Asymmetric Effects of Monetary Policy Transmission to Stock Markets

by

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Abstract

In this thesis I examine asymmetric effects of stock responses to monetary policy shock. I discuss alternative approaches to identification of monetary policy shocks proposed by empirical and theoretical literature on monetary policy. I focus on two most popular measures defined by VAR orthogonalized innovations and decomposed federal funds rate change. I show how the results of stock responses can vary with respect to the measure of policy stance chosen for estimation. My empirical results confirm the presence of firm-specific and industry-specific effects of stock returns to monetary conditions. One notable finding of my research, which is worth special attention, is omitted variable in the regression of stock returns on policy shocks, which I found to be implied volatility index, VIX.

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Introduction

The question of whether monetary policy affects the stock markets has been of great interest both for macroeconomists and financial economists. The pioneering paper was published in 1969 in the Journal of Money, Credit and Banking (JMCB) by James Tobin and together with another contribution of his, published in 1978, became the cornerstone in formulation of the basic idea of monetary policy transmission to the stock markets. However, up until now mutual accord has not been reached on the relationship between monetary policy and equity prices. The main issues of the debate are centered on exact identification of policy changes and endogeneity of policy decisions.

In my research I perform extensive analysis of alternative monetary policy measures and focus on two most widely accepted ones in empirical research. I use orthogonalized innovations extracted from identified VAR system as one of the measures of monetary policy. However, this measure was found to be largely disputed and argued to be not purely exogenous. The event study's approach, i.e. the reaction of the stock prices on the day of change in the target funds rate, has come to be used in order to identify monetary policy shocks more accurately. Kuttner(2001) suggested a decomposition of the federal funds rate change into anticipated and unanticipated components using 30-day federal funds rate futures quoted prices. Hence, one of the objectives of the current research is to establish whether results of stock market returns are robust for alternative specification of monetary policy measure.

Then, I aim to establish whether stock returns react in a heterogeneous way to change in monetary conditions. I test for the presence of firm-specific and industry-specific effects. I perform a number of robustness checks with respect to alternative classifications of stock portfolios.

Another objective of the given research is to question the validity and performance of general regression of stock returns on monetary policy shock. I suggest the existence of an omitted variable which is correlated with monetary policy shocks and causes misspecification in the original regression.

The remainder of this work is organized as follows. In the first section, theoretical foundations for alternative identification of monetary policy shocks are summarized; relevant papers which identified asymmetries of monetary policy transmission on stock markets are reviewed. Chapter 2 presents methodology used, gives general overview of the data and describes relevant variables; thorough analysis of estimated VAR models is provided. In the following section I present my empirical findings on asymmetries in stock responses and perform alternative robustness tests. In last section I provide my concluding remarks.

1. Overview of Monetary Policy and Equity Markets

1.1. Measures of Monetary Policy

The measures of monetary policy have evolved gradually through theoretical and empirical research. I will make a brief overview of most relevant results and conclusions which were reached by now in order to identify most appropriate policy measures for my analysis.

In the late 70's it was common to identify the stance of monetary policy with changes in the money stock. The debate assumed that the tendency of money to lead output implied some sort of causality. The deficiencies of this traditional approach were gradually recognized as other variables besides the growth rates of monetary aggregates proved to be better forecasters of output fluctuations. For instance, interest rates were proved to absorb the predictive power of money by Litterman and Weiss (1985).

While the traditional approach was discarded the more appropriate measures were yet to be found. Romer and Romer (1989) reintroduced "narrative approach" presented initially by Friedman and Schwartz (1963). This study provides elaborate analysis of the Federal Reserve actions and identifies contractionary shifts in monetary policy in the postwar period. Their approach is centered on using non-statistical procedures and historical record for identification of monetary policy shocks. The definition of the shock itself was narrowed to account only for episodes of deliberate attempts by the Federal Reserve to counteract inflationary pressure at the expense of potential declines in real output. The minutes of the FOMC and "Record of Policy Actions" were used to trace the reasoning of the Fed officials. The statements were noted which identified the concerns about inflation and intention to induce growth recession. Other concerns except for inflationary are deliberately disregarded. Nevertheless, such single-minded focus limited the role for subjective judgment and defined a 'shock' in precise and concrete terms.[1]

[1] C.D. Romer and D. Romer, "Does Monetary Policy Matter? A New Test in the Spirit of Friedman and Schwartz", *National Bureau of Economic Research*, 1989.

However, as Bernanke and Mihov (1995) point out in their brief critique on Romer and Romer (1989), the authors did not account for expansionary shifts in monetary policy along with contractionary ones; in addition, the severity and duration of the policy impact and the problem of potential endogeneity of policy changes were not considered at all.[2]

While "narrative approach" has enjoyed some attention in applied studies, other methods have been developed taking advantage of advances in econometric tools and estimation techniques. VAR was a major breakthrough in the econometric research in the 80s. VAR models were introduced by Sims and afterwards became a workhorse model in macroeconomic research.[3] They gained widespread acceptance due to the fact that they finally allowed for alleviation of certain implausible assumptions which were imposed for consistent econometric estimation. Monetary policy changes are by and large endogenous, because the policy-makers react on the stance of the economy and act to induce desirable changes consequently. Hence, one of the main problems VAR models were able to resolve was the one of endogeneity.

In a benchmark study performed by Bernanke and Blinder (1992) a VAR model was developed aimed at isolating a direct measure of monetary policy.[4] The authors of this paper pick up the discussion on the issue whether interest rates in general, and federal funds overnight rate in particular, are an indicator and good policy measure. They examine the relation between funds rate and overall economy. They assume that if funds rate is a measure of policy, and if policy has any effect on the economy, then fed funds rate should have a predictive power for the performance of macroeconomic variables. To prove their assumption they run several regressions with different dependent variables which stand for various measures of economic activity (such as industrial production, consumption, unemployment etc.) regressed on six own lags, CPI, as well as six lags of money stocks (M1 and M2) and interest rates (3 month T-bill, ten-year government bond, fed funds rate). According to the Granger-causality criteria, i.e. marginal

[2] B.S. Bernanke and I. Mihov, "Measuring Monetary Policy", *National Bureau of Economic Research*, 1995.
[3] Ch. Sims, "Macroeconomics and Reality", *Econometrica*, 1980.
[4] B.S. Bernanke and A.S. Blinder, "Federal Funds Rate and Channels of Monetary Transmission", *American Economic Association*, 1992.

significance level for omitting six lags, federal funds rate is found to be the best variable for predicting eight out of nine (except for housing starts) measures of aggregate economic activity. Meanwhile, M1 appeared to have no predictive power at all and M2 seem to have some forecasting power for retail sales. Federal funds rate is also superior to T-bill and Bond rates. Alternatively, they compare fed funds rate to spread between six-month commercial paper and six-month T-bill rate, and the Term spread (difference between the ten-year and one-year government bond rates). Both of the alternative measures seem to possess some predictive power.

Even though the fluctuations in the fed funds rate were found to be informative, the question remains whether they can be attributed to changes in the Federal Reserve policy decisions. If there's a variable which indicates the policy stance and Federal Reserve is consistent in its policy-making, then this variable should systematically respond to macroeconomic conditions, e.g. inflation or unemployment. Bernanke and Blinder (1992) proceed with testing fed funds rate as a useful monetary indicator, which signals the tightness or ease of monetary policy. They estimate a three-variable VAR model with six lags of policy variable, inflation and unemployment. The impulse responses obtained look very plausible and establish the facts that inflation shocks drive up the funds rate, while unemployment shocks push the funds rate down.

Thus, the conclusion is attained that federal funds rate is indeed a good measure of the Fed's policy and I will rely on this fact heavily in my further estimation.

Christiano, Eichenbaum, Evans (1998) consider in greater detail the notion of monetary policy shock and focus on analysis of identification schemes essential for consistent VAR models estimation.

It is assumed that policy makers systematically react to the developments in the economy. Thus, the concept of the feedback rule or reaction function is used to account for systematic component in the policy response to the state of the economy. But it is not always the case that variation in the central bank policy can be explained by the variation in the underlying explanatory variables belonging to the information set of the policy-makers. Unexplained variation in the instrument of monetary authorities is recognized as *policy shock*. The latter one can also be identified as disturbance term, $\sigma_s \varepsilon_t^s$, in the following equation:

$$S_t = f(\Omega_t) + \sigma_s \varepsilon_t^s \tag{1}$$

where S_t is an instrument of the monetary authority; f is a linear function specifying the feedback rule or reaction function; and Ω_t is an information set of policy-makers.

The authors discuss three potential sources which may cause exogenous disturbances to the policy rule. One of the sources is purely technical factors. At the time of the decision making the preliminary data available to the FOMC might contain measurement error and can be a subject to further adjustment. Another interpretation of the policy shocks comes directly from the preferences of monetary authorities, whether they put higher weights on inflation or unemployment and thus react on the stance of the economy. And the last interpretation accounts for public sentiment and unwillingness of the Fed to incur large social costs of failing to meet private agents' expectations. So they adjust and smooth their policy actions.[5]

Therefore, relying on the described findings and mutual agreement reached in research I will use orthogonalized innovations extracted from identified VAR system as one of the measures of monetary policy.

1.2. The Monetary Policy Transmission to Stock Markets

Monetary policy's main objective is to maintain the health of the economy in the long run by pursuing the goal of price stability, maximum sustainable output and employment. It has been established that policy instruments have lagged impact on the economic variables they intend to influence. The change in the federal funds rate has an indirect impact on the public demand for goods and services through credit channel (costs of borrowing and availability of

[5] L.J. Christiano, M. Eichenbaum, Ch. Evans (CEE), "Monetary Policy Shocks: What Have We Learned?", *National Bureau of Economic Research*, 1998.

loans), foreign exchange rates and the wealth of households. But it will take a while for the ultimate goal, such as output and inflation, to be affected. In contrast, the most direct effect of monetary policy which can be traced is on the stock markets.

The question of whether monetary policy affects the stock market has been of great interest both for macroeconomists and financial economists. The pioneering paper was published in 1969 in the Journal of Money, Credit and Banking (JMCB) by James Tobin and together with another contribution of his, published in 1978, became the cornerstone in formulation of the basic idea of monetary policy transmission to the stock markets. The central argument was that tightening of monetary policy will lead to depressed equity markets because of the decline in present value of the future cash flows. This reasoning is justified by standard approach of rational valuation, which considers that stock prices should reflect the fundamental value of the underlying stock which in turn is equal to the discounted (by time-varying discount factor) stream of future dividends. Further, Tobin proceeds to argue for crucial impact of policy changes on what he called as *Tobin's q* ratio, the market value of firm's assets relative to their replacement costs.

However, up until now mutual accord has not been reached on the relationship between monetary policy and equity prices. The main issues of the debate are centered on exact identification of policy changes and endogeneity of policy decisions.

1.3. Market-Based Measures of Monetary Policy

The VAR methodology, used to extract monetary policy shocks has one major shortcoming. It has been argued by Rigobon and Sacks (2002, 2003) to possess an *endogeneity* bias. The orthogonalized innovations obtained from the structural VAR are very unlikely to be purely exogenous. The authors have shown that the causality between the interest rates and stock prices may run in both directions.

The event study's approach has come to be used in order to identify monetary policy shocks more accurately. Higher frequency data, daily observations predominantly, have been used to analyze how equity markets react to policy changes. These studies consider the reaction of stock prices to changes in federal funds rate on days of FOMC meetings. For instance, Thorbecke (1997) applies this methodology and finds indeed significant U.S. equity index changes in response to FOMC policy decisions' announcements.

There's a tendency in the market to form expectations about the upcoming events and about policy changes in particular. Naturally, markets' expectations should be reflected in the stock prices. Hence, Krueger and Kuttner (1996) suggested distinguishing expected from unexpected component in the change of the federal funds rate. They argue that if the policy change is exactly the same as market anticipated, prices and returns won't notably change. But if the target funds rate change was different from expected, the returns and prices will be adjusted with regard to surprise component.

Expectations of the policy actions are not easily observable on the market. Krueger and Kuttner (1996) suggest that the quoted prices for the federal funds futures contracts can be a good and natural market-based proxy for these expectations. They find that the forecasts of the target federal funds rates based on the futures prices are efficient. Kuttner (2001) keeps exploiting the advantage of the information incorporated into prices of futures contracts and suggests a decomposition of the federal funds rate change into anticipated and unanticipated components using futures quoted prices. He uses event study approach to estimate the responses of the market rates to unexpected policy changes. Kuttner reports that interest rates' response to anticipated changes in the fed funds rate is very mild, but it is found to be large and highly significant to unanticipated changes.

Bernanke and Kuttner (2003) further develop this idea of federal funds rate decomposition and consider not only the event study, i.e. the reaction of the market rates on the day of change in the target funds rate, but also suggest estimation for the regular monthly time horizon. In their event study estimation they compare regression of value-weighted CRSP stock returns on the raw change of federal funds rate with the regression of the same returns on decomposed federal funds rate change into surprise and expected components:

$$H_t = a + b\Delta i_t + \varepsilon_t \quad (2)$$

$$H_t = a + b^e \Delta i_t^e + b^u \Delta i_t^u + \varepsilon_t \quad (3)$$

In the first specification the coefficient on the target rate change has a negative sign, but it is very small in magnitude and insignificant. While in the latter specification the estimated stock response to unexpected fed funds rate change is highly significant: a one percentage point surprise rate increase will lead to a decline of -4.68% in one-day stock return. When they took into account the presence of outliers and excluded them from the sample, the estimated response still remained significant but became smaller in magnitude: -2.55% compared to -4.68%.

In their both specifications the assumption is imposed on the orthogonality of the error term ε_t. It implies that other factors affecting stock returns on event days should be independent of changes in federal funds rate. Whether this assumption holds is an open question. It can be violated if both monetary policy changes and stock market returns respond together to a common factor, i.e. the release of report indicating expected decline in output and slowdown in economic growth. Thus both rates will be cut and markets will be depressed in response to this news, what will cause a downward bias in the given specification. However, Bernanke and Kuttner find that the alternative econometric methods used to correct for the endogeneity problem yield very similar results. If there's a bias, then it would tend to underestimate the true response to policy surprises and hence the estimates of the event-study approach at most might be a bit conservative.

1.4. Asymmetries of Stock Market Returns

There are different possibilities for the asymmetries of stock market returns. It depends on how the authors will treat the notion of "asymmetry". The paper discussed above, Bernanke and Kuttner (2003) also considers heterogeneity in stock price responses to policy changes. They tested whether the *sign of the surprise* (positive or negative) matters for the magnitude of the market's response. They use a dummy variable for positive surprise changes and interaction term of dummy with unanticipated federal funds rate change. The results show no statistically significant evidence for this form of asymmetry. Among other forms, Bernanke and Kuttner consider whether *policy reversals* should have a larger impact on the returns in comparison with other changes. Hence, they include reversal interaction term along with other relevant regressors. The results show that the magnitude of the response is indeed larger, i.e. the coefficient on the interaction term is statistically significant. The authors argue that this phenomenon can be explained by the fact that market tends to *overreact* to the reversal in the direction of policy changes.

Ehrmann and Fratzscher (2004) employ the methodology developed by Bernanke and Kuttner (2003) to analyze other forms of asymmetries. In particular they focus on heterogeneous reaction of individual stocks comprising S&P 500 to monetary policy shocks. They suggest that tightening of monetary policy will likely have a stronger impact on some firms and lesser impact on others.

What should define the firms' exposure to monetary policy shock? The authors suggest that when credit channel of monetary policy transmission is at work firms get affected in two primary ways. Firstly, when credit conditions become tighter banks tend to reduce their overall supply of credit; thus, highly dependent bank borrowers become significantly exposed to risk. The banks certainly try to keep their long-term and reliable clients while cutting credit lines to small unknown firms, they have the least information about. This argument is grounded on the *theory of information asymmetries*. Secondly, firms can be affected through their balance sheets: with higher interest rates the present value of discounted cash flows falls and the size of collateral diminishes. For both of the described arguments, small firms are likely to be more exposed to cut in credit lines and decline in collateral; they are in fact as well a subject to larger informational asymmetries. Thorbecke (1997) shows that the response of stock returns to monetary policy tightening is indeed larger for small firms.

Another channel at work is through interest-rates. The firms with more cyclical production, i.e. changing patterns in demand for their goods, are more sensitive to interest rate changes. Hence, responses to policy shocks should vary not only with *firm-specific* but also with *industry-specific characteristics*.

To understand and explain the asymmetry in stock returns Ehrmann and Fratzscher (2004) use panel framework and regress stock returns on firms' characteristics, monetary surprise and interaction term of both. They confirm their hypothesis about the fact, that cyclical and capital-intensive industries are affected most, while non-cyclical industries like food, agriculture or beverages are affected less so.

To analyze the role of the credit channel they use several proxies which measure the degree of financial constraint, i.e. how difficult it is for the firm to raise funds to finance investment. First of all, they look at the size of firm, considering the number of employees and the value of market equity as proxy variables. In view of possibilities of financing, they look at the cash flow to income ratio as the source of internal financing and the ratio of debt to total capital as an exposure of the firm to external funding. The authors' a priori beliefs were that the firms with large cash flows should be more immune to monetary policy shocks and their estimated findings go in line with their expectations. The results have shown that firms with small relative indebtedness, low debt to capital ratio, must be currently financially constrained and thus are stronger affected by policy shock. They also consider price earnings ratio and find that more expensive stocks, i.e. the ones with higher ratio, are more strongly affected by monetary policy.

Besides, the firms with good Moody's investment and bank loan rating are found to be basically immune to monetary policy shocks.

It is worth mentioning another notable paper published in the Journal of Money, Credit and Banking by Shiu-Sheng Chen. He emphasizes an important fact, that stock returns vary cyclically and hence the reaction to monetary policy may vary as well. He argues that according to theoretical models of financial intermediation with agency costs agents may behave as if they are constrained financially. The financial constraint is likely to be binding during economic downturns, or, as the author identifies it, bear market. Hence, an asymmetry that the author considers arises from different impact of policy changes in bear and bull markets. By using the Markov-switching technique Chen proves his hypothesis by showing significantly stronger reaction to policy changes in bear markets rather than in bull markets.

1.5. Investor Sentiment and Stock Market Volatility

Recently, economic and financial literature started to evolve not around economic but rather behavioral aspects in attempt to explain old controversies. Traditional theories and models with most crucial underlying assumption of perfect rationality of economic agents were questioned, and updated theories and models accounting for various psychological biases, so typical of human behavior but not admitted before, are emerging in the 'adjusted' *behavioral* economic theory.

Some studies have reached the conclusion that shifts in investor sentiment can well explain variation in stock returns in the short run (e.g. Baker and Wurgler, 2006). This variable is found to be one of the crucial determinants in asset price formation. But along with that fact, the volume of studies suggesting various measures of investor sentiment is increasing.

Whaley (2000) suggested to use Chicago Board Options Exchange's market volatility index, VIX or *"investor fear gauge"* as it is often called. It has been noticed that VIX index has a tendency to spike in times of market turmoil and thus in a way signals increase in investors' fear.

Index's computation is based on the stock index option valuation model. All of the parameters of the model can be fairly precisely estimated except for the index's expected volatility. Hence, the implied volatility can be found by equating the market price of an option with the one suggested by the model and obtain the precise value of *implied* volatility.

Not only volatility index but also stock prices on their own incorporate investors' concerns. Naturally, it has a reason; investors are likely to demand higher rates of return on stocks as the market conditions become more volatile and risky; hence, stock prices fall. It can be argued as one of the most determinant reasons for a measure of investors' sentiment to explain stock prices.

2. Estimation of Monetary Policy Measures

2.1. Methodology and Specification

VAR analysis is a useful and suitable method to learn about rich dynamics of multiple time series in the economy, extract innovations in monetary policy changes and trace their macroeconomic effects. Stock and Watson (2001) summarized the theory on VAR modeling approach and assessed effectively its advantages. They stressed that, while VAR methodology has proven to be very powerful in forecasting, "identification problem", the ability to distinguish between causality and correlation in the economic time series, is the one which can make structural inference problematic. Therefore very sound and profound theoretical reasoning is required to solve the problem of identification.

It is important to distinguish between different forms of VAR models. In a *reduced form*, each variable is expressed as a linear function of its own and other variables' past values; the error terms are serially uncorrelated, but can be correlated across equations, if the variables in the model are correlated with each other. A *recursive* VAR is constructed in a way that the error term in each regression is uncorrelated with an error term from the preceding equation. This result can be achieved by cautiously including contemporaneous values of the preceding dependent variable as a regressor in the following equation. The ordering of the variables is crucial; the estimated results will certainly change with different specification of ordering. A *structural* VAR relies heavily on the economic theory and empirical facts to track the causal relationships between the variables.[6]

Importance of a *recursiveness assumption* is stressed by CEE (1998). In order to consistently estimate policy function of Federal Reserve, the analyst has to make enough identifying assumptions, such as functional form specification, operating instrument choice and variables

[6] J.H. Stock and M.W. Watson, "Vector Autoregressions", *Journal of Economic Perspectives*, 2001.

important and available to the Fed when setting the target level of policy instrument. On top of this, the critical assumption must be made about the nature of interaction of the policy shock with the variables in the information set of the Fed. CEE (1998) assume orthogonality of the policy instrument shock to the variables in the feedback rule of VAR specification; they refer to it as recursiveness assumption. Generally speaking, it implies that variables in Fed's information set, e.g. output and prices, will respond only with a lag to policy innovations. Technically speaking, this assumption justifies usage of fitted residuals as policy shocks in the ordinary least squares regression of the Fed's instrument on other variables in the feedback rule.

Two benchmark recursive identification schemes are considered in my research used by CEE(1998) and Chen (2007), which correspond to different specifications of information set of policy-makers, Ω_t in equation (1).

As stated above, Bernanke and Blinder (1992) provided comprehensive justification of using fed funds rate as policy instrument. Relying on their institutional arguments, CEE (1998) measure policy changes by innovations in the federal funds rate in their benchmark specification. They include the following variables in the information set in the specified order given: $\{Y_t$, P_t, $PCOM_t$, FF_t, TR_t, NBR_t, $M_t\}$; which accordingly stand for the log of real GDP, the log of implicit GDP deflator, smoothed change in an index of sensitive commodity prices, fed funds rate, the log of total reserves, the log of nonborrowed reserves and the log of money stock, M1 or M2. Hence, the policy shock will be identified with FF_t innovations. The authors also suggest to use innovations to non-borrowed reserves, NBR_t, as an alternative measure of policy instrument, S_t, and keeping the rest of the feedback rule specification the same. Yet, I will focus on the first one alone.

Under stated model specification CEE (1998) assume that innovations to policy variable do not influence contemporaneously Y_t, P_t, $PCOM_t$, but do affect the level of total and nonborrowed reserves, as well as money aggregates. Monetary authorities are also believed to observe current output and inflation when making their decision about the target level of policy instrument. In reality though, real GDP and GDP deflator can be observed only with a delay, thus some measurement error can be incurred.

Chen (2007) considers similar specification for the VAR model, where he uses industrial production instead of real GDP, and CPI index instead of GDP deflator, and does not include monetary aggregates in the model: $\{IP_t, CPI_t, PCOM_t, FF_t, TR_t, NBR_t\}$. The ordering (identification of the model) will be preserved as given. However, Chen (2007) defines PCOM as the index of commodity prices, i.e. PPI for crude materials. [7] I will consider two described specifications of the VAR model to test which one performs better.

As an alternative to VAR approach I will study another strategy used to isolate monetary policy shocks, which was developed predominantly by Kuttner and extended further by him in co-authorship of Bernanke. It treats endogeneity of federal funds rate changes in a different way. It relies heavily on the assumption of market efficiency: observed stock prices should reflect all the information available to investors at present moment along with their incorporated expectations. Therefore the policy changes in the federal funds rate are partially anticipated and already reflected in the prices of assets. As discussed in the section on literature review, Kuttner (2001) decomposed the federal funds rate change into anticipated and unanticipated components with event study method and Bernanke and Kuttner (2003) suggested estimation for the regular monthly time horizon. They defined the unexpected month-t surprise component as follows:

$$\bar{\Delta} i_t^u \equiv \frac{1}{D}\sum_{d=1}^{D} i_{t,d} - f_{t-1,D} \qquad (4)$$

where i_t^d is target funds rate on day *d* of the month *t*, and $f_{t-1,D}$ is the rate corresponding to 30-day futures contract on the last (Dth) day of month t-1. The expected funds rate change is measured accordingly as:

$$\bar{\Delta} i_t^e \equiv f_{t-1,D} - i_{t-1,D} \qquad (5)$$

[7] Shiu-Sheng Chen, “Does Monetary Policy Have Asymmetric Effects on Stock Returns?”, *Journal of Money, Credit and Banking*, 2007.

2.2. Data Description

In the given part of my work at first I will turn my attention to the variables used in estimation of specified VAR models. In the literature review the importance of the overnight federal funds interest rate has been extensively discussed. The study by Bernanke and Blinder (1992) which was thoroughly elaborated provides sufficient evidence for the fact that federal funds rate can be regarded as the main policy instrument of the Federal Reserve.

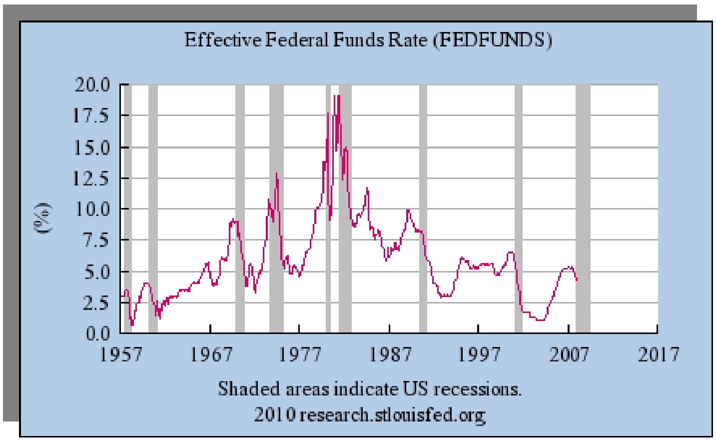

Figure 1. Time Series of the Federal Funds Rate, 1957-2007.

The time series of the fed funds rate are presented at the figure 1. The graph was generated with help of ALFRED Graph Gadget application available at the St. Louis Federal Reserve website.[8] Along with index series the graph provides timing of the economic downturns in shaded areas. There are spikes observed on the graph which can certainly be attributed to the tightening of monetary conditions and troughs signaling expansionary shifts in the Federal Reserve policy.

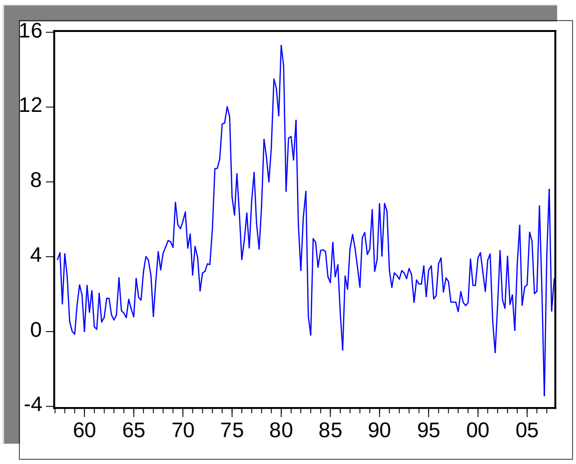

Figure 2. Inflationary Time Series, 1957-2007.

By the end of 60's the Fed was ready to fight persistent inflationary pressures and, as particularly noted by Romer & Romer in their thorough analysis of the FOMC minutes, the Fed was ready to keep monetary restrain at the expense of reductions in projected growth rates. After the first oil crisis, in spite of ongoing

[8] http://research.stlouisfed.org/

recession, the Fed again took very decisive steps to oppose price increases: overnight rate was increased and money targets were being kept under tight control. From figure 2 it can be observed that the concerns of the Fed had been well-grounded: over the 70's the inflationary rates were notably high, escalating after oil embargo and reaching 11.5% in 1974 and peaking at 13.5% in 1981.

Romer & Romer define October 1979 as the major anti-inflationary shock to monetary policy. Precisely at this time Paul Volcker was appointed a Chairman of the Federal Reserve, August 1979, and stayed in the office until 1987. The overnight federal funds rate which averaged around 11% in 1979 was raised by Volcker to a peak of 20% in June 1981. But he managed to finally end the stagflation crisis of 70's and successfully lower inflation to reasonable 3.2% by 1983.

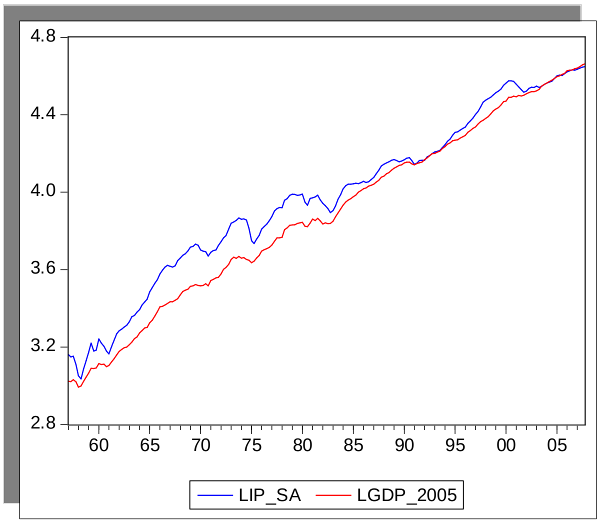

Figure 3. Time Series of the Logs of Industrial Production and Gross Domestic Product, 1957Q1-2007Q4.

Alan Greenspan was a distinguished successor of Volcker, who stayed at the office for unprecedented five terms, up until January 2006. Overall, during his chairmanship inflation has been predominantly stable, output growth was persistent and the economy of the United States showed all the signs of perfectly healthy development.

Figure 3 presents the time series of alternative measures of economic activity used in two specifications of VAR models, GDP and industrial production. It can be noted that the first variable is smoother then the latter, pointing to the fact that industrial production might be more sensitive to the performance of the economy.

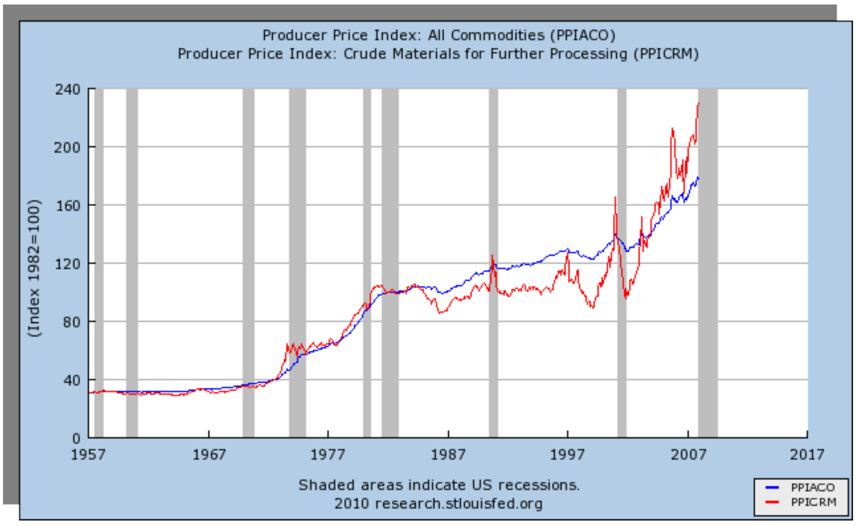

Figure 4. Time Series of the Producer Price Index for All Commodities and Crude Materials, 1957-2007.

The time series of the producer price index, both for all commodities and for crude materials, are presented in figure 4. Most notable spike in producer prices occurred in 1973-74 after oil embargo and consequently stimulated a recession. In the 80's a downturn in the producer price index was induced by overwhelming stock market crash of 1987, Black Monday as it is often known. It was argued that newly appointed chairman, Alan Greenspan, acted vigorously and effectively to prevent unfolding of a recession. Then, in the 90's, Asian crisis temporarily induced a slump in producer price index, which was followed by an unforeseen surge of prices because of the 'dot-com' bubble.

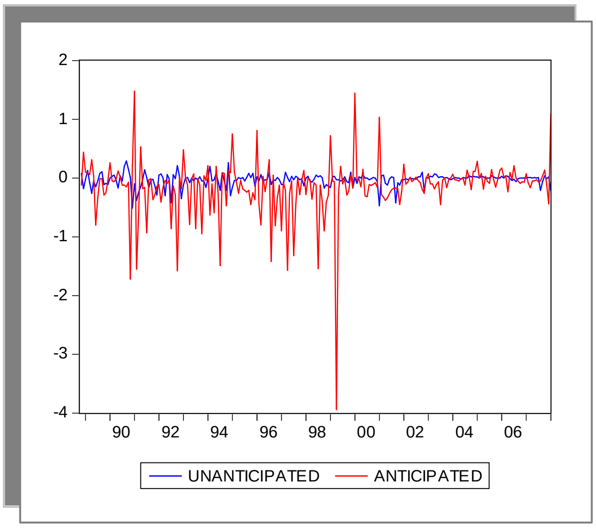

Figure 5. Anticipated and Unanticipated Changes in the Federal Funds Rate, 1989-2007

According to Bernanke and Kuttner directions I constructed the measures of anticipated and unanticipated changes in the federal funds rate. The series for the monthly average target funds rate can be found in figure 5. Along with them there's a graph for 30-day feds futures rate series, measured on the last day of the month, which proxy market anticipations of the funds rate changes in the next month.[9] It can be observed that most of the time market is quite accurate in its expectations. Surprise components are small in magnitude and make up only to few basis points. The sign of the surprise can be any: negative surprise implies that market expectations of the rate change exceeded real policy target; while positive sign suggests that market participants underestimated intentions of the Fed to tighten monetary policy.

As it was suggested above stock prices may react in heterogeneous way to monetary policy shocks. The asymmetries will be identified by using disaggregated measure of stock returns. Fama and French formalized several anomalies in asset price behavior and questioned the validity of classic CAPM model with their extended Three-Factor model, which suggests that not only market "beta" but other factors such as market capitalization and "value" can explain asset returns. I will rely on the results of their fruitful research and use data which they thoughtfully provided on their webpage.[10]

First of all, I consider Fama-French categorization of stock returns with respect to industry. They perform their classification by assigning every stock in NYSE, AMEX and NASDAQ indices to an industry portfolio based on its four-digit SIC code. There are twelve industry portfolios which were formed at the end of June annually. Detailed description of the name and industry specification can be found in appendix.

Secondly, I use categorization of stocks with regard to their market capitalization or market equity, which proxies for size of the firm. Like industry portfolios they are constructed annually at the end of June. As a general principle for their analysis Fama and French divide firms into several (3, 5 and 10) portfolios according to the position of the firm in the cross-sectional distribution of the respective variable, e.g. market equity. Thus, classification of firms into 3 portfolios considers every one-third of the distribution of the variable: firms with market equity in the bottom range (up to 33%) of the distribution are classified to the first group with lowest

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[9] The data on the settlement prices of the 30-day federal funds futures contract was kindly provided as free sample by the Thomson Reuters, http://thomsonreuters.com/.

[10] http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

market capitalization; between 33% and 67% medium level of market capitalization; and top third of the distribution to have highest level of capitalization. The same strategy is employed with more detailed categorization of size portfolios using quintiles (every 20% of the distribution) and deciles (every 10%) as breakpoints.

Finally, to test for other forms of asymmetries in stock responses to monetary policy changes other classifications of firms will be examined with regard to their cash flow, price earnings ratio and book equity to market equity. Classified portfolios of stock returns constructed by the same methods as described above are also available at the data library of Fama and French. Descriptive statistics for specified portfolios is provided in appendix.

2.3. VAR Estimation

Now I proceed with analysis of VAR model specifications suggested by CEE (1998) and Chen (2007). The orthogonalized residuals in federal funds rate equation will be used as monetary policy shocks estimated by the VAR system which will be proved to perform better (according to stability and other relevant performance tests).

Christiano, Eichenbaum, Evans (1998) VAR Estimation

I will start with identifying the order of integration of the variables. The results are presented in Table 1.

Table 1. Augmented Dicky-Fuller and Kwiatkowski-Phillips-Schmidt-Shin Unit Root tests.

Variable	ADF	KPSS
log(GDP)	I(1)	I(1)
log(IP)	I(1)	I(1)
log(GDP_def)	I(2)	I(1)
log(CPI)	I(2)	I(1)
log(PPI_ACO)	I(1)	I(1)
log(PPI_CRM)	I(1)	I(1)
FF	I(1)	I(0)
log(TR)	I(1)	I(1)
log(NBR)	I(1)	I(1)
log(M2)	I(2)	I(2)

Awareness of the order of integration of the series is crucial for consistent econometric estimation of VAR models. Hence I perform 2 tests for all the variables to determine whether their level or their first/second difference is stationary. ADF and KPSS stand for Augmented Dicky-Fuller and Kwiatkowski-Phillips-Schmidt-Shin unit root tests respectively. It should be noted that null hypothesis for these tests are different: the former ADF test suggests that series have unit root, while the latter test, KPSS, hypothesizes that series are stationary.

Both tests uniformly agree on the first order of integration of the log of real GDP series. But for the log of GDP deflator the results of the tests are not so unanimous. ADF suggests the second difference to be stationary, while KPSS can accept stationarity of the first difference. Under scrutiny of LM-statistics, however, it can be noticed that KPSS is also likely to reject the null hypothesis of stationarity of the first difference at 10% significance level, and it can't absolutely reject it for second difference. For the fed funds rate series the results are again disputed. KPSS can't reject the stationarity of the level of federal funds rate, but ADF suggest first order of integration. As for the monetary aggregate M2, KPSS rejects the stationarity of the first difference at the 5% significance level and ADF test can't reject the null hypothesis of unit root, what implies uniform agreement of both tests on the second order of integration of M2.

VAR model should consist of the variables of the same order of integration, e.g. I(1). Hence, variables in the first level of integration should be used in levels and those of the second order should be differenced. With regard to unit root tests, the results are disputed for GDP deflator and CPI index. Both options can be tested to identify which of the alternatives would perform better in the VAR model. Other variables will be used in levels except for M2, which will be transformed into money growth rate by first-differencing.

I estimated two VAR systems according to CEE(1998) but using alternatively level and first difference of GDP deflator. The number of lags was optimally chosen to be three by AIC and FPE criteria in both specifications. There is not much difference with regard to stability of the VAR systems according to AR unit root test. In both specifications there are some roots close to unit circle. Autocorrelation LM Test provides evidence for serial correlation in the residuals at the 1st, 2nd, 5th and 6th lags (even though the number of lags was chosen according to information criteria). However if we check residuals, the model with level of gdp_def seem to perform slightly better (the graphs of both series of fitted residual are presented below). So, I'd stay with level, even though the ADF test shows second order of integration.

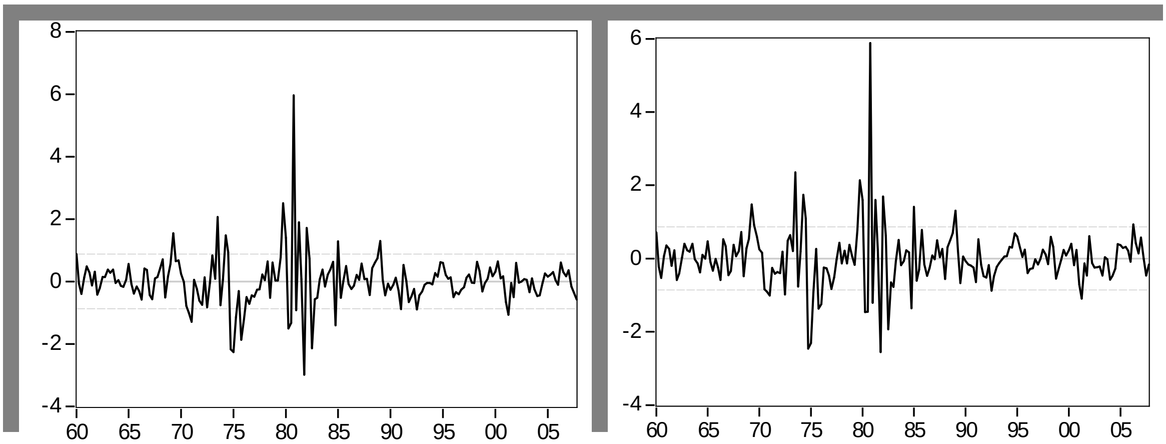

Figure 6. Fitted Residuals for the Federal Funds Rate equation from the VAR systems of CEE(1998) with level lgdp_def (to the left) and first difference of lgdp_def (to the right).

I have tested two measures of the producer price index and found no significant difference in the performance of the model whether I was including PPI for all commodities or PPI for crude materials.

Despite the presence of some unit roots the estimated coefficients are consistent, but standard errors are not; the impulse responses would be invalid but the fitted residual series from the federal funds rate equation can be used as monetary policy shocks.

<u>Chen (2007) VAR Estimation</u>

I employ the same strategy as for the analysis of the previous model specification. The model of Chen will be composed of I(1) variables as well. The consumer price index is transformed into rate of inflation by differencing the log of CPI and multiplying it by 400. The number of lags is suggested to be 1 by Schwarz criterion and 3 by FPE, AIC and HQ criteria. Thus, estimated VAR model is composed of optimal 3 lags.

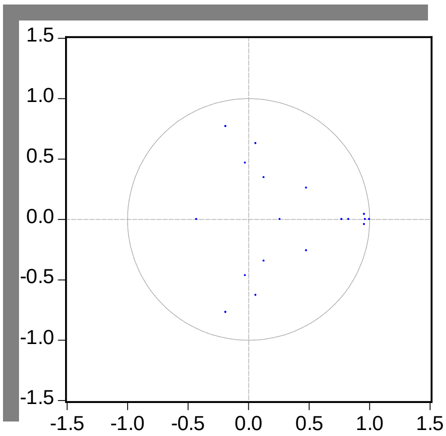

Figure 7. AR Unit Root Graph for Chen (2007) VAR model.

The AR unit root graph can be seen on the figure 7. All the roots lie inside the unit circle but some of them are very close to the boundary. Again, we cannot rely on the validity of standard errors, but the estimated coefficients should be consistent.

Residual serial correlation LM test shows, that there is some autocorrelation for the 6th and 9th lags. To understand which variables are correlated at the lags suggested by LM test, I can consider correlograms. There is evidence of the presence of cross-correlation at the 9th lag between CPI inflation rate and federal funds rate and at the same lag there's autocorrelation in the total reserves (TR). Besides, there's cross-correlation at the 6th lag between PPI for crude materials and TR.

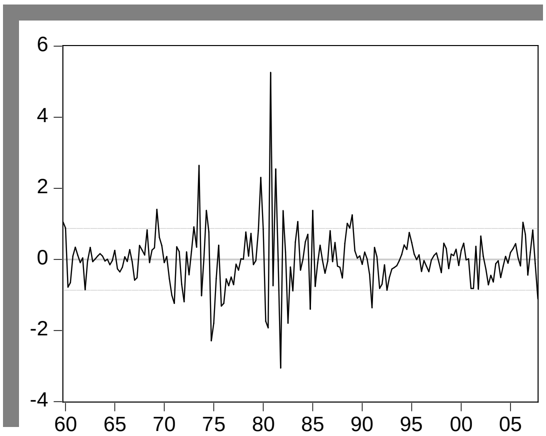

Figure 8. Fitted Residuals for the Federal Funds Rate Equation from the VAR system of Chen (2007)

Overall, the estimated model performs reasonably well and notably better than previous specification. The graph of the fitted residuals can be found in figure 8.

To compare estimated policy shocks I estimate the correlation between fitted residuals. It appears that estimated series are extremely closely related with correlation of 0.9.

Hence for my further analysis I will stay with Chen (2007) model which was proved to perform better then CEE(1998) on quarterly basis and estimate the same model using monthly data.

The optimal number of lags included was suggested to be 1 by Schwarz information criterion (IC), 2 by Hannan-Quinn IC, and 3 by Akaike IC and Final prediction error. So, I will estimate the model with optimally chosen three lags. AR Graph also shows few roots close to unit circle and LM-test suggests autocorrelation at 4th and 7th lag. All the variables, except for total reserves, appear to be jointly significant to granger-cause dependent variables in the system at 1% level of significance. The results for the Granger Causality test are reported in appendix.

After extensive discussion of VAR based monetary policy innovations I am now justified to proceed to assessment of the impact of Federal Reserve policy on stock market returns.

3. Monetary Policy and Stock Returns: Empirical Results

Firm-Specific Effects

In the literature overview made in the first section it has been mentioned that size of firms, or market capitalization, is often used to proxy for the degree of credit constraint of firms. The reasoning was defined based on theory of informational asymmetries. There is evidently less information available for small firms rather than for large corporations, and banks are more likely to cut their credit lines first to small unknown customers when monetary conditions become tighter. Thus small firms might be affected more in a result of monetary policy shock or surge in the funds rate.

The robustness of the responses of stock returns will be checked with regard to different specification of monetary policy shocks, classifications of stock portfolios and sample periods. All estimated results are reported in appendix.

At first I estimate panel data regression of the form:

$$R_t = \alpha + \beta_1 \cdot S_t + \beta_2 \cdot S_t \cdot D_{it} + \varepsilon_t \qquad (6)$$

where R_t denotes the stock return; S_t defines monetary policy shock measured by VAR extracted innovations to the federal funds rate; D_{it} represents a dummy variable for every quintile *i (from 2 to 5)* portfolio.

The interaction term is included into regression to consider heterogeneity among stock responses to the monetary policy shock, but I consciously simplified regression by allowing common intercept for all portfolios of stocks, because individual size dummies had very insignificant coefficients (it can be noted, however, based on descriptive statistics for size stocks and Fama-French arguments, that small stocks have higher mean returns).

Chow Breakpoint test showed that there's evidence for a breakpoint in the estimated sample, hence the results for full and adjusted sample are reported. Different patterns can indeed be observed in two samples, but estimated coefficients for interaction terms still remain insignificant. In the first part of the sample the reaction to policy shock is indeed larger and significant while in the second part of the sample the relation seems to break down completely, all of the coefficients are found to be insignificant.

These facts bring me to the conclusion that according to aggregated panel data estimation there is no statistically significant difference in the responses of small firms' returns as opposed to returns of large ones. In the hope of producing more informative results I will use standard ordinary least squares estimation to find precise measures of every size portfolio reaction to VAR innovations. I estimate OLS regression of stock returns of every size portfolio on MP shock:

$$R_{it} = \alpha + \beta_i \cdot S_t + \mu_{it} \quad (7)$$

To perform a robustness check I make use of alternative size portfolio classifications. Instead of 5 detailed quintile portfolios, I leave only lowest and highest quintile and average stock returns in the middle. To consider the potential problem of outliers I use 10% and 90% levels of the distribution as cut-offs.

For both of these specifications the response of small stocks is slightly larger compared to medium and large portfolios in the first period, but cannot be considered statistically significantly different (because the difference falls within +/- 2 standard errors). Positive monetary policy shock of 1% will lead to -2.24% drop in stock returns for firms with lowest (bottom 20%) market capitalization and only to -1.73% decrease in returns for large firms with highest market equity (top 20%). In the second period the coefficient on small size portfolio is insignificant, what comes in contradiction with my expectations and theoretical assumptions; the response of large stocks is roughly one-to-one with policy shock.

While performing this empirical analysis I was concerned with alarmingly small value of explanatory power of these regressions, which reaches at most 3%, and magnitude of coefficients on its own. I supposed what if a relevant variable was excluded and the model is generally misspecified. I questioned the validity of standard regressions performed in this research by many authors (e.g. Bernanke and Kuttner, 2003 or Ehrmann and Fratzscher, 2004), who generally disregard all other variables except for the variable of interest, i.e. monetary policy shock itself. However, if there does exist an omitted variable which is correlated with monetary policy disturbances then the estimated coefficient on the policy variable is by all means biased.

I reflected on the common patterns in investors' behavior in the stock market. Akerlof and Shiller (2009) have recently published a book "Animal Spirits". They develop a popular topic of behavioral finance literature, and argue for the fact that most of the time it is no more than human psychology which drives the economy. All the abundant fundamentals cannot explain volatility in market returns. When periods of overconfidence are followed by aggregate panic and market index crash the fundamentals do not change as drastically as prices in fact do.

News about changes in monetary policy may cause shifts in investor sentiment and alterations in asset prices. Thus, it is reasonable to suggest that there is a possibility for some correlation between policy shocks and investor sentiment. Among alternative measures of investor sentiment I focused on Volatility Index, VIX. I expand estimated regressions to include this index of implied volatility and again report the results in appendix. The regression is defined as following:

$$R_{it} = \alpha + \beta_{i1} \cdot S_t + \beta_{i2} \cdot VIX_t + \nu_{it} \qquad (8)$$

The estimated results for size portfolios have notably changed: the estimated coefficients on policy shock have become larger in magnitude and standard errors decreased. The explanatory power of the regression improved from barely 1-3% up to 11%.

If there is omitted variable which is negatively correlated with another variable in the regression, then estimated coefficient should have an upward bias, if it has a negative sign, and a downward bias in case of a positive sign. The correlation between the estimated VAR shocks and VIX index has been found to be -0.20. Therefore, the estimated coefficients in the previous regressions can be argued to possess an upward bias. A 10 basis points (b.p.) positive policy shock will cause a drop in returns by 0.35%-0.39% on average. These results are evidently more sensible, since the magnitude of policy shocks compounds few basis points reaching at most +/-0.5%. However, no size effect has been detected in the responses of portfolio returns.

To check the robustness of these results I constructed another measure of the monetary policy, defined by anticipated and unanticipated changes in the federal funds rate. Both specifications of the regressions are estimated: returns regressed on policy shocks only and together with VIX variable (though very slight correlation has been detected between VIX and new policy measure). The results are provided in the appendix.

There are some interesting and remarkable findings in the estimation. The one which catches the eye first is the magnitude of the coefficient on the unanticipated federal funds rate change. Obviously, unexpected component has its mean around 3 b.p. only, but still "surprise" policy tightening of 10 b.p. will lead to decrease in small stock returns of -1.16% and -0.99% for firms with highest market equity values. If I consider another specification without excluding 10%-90% outliers, the difference is found to be even stronger: small stock returns will drop by -1.2% and large stock returns by -0.95% in response to unanticipated 10 basis points tightening. This provides evidence of some heterogeneity in adjustment of stock returns to unanticipated policy changes. In addition, this reaction is considerably larger than the one estimated with VAR orthogonalized innovations. Besides, the explanatory power of the regression improved from approximately 8% up to almost 18%.

If we look at the coefficients on the volatility index, an interesting finding can be observed: an increase in market volatility, which can be also associated with some disturbance of investors' confidence, has significantly larger impact on small stock returns. An increase in VIX by 1% will cause -0.26% drop in small stock returns and -0.21% decrease for large firms.

Additionally, I briefly analyze other classifications of stock returns with regard to financial constraint. Following Ehrmann and Fratzscher (2004) arguments who suggest using cash flow to income ratio as alternative measure of financial constraint, I estimate whether firms with lower cash flow are affected more strongly by policy shocks. The intuition for this hypothesis stems from the fact that having limited amount of own funds they can be generally regarded as more dependant bank borrowers as they should rely more on bank credit lines. Naturally, bank-dependant borrowers are expected to be hit more strongly.

Indeed, from most detailed classification with 5 quintile portfolios it can be noticed that firms with lowest cash flows (bottom 20% in the distribution) are expected to have their returns dropped by 1.03% in response to positive unanticipated policy shock of 10 basis points; while firms with highest cash flows (top 20% in the distribution) are proved to be more immune to unexpected policy changes, having their returns decreased only by -0.6% in reaction to 10 b.p. surprise.

For alternative comparison and for the purpose of extending current analysis to account for other possible factors in place, I analyze two more classifications with regard to price earnings ratio and book to market equity ratio.

Price-earnings ratio is a standard measure of the price relative to annual income earned by the firm per share. P/E ratio is determined in units of years implying the time period required for investment in stock to pay back. Higher ratio would lead us to argue that investors are confident in stock returns in the long run; they might even expect higher profits in the future and are ready to pay more for each unit of net income now.

The estimated results for quintile portfolios show that firms with lowest (bottom 20%) price-earnings ratio will have their returns dropped by -1.01% in response to 10 b.p. surprise tightening of monetary conditions, while firms with highest price-earnings ratio will react only by -0.78%. However, this finding comes into conflict with estimated results of Ehrmann and Fratzscher (2004). They found responses to policy shocks larger for firms with highest price-earnings ratio; and their justification of this fact is rather convincing as well. Investors might be forced to reassess their earnings expectations with regard to higher discount factor and thus will be less willing to pay as much for the unit of net income; thus prices and returns of stocks with higher P/E should drop more than those with low P/E ratio.

Finally book to market equity ratio is another financial measure used in a sense to compare investors' assessment of the stock perspectives relative to the fundamental. The book equity represents firm's accounting position in the difference of its tangible assets minus liabilities. While the market capitalization represents public's consensus on the value of company's assets. When the ratio of these two measures is found to be high, then it can be argued that firm has experienced a sequence of shocks which disturbed investor's confidence in its fundamentals. The low ratio will thus represent market's overconfidence about the firms' position and can signal emergence of a bubble. The estimated results show that firms with low BE/ME ratio will be found to be more affected by tightening of policy conditions then those with larger ratio.

Industry-Specific Effects

In addition to considering firm-specific effects to monetary policy shocks I will test the responses stock returns with regard to industry affiliation. The presence of industry-specific effects has been already confirmed in papers of Ehrmann and Fratzscher (2004) and Bernanke and Kuttner (2003). Both of those papers used decomposed federal funds rate change as a measure of policy shock in the event study approach (in the former paper) and monthly estimation (in the latter one). I will test whether the results appear to be robust under alternative measure of policy shock identified with VAR innovations. Besides, I will estimate whether inclusion of volatility index alters the results in any significant way.

Monetary policy can affect the demand for products differently depending on sensitivity of industry to interest rate changes. It can be expected that more capital-intensive industries will be influenced more due to alterations in the cost of capital because of federal funds rate changes. Firms in cyclical industries and those in relatively open to trade are also expected to react more strongly to policy shocks.

It has been found that regression of industry returns on VAR extracted policy shocks along with volatility index produces mush better results, in terms of magnitude and significance of coefficients, then the one with VIX omitted. Durables seem to be most responsive to policy changes, while the estimated responses of firms in energy, utilities and health sectors are found to be insignificant. Other sectors showed average reaction of around -4% to 1% policy shock.

However, the results obtained from the regression of stock returns on alternative policy measure do not seem to be very robust. Sectors of Business Equipment and Telecommunication seem to react most strongly; Durables and Money industries are affected slightly less. Utilities and Energy sectors are found to be essentially unaffected.

Conclusion

The focus of my research was on identification of monetary policy shocks and consequent analysis of its impact on the stock market returns. Hence, one of the objectives was to establish whether results of stock market returns are robust for alternative specification of monetary policy measure. In my empirical estimation I found that stock returns responses are not robust across measures considered, the magnitude of the reaction of stock returns vary significantly.

However, I established that stock returns react in a heterogeneous way to change in monetary conditions. I tested for the presence of firm-specific and industry-specific effects. Positive monetary policy shock of 1% leads on average to -2.24% drop in stock returns for firms with lowest (bottom 20%) market capitalization and only to -1.73% decrease in returns for large firms with highest market equity (top 20%). Sectors of Business Equipment and Telecommunication, Durables and Money seem to react most strongly to monetary policy shock. But Utilities and Energy sectors are found to be essentially unaffected.

One of the notable results of my research was the finding of the omitted variables in the regression. I questioned the validity of standard regressions performed in this research by many authors (e.g. Bernanke and Kuttner, 2003 or Ehrmann and Fratzscher, 2004), who generally disregard all other variables except for the variable of interest, i.e. monetary policy shock itself. I suggested that news about changes in monetary policy may cause shifts in investor sentiment and alterations in asset prices. Among alternative measures of investor sentiment I focused on Volatility Index, VIX. The results have been found to change significantly with adding VIX into standard regression.

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APPENDIX

Table 2. Industry Portfolios, Fama-French Classification

Variable	*Industry*	*Description*
Nodur	Non-Durables	Food, Tobacco, Textiles, Apparel, Leather, Toys
Durbl	Durables	Cars, TV's, Furniture, Household Appliances
Manuf	Manufacturing	Machinery, Trucks, Planes, Off Furn, Paper, Com Printing
Enrgy	Energy	Oil, Gas, and Coal Extraction and Products
Chems	Chemicals	Chemicals and Allied Products
BusEq	Business Equipment	Computers, Software, and Electronic Equipment
Telcm	Telecommunication	Telephone and Television Transmission
Utils	Utilities	Utilities
Shops	Shops	Wholesale, Retail, and Some Services (Laundries, Repair Shops)
Hlth	Healthcare	Healthcare, Medical Equipment, and Drugs
Money	Finance	Finance
Other	Other	Mines, Construction, Building Materials, Transport, Hotels, Service, Entertainment

Table 3. Descriptive statistics of stock returns classified with respect to market equity, ME.

	Mean	*Median*	*Max*	*Min*	*Std. Dev.*
QNT_1	1.234066	1.345000	27.69000	-29.62000	5.838504
QNT_2	1.219957	1.475000	25.02000	-29.24000	5.429926
QNT_3	1.175647	1.470000	22.59000	-27.04000	4.966154
QNT_4	1.145259	1.465000	20.26000	-25.20000	4.671471
QNT_5	0.986221	1.170000	18.08000	-20.32000	4.036515
QNT_LOW	1.234066	1.345000	27.69000	-29.62	5.838504
QNT_MIDDLE	1.180287	1.54	22.62333	-27.16	4.964388
QNT_HIGH	0.986221	1.170000	18.08000	-20.32	4.036515
LOW_30	1.235776	1.430000	26.95000	-29.42	5.691888
MID_40	1.176868	1.540000	22.76000	-27.13	4.909748
HI_30	0.997385	1.240000	17.77000	-20.79	4.063089
DEC_LOW	1.236092	1.460000	26.69000	-29.49	5.620547
DEC_MIDDLE	1.180093	1.480000	22.84000	-27.125	4.982376
DEC_HIGH	1.130302	1.520000	18.87000	-24.2867	4.509966

Note: Qnt_Middle was constructed as an average of three middle quintiles (qnt_2, qnt_3 and qnt_4). Portfolios classified by deciles of the distribution were used to make 10%-90% cut-offs; *dec_low* is constructed as an average of the returns in the 20%-30% deciles; accordingly, *dec_middle* is an average of 40%-70% and *dec_high* is composed of top 80%-90% deciles.

Table 4. Descriptive Statistics of Stock Returns Classified with respect to Cash Flow, P / E and BE / ME

	Mean	*Median*	*Max*	*Min*	*Std. Dev.*
Cash Flow					
QNT_1	0.859558	1.110000	22.87000	-24.84	4.918813
QNT_2	0.900527	1.120000	15.62000	-22.86	4.317950
QNT_3	1.026994	1.125000	15.86000	-24.04	4.297883
QNT_4	1.098832	1.270000	20.53000	-21.61	4.164640
QNT_5	1.337607	1.600000	25.37000	-20.72	4.613565
LOW_30	0.848148	1.145000	21.50000	-23.67	4.686032
MID_40	1.005456	1.230000	16.37000	-23.8	4.198948
HI_30	1.250057	1.590000	23.96000	-18.3	4.369276
Price Earnings Ratio					
QNT_1	0.797379	1.080000	22.16000	-24.72	4.941793
QNT_2	0.922906	1.155000	15.71000	-23.03	4.188270
QNT_3	1.049573	1.180000	19.90000	-22.94	4.250747
QNT_4	1.202208	1.285000	20.92000	-19.51	4.244742
QNT_5	1.377308	1.695000	26.14000	-19.69	4.815773
LOW_30	0.831895	1.105000	21.43000	-23.99	4.647176
MID_40	1.031795	1.090000	16.85000	-22.22	4.130903
HI_30	1.325285	1.605000	25.04000	-18.57	4.559190
Book Equity to Market Equity					
QNT_1	0.859558	1.110000	22.87000	-24.84	4.918813
QNT_2	0.900527	1.120000	15.62000	-22.86	4.317950
QNT_3	1.026994	1.125000	15.86000	-24.04	4.297883
QNT_4	1.098832	1.270000	20.53000	-21.61	4.164640
QNT_5	1.337607	1.600000	25.37000	-20.72	4.613565
LOW_30	0.848148	1.145000	21.50000	-23.67	4.686032
MID_40	1.005456	1.230000	16.37000	-23.8	4.198948
HI_30	1.250057	1.590000	23.96000	-18.3	4.369276

Table 5. Granger-Causality Test Results for Monthly VAR, Chen (2007)

	LIP_SA	*D(LCPI)*	*LPPI*	*FF_RATE*	*LNBR_SA*	*LTR_SA*
LIP_SA	-	0.0543	0.0014	0.0003	0.2733	0.2661
D(LCPI)	0.7880	-	0.0069	0.6385	0.7281	0.9525
LPPI	0.7982	0.2568	-	0.0572	0.0376	0.0333
FF_RATE	0.2759	0.0000	0.0012	-	0.7124	0.5936
LNBR_SA	0.0183	0.5692	0.0697	0.0000	-	0.7644
LTR_SA	0.0321	0.8993	0.0853	0.0005	0.0000	-
ALL	0.0006	0.0000	0.0000	0.0000	0.0000	0.3391

Note: Only p-values are reported, associated with corresponding F-statistics with null hypothesis that the coefficients are zero.

Table 6. Panel Data Estimation of Size Portfolios' Responses to VAR MP Shock

	Full sample: 1959M01 - 2007M12	*Adjusted Sample: 1959M01 - 1979M12*	*Adjusted Sample: 1980M01- 2007M12*
VAR_ shock	-1.277	-2.237	-0.730736

	(-2.65)***	(-2.74)***	(-1.227)
Qnt_2*var_shock	-0.195	0.008	-0.311
	(-0.286)	(0.007)	(-0.370)
Qnt_3*var_shock	-0.216	0.249	-0.481
	(-0.316)	(0.216)	(-0.572)
Qnt_4*var_shock	-0.294	0.124	-0.533
	(-0.432)	(0.107)	(-0.633)
Qnt_5*var_shock	0.096	0.513	-0.142
	(0.141)	(0.445)	(-0.169)
R^2	0.0144	0.0253	0.0091

Note: t-statistics is reported in parentheses. (***) – estimated coefficient is significant at 1%, (**) – at 5%, (*) – at 10% significance level.

Table 7. OLS Estimation of Size Portfolios' Responses to VAR MP Shock

	Full sample: 1959M01 - 2007M12	*R^2*	*Sample: 1959M01 - 1979M12*	*R^2*	*Sample: 1980M01- 2007M12*	*R^2*
Qnt_1	-1.2785	0.00875	-2.238	0.02083	-0.730229	0.00342
	(-2.269)**		(-2.292)**		(-1.070)	
Qnt_2	-1.473	0.01337	-2.230	0.02442	-1.043	0.00784
	(-2.811)***		(-2.487)***		(-1.624)*	
Qnt_3	-1.493	0.01656	-1.989	0.02403	-1.213	0.01253
	(-3.133)***		(-2.466)**		(-2.059)**	
Qnt_4	-1.571063	0.02076	-2.113	0.03139	-1.266	0.01522
	(-3.516)***		(-2.829)***		(-2.272)**	
Qnt_5	-1.177	0.01608	-1.723513	0.03186	-1.043	0.01457
	(-3.087)***		(-2.851)***		(-2.262)**	

Notes: Returns of each quintile portfolio were regressed on the VAR extracted monetary policy shocks; t-statistics is reported in parentheses; (***) – estimated coefficient is significant at 1%, (**) – at 5%, (*) – at 10% significance level.

Table 8. OLS Estimation of Size Portfolios' Responses to VAR MP Shock

	Full sample: 1959M01 - 2007M12	*R^2*	*Sample: 1959M01 - 1979M12*	*R^2*	*Sample: 1980M01- 2007M12*	*R^2*
Qnt_low	-1.2785	0.00875	-2.238	0.02083	-0.730229	0.00342
	(-2.269)**		(-2.292)**		(-1.070)	
Qnt_middle	-1.512572	0.01697	-2.1105	0.02683	-1.1739	0.01177
	(-3.171)***		(-2.610)***		(-1.995)**	
Qnt_high	-1.177	0.01608	-1.723513	0.03186	-1.043	0.01457
	(-3.087)***		(-2.851)***		(-2.262)**	

Notes: qnt_low stands for the bottom 20% of the distribution of the stock returns, *qnt_high* corresponds to the top 20% of the distribution; while the *qnt_middle* stands for the average between 20% and 80%. (***) – estimated coefficient is significant at 1%, (**) – at 5%, (*) – at 10% significance level.

Table 9. OLS Estimation of Size Portfolios' Responses to VAR MP Shock

	Full sample:1959M01 - 2007M12		*Sample: 1959M01 - 1979M12*		*Sample: 1980M01- 2007M12*	
	Coeff.	R^2	Coeff.	R^2	Coeff.	R^2
Dec_low	-1.420	0.01161	-2.275	0.02373	-0.933	0.00582
	(-2.617)***		(-2.451)**		(-1.405)	
Dec_middle	-1.491	0.01640	-1.985	0.02382	-1.212	0.01246
	(-3.118)***		(-2.455)**		(-2.048)**	
Dec_high	-1.479	0.01977	-2.037	0.03131	-1.165	0.01388
	(-3.429)***		(-2.826)***		(-2.168)**	

Table 10. Size Portfolio Response to VAR MP shock including Volatility Index

- *Notes:* 10% and 90% levels of the distribution are used as cut-offs, hence *dec_low* consists of 20%-30% percentile of the distribution, *dec_middle* – 40%-60% and *dec_high* – 70%-80%

Qnt_low	-2.486	-0.253	0.069011
	(2.283)	(0.064) ***	
Qnt_middle	-3.841	-0.254	0.107025
	(1.844) ***	(0.052) ***	
Qnt_high	-3.533	-0.199	0.104293
	(1.498) ***	(0.042) ***	
Dec_low	-3.239	-0.2699	0.087203
	(2.179) *	(0.060) ***	

Dec_middle	-3.954 (1.861) ***	-0.259 (0.052) ***	0.109629
Dec_high	-3.828 (1.635) ***	-0.228 (0.046) ***	0.112123

Notes: standard errors are reported in parenthesis.

Table 11. Size Portfolio Responses to Market-Based Measure of MP Shock

	Sample: 1989M01 - 2007M12		
	Anticipated	Unanticipated	R^2
Qnt_low	-0.523 (0.799)	-11.283 (3.568)***	0.044066
Qnt_middle	-1.343743 (0.654)**	-10.30559 (2.917)***	0.068996
Qnt_high	-1.046864 (0.532)*	-9.622379 (2.375)***	0.082529
Dec_low	-0.995 (0.769)	-11.029 (3.430)***	0.05052
Dec_middle	-1.504 (0.660)**	-10.44792 (2.941)***	0.073294
Dec_high	-1.336813 (0.582)**	-9.716009 (2.595)***	0.078869

Notes: standard errors are reported in parenthesis.

Table 12. Size Portfolio Responses to Market-Based Measure of MP Shock including Volatility Index, VIX

	Sample: 1989M01 - 2007M12			
	Anticipated	Unanticipated	VIX	R^2
Qnt_low	-0.818038 (0.803)	-12.11675 (3.656)***	-0.244699 (0.061)***	0.114408
Qnt_middle	-1.690082 (0.640)***	-10.68840 (2.919)***	-0.242172 (0.049)***	0.169552
Qnt_high	-1.299562 (0.519)**	-9.557488 (2.367)***	-0.187544 (0.039)***	0.170221
Dec_low	-1.360811 (0.764)***	-11.65040 (3.479)***	-0.262468 (0.058)***	0.136944
Dec_middle	-1.868658 (0.645)***	-10.80015 (2.938)***	-0.248130 (0.049)***	0.176867
Dec_high	-1.627539 (0.566)***	-9.892892 (2.580)***	-0.216456 (0.043)***	0.179217

Notes: standard errors are reported in parenthesis.

Table 13. Cash Flow Portfolios: Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate.

	Sample: 1989M01 - 2007M12		
	Anticipated	*Unanticipated*	*R^2*
Low_30	-1.033871 (0.585)*	-10.15511 (2.608)***	0.074994
Middle_40	-1.381138 (0.491)***	-8.065655 (2.192)***	0.086943
High_30	-1.345980 (0.511)***	-6.901389 (2.277)***	0.066867

Table 14. Cash Flow Portfolios: Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate with Additional Variable, VIX

	Sample: 1989M01 - 2007M12

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	Anticipated	*Unanticipated*	*VIX*	*R^2*
Low_30	-1.309943 (0.578)**	-10.10158 (2.630)***	-0.186757 (0.044)***	0.147552
Middle_40	-1.623711 (0.478)***	-7.992379 (2.177)***	-0.178819 (0.037)***	0.181754
High_30	-1.617887 (0.494)***	-6.835587 (2.252)***	-0.191789 (0.038)***	0.171196
Dec_Low	-1.410251 (0.514)***	-8.423403 (2.341)***	-0.177464 (0.039)***	0.156911
Dec_Mid	-1.281060 (0.486)***	-8.695265 (2.213)***	-0.185963 (0.037)***	0.178020
Dec_Hi	-1.978215 (0.464)***	-6.097153 (2.112)***	-0.168674 (0.035)***	0.181258
Qnt_low	-1.333041 (0.613)**	-10.26559 (2.794)***	-0.191155 (0.047)***	0.137594
Qnt_2	-1.325793 (0.521)**	-8.973868 (2.372)***	-0.180714 (0.040)***	0.158945
Qnt_3	-1.251561 (0.485)***	-9.019033 (2.210)***	-0.182828 (0.037)***	0.178690
Qnt_4	-2.156106 (0.462)***	-5.709201 (2.105)***	-0.163895 (0.035)***	0.185364
Qnt_Hi	-1.598279 (0.525)***	-6.833838 (2.392)***	-0.202924 (0.040)***	0.162693

Table 15. Price-Equity Portfolios. Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate

	Sample: 1988M11 - 2007M12		
	Anticipated	*Unanticipated*	*R^2*
Low_30	-0.963288 (0.574)	-9.477622 (2.561)***	0.068165
Mid_40	-1.392344 (0.488)***	-8.517022 (2.176)***	0.094345
Hi_30	-1.390715 (0.552)**	-7.747188 (2.460)***	0.067425

Table 16. Price-Equity Portfolios. Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate with Additional Variable, VIX

	Sample: 1988M11 - 2007M12			
	Anticipated	*Unanticipated*	*VIX*	*R^2*
Low_30	-1.253357 (0.565)**	-9.356793 (2.572)***	-0.186566 (0.043)***	0.144263
Middle_40	-1.632099 (0.477)***	-8.344298 (2.173)***	-0.169764 (0.036)***	0.179477
High_30	-1.650747 (0.534)***	-8.076268 (2.434)***	-0.212607 (0.041)***	0.177625
Qnt_low	-1.291376 (0.617)**	-10.06268 (2.811)***	-0.201397 (0.047)***	0.139547
Qnt_2	-1.155015 (0.491)**	-7.511816 (2.239)***	-0.151230 (0.038)***	0.130815
Qnt_3	-1.770542 (0.494)***	-7.743769 (2.251)***	-0.166181 (0.038)***	0.166295
Qnt_4	-1.838168 (0.480)***	-8.995224 (2.184)***	-0.166477 (0.037)***	0.192033
Qnt_Hi	-1.507871 (0.578)***	-7.821094 (2.635)***	-0.246309 (0.044)***	0.174867

Table 17. BE / ME Portfolios. Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate

	Sample: 1988M11 - 2007M12		
	Anticipated	*Unanticipated*	*R^2*
Low_30	-0.999933 (0.587)	-10.62807 (2.617)***	0.079149
Mid_40	-1.397313 (0.509)***	-7.801919 (2.271)***	0.079091
Hi_30	-1.210548 (0.509)**	-6.944306 (2.288)***	0.061624

Table 18. BE / ME Portfolios. Responses to Anticipated and Unanticipated Changes in the Federal Funds Rate with Additional Variable, VIX

	Sample: 1988M11 - 2007M12			
	Anticipated	*Unanticipated*	*VIX*	*R^2*
Low_30	-1.270386 (0.580)**	-10.54550 (2.643)***	-0.181972 (0.044)***	0.146916
Middle_40	-1.675393 (0.489)***	-7.799205 (2.227)***	-0.205684 (0.037)***	0.197457
High_30	-1.473524 0.496033	-7.051202 2.259525	-0.206388 0.037933	0.179288
Qnt_low	-1.224943 (0.605)**	-10.51077 (2.756)***	-0.172341 (0.046)***	0.129954
Qnt_2	-1.564864 (0.519)***	-9.131103 (2.363)***	-0.210873 (0.040)***	0.192236
Qnt_3	-1.639181 (0.498)***	-7.880971 (2.267)***	-0.200486 (0.038)***	0.186929
Qnt_4	-1.555726 (0.483)***	-6.813578 (2.200)***	-0.186560 (0.037)***	0.170724
Qnt_Hi	-1.365440 (0.539)***	-7.390985 (2.454)***	-0.227615 (0.041)***	0.173099

Table 19. Heterogeneous Industry-Specific Effects to VAR-based MP shocks

Industries	*Full sample: 1959M1 – 2007M12*			*Adjusted Sample: 1980M1 – 2007M12*		
	Coefficient	Std. Error	R^2	Coefficient	Std. Error	R^2
Non-Durables	-1.238	(0.4003)***	0.016159	-0.965	(0.490)**	0.0115
Durables	-1.681	(0.5071)***	0.018509	-1.525	(0.6694)**	0.0153
Manufacturing	-1.420	(0.4546)***	0.016461	-1.392	(0.5761)***	0.0172
Energy	-0.809	(0.4736)*	0.004985	-0.364	(0.6377)	0.0010
Chemical	-1.499	(0.4185)***	0.021536	-1.508	(0.5187)***	0.0246
BusEq	-1.358	(0.6033)**	0.008617	-0.851	(0.8343)	0.0031
Telecom-n	-1.611	(0.4159)***	0.025103	-1.010	(0.5795)*	0.0090
Utilities	-1.457	(0.3634)***	0.026830	-0.914	(0.4513)**	0.0121
Shops	-1.361	(0.4783)***	0.013699	-1.287	(0.5970)**	0.0137
Health	-0.565	(0.4678)	0.002495	-0.189	(0.5537)	0.0004
Money	-1.373	(0.4670)***	0.014611	-1.090	(0.5720)*	0.0107
Other	-1.514	(0.4875)***	0.016275	-1.189	(0.5906)**	0.0120

Table 20. Heterogeneous Industry-Specific Effects to VAR-based MP shocks, including Volatility Index.

Industries	*Adjusted Sample: 1980M1 – 2007M12*		
	VAR shock	*VIX*	R^2
Non-Durables	-2.365436 (1.455762)*	-0.153878*** (0.040711)	0.066310
Durables	-7.331836 (2.121603)***	-0.295008 (0.059331)***	0.127839
Manufacturing	-4.648388 (1.698632)***	-0.262633 (0.047502)***	0.135843
Energy	-0.892831 (1.889884)	-0.156873 (0.052851)***	0.039763
Chemical	-4.941340 (1.494692)***	-0.185120 (0.041799)***	0.108328
BusEq	-4.404766 (2.963416)*	-0.255768 (0.082872)***	0.046362
Telecom-n	-4.394360 (2.010838)***	-0.198842 (0.056233)***	0.065218
Utilities	-1.972797 (1.556588)	-0.099768 (0.043530)***	0.027237
Shops	-3.362917 (1.789177)**	-0.175963 (0.050035)***	0.061157
Health	-0.035187 (1.780343)	-0.094577 (0.049787)	0.017219
Money	-4.620010 (1.850911)***	-0.259505 (0.051761)***	0.114635
Other	-5.169478 (1.663907)***	-0.252852 (0.046531)***	0.137484

Table 21. Industry-Specific Responses to Anticipated and Unanticipated MP shocks

	Sample: 1989M01 - 2007M12		
	Anticipated	*Unanticipated*	*R^2*
Non-Durables	-0.945269 (0.520)*	-7.908168 (2.318)***	0.062209
Durables	-1.292587 (0.768)*	-10.77850 (3.427)***	0.053429
Manufacturing	-1.206498 (0.620)*	-9.238336 (2.766)***	0.062187
Energy	-1.532704 (0.659)**	-2.111025 (2.939)	0.025558
Chemical	-1.978665 (0.537)***	-7.400504 (2.394)***	0.093241
BusEq	-0.801525 (1.031)	-13.29470 (4.598)***	0.038150
Telecom-n	-0.775905 (0.704)	-12.92191 (3.141)***	0.074306
Utilities	-0.836201 (0.545)	-2.188198 (2.431)	0.013847
Shops	-1.122491 (0.630)*	-8.742052 (2.808)***	0.05402
Health	-0.442109 (0.627)	-6.775302 (2.795)**	0.027433
Money	-1.710630 (0.657)***	-10.82391 (2.929)***	0.083232
Other	-1.192005 (0.609)*	-9.316865 (2.717)***	0.064691

Table 22. Industry-Specific Responses to Anticipated and Unanticipated Federal Funds Rate Changes, including Volatility Index into Regression

	Sample: 1989M01 - 2007M12			
	Anticipated	*Unanticipated*	*VIX*	*R^2*
Non-Durables	-1.154383 (0.510)**	-7.274548 (2.324)***	-0.147499 (0.039)***	0.117605
Durables	-1.524268 (0.759)**	-11.61232 (3.456)***	-0.264218 (0.058)***	0.141702
Manufacturing	-1.546571 (0.597)***	-9.314863 (2.720)***	-0.246101 (0.046)***	0.177822
Energy	-1.786412 (0.670)***	-1.821367 (3.051)	-0.160829 (0.051)**	0.071649
Chemical	-2.315937 (0.518)***	-7.013873 (2.359)***	-0.170448 (0.040)***	0.175980
BusEq	-1.122103 (1.050)	-13.77505 (4.785)***	-0.238996 (0.080)***	0.077835
Telecom-n	-1.095826 (0.703)	-12.74906 (3.202)***	-0.181888 (0.054)	0.120751
Utilities	-0.923772 (0.559)	-1.334625 (2.547)	-0.093747 (0.043)**	0.033694
Shops	-1.380955 (0.630)**	-8.669891 (2.868)***	-0.165466 (0.048)***	0.105183
Health	-0.620118 (0.633)	-6.510740 (2.882)**	-0.098062 (0.048)**	0.044801
Money	-1.992365 (0.639)***	-11.52434 (2.912)***	-0.245498 (0.049)***	0.187253
Other	-1.524970 (0.586)***	-9.576627 (2.671)***	-0.233449 (0.045)***	0.175625