and that if financial crisis data is excluded from the sample, then these estimated effects become

even smaller. Thus, we conclude that if the economy is operating in “normal” conditions, then the effects of unexpected Federal funds rate changes on stock prices might be smaller than previously estimated in the literature in this area.

### **3. Regression Model and Empirical Results**

This paper aims at exploring the relationship between monetary policy and the stock market. Investors in the stock market are very sensitive, and respond immediately to any changes in the economic environment in which they operate. Investors are likely to hold expectations about future policy developments, and to incorporate these expectations into their actions. Thus, policy changes that were expected by operators will likely have limited impact on the stock market, but changes that were not anticipated might be able to create large market fluctuations. In particular, unexpected policy changes that are considered “bull” news will likely increase stock prices, while changes that are considered “bear” news might cause stock prices to drop. As shown in an influential contribution by Beaudry and Portier (2006), the volatility of the stock market reflects the market’s expectation of future developments in the macroeconomy. At any given point in time, stock prices will already incorporate agents’ expectations of future policy decisions, but they will fluctuate in response to changes in expectations that are caused by policies that were not anticipated. For this reason, in order to properly assess the impact of monetary policy on the stock market, it is essential to distinguish the effects of unexpected policy changes from the expected ones.

In this paper, we measure expected and unexpected policy changes using monthly data rather than daily data as in Bernanke and Kuttner (2005) because of the availability of the data source.<sup>3</sup> However, in their work Bernanke and Kuttner (2005) also presented an extension of their baseline framework in which monthly data is used, so we are still able to compare our results to those of this previous contribution.

Following Bernanke and Kuttner (2005), the “surprise” component of the Federal funds rate changes can be defined as the deviation of the average Federal funds rate target in month  $t$  from the rate of the 1-month futures contract on the last (Dth) day of month  $t-1$ . Thus, the expression used to compute the month- $t$  surprise component is:

$$\Delta i_t^u \equiv i_t - f_{t-1,D}^1 \quad (1)$$

where  $i_t$  is the Federal funds rate target for month  $t$ , and  $f_{t-1,D}^1$  is the Federal funds rate corresponding to the 1-month futures contract on the last day of month  $t-1$ .

Similarly, the expected component of the policy changes can be defined as

$$\Delta i_t^e \equiv f_{t-1,D}^1 - i_{t-1,D} \quad (2)$$

where  $i_{t-1,D}$  is the Federal funds rate target on the last day of month  $t-1$ .

The total policy change can be defined as the sum of these two components, which is the difference between the average Federal funds rate target in month  $t$  and the target on the last day of month  $t-1$ .

$$\Delta i_t \equiv i_t - i_{t-1,D} \quad (3)$$

The efficient market hypothesis (EMH) states that a stock market is efficient if

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<sup>3</sup> We currently do not have access to the daily returns of S&P 500 index and of the Dow Jones Industrial Average.

stock prices always incorporate and reflect all relevant information. The EMH implies that it is impossible for investors to make economic profits by trading stocks on the basis of the available information, including monetary policy. The current stock prices have reflected all publically available information on monetary policy changes. Thus, in an efficient market, monetary policy does not have lagged effect on stock returns, and investors could not predict the trend of stock prices based on the information of monetary policy.

On the basis of the efficient market hypothesis, we focus on estimating the impact of monetary policy changes on the current stock returns, without lags. An OLS regression model is employed to explore the relationship between S&P 500 stock returns and Federal funds rate changes. Following Bernanke and Kuttner (2005), we will first estimate the general model:

$$H_t = a + b\Delta i_t + \varepsilon_t \quad (4)$$

where  $H_t$  represents the stock return, and  $\Delta i_t$  is defined by (3). Then, we will focus on the main regression model employed for our analysis:

$$H_t = a + b^e\Delta i_t^e + b^u\Delta i_t^u + \varepsilon_t \quad (5)$$

where  $H_t$  represents again the stock return, and  $\Delta i_t^e$  and  $\Delta i_t^u$  are defined by (1) and (2) respectively. In both models,  $\varepsilon_t$  is the error term, which represents the residual component of stock returns, once we have controlled for the right-hand side variables.

The error terms are assumed to be uncorrelated to independent variables, normally distributed, has an expected value of zero, and heteroscedasticity. The zero conditional mean assumption implies that other factors affecting stock returns are

assumed to be uncorrelated with raw Federal funds rate changes in model (4) and uncorrelated with expected and unexpected Federal funds rate changes in model (5). In Section 3.1, we will discuss the situation when the zero conditional mean assumption does not hold. In addition, since the errors have different variance across all observations, the errors are said to be heteroskedastic. We use Heteroskedasticity robust standard errors to correct heteroskedastic residuals.

The variables employed in the OLS regression models (4) and (5) and the data sources can be found in Table I . The data on the average Federal funds rate target, effective Federal funds rate and Federal funds rate target on the last day of the month come from the economic database of the Federal Reserve Bank of St Louis. S&P 500 comes from the official website of the Standard & Poor's 500. Raw Federal funds rate changes, surprise changes, and expected changes are computed using expressions (1), (2) and (3). Table II presents descriptive statistics on the policy changes and stock return in the sample period, May 1989 to December 2006. Figure I presents the time series plots of the first 10 variables in Table I .

We have the expected negative sign for the regression coefficient  $b$  in equation (4) and the coefficients  $b^e$  and  $b^u$  in equation (5). Based on the Gordon growth model, when the Federal Reserve decreases the Federal funds rate, the return on bonds (an alternative financial asset to stocks) declines. Investors will then lower the required return on an investment in equity and invest more on equity, which might raise stock prices. So there is a negative relationship between Federal funds rate changes and stock returns.

Table III presents the estimates of equation (4), that is the regression of the monthly S&P 500 returns on the raw changes in the Federal funds rate target, making no distinction between surprise and expected changes. It can be observed from Table III that there is a strong and negative response of the stock return to Federal funds rate changes. If the Federal funds rate decreases by 1%, the S&P 500 equity return will increase in average by 5.27% (with a 95% confidence interval of [1.07%, 9.46%]). This result is statistically significant at the 5% level.

As Bernanke and Kuttner (2005) pointed out, since the stock market tends to include any information about expected monetary policy changes, it is necessary to isolate the surprise Federal funds rate changes from the raw changes. By focusing on the surprise monetary policy changes, we can avoid difficult issues of endogeneity related to the simultaneous interactions between variations stock prices and expected changes in policy. For this reason, our main analysis will be based on the regression model described by equation (5). Table IV reports the estimated coefficients for this model. We find a strong, statistically significant positive response of the stock return to surprise Federal funds rate decrease. The estimated coefficients imply that an unexpected decrease in the Federal funds rate by 1% would increase the S&P 500 stock return by 5.38% (with a 95% confidence interval of [1.08%, 9.69%]). The result is statistically significant at the 5% level. Thus, an unexpected 25-basis-point Federal funds rate cut would in average lead to an increase in the S&P 500 stock return of about 1.35%. The effect of expected Federal funds rate changes is almost as strong as the effect of the unexpected component, but it is only statistically significant at the 10%

level.

The results reported in Table IV are slightly different from those of Bernanke and Kuttner (2005), who found a larger impact of surprise Federal funds rate changes on stock prices. More specifically, they estimated an 11.43% increase in stock returns in response to 1% unexpected decrease in the Federal funds rate. A more in depth comparison of our results with those of Bernanke and Kuttner (2005) will be made in Section 4.

### 3.1 A discussion of the Issue of Endogeneity

In the model described by equation (5), the error term  $\varepsilon_t$  is assumed to be orthogonal to the Federal funds rate changes (this is simply the zero conditional mean assumption used to estimate the parameters in the OLS regression model). The error term represents the residual component of stock returns, once we have controlled for unexpected and expected Federal funds rate changes. If this orthogonality assumption does not hold, the results of the OLS estimation would be biased.<sup>4</sup>

Bernanke and Kuttner (2005) explain that there are mainly two situations in which the assumption of orthogonality of the error term might not hold. The first one is if there exists a contemporaneous response of monetary policy to the stock market. In such situation, our results might be biased. Bernanke and Kuttner (2005) report the estimates of regression (5) using both daily and monthly data. They suggest that the

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<sup>4</sup> One possible solution to this problem would be to employ the approaches proposed by Rigobon and Sacks (2003) or D'Amico and Farka (2012), which we described in Section 2. However, because of the unavailability of data, we are unable to implement the techniques adopted in these two contributions.

monthly estimates are potentially more affected by the endogeneity caused by the contemporaneous response of monetary policy to developments in the stock market, given the longer time available for the monetary authorities to react. Their monthly estimates are larger than the estimates using daily data, and imply a stronger response of stock prices to unexpected Federal funds changes. Given what discussed above, it is possible that this difference might be partially due to the effects of the contemporaneous policy response to the stock market. Thus, we acknowledge that our estimates reported in Table III might also be biased, and might overestimate the negative impact of unanticipated Federal funds changes on the stock return.

A second circumstance in which endogeneity problems might arise is when monetary policy and the stock market both respond jointly to new information. As an example, if the macroeconomic data released in the current month is weaker than the markets expected, the stock prices might decrease, and the Federal funds rate might be cut at the same time in response to the worse than expected economic conditions. Bernanke and Kuttner (2005) explain that the joint response of monetary policy and stock prices to new information would lead to a downward bias in the estimated response of stock prices to Federal funds changes. Thus, we are less concerned about the possible presence of this issue, because in any case it would imply a bias on our results on the conservative side.

#### **4. Robustness Analysis**

This section evaluates the robustness of the results reported above. More

specifically, we perform a first exercise using a different stock index (the Dow Jones Industrial Average), a second exercise using an alternative sample period (1989 to 2002), and a third exercise that aims at investigating the role of including the periods of stock market crash in the data sample.

#### **4.1 Using An Alternative Stock Index**

In the baseline estimates, S&P 500 stock returns are used to identify the relationship between the Federal funds rate and the stock market. However, several other indexes are regularly computed to measure the performance of the U.S. stock market. In this section, the equity return of the Dow Jones Industrial Average (DJIA), is used to study the extent to which the results presented in Section 3 are dependent on the specific index employed for the analysis.

The main differences between these two indexes are their diverse components and the different weighting methodology. The Dow Jones Industrial Average (DJIA) is the price-weighted average of 30 stock components, while the S&P 500 is the market value-weighted average of 500 stocks.<sup>5</sup> Both indexes are widely used by investors to assess and predict the trend of the stock market; however, the S&P 500 is more encompassing, because it includes a larger sample of total stocks, while the Dow Jones Industrial Average is more likely to be influenced by the large stocks in its portfolio. Such differences could potentially lead to a different estimated response of the stock return to monetary policy. Figure II presents the time series plots of the S&P 500 stock return and the DJIA stock return.

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<sup>5</sup> A price-weighted index is constructed so that the weighting of each constituent in the index is proportional to its price, while a market value-weighted index is constructed so that the weighting in the index is commensurate with each constituent's total market value.

The model that is estimated is still the one described by equation (5), including both surprise policy changes and unexpected changes. Table V reports the results from a regression of the 1 month DJIA total return on the expected and unexpected components of the monthly Federal funds rate changes for the sample period from May 1989 to December 2006. As for the data source, Dow Jones Industrial Average comes from the official website of the Dow Jones Indexes.

Compared with the results obtained using the S&P 500 stock return, we still find that DJIA returns show a negative response to a surprise increase in the Federal funds rate. More specifically, the estimated coefficient implies that an unexpected 25-basis-point rate cut will increase stock prices by 1.04% for the DJIA stock return. The magnitude of this increase is slightly smaller than the one estimated for the S&P 500 stock return. In addition, the coefficient on the surprise component of the Federal funds changes is statistically significant only at the 10% level, and the coefficient on the expected changes is statistically insignificant. As mentioned above, the Dow Jones Industrial Average is less encompassing than the S&P 500, and its behavior might be more influenced by the large stocks in its portfolio rather than by the general developments in the market. This might explain the difference in results.

#### **4.2 Alternative Sample Period**

In this paper, the baseline sample period covers the period May 1989 - December 2006. As previously mentioned, the analysis in Bernanke and Kuttner (2005) focuses on the period from May 1989 to December 2002. Thus, in order to investigate the

possible reasons of the difference in the results presented in Section 3 with those of Bernanke and Kuttner (2005), the sample period of May 1989 to December 2002 will be analyzed next. In this exercises, the S&P 500 stock return will still be used as the measure of stock market prices.<sup>6</sup>

The estimated model is still the one described by equation (5), except that now the data used in the estimation covers the period May 1989 - December 2002 instead of May 1989 - December 2006. Table VI reports the results of the regression. Our results show that there is a strong, statistically significant negative response to surprise Federal funds rate increases. The point estimate suggests that if the Federal funds rate unexpectedly decreases by 1%, the S&P 500 stock return will increase by 6.803%. The result is statistically significant at the 1% level. Our estimates imply that an unexpected 25-basis-point rate cut would in average lead to an increase in stock returns about 1.7% for the S&P 500 stock return. The effect of expected Federal funds rate changes is as strong as the effect of the unexpected component, but it is only statistically significant at the 10% level.

Compared with the baseline results, the response of the stock return to the surprise Federal funds rate changes is larger, the significance level is improved, and the adjusted  $R^2$  also increases from 2% to 4%, which implies that a slightly larger fraction of the variance of monthly stock returns is explained by Federal funds changes when the shorter sample is used.

Since the stock return used in the baseline analysis and in the exercise performed

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<sup>6</sup> A better exercise would have been to use the same stock index as Bernanke and Kuttner (2005), the CRSP value-weighted index for the longer time period of May 1989 to December 2006. However, this exercise cannot be performed because we are currently unable to access the data for the CRSP value-weighted index.

in this section are the same, the difference in results can be traced to the different sample period, more specifically to the data from 2003 to 2006. It should be noted that during the years from 2003 to 2006, the performance of the stock market was much less volatile than in the period 1997-2002. This might be a possible reason why the estimated effect of surprise Federal funds rate changes on stock prices is larger in this exercise than in the baseline sample.

If we compare the results of the exercise performed in this Section with those of Bernanke and Kuttner (2005), we can see that the estimated response of the stock return to the surprise Federal funds rate changes is a little smaller here. On the other hand, the effects of an expected change in the Federal funds rate is much larger here than in Bernanke and Kuttner (2005). How to explain such differences? Since in this exercise the sample period is the same as Bernanke and Kuttner (2005), the differences in the magnitude of the results can be ascribed to the different stock returns used in the empirical analysis. Bernanke and Kuttner (2005) use the equity return of the CRSP value-weighted index, while in this paper we use the equity return of the Standard & Poor's 500 Index. The Indexes constructed by the Center for Research in Security Prices (CRSP) are designed to represent the market of investable U.S. equity securities, and include around 4000 common stocks and REITs of U.S. companies that are listed on a CRSP exchange of interest (NYSE, NYSE Market, ARCA or NASDAQ). Thus, the CRSP Indexes include a much larger number of stocks than S&P 500, which might explain the difference in results. In particular, it is interesting that the more encompassing CRSP value-weighted index, seems to exhibit

a stronger reaction to surprise Federal funds rate changes relative to the S&P 500. In Section 4.1 we found that the estimated response of the S&P 500 stock return to unexpected Federal funds changes was slightly larger than the response of the Dow Jones Industrial Average. In this case, the S&P 500 was the index that included the larger set of stocks. It follows that, overall, our results seem to suggest that more encompassing indexes exhibit a stronger reaction to unexpected changes in the Federal funds rate.

### 4.3 The Impact of Stock Market Crash

The purpose of this section is to investigate the extent to which our results are affected by the stock market crash in the data. As Mishkin and Serletis (2012) states in their textbook, *the\_Economics\_of\_Money, Banking\_and\_Financial\_Markets*, financial crises occur when there is a disruption in the financial system that causes such a sharp increase in adverse selection and moral hazard problems in financial markets that the markets are unable to channel funds efficiently from savers to investors. As a result, economic activity contracts sharply. According to their definition, there are five factors that can cause financial crisis, that is, deterioration in banks' balance sheets, increase in interest rates, stock market decline, increase in uncertainty and bank panic. So stock market decline is one of factors that causes financial crisis. Mishkin and Serletis (2012) considers the other events, like the United States Savings & Loan crisis and the Internet bubble crash, as close calls to financial crisis. During both events, the stock market declined dramatically. It ultimately didn't

develop as the real financial crisis because the Federal Reserve took timely actions.

We will focus on two major events when the stock market crash happens: the United States Savings & Loan crisis, which characterized the years 1989-1991, and the Internet bubble crash, which affected the period 2000-2002. We don't include the sample period of the recent 2008 financial crisis because the Federal funds rate has been cut to zero by Federal Reserve during this period. So there is no surprise Federal funds rate changes, which this paper tries to investigate.

The United States Savings & Loan crisis refers to the failure of the Savings and Loans Associations in the United States. This event triggered an economic recession that lasted from 1989 to 1991. In this period, a lot of financial institutions went bankrupt, including Lincoln Savings & Loan, one of the largest S&L companies. The Federal Deposit Insurance Corporation, which insured all S&L deposits, became insolvent as well. The largest one-day drop in the history of the United States stock market, in which stock prices plummeted more than 20% ("The Black Monday") occurred during this financial crisis.

The US economy also experienced the "Internet bubble" in the late 1990s, when stock prices rose rapidly from the growth of the Internet sector and related high-tech industry. The collapse of the Internet bubble started in March 2000. The entire Internet industry suffered heavy losses in terms of stock values, and the stock market crash resulted in a total loss of \$5 trillion in the market value of companies from March 2000 to October 2002.

In this section, we will perform two exercises. First, we will analyze the impact

of monetary policy changes on stock returns during stock market crash. Second, we will exclude financial crisis years from the full sample.

Table VII reports the results from a regression of the monthly S&P return on the expected and unexpected components of the monthly Federal funds rate changes in a sample that includes data from May 1989 to December 1991 and from March 2000 to October 2002. Unfortunately, the results of this exercise are not very meaningful. We find a slightly negative response of the stock return to surprise Federal funds rate increases. The estimated coefficients imply that an unexpected decrease in the Federal funds rate by 1% would increase the S&P 500 stock return by only 0.26%. But the results are statistically insignificant at even 10% level. This might be due to the small sample used in this exercise, which only includes 64 observations.

Now, we want to think about the problem from the opposite perspective: what if the observations relative to the periods of stock market crash were not included in the full samples? Table VIII reports the results from a regression of the monthly S&P return on the expected and unexpected components of the monthly Federal funds rate changes in the baseline sample period excluding the United States Savings & Loan crisis and the Internet bubble crash. In more detail, the sample period used in this exercise goes from May 1989 to December 2006, excluding the intervals from May 1989 to December 1991 and from March 2000 to October 2002. The results show a statistically significant negative response of the S&P 500 stock return to surprise Federal funds rate increases. More specifically, if the Federal funds rate unexpectedly decreases by 1%, the S&P 500 stock return will increase by 1.23%, with a 95%

confidence interval of [0.75%, 1.71%]. The result is statistically significant at the 1% level. The estimated coefficient implies that an unexpected 25-basis-point rate cut would in average lead to an increase in stock returns of about 0.31% for the S&P 500 stock return. The effect of expected Federal funds rate changes is positive, but statistically significant only at the 10% level.

Compared with the baseline analysis, the estimated impact of a surprise Federal funds rate change on stock prices is much smaller in this case. Our results seem to suggest that during non-stock market crash periods, the response of the stock market to the surprise Federal funds rate changes is much more limited. This observation is supported by our results in Section 3.2, which showed that the inclusion in the sample of the “stable” years from 2003 to 2006 reduces the estimated impact of Federal funds rate changes on the stock return.

In turn, our results imply that the impact of surprise Federal funds rate changes on stock returns is larger during stock market crash. A natural explanation of this result is that the high volatility and higher uncertainty that typically characterize the periods of stock market crash will likely amplify the response of the stock market to any small unexpected monetary policy changes.

## **5. VAR Model**

The sections above have analyzed the reaction of equity returns to the Federal Reserve’s policies. This section turns to the question of the channels through which monetary policy can affect stock prices. We will address this question within the

vector autoregression (VAR) framework.

The VAR model was first advocated by Christopher Sims in 1980. The advantage of VAR models is that, compared to more structural and microfounded models, they allow less restrictions on the relationships between the variables of interest. VAR models have been used to analyze the impact of structural shocks on the economy, and to study the response of policy to a number of macroeconomic variables. In this paper, the VAR framework will be used to study the dynamic relationship between stock market returns and unexpected changes in the Federal funds rate.

Following Bernanke and Kuttner (2005), this paper employs a VAR framework similar to the one proposed by Campbell (1991) and Campbell and Ammer (1993). Previous contributions using this same VAR framework (Patelis, 1997; Goto and Valkanov, 2000; Hu, 2001) obtained that the impact of monetary policy on the stock market is mostly due to revisions of expectations of future excess returns and future dividends. On the other hand, they find that the real interest rate channel has a very small role in the transmission of monetary policy to stock returns.

We will follow Bernanke and Kuttner (2005), and we will focus on the analysis of the dynamic response of excess stock returns and the real interest rate to surprise Federal funds changes. These two variables are assumed to be the main channels through which unexpected changes in monetary policy affect stock prices (see Bernanke and Kuttner (2005) for a discussion). As in Bernanke and Kuttner (2005), the Federal funds rate surprise is introduced in the VAR model as an exogenous variable. The VAR model is:

$$z_{t+1} = Az_t + \varphi \Delta i_{t+1}^u + w_{t+1} \quad (7)$$

where  $z_{t+1}$  is a  $n \times 1$  vector containing the endogenous variables of interest.  $\varphi$  is an  $n \times 1$  vector capturing the contemporaneous response of the elements of  $z_{t+1}$  to the unexpected Federal funds rate change in period  $t+1$ . The error term  $w_{t+1}$  is assumed to be uncorrelated with both  $z_t$  and  $\Delta i_{t+1}^u$ .

The vector  $z_{t+1}$  includes two financial variables, excess equity return ( $s_t$ ) and the real interest rate ( $r_t$ ), in addition to the following macroeconomic variables: core consumer price index (CPI), purchasing managers' index (PMI), nonfarm payrolls (NFP), producer price index (PPI). The choice of the two financial variables, excess equity return and the real interest rate, are based on Bernanke and Kuttner (2005), and the choice of the other macroeconomic variables is based on Rigobon and Sack (2002). Using these variables, the VAR model in (7) can be rewritten in extended form as:

$$\begin{pmatrix} cpi_{t+1} \\ ppi_{t+1} \\ pmi_{t+1} \\ nfp_{t+1} \\ s_{t+1} \\ r_{t+1} \end{pmatrix} = A \begin{pmatrix} cpi_t \\ ppi_t \\ pmi_t \\ nfp_t \\ s_t \\ r_t \end{pmatrix} + \varphi \Delta i_{t+1}^u + \begin{pmatrix} w_{t+1}^{cpi} \\ w_{t+1}^{ppi} \\ w_{t+1}^{pmi} \\ w_{t+1}^{nfp} \\ w_{t+1}^s \\ w_{t+1}^r \end{pmatrix} \quad (8)$$

From the reduced-form VAR model described in (7) and (8), we are interested in obtaining the structural VAR model:

$$z_{t+1} = Az_t + \varphi \Delta i_{t+1}^u + C\varepsilon_{t+1} \quad (9)$$

where  $C\varepsilon_{t+1} = w_{t+1}$ . The matrix  $C$  satisfies  $CC' = \Omega$ , where  $\Omega = E(w_{t+1}w_{t+1}')$ . A Cholesky identification scheme is imposed to obtain the matrix  $C$  from the estimated reduced-form covariance matrix  $\Omega$ . As commonly known, the Cholesky

identification approach implies that the variables in the model influence each other in a specific order. More specifically, each variable is assumed to be affected contemporaneously by all the variables ordered before, and to be affected only with a lag by the variables ordered after in the VAR model. As alternative orderings imply different assumptions on the way in which the variables affect each other, the results of the VAR estimation will typically depend on the specific ordering selected by the researcher. The Cholesky identification approach we use is based on the structural-form model.

As noted by Bernanke and Kuttner (2005), the model described by (9) is also equivalent to a VAR model where the surprise changes in the Federal funds rate are included as one of the endogenous variables, and ordered first in the identification of the structural model. The structural VAR model in (9) can be rewritten in extended form as:

$$\begin{pmatrix} \Delta i_{t+1}^u \\ cpi_{t+1} \\ ppi_{t+1} \\ pmi_{t+1} \\ nfp_{t+1} \\ S_{t+1} \\ r_{t+1} \end{pmatrix} = A \begin{pmatrix} \Delta i_t^u \\ cpi_t \\ ppi_t \\ pmi_t \\ nfp_t \\ S_t \\ r_t \end{pmatrix} + C \begin{pmatrix} \varepsilon_{t+1}^{\Delta i^u} \\ \varepsilon_{t+1}^{cpi} \\ \varepsilon_{t+1}^{ppi} \\ \varepsilon_{t+1}^{pmi} \\ \varepsilon_{t+1}^{nfp} \\ \varepsilon_{t+1}^S \\ \varepsilon_{t+1}^r \end{pmatrix} \quad (10)$$

Thus, surprise Federal funds rate changes are assumed to affect all the other variables contemporaneously, and to be affected with a lag by other variables in the VAR model. As in Bernanke and Kuttner (2005), we interpret unexpected Federal funds changes as a measure of changes in monetary policy but, as them, we are aware that because of this assumption, the impulse responses obtained from the VAR could

include other effects in addition to monetary policy.

The ordering of the other variables in the structural VAR model is: consumer price index (CPI), producer price index (PPI), purchasing managers' index (PMI), nonfarm payrolls (NFP), the excess equity returns, the real interest rate. This ordering implies that equity returns will react to the current macroeconomic conditions, but will affect prices and real variables only with a one month delay. The position of the real interest rate in the VAR is based on the assumption that the expected component of monetary policy reacts contemporaneously to the developments in the macroeconomy in addition to the excess returns.<sup>7</sup>

So surprise Federal funds rate changes are assumed to affect prices and real variables, equity returns and real interest rate contemporaneously. Prices are assumed to affect real variable contemporaneously. The macroeconomic variables are assumed to affect the financial variables contemporaneously.

The VAR model is estimated using monthly data, and the baseline sample runs from May 1989 to December 2006. The VAR includes one lag of each variable; this choice follows Bernanke and Kuttner (2005). Each variable is measured in logarithmic form, except excess equity return and the real interest rate. The excess equity return is measured by the difference between S&P 500 return and 3-month Treasury bill rate. The real interest rate is expressed as the 3-month bill yield minus the log difference in the non-seasonally adjusted CPI. The non-seasonally adjusted

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<sup>7</sup> We tried several alternative orderings, and we found that even if the financial variables are ordered before the macroeconomic variables, or the price variables are ordered after the real variable, the results are almost unchanged.

CPI is used to make our results more comparable to those of Bernanke and Kuttner (2005). The surprise Federal funds rate changes obtained in Section 3 will be used in the VAR model. As for the data source, please refer to Table I .

Figure III reports the responses of the financial variables to surprise Federal funds changes obtained from the VAR model. This figure shows the response of excess equity returns and the real interest rate to a 1 percentage point Federal funds rate surprise. The sample period is from May 1989 to December 2006. The impulse response function is estimated for 25 months. The solid line is the impulse response computed using the mean values of the estimated parameters and the shaded area represents the 95% level confidence interval.

The left-hand panel of Figure III displays the response of excess returns. In the first few months, the average response of excess returns is initially negative, then it quickly reverts to positive values, but after a few months it becomes negative again and then converges to zero. However, the uncertainty around the response obtained with our point estimates is quite large, and the error bands always include the zero value.

The right-hand panel displays the response of the real interest rate. The average response is positive and significantly different from zero in the first 14 months. In addition, this response is increasing at first, but after the first 8 months, the real interest rate begins to decrease and converge to zero gradually.

The results are fairly similar to those of Bernanke and Kuttner (2005). In our estimated responses, the excess equity return is negative at impact, but then becomes

positive. After a few months, it becomes negative again and then converges to zero. The result of Bernanke and Kuttner (2005) show the same initial decline in excess equity returns, and the same change in sign after the first period; however, in their case the response remains positive for several months afterwards. This is the main difference with the results reported in the left-hand side panel of Figure III. Regarding the real interest rate, Figure III shows that it will increase at first, and then gradually converge to zero. This pattern is comparable to the one obtained by Bernanke and Kuttner (2005), although in our case the response seems to return to zero a lot more slowly. Similarly to the results discussed in Sections 3 and 4, we think that the differences between the responses shown in Figure III and those reported by Bernanke and Kuttner (2005) could be attributed to the different sample period and the different stock index used in this paper. But in addition, the VAR analysis performed in this section provides a more in depth interpretation of the reasons why, using our sample and stock returns, we obtain a more reduced response of stock prices to unexpected changes in the Federal funds rate. More specifically, based on the results reported in Figure III, such reduced effect seems to be mostly due to the different dynamic response of excess equity returns to surprise Federal funds changes rather than the response of real interest rate. Thus, the reduced response of excess equity returns to surprise Federal funds changes leads to the difference in the response of stock prices to unexpected Federal funds rate changes between Bernanke and Kuttner (2005) and ours.

The responses of the macroeconomic variables to surprise Federal funds rate

changes are shown in Figure IV. As previously mentioned, the ordering of the variables in the VAR is: the Federal funds rate surprises, the consumer price index (CPI), the producer price index (PPI), the purchasing managers' index (PMI), nonfarm payrolls (NFP), the excess returns, the real interest rate.

All panels in Figure IV show the response of each variable to a 1 percentage point Federal funds rate surprise. In the panels, all macroeconomic variables increase at first, except that the initial impact on the CPI and on the PPI is negative. But after a few months, they all decrease and converge to zero gradually. The responses of the macroeconomic variables are small, especially for the nonfarm payrolls. In addition, the uncertainty around these responses is large, so the patterns are often not statistically different from zero.

### 5.1 Robustness Analysis

We perform a similar exercise to the one presented in Section 4.2, and we repeat the analysis using the sample period of May 1989 to December 2002 (still employing the S&P 500 stock return as our measure of stock prices). The responses of excess returns and of the real interest rate to surprise changes in the Federal funds rate are shown in Figure V. The patterns of the responses of these two variables are very similar to those obtained in the baseline sample period. Again, the uncertainty around these responses is large.

The responses of macroeconomic variables to the surprise Federal funds rate changes for the VAR model estimated using the reduced sample are shown in Figure

VI. All panels show the response of each variable to a 1 percentage point Federal funds rate surprise. As for the baseline case, all variables increase at first, but after a few months, they all decrease and gradually converge to zero. Again, the magnitude of the responses of the macroeconomic variables is small, and the error bands are large. Overall, we find that the results for the reduced sample (1989-2002) are very similar to baseline results (1989-2006).

## 6. Conclusions

This paper offers an empirical study of the impact of unexpected Federal funds changes on stock prices. In our baseline regression model, we find that an unexpected 25-basis-point cut in the Federal Funds rate would lead to an average increase in the S&P 500 stock return of about 1.35% over the sample period 1989-2006. We also find that the same unexpected 25-basis-point cut would increase stock return by 1.04% if the Dow Jones Industrial Average is used to measure stock prices. Finally, if the sample period 1989-2002 (the same as in Bernanke and Kuttner, 2005) is used for analysis, we find that an unexpected 25-basis-point rate cut would in average lead to an increase in stock return of about 1.7% for the S&P 500 stock return, while if the observations relative to periods of stock market crash are excluded from the sample, the same unexpected 25-basis-point rate cut would in average lead to an increase in stock return of about 0.31% for the same index. It should also be noted that the period of the recent financial crisis in 2008 is not included in our sample because the Federal Reserve has cut the Federal funds rate to zero during this period, so there is no

surprise Federal funds rate changes, which this paper tries to investigate. As discussed in the main text, our estimations might suffer from some endogeneity problems, so we are aware that they should be taken with caution.

It should also be noted that in all of our regressions, the expected and unexpected Federal funds rate changes are able to explain only a small proportion of the overall volatility of the stock market return, and many other factors for instance fiscal policy, international politics, financial rumors, and so on, could play an important role in generating stock market fluctuations.

Using the VAR model presented in Section 5, we studied the dynamic response of expected excess returns and the real interest rate to unexpected changes in the Federal funds rate. We found that the impact on excess returns is negative at first, but the sign immediately reverts to positive, and then the response slowly converges to zero over time. The impact on the real interest rate is a lot less volatile: it is positive and slightly increasing in the first 8 months after the unexpected policy change, and then it gradually goes back to zero. These results are similar to those obtained by the previous literature in this area.

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## Appendix: Figures and Tables

Table I

Variables of Interest in the OLS regression Model and the VAR Model<sup>8</sup>

VARIABLES	NOTATIONS	LABELS	DATA SOURCE
average Federal funds rate target	$i_t$	DFEDTAR	the economic database of the Federal Reserve Bank of St Louis ( <a href="http://research.stlouisfed.org/fred2/">http://research.stlouisfed.org/fred2/</a> )
Federal funds future contracts on the last day	$f_{t-1,D}^1$	FEDFUNDS	
Federal funds rate target on the last day	$i_{t-1,D}$	DFEDTAR	
S&P 500 stock return	$H_t$	S&P 500 MONTHLY RETURNS	the official website of the Standard & Poor's 500 ( <a href="http://us.spindices.com/indices/equity/sp-500">http://us.spindices.com/indices/equity/sp-500</a> )
raw changes in the Federal funds rate	$\Delta i_t$	-	computed using expressions (1), (2) and (3)
unexpected Federal funds rate changes	$\Delta i_t^u$	-	
expected Federal funds rate changes	$\Delta i_t^e$	-	
Dow Jones Industrial Average stock return	$D_t$	DJIA MONTHLY RETURNS	the official website of the Dow Jones Indexes ( <a href="http://www.djaverages.com/?go=industrial-index-data">http://www.djaverages.com/?go=industrial-index-data</a> )
surprise Federal funds rate changes	$\Delta i_t^u$	-	obtained in Section 3
excess equity return	$S_t$	-	the difference between S&P 500 return and 3-month Treasury bill rate
real interest rate	$r_t$	-	the 3-month bill yield minus the log difference in the non-seasonally adjusted

<sup>8</sup> The data sample of each series is May 1989 - December 2006. The data frequency of each series is monthly.

The Impact of Unanticipated Monetary Policy Changes on Stock Prices

			CPI
core consumer price index	CPI	CPIAUCSL	the economic database of the Federal Reserve Bank of St Louis ( <a href="http://research.stlouisfed.org/fred2/">http://research.stlouisfed.org/fred2/</a> )
producer price index	PPI	PPIACO	
purchasing managers' index	PMI	NAPM	
nonfarm payrolls	NFP	PAYEMS	

**Table II**  
**Descriptive Statistics**

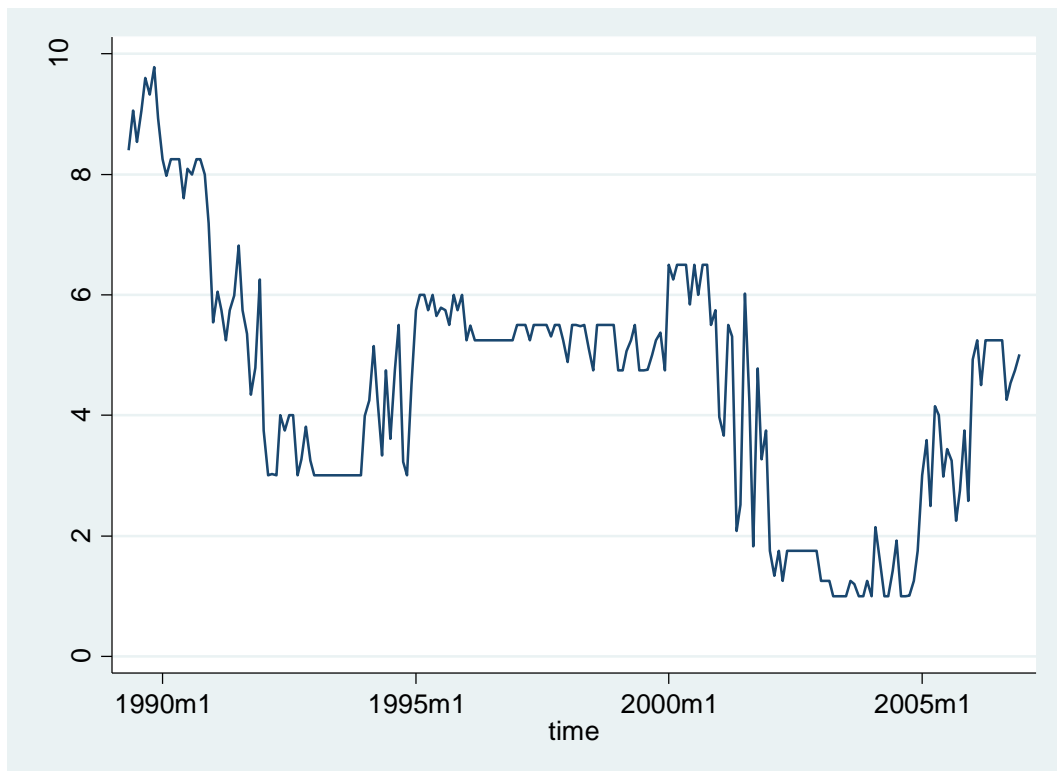
VARIABLES	(1) N	(2) mean	(3) sd	(4) min	(5) max
Average funds rate target	212	4.512	2.052	1	9.780
Federal funds future contracts	212	4.524	2.055	0.980	9.810
Federal funds rate target on the last day	212	4.506	2.038	1	9.813
S&P 500	212	0.984	4.006	-14.46	11.44
Raw funds rate change	211	-0.0152	0.128	-0.500	0.500
Surprise change	211	-0.0335	0.187	-0.660	0.470
Expected change	211	0.0183	0.112	-0.280	0.480

The table reports the descriptive statistics for the average Federal funds rate target, Federal funds future contracts, Federal funds rate target on the last day of the month, S&P 500 stock returns, raw changes in the Federal funds rate, and expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 2006.

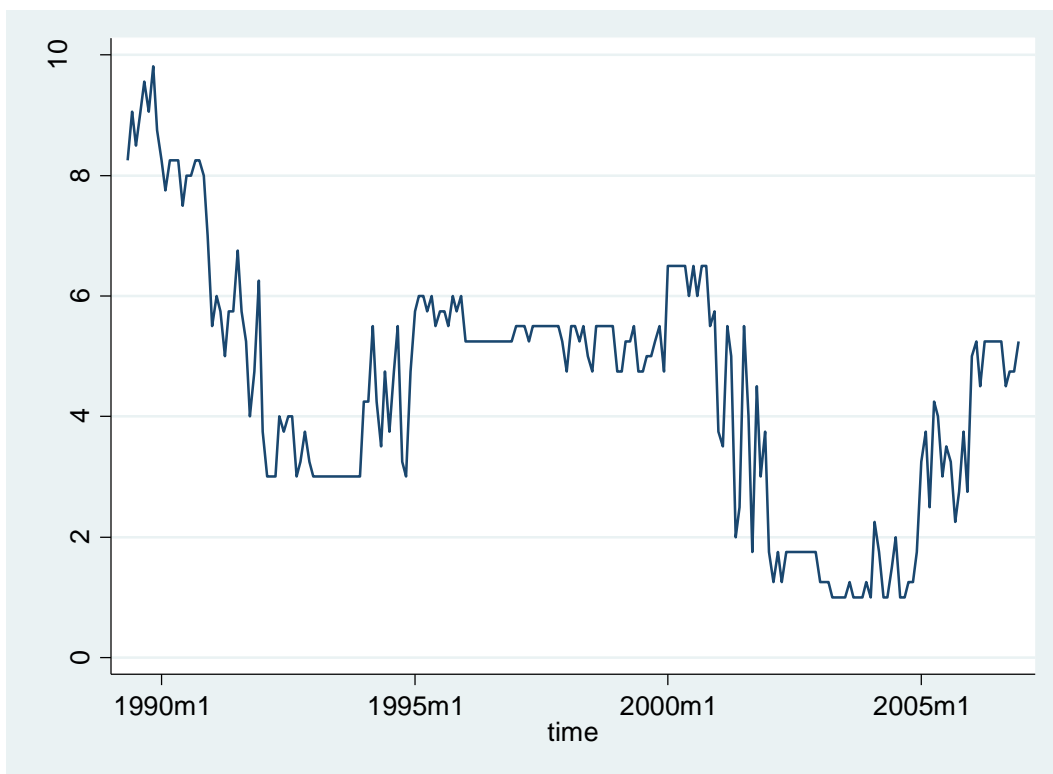
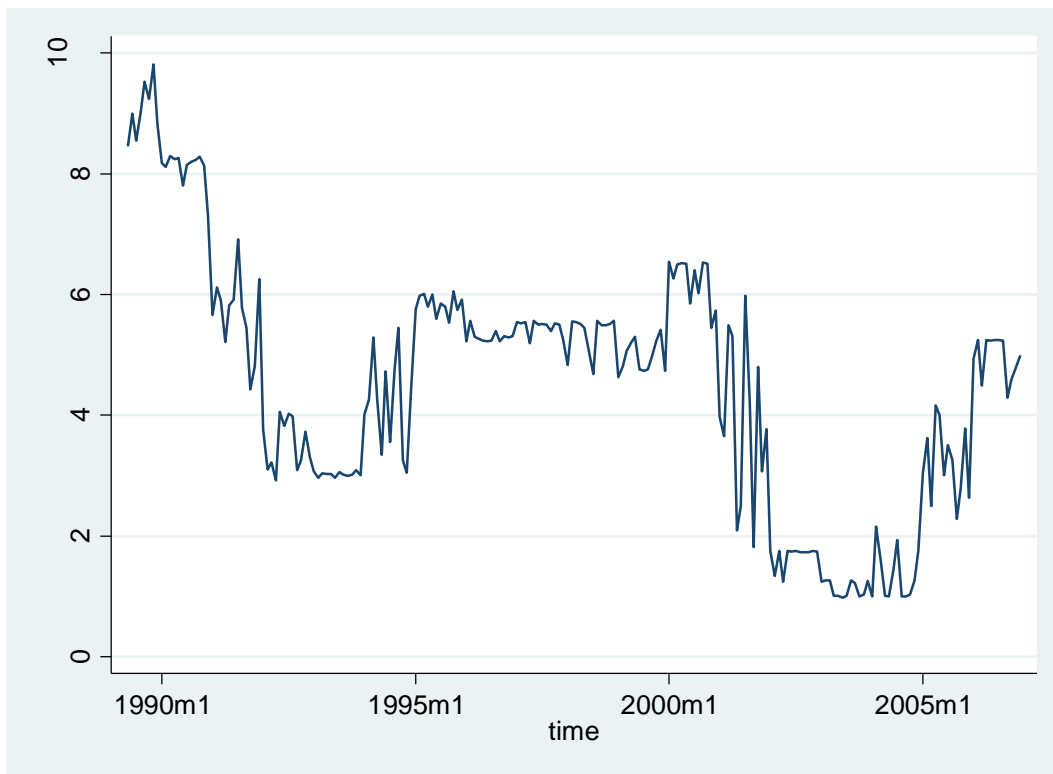
Figure I

**Time Series Plots of the First 10 Variables in Table I**

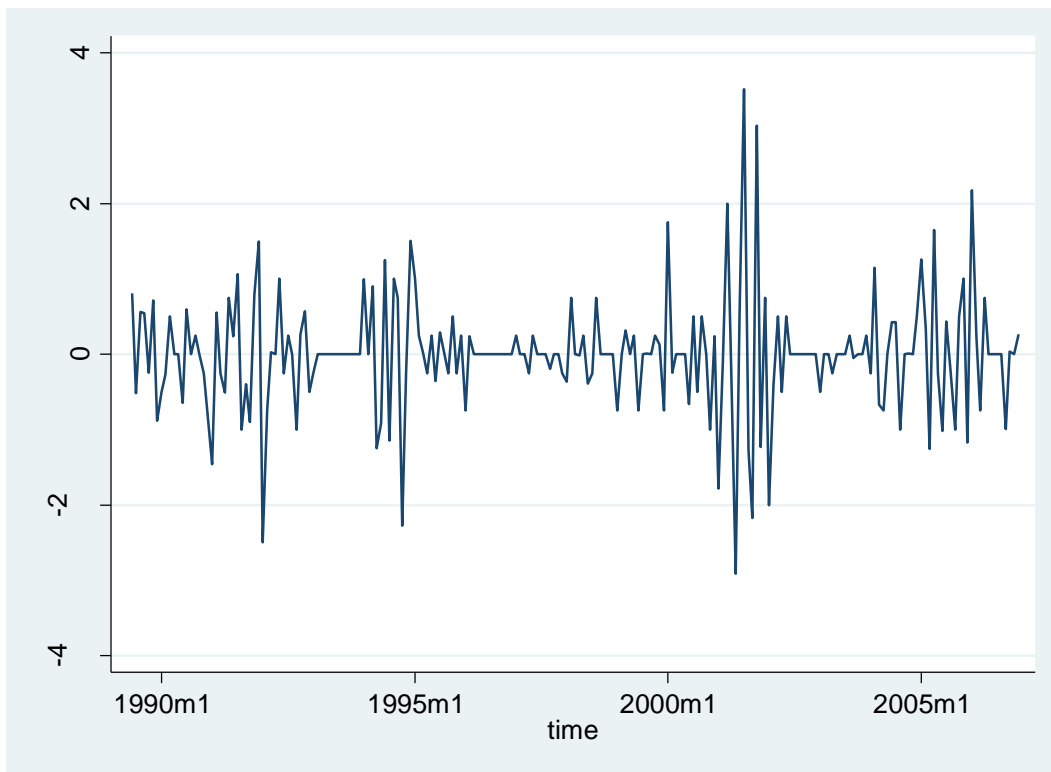
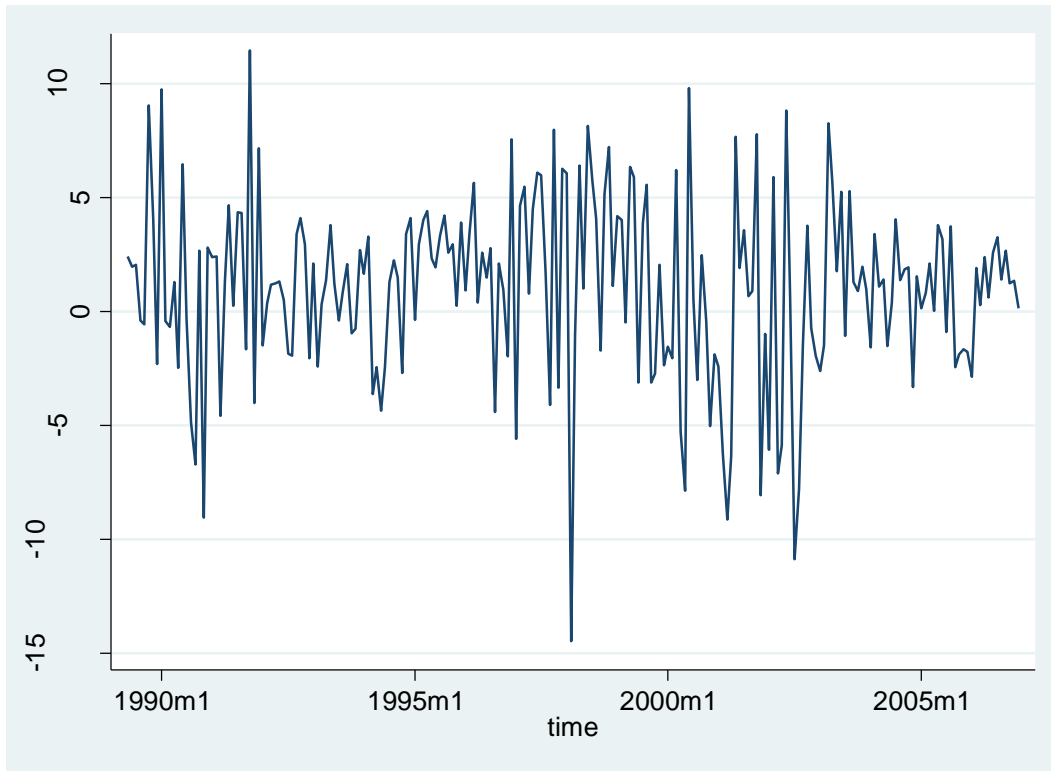
The following graphs plot the time series of the average Federal funds rate target, the Federal funds future contracts on the last day, the Federal funds rate target on the last day, the S&P 500 stock return, the raw changes in the Federal funds rate, the unexpected Federal funds rate changes, the expected Federal funds rate changes, the DJIA stock return, the excess equity return, the real interest rate over the period May 1989 - December 2006.



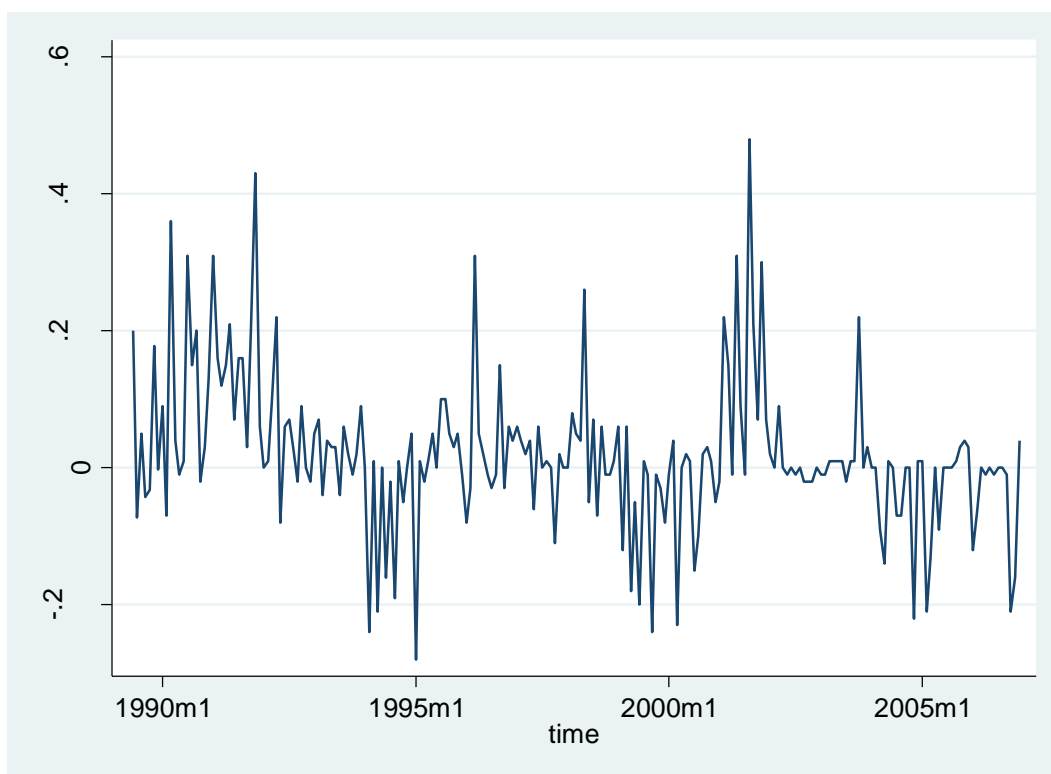
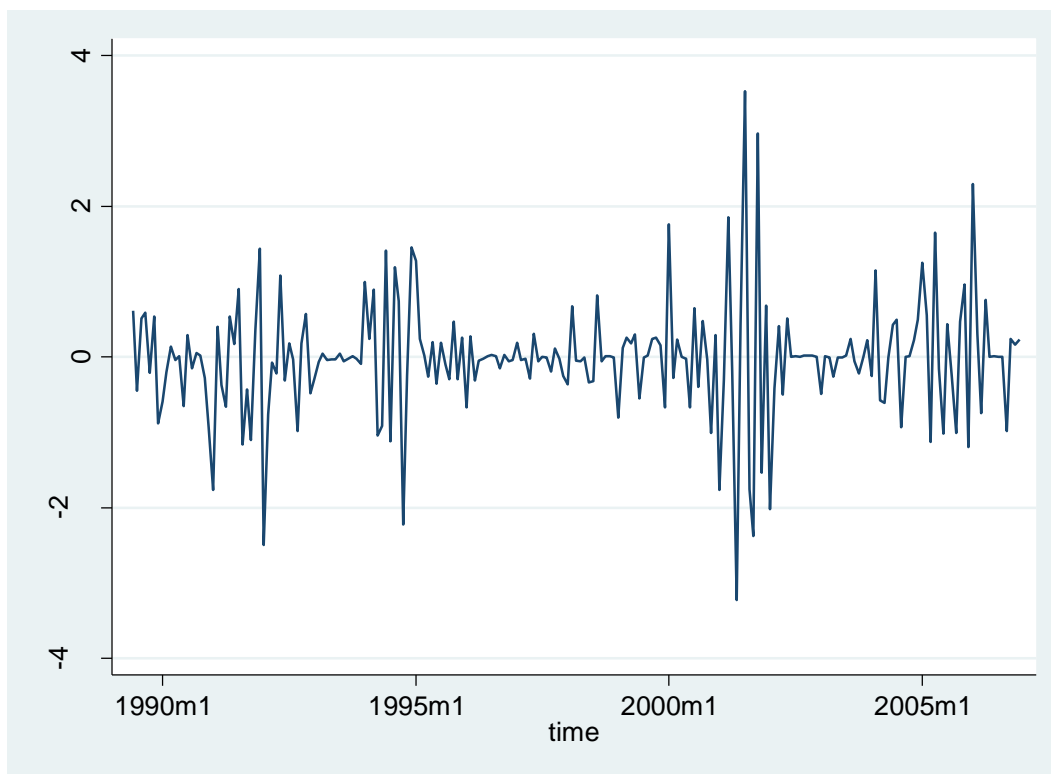
The Impact of Unanticipated Monetary Policy Changes on Stock Prices



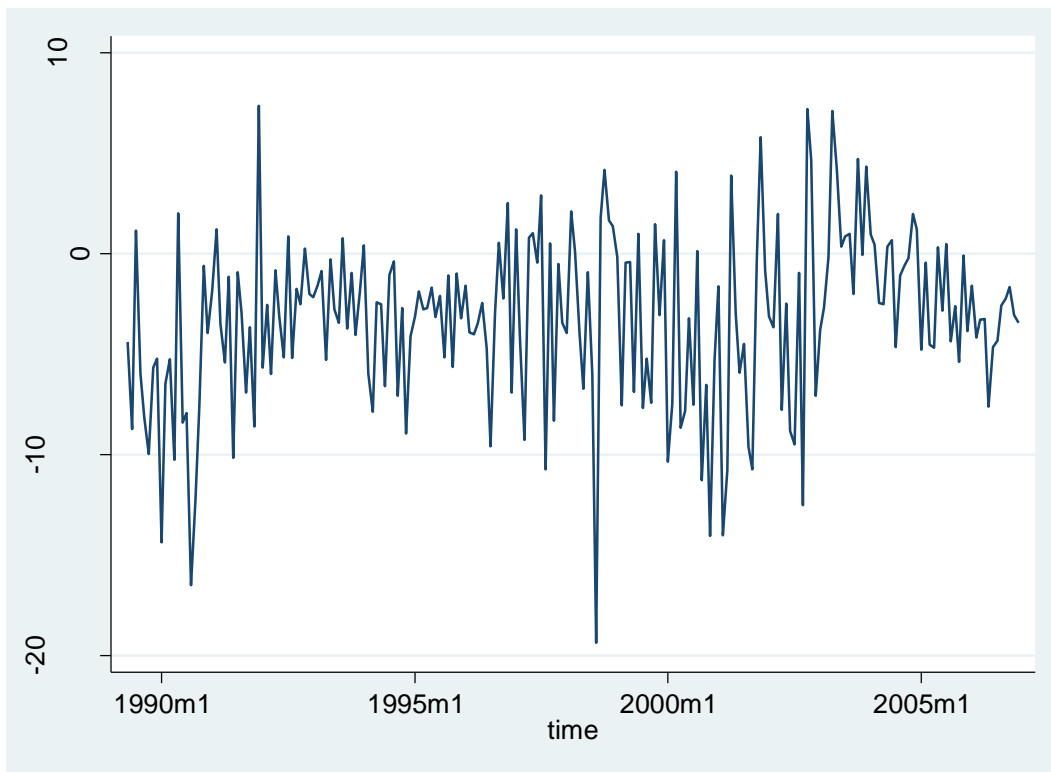
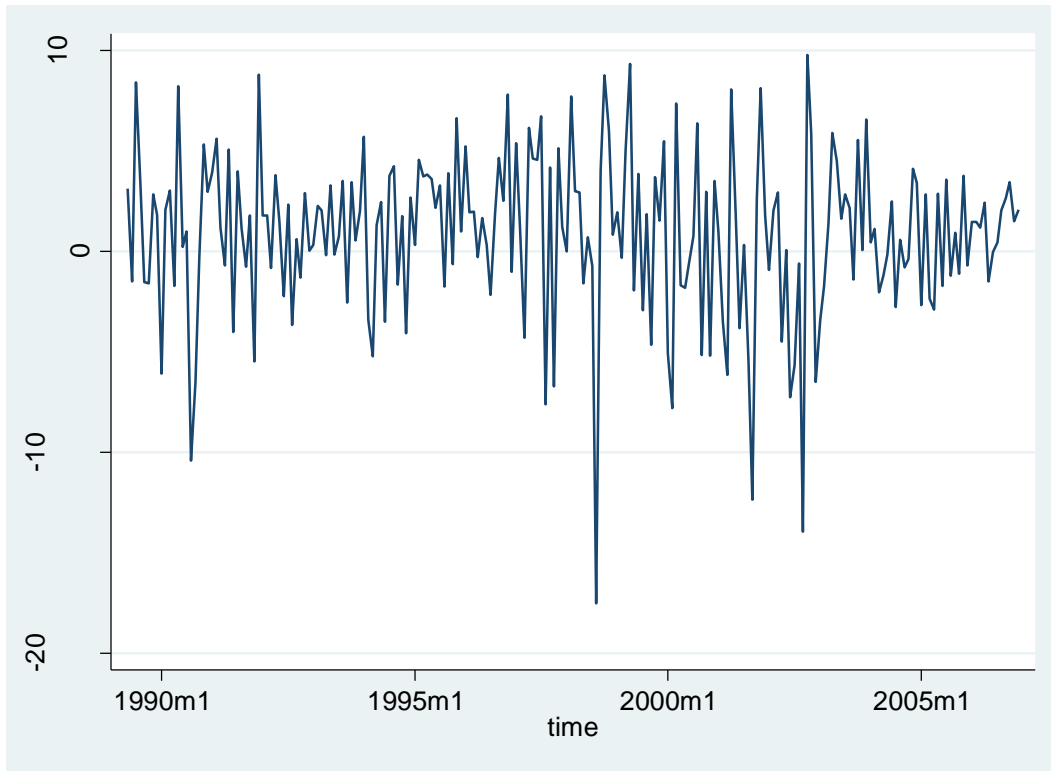
### The Impact of Unanticipated Monetary Policy Changes on Stock Prices



### The Impact of Unanticipated Monetary Policy Changes on Stock Prices



### The Impact of Unanticipated Monetary Policy Changes on Stock Prices



### The Impact of Unanticipated Monetary Policy Changes on Stock Prices

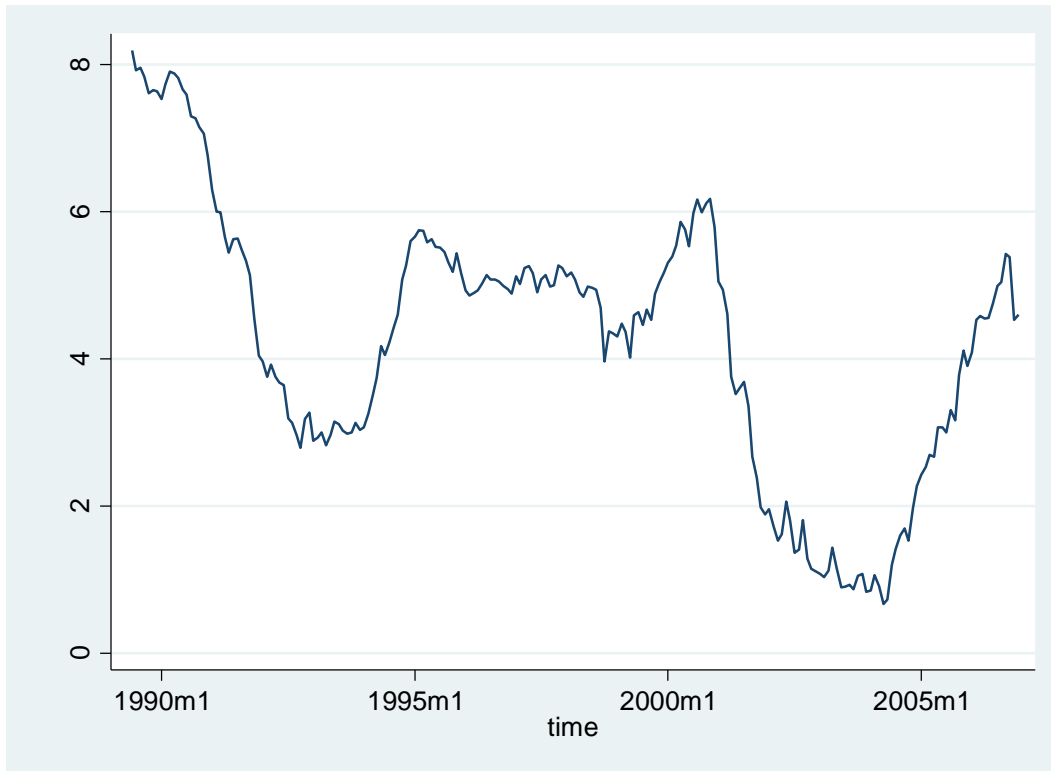
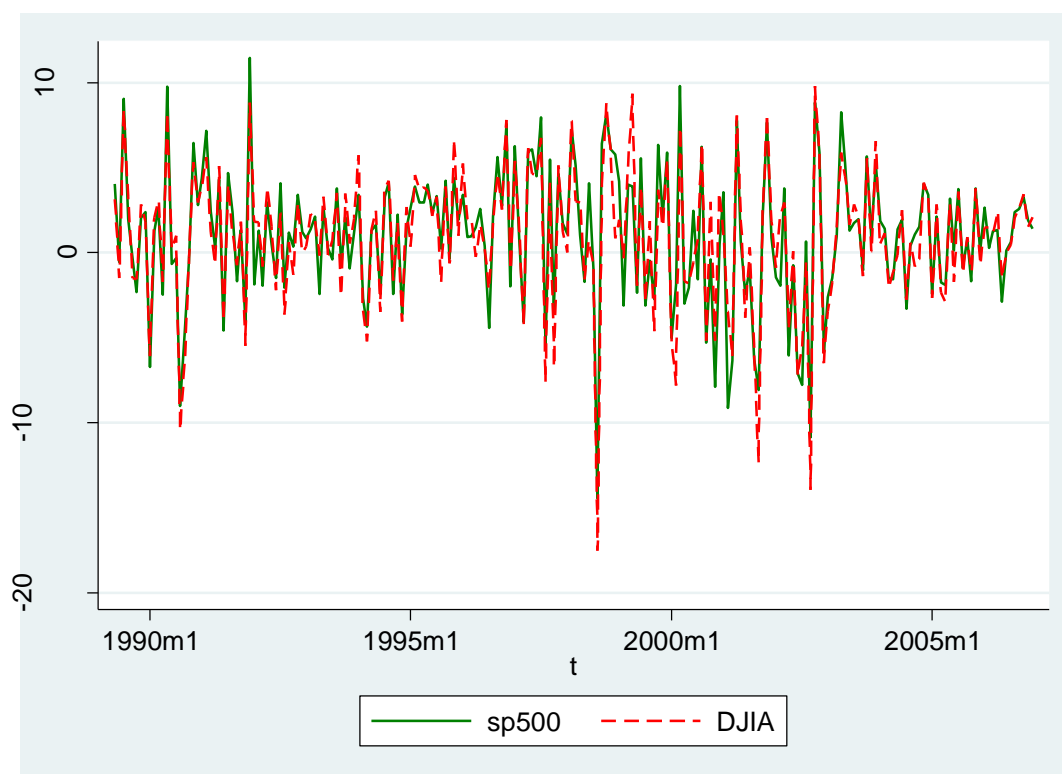


Figure II

Time Series Plots of the S&P 500 stock return and the DJIA stock return



The graph plots the time series of the S&P 500 stock return and DJIA stock return over the period May 1989 - December 2006. The main differences between these two indexes are their diverse components and the different weighting methodology. The Dow Jones Industrial Average (DJIA) is the price-weighted average of 30 stock components, while the S&P 500 is the market value-weighted average of 500 stocks.

Table III

The Monthly Response of Equity Returns to Raw Funds Rate Changes

VARIABLES	(1) Model 1
Raw funds rate change	-5.265** (2.086)
Constant	0.890*** (0.272)
Observations	211
R-squared	0.028

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly S&P 500 return on the raw changes in the Federal funds rate over the period May 1989 - December 2006. Parentheses contain heteroskedasticity robust standard errors.

Table IV

The Monthly Response of Equity Returns to Federal Funds Rate Surprises

VARIABLES	(1) Model 2
Expected change	-6.020 (3.864)
Surprise change	-5.383** (2.143)
Constant	0.900*** (0.268)
Observations	211
R-squared	0.029

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly S&P 500 return on the expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 2006. Parentheses contain heteroskedasticity robust standard errors.

Table V

The Monthly Response of DJIA return to Federal Funds Rate Surprises

VARIABLES	(1) Model 1
Expected change	-2.836 (3.381)
Surprise change	-4.176* (2.213)
Constant	0.788*** (0.276)
Observations	211
R-squared	0.020

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly DJIA return on the expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 2006. Parentheses contain heteroskedasticity robust standard errors.

Table VI

The Monthly Response of Equity Returns to Federal Funds Rate Surprises

VARIABLES	(1) Model 2
Expected change	-8.223* (4.419)
Surprise change	-6.803*** (2.417)
Constant	0.736** (0.346)
Observations	163
R-squared	0.042

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly S&P 500 return on the expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 2002. Parentheses contain heteroskedasticity robust standard errors.

Table VII

The Monthly Response of Equity Returns to Federal Funds Rate Surprises

VARIABLES	(1) Model 2
Expected change	3.431 (6.914)
Surprise change	-0.258 (3.677)
Constant	-0.250 (0.788)
Observations	63
R-squared	0.009

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly S&P 500 return on the expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 1991 and March 2000 - October 2002. Parentheses contain heteroskedasticity robust standard errors.

**Table VIII**

**The Monthly Response of Equity Returns to Federal Funds Rate Surprises**

VARIABLES	(1) Model 2
Expected change	5.421* (2.750)
Surprise change	-1.231*** (0.245)
Constant	1.418*** (0.274)
Observations	147
R-squared	0.052

Robust standard errors in parentheses

\*\*\* p<0.01, \*\* p<0.05, \* p<0.1

The table reports the result of the regression of the monthly S&P 500 return on the expected and unexpected components of the monthly Federal funds rate changes over the period May 1989 - December 2006, excluding May 1989 - December 1991 and March 2000 - October 2002. Parentheses contain heteroskedasticity robust standard errors.

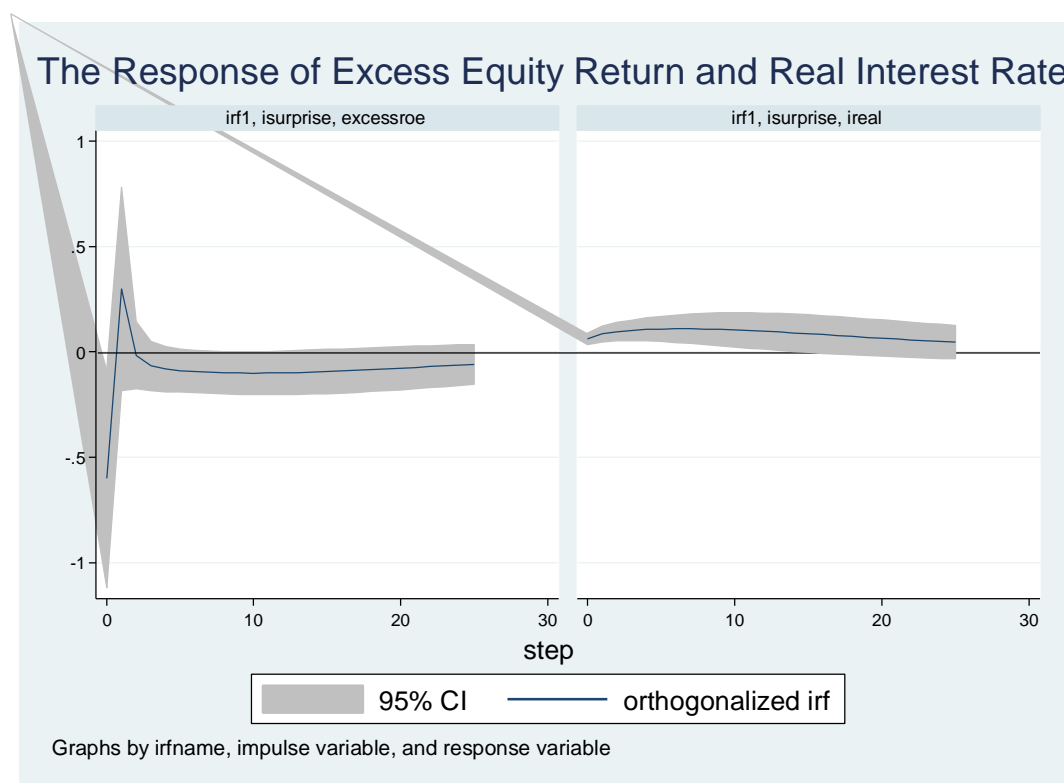
**Table IX**

**Variables of Interest in the VAR Model**

VARIABLES (Abbreviation)	VARIABLES (FullSpell)
isurprise	surprise Federal funds rate changes
excessroe	excess equity return
ireal	real interest rate
cpi	core consumer price index
ppi	producer price index
pmi	purchasing managers' index
nfp	nonfarm payrolls

Figure III

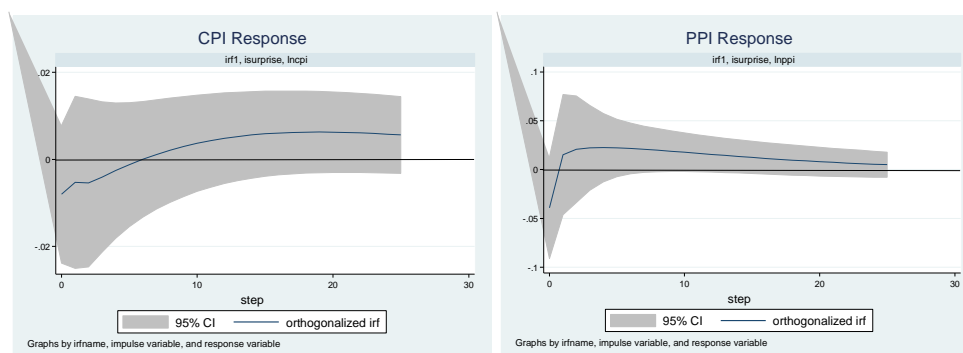
Financial Variables Impulse Responses



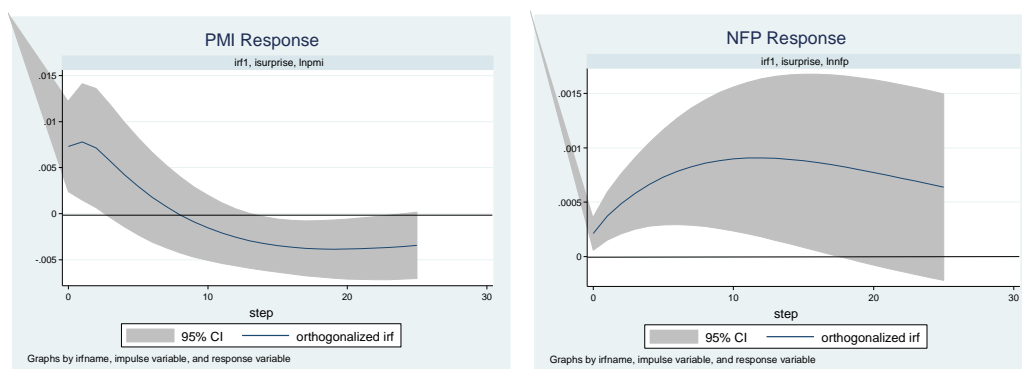
The left-hand panel depicts the response of excess equity returns to surprise Federal funds rate changes. The right-hand panel depicts the response of the real interest rate to surprise Federal funds rate changes. The sample period is May 1989 - December 2006. Table IX provides a description of the abbreviations used in the figure.

Figure IV

Macroeconomic Variables Impulse Responses



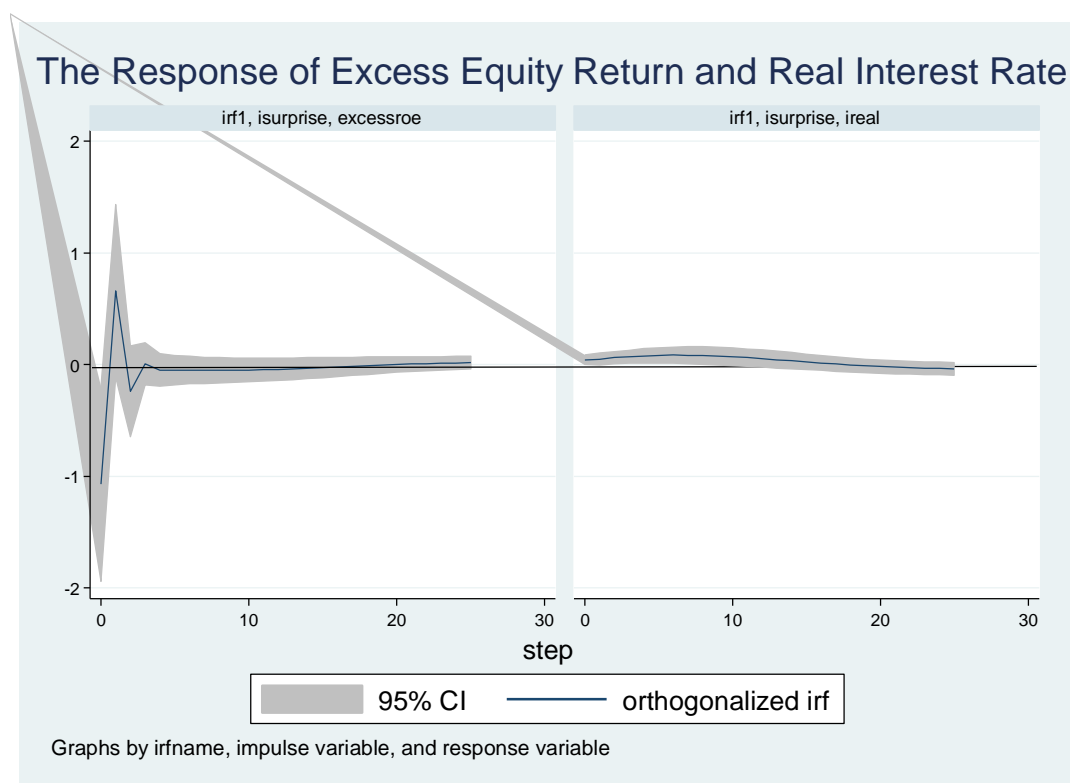
The left-hand panel depicts the response of the core consumer price index (CPI) to surprise Federal funds rate changes. The right-hand panel depicts the response of the producer price index (PPI) to surprise Federal funds rate changes. The sample period is May 1989 - December 2006. Table IX provides a description of the abbreviations used in the figure.



The left-hand panel depicts the response of the purchasing managers' index (PMI) to surprise Federal funds rate changes. The right-hand panel depicts the response of the nonfarm payrolls (NFP) to surprise Federal funds rate changes. The sample period is May 1989 - December 2006. Table IX provides a description of the abbreviations used in the figure.

Figure V

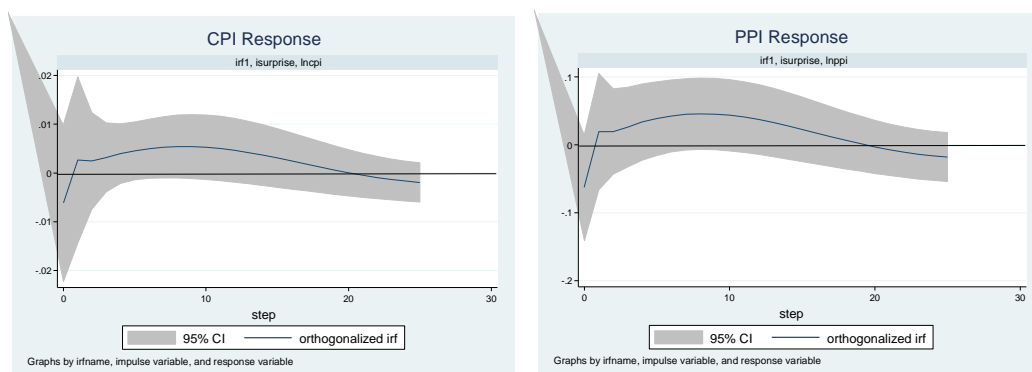
Financial Variables Impulse Responses



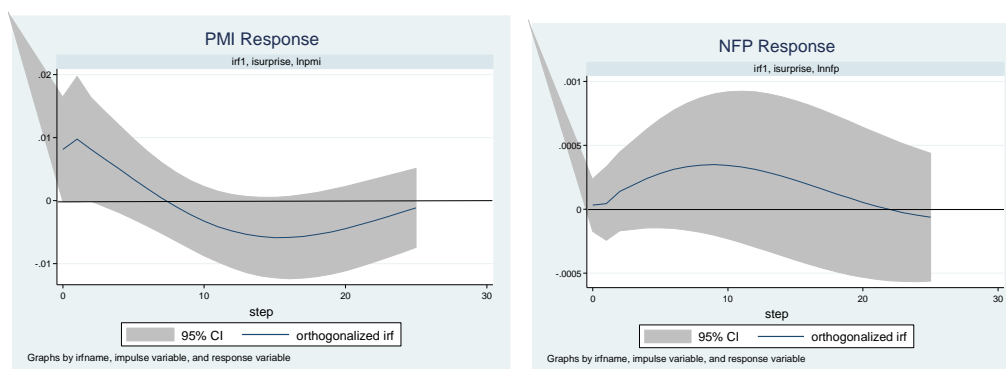
The left-hand panel depicts the response of excess equity returns to surprise Federal funds rate changes. The right-hand panel depicts the response of the real interest rate to surprise Federal funds rate changes. The sample period is May 1989 - December 2002. Table IX provides a description of the abbreviations used in the figure.

Figure VI

Macroeconomic Variables Impulse Responses



The left-hand panel depicts the response of the core consumer price index (CPI) to surprise Federal funds rate changes. The right-hand panel depicts the response of the producer price index (PPI) to surprise Federal funds rate changes. The sample period is May 1989 - December 2006. Table IX provides a description of the abbreviations used in the figure.



The left-hand panel depicts the response of the purchasing managers' index (PMI) to surprise Federal funds rate changes. The right-hand panel depicts the response of the nonfarm payrolls (NFP) to surprise Federal funds rate changes. The sample period is May 1989 - December 2006. Table IX provides a description of the abbreviations used in the figure.