

# DIFFERENCES IN INDUSTRY RESPONSES TO MONETARY POLICY SHOCKS: A STUDY OF INDUSTRY FINANCIALS, EQUITY PRICES, AND VALUATION

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## **Abstract**

*This paper employs a robust and exogenous measure of monetary policy shocks to test sectoral differences in firm responses to monetary policy, at the output and profit level, as well as in the equity market and in terms of their intrinsic valuation. Estimates obtained indicate that monetary policy has a large, persistent, and statistically significant effect on total output and profits. These estimates help explain the negative equity market response to the announcement of contractionary monetary policy shocks, and allow us to construct estimates for the implied change in intrinsic valuation. These analyses on company financials, equity price responses, and implied valuation all suggest there are clear differences in the way that monetary policy affects the different industries that make up the U.S. economy.*

\* I would like to thank my advisor, Professor Emi Nakamura for all her help and continued guidance and support throughout this adventure.

# 1 Introduction

Ever since the establishment of the Federal Reserve in 1913, economists have debated the ability of central banks to influence real macroeconomic variables through monetary policy. This question of monetary policy effectiveness is notoriously hard to analyze, given the interconnectedness of the financial system and the economy and the difficulty in reliably isolating the impact of changes in monetary policy on the real economy. In the past 30 years, economists have tried to work around the problem of reverse causality when analyzing this topic. Many have derived ‘monetary policy shock’ measures using approaches ranging from vector autoregressive models to the narrative approach first pioneered by Friedman & Schwartz in their “A Monetary History of the United States: 1867 – 1960.” My paper aims to bring this same level of rigor in the identification of monetary policy shocks to explore how different industries react to monetary policy. Specifically, I aim to discover differences across industries in financial, equity price and valuation responses to interest rate policy changes set by the Federal Reserve.

This paper begins its approach by evaluating both output and profit responses by the primary industries that make up the U.S. economy. Secondly, I explore investor reactions to monetary policy shocks on the day of the announcements to determine whether I can also identify differences in equity price responses across industries. In an effort to understand investor reactions and the reason for why these differences across industries in equity price responses exist, I analyze the relationship between equity price responses and my estimates on output and profit responses to monetary policy obtained from the first section of this paper. I thus evaluate the relative weight that investors give to ‘real’ changes in companies financials when buying or selling in the stock market. In the third and final part of my paper, I discuss the implications that my results have for the valuation of companies across different industries. I model the expected changes in industry

valuation as a result of changes in monetary policy. Specifically, I observe how much of the industry differences in equity price responses can be explained by my analysis on industry valuations.

I find that contractionary monetary policy seems to affect overall output negatively, in a statistically significant and persistent manner. I also see that aggregate profits across the U.S. tend to fall even more than output following a negative monetary policy shock. Furthermore, I document how contractionary monetary policy shocks have a negative effect on equity prices. All these findings are consistent with existing literature and economic intuition. For each of the three parts of my analysis, I identify that there are clear differences across industries in: 1) output and profit responses, 2) equity prices, following monetary policy shock announcements, and 3) intrinsic valuation responses.

## **1.1 Literature Review**

Literature on the effect of monetary policy on real economic variables in the United States can be divided into two periods, before and after 1971; namely, the period of the Gold Standard, and the period after its repeal, when the U.S. Dollar became a floating currency. This is partly due to the changing roles and capabilities of the Federal Reserve during the 20<sup>th</sup> Century, as described in Schultz (2005). For this paper, it is of interest to study the period from the U.S. Dollar's transition to a floating currency, up until the financial crisis of 2008, when the roles of the Fed once again changed drastically, and interest rate policy lost its relevancy to non-standard monetary policy in the Fed's macroeconomic toolset.

## Monetary Policy Shock Identification: Romer and Romer

Christina & David Romer tackle the issue of monetary policy effectiveness in their paper “A New Measure of Monetary Shocks: Derivation and Implications” by studying the effect that interest rate policy shocks have on economic variables, particularly on output and inflation. Their approach is innovative and does not follow traditional VAR literature; instead, they construct a measure of a monetary policy shock (using interest rates) that is exogenous and uncorrelated with concurrent economic conditions. The authors study changes in interest rates in 1969 – 1996 by the Federal Reserve, and specifically, they regress the changes in the intended federal funds rate (decided at each FOMC meeting during that period) on the existing target federal funds rate, output, inflation, and unemployment forecasts, as seen below:

$$(1) \Delta f_m = \alpha + \beta f_m + \sum_{i=-1}^2 \gamma_i \bar{\Delta y}_{mi} + \sum_{i=-1}^2 \gamma_i (\bar{\Delta y}_{mi} - \bar{\Delta y}_{m-1,i}) + \sum_{i=-1}^2 \varphi_i \tilde{\pi}_{mi} + \sum_{i=-1}^2 \theta_i (\tilde{\pi}_{mi} - \tilde{\pi}_{m-1,i}) + \rho \tilde{u}_{m0} + \varepsilon_m$$

They identify the error term  $\varepsilon_m$  as the measure of monetary policy shock, as it represents the change in the level of the intended federal funds rate, purged from endogeneity and the expected influence of macroeconomic forecasts on interest rate policy decisions. This measure guarantees exogeneity and will help discover causality in the study of the relationship between these shocks, output, and inflation. By regressing changes in these variables on these shocks (as well as time dummies and lags to avoid the impact of seasonal trends), they find statistically significant results suggesting that monetary policy shocks have sizable effects on output and prices.

This paper will employ this same measure of monetary policy shocks to discover the causal relationship between monetary policy shocks and industry-specific output, profit, equity prices,

and valuation; particularly, it will use the extended shock series (until 2008) constructed in Coibon et al. (2012). This extension is constructed by 1. Recording Greenbook forecasts until Dec. 2006<sup>1</sup>, 2. Using forecasts from the *Blue-Chip Economic Indicators*<sup>2</sup> for the 2007-2008 period as a substitute for Greenbook forecasts, 3. Using these forecasts and the same estimation as in Romer & Romer (2004), you can then extend the shock series until 2008. Using this methodology, the shocks constructed appear consistent with those presented in Romer & Romer (2004) (this series also reports large and volatile shocks during the 1974 period and Volcker disinflation in the early 1980s).

As a useful extension of Romer & Romer (2004), analyzing the topic of monetary policy effectiveness at an industry level also helps guarantee further exogeneity given that it is unlikely the Fed considers industry-specific economic variables when making interest rate decisions. More importantly for the context of this paper, using this exogenous shock measure to study the heterogeneity in industry responses to monetary policy improves the reliability and validity of results, as existing literature fails to provide the same level of rigor in guaranteeing that the shocks used are free from endogeneity and anticipatory movements by the Fed.

### **Heterogeneity of Industry Responses to Monetary Policy Shocks: Dedola & Lippi, Ganley and Salmon, Peersman & Smets, and Otero**

Existing literature studying the heterogeneity of industry responses to monetary policy shocks can be found in Dedola & Lippi (2005), Ganley and Salmon (1997) and Peersman & Smets (2005). Differing to the identification methodology in Romer & Romer (2004), this strand of

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<sup>1</sup> Last available Greenbook forecast release.

<sup>2</sup> Consensus estimates from panelists including institutions such as: U.S. Chamber of Commerce, Oxford Economics, AIG, and Goldman Sachs.

literature identifies monetary policy shocks and evaluates the impact on the economy using a vector autoregression (VAR) approach. In particular, they emphasize the need for a structural VAR to capture the effect of monetary policy shocks on macroeconomic variables, such as output and inflation, given the clear interactions between these variables. Each of these papers focuses on different geographical locations, but in general, they all focus on manufacturing sectors and follow the structured VAR methodology developed in Christiano et al. (1999)<sup>3</sup> in their identification of monetary policy shocks. One recent paper applying this same methodology is Otero (2017), where he studies the impact of monetary policy and heterogeneity of industry responses across some key countries in Latin America. Another recently published paper that is related to my analysis is (Skaperdas, 2019); in this paper, Skaperdas studies the effectiveness of monetary policy at the zero lower bound and uses identification through industry heterogeneity. Similar to my paper, Skaperdas uses public company data to find estimates for output (proxied by revenue), but for a more complete industry list, not just focusing on manufacturing sectors. That said, Skaperdas' paper focusses on a time period when non-standard monetary policy dominated the Federal Reserve's policy toolkit. This does not align with my approach and goals for this paper.

While there is certainly academic backing behind the validity of the VAR identification of monetary policy shocks, this paper aims to tackle two key issues raised by Romer & Romer (2004) in the identification of shocks: 1. the necessity of an 'intended' or target interest rate instead of the actual rate given the risk of endogeneity, and 2. the risk of containing the Fed's own anticipatory movements to expected developments in the real economy. Furthermore, this paper will use an updated dataset from 1969 until 2008 for the United States and extends the industries under

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<sup>3</sup> They specify a 5 variable VAR including industrial production, the CPI & commodity price index, a short-term interest rate (federal funds rate), and a monetary aggregate (M1). As with Romer & Romer (2004), their measure for monetary policy shocks can be found in the error term of the regression.

consideration beyond just manufacturing sectors. This extension of the industry list represents a more comprehensive and realistic picture of the industry makeup of the U.S. economy.

### **Equity Price Responses to Monetary Policy Shocks: Bernanke & Kuttner (2004)**

When exploring the relationship between the stock market and monetary policy, it is crucial to be rigorous with the construction of your monetary policy shock series in order to guarantee exogeneity. This is particularly important for the study of equity price responses, given that the economy and stock market are so closely interconnected, and because stock market data is typically very noisy.

Bernanke & Kuttner explore the relationship between equity price responses and monetary policy shocks, by using a shock series that was constructed employing a VAR model. They find that the stock market reacts strongly to the announcement of monetary policy shocks, and document the negative relationship between stock market returns and unexpected changes in interest rates, i.e. monetary policy shocks. Bernanke & Kuttner then proceed to show that differences in equity price responses to changes in monetary policy can be explained by the impact of these policy actions on expected future excess returns and on discounted future dividends.

My paper takes a similar approach in my analysis of equity price responses to monetary policy shock announcements. In an effort to explain the differences that I observe in equity price responses across industries, I compute the change in intrinsic valuation implied by my estimates of output and profit responses to monetary policy shocks. This differs from the approach taken in Bernanke & Kuttner (2004), as they do not forecast expected changes in future dividends, as a result of changes in monetary policy. Aside from extending the time period and number of industries considered in my sample, this paper attempts to explain cross-industry differences in

equity price responses in the context of the expected changes in industry financials, at the output and profit level. Furthermore, the use of an alternative monetary policy shock measure and the implications of my analysis for industry valuations are all helpful contributions to existing literature exploring the relationship between monetary policy and equity market returns.

## **2 Data**

In this section, I will describe the data used in this paper for each of the three parts of my analysis, including the dataset source, and any necessary transformations to prepare the data for my analysis. The three main datasets used are 1. a monetary policy shock series for the 1969 – 2008 period, 2. industry-level financial data, and 3. industry-level equity trading data. As described in section 1.1, the monetary policy shock series used in this paper represents the extension of the Romer & Romer shock series presented in Coibion et al. (2012). The industry-level financial was sourced using quarterly financial data from Compustat<sup>4</sup>, and the industry-level equity trading data was sourced using daily trading data from the Center for Research in Security Prices (CRSP). I now go on to describe the transformations I have completed on each of these three datasets.

### **2.1 Monetary Policy Shock Series**

As mentioned above, this paper aims to uncover the relationship between monetary policy shocks and industry level output using the updated monetary policy shock series from Coibion et al. (2012). These monetary policy ‘shocks’ represent ‘unexpected’ changes of the federal funds

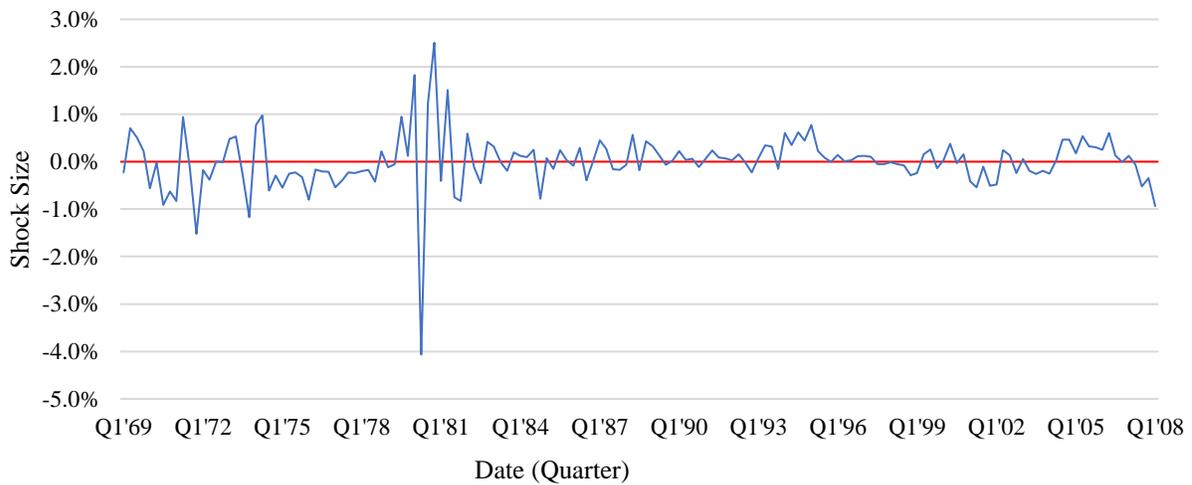
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<sup>4</sup> The Compustat database aggregates quarterly financial data for North American public companies from Capital IQ, which in turn sources directly from public 10Q-filings. This company-level quarterly financial data is available since 1961.

rate during the Federal Reserve’s monetary policy meetings from January 1969, up until March 2008. As mentioned in the introduction, after March 2008, interest rate policy became less relevant within the Fed’s policy toolkit. Thus, in the context of monetary policy shocks, it did not make sense for this paper to extend these interest rate shocks after that date.

This paper proceeds to aggregate monetary policy shocks by quarter for each calendar year from 1969 until 2008 (shown in figure 2.1). This way, I can remain consistent with the time interval used in my data series for quarterly financials, from which I will obtain my measures of industry output and profits.

Figure 2.1: Extended Monetary Policy Shock Series (1969 – 2008)



In figure 2.1 above, I can see how these monetary policy shocks oscillate around 0; the data series has a median of 0 and a standard deviation of 0.591%. Out of a total of 157 observations (number of quarters in my period of interest), about half are positive (contractionary) and half are negative interest rate shocks (expansionary). The largest negative shock occurred in Q2 – 1980 (4.1% ‘unexpected’ decrease in the federal funds rate), and the largest positive shock occurred in Q4 – 1980 (2.5% ‘unexpected’ increase in the federal funds rate). These two shocks occurred during the beginning of the ‘Volcker Era’. Romer & Romer indicate how, during the beginning of

his time as the Federal Reserve chairman (specifically, during the 1979 – 1982 period), the Federal Reserve “placed considerable emphasis on some quantity measure in implementing policy”. This ‘quantity measure’ refers to the quantity of money (specifically, non-borrowed reserves) in the economy, which had become a new target of monetary policy under the Federal Reserve’s approach. Romer & Romer suggest that this change in approach resulted in increased volatility of the monetary policy shock measure during that period. This is because interest rate policy was not implemented in the same traditional manner, given its estimates and expectations for output growth and inflation in the economy. As a result, one can argue that this increased volatility can at least partly account for the largest shocks of the series.

One final thing to note about this data series: for the second and third part of my analysis, where I evaluate the effect that monetary policy has on equity prices, I use the original shock series (not the series with shocks aggregated by quarter). This original series represents the monetary policy shocks that were announced on the dates when the Federal Reserve held monetary policy meetings and decided to change interest rates (in an ‘unexpected’ manner). I will be considering daily equity price data for these same dates, and specifically, during the day of the announcement of an interest rate policy change. In the Coibion et al. (2012) monetary policy shock series, there is no distinction made between the days during which the Federal Reserve met to decide on changes to the federal funds rate, from the days when actual such changes were announced. Though most dates do coincide, I have corrected for the cases where they did not<sup>5</sup>.

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<sup>5</sup> The announcement days are documented in the Federal Open Market Committee section of the Federal Reserve website. These represent the day in which a monetary policy meeting took place, and in the case when the meeting spanned multiple days, the announcement day would be represented by the last date. I have verified that the stock market was open during each of the announcement dates, and that there was active trading in the market from the time of the announcement until stock market close.

## 2.2 Industry Level Financial Data (Output & Profits)

For industry level financial data, this paper will use the database Compustat to obtain specific firm-level financial data, aggregated by industry for the January 1969 – March 2008 period. This data includes both revenue and net income figures, which represent proxies for firm output and profits respectively. Both are widely used proxies in literature, as seen in Melitz (2000). Since the firms represented in the data set are public companies, on the aggregate, the sample is skewed towards including larger sized firms. This said, using reported data is more accurate than output estimates from firm surveys (which have been traditionally used in literature on the topic). As mentioned previously, this dataset includes all sectors that make up the U.S. economy (classified by GICS<sup>6</sup> codes) and not just manufacturing sectors. This way, I account for sectors such as: ‘Banks’, ‘Energy’, and ‘Software and Services’, which are all very significant within the U.S. economy.

Note that my dataset of financial data is constructed using quarterly reported company financials. These financials are reported on a fiscal year basis, which do not always align with the calendar year amounts. To remain consistent with my (calendar-year) quarterly monetary policy shock series, I have ‘calendarized’ all firm-level financial data<sup>7</sup>. I then aggregate all values for revenue and net income (i.e. output and profits) for all of the companies in each industry. The result is a calendarized dataset for aggregate output and profits for each quarter between 1969 and 2008, which I can then proceed to run my analysis on.

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<sup>6</sup> Global Industry Classification Standard.

<sup>7</sup> To calendarize firm level financial data, I have used the weighted average of the quarterly financials for the fiscal-year that overlap during each calendar-year quarter (Q1: Jan 1<sup>st</sup> – Mar 31<sup>st</sup>, Q2: Apr 1<sup>st</sup> – Jun 30<sup>th</sup>, Q3: Jul 1<sup>st</sup> – Sep 30<sup>th</sup>, and Q4: Oct 1<sup>st</sup> – Dec 31<sup>st</sup>). For example, if a firm’s fiscal year ends on Jan 31<sup>st</sup>, the ‘calendarized’ Q1 amount would be equal to the sum of one third of the previous year’s fiscal-Q4 amount and two thirds of the current year’s fiscal-Q1 amount).

This dataset, before aggregating financial data by industry and date, has a total of 895, 442 observations, across 20,432 unique companies that pertain to 25 different industries. Once aggregated by industry, the number of observations per industry drops to 157, the number of quarters from 1969 until 2008. Note that this number is slightly lower for select industries that experienced total quarterly losses in net income. Those data points, when computing the change in the log of profits, result in non-meaningful entries for the regression.

### **2.3 Equity Market Returns**

This paper uses CRSP daily equity price data for the same set of companies I have available financial data for. By matching the list of unique company identifiers (CUSIP), I obtain equity trading data (daily closing prices) for this set of companies for the January 1969 – March 2008 period. By remaining consistent with my company list, I guarantee more reliable results from any analysis that requires to cross the two datasets. Since CRSP only records daily closing prices, I construct a measure of ‘daily return’ using the percentage change in price from the closing price at time =  $t - 1$ , to the closing price at time =  $t$ . In addition, CRSP also fails to provide GICS sector codes, which I add to the dataset by matching the sector codes to the companies for which I already have equity price data.

I proceed to restrict my dataset to all the dates when the Federal Reserve held a meeting to discuss changes in interest rate policy, from which my monetary policy shock series was produced. This dataset (restricted to the dates of interest), has 1,328,548 observations, with a median of 0.0%, and a standard deviation of 7.4%. In Figure A.6, I notice how the distribution of returns appears to be normal and centered at 0.0% daily returns. In this histogram, I have restricted my dataset to

observations of (absolute value) daily returns of lower than 20%. I can conclude with a high degree of certainty that any observations that lie outside of this range can be considered as outliers for two main reasons. It is first clear from the spread of the data that the majority of my observations will lie within this range; only a few observations with oversized returns will be omitted. Secondly, in Bernanke and Kuttner (2003), possible outliers are defined as entries with daily returns greater than about 10% (in absolute value terms). Though their monetary policy shock series is not the same as the one used in this paper, and acknowledging that the Romer & Romer shock series are generally larger in magnitude than other existing measures of monetary policy shocks, this paper thus claims that observations with absolute value daily returns greater than 15% are likely outliers. However, I will use the complete equity price dataset for the second and third parts of my analysis, and will only omit these outliers as a robustness check.

### **3 Results**

The key results of this paper can be divided into three parts. First, I analyze the effect of monetary policy shocks on firm output and profits across different industries (section 3.1). Second, I explore the reaction of the stock market to monetary policy shock announcements, and how this reaction varies across my industries of interest (section 3.2). Lastly, I explore the implications that my results from the previous two sections have for firm valuation. I specifically evaluate the effect that monetary policy shocks have on firm valuation across industries, given a simplified model for intrinsic company valuation (section 3.3).

### 3.1 Output & Profit Response to Monetary Policy Shocks

In this first section of my results, I first analyze the impact of interest rate policy shocks on firm output. As with existing literature, I aim to evaluate the ability of the Federal Reserve to affect economic output. I then disaggregate the effect that monetary policy shocks have on total economic output by industries; specifically, using the complete list of GICS sectors that make up the U.S. economy. Finally, I run my same analysis on firm profits to understand how industries' overall profitability is affected by monetary policy shocks. This allows me to assess the importance that the interest rate channel has, relative to the 'direct' channel, through which monetary policy affects output.

Now, this paper will first present the empirical approach used in this section.

#### Regression Estimation

As discussed, the monetary policy shock series used in this paper is considered exogenous to economic conditions. I can thus run simple regression models of the variables of interest (output and profits by industry) on my monetary policy shock series, without the need to add unnecessary control variables (such as entity fixed effects) to try capture causality. This is the regression equation that was estimated:

$$(2) \quad \Delta y_{n,t} = a_{n,0} + \sum_{i=1}^3 c_i Q_i + \sum_{i=1}^8 c_{n,i} \Delta y_{n,t-i} + \sum_{j=1}^{12} d_{n,j} S_{t-j} + v_{n,t}$$

Here,  $\Delta y_{n,t}$  is the difference in log of output (or profits, by industry and quarter),  $Q_i$  is a (date) quarter dummy, and  $S_{n,t}$  is my monetary policy shock variable. Specifically, my regression controls for lags in output ( $\Delta y_{n,t-i}$ ) and in my monetary policy shock ( $S_{n,t-j}$ ). Including lags of

my dependent variable ensures that the estimates from the regression are not explained by its own seasonal trends, and lags of  $S_{n,t}$  are needed to identify the (potentially delayed) effect that a past monetary policy shock has on my dependent variable. The number of lags follows the regressions computed in Romer & Romer (2004); allowing one monetary policy shock to affect output up to three years after the initial shock. This paper will run this specific regression on each sector's output series for the same period considered (as indicated by  $n$ , the sector index). I can thus uncover the differences in magnitude and timing of the expected impact of monetary policy on each industry's output, providing results that can be easily compared. The same analysis will be completed using each industry's profit series. This said, I will first start by regressing total economic output on my monetary policy shocks series to ensure that the estimated results align with existing literature on the topic.

### 3.1.1 Effect on Total Output

Table 3.1.1: OLS Regression: Effect of Monetary Policy Shocks on Total Output

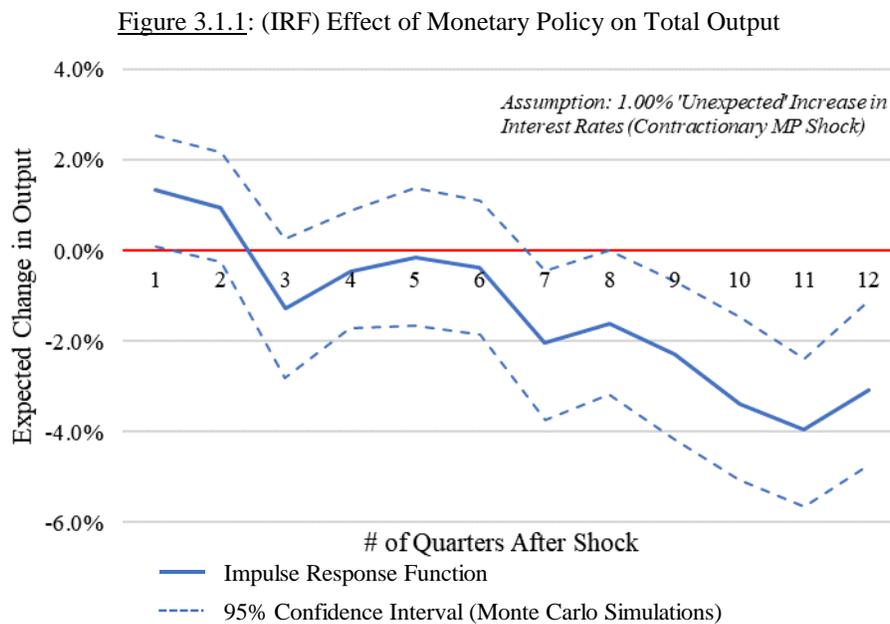
Monetary Policy Shock Variable	Change in Log Output	
	Coefficient	Standard Error
Lag #1: $S_{t-1}$	0.0135*	0.0075
Lag #2: $S_{t-2}$	0.000337	0.0074
Lag #2: $S_{t-3}$	-0.0205**	0.0094
Lag #4: $S_{t-4}$	0.00110	0.0067
Lag #5: $S_{t-5}$	-0.00585	0.0065
Lag #6: $S_{t-6}$	0.00178	0.0062
Lag #7: $S_{t-7}$	-0.00579	0.0066
Lag #8: $S_{t-8}$	-0.00559	0.0058
Lag #9: $S_{t-9}$	-0.0113*	0.0064
Lag #10: $S_{t-10}$	-0.0143**	0.0058
Lag #11: $S_{t-11}$	0.000351	0.0049
Lag #12: $S_{t-12}$	0.000513	0.0056

Notes : Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .  $R^2 = 0.853$ ,  $N = 145$ . Sample period is Q1-1969 through Q1-2008. Coefficients and SEs for dummies and lags on  $\ln(\text{output})$  are not reported.

In this first part of section 3.1, this paper explores the effect that monetary policy has on total output to ensure my results align with similar estimates from existing literature. In Table 3.1.1, I can find the estimates of the regression of total output (an aggregated measure of all industries) on my monetary policy shock series. I firstly notice how most coefficients on the lags of my monetary policy shock variable are negative. Even though many coefficients are not individually statistically significant, this is not a concern given that monetary policy shocks affect industries in a cumulative manner, and so, it is not meaningful to consider coefficients on individual lags separately. Aside from the first two and last coefficients on the lags of the monetary policy shock variable, I also observe that the fourth and sixth lags are positive. This is not concerning given that they are very small in magnitude, and when compared to the cumulative effect of monetary policy shocks on total output, I see that they do not change the direction of my conclusions. I further note that the  $R^2$  value is 0.85, suggesting that the OLS regression run is a good fit for the question analyzed.

These results are similar to the estimates obtained in Romer & Romer (2004); where their monetary policy shock lags were mostly negative, but also mostly statistically insignificant. Thus, my results are in line with existing literature, and since most coefficients are indeed negative, this points to a clear negative relationship between ‘unexpected’ changes in interest rate policy by the Federal Reserve and changes in output. This implies, for example, that a contractionary monetary policy shock (positively-valued shock), would negatively affect output (as is expected from economic intuition). Specifically, the coefficient on each lag of my monetary policy shock variable indicates that for every 1.00% ‘unexpected’ increase in interest rates (during quarter  $t - j$ ), output at time  $t$  is expected to change by the coefficient on lag  $j$  in percentage terms (for  $j = 1, \dots, 12$ ). For example, for lag 10 in my results, for a 1.00% ‘unexpected’ increase in interest rates at time  $t - 10$ , total output at time  $t$  is expected to drop by 1.27%.

For the context of this paper, it is crucial to evaluate the effect of monetary policy on time  $t$  as the cumulative impact of previous shocks prior to the period in question. For this reason, this paper will use the estimated coefficients on the lags of the monetary policy shock variable to build an impulse response function (IRF). This will allow me to estimate the expected cumulative effect on output after a one time change in monetary policy (specifically, this section of the results will present the effect of a 1.00% contractionary monetary policy shock on output, and later, on profits). Each of the impulse response function graphs in this paper will also include a 95% confidence band (indicated by dotted lines), which is constructed using the standard errors of each of the coefficients of the monetary policy lags<sup>8</sup>.



In Figure 3.1.1 I observe the expected cumulative response of total output after a 1.00% (contractionary) monetary policy shock (i.e. after a +1.00% change in the intended federal funds rate) at time  $t = 0$ . Although the initial expected response of output to a contractionary monetary

<sup>8</sup> The 95% confidence band is computed by running Monte Carlo simulations based on the predicted IRF. Specifically, I ran simulations of the predicted cumulative response using the coefficients and standard errors of each monetary policy lag and output lag. The confidence band represents the 5<sup>th</sup> and 95<sup>th</sup> percentile of the results obtained from a sample of 1000 draws.

policy shock is positive, the overall trend and actual IRF suggest that monetary policy shocks have a strong and permanent negative effect on economic output. Despite the delay caused by the initial positive response, cumulative economic output is expected to fall, with the lowest point occurring 11 quarters after the shock. At that point, the implied loss of total output drops to about 4.00%. Even when considering the upper confidence band, I still expect a moderate negative response from 7 to 12 quarters after the shock.

It is also important to highlight the positive and statistically significant coefficient on the first lag of the monetary policy shock variable (in Table 3.1.1, equivalent to the first data point in Figure 3.1.1). This positive coefficient initially disagrees with economic intuition on the effect of contractionary monetary policy. Existing literature using the Romer & Romer monetary policy shock series suggest that this coefficient could be explained by sampling error, specifically, due to the economic contraction following the large expansionary monetary policy shock that occurred in April 1980. However, as described in my robustness checks, when I drop these ‘large’ monetary policy shocks from my series, I still find an initial positive reaction of output to a contractionary monetary policy shock (i.e. a positive coefficient on the first lag of the monetary policy shock variable).

Nevertheless, it is also possible that this first coefficient individually reflects the ‘information effect’ that follows announcements of policy changes by the Federal Reserve, fully captured in Nakamura & Steinsson (2018). They describe how this ‘information effect’ accounts for the unintuitive phenomenon in which firms react positively to news of contractionary monetary policy. The logic is that contractionary monetary policy indicates to markets that the Federal Reserve believes the economy is performing well (perhaps excessively well) and expects further growth, which they believe requires some stabilization. The authors show that this positive outlook raises

business confidence and expectations of growth, which can incentivize firms to increase their investment, and thus, output. Although their estimates suggest that this positive effect persists for longer than one quarter after the shock, they also acknowledge that actual output responses are much more modest than private sector responses in growth expectations. It is plausible that these positive expectations fuel output expansion only in the short run, which would allow me to reconcile this ‘extended’ positive information effect with my results.

This said, it is clear that in the medium to long term, contractionary monetary policy will likely depress output, and evidence in this paper suggests this is a strong causal relationship. This confirms my hypothesis that monetary policy has a significant and permanent impact on economic output.

*Robustness.* – To ensure that the results obtained above are robust, I will reevaluate my analysis using three alternative approaches.

Firstly, I wish to test whether my choice of lags on the monetary policy shock variable in regression (2) has an impact on the size of coefficients from my regression. One could argue, for example, that monetary policy shocks that occurred more than three years ago (i.e. 12 quarters) could still affect the level of output today. In the left chart of Figure A.1, I can observe two variations of an IRF that reflects the expected output response following a contractionary monetary policy shock of size 1.00%. In blue, I have my original IRF, which is based on the regression estimation (2) using 12 lags on the monetary policy shock variable. In gold, I have an IRF that is based on a variation of regression (2), where it instead uses 16 lags on the monetary policy shock variable. Overall, I observe that the newly estimated IRF with 16 lags is very similar to the original IRF and lives well within the 95% confidence bands. This said, it is also worth noting that after the 12<sup>th</sup> quarter, total output is expected to remain constant. This provides me with further evidence

that suggests that monetary policy shocks have a permanent impact on the economy's output levels.

Second, another supporting analysis I can run is to test whether 'extreme-valued' observations from my monetary shock series<sup>9</sup> skewed my results. In the left graph of Figure A.2, I see how dropping these key observations delays the (negative) output response after a monetary policy shock. However, output is still expected to fall over the span of 12 quarters after the shock occurs, and in fact, I also notice how by quarter 10, the new IRF reaches a similar minimum to that of my original IRF (at about - 4.00%).

Lastly, as previously mentioned, existing literature on the topic has traditionally been limited to datasets constructed using firm surveys, and specifically, from manufacturing companies. This paper uses a different dataset, which aggregates company level data by industry, but including all available industries that make up the U.S. economy. For this reason, as a robustness check of my results from this section, I wish to run my analysis using the 'traditional' data sources on total output<sup>10</sup>. In Figure A.3, I see how using this alternate database results in similar estimates to the original IRF for the response of output to a monetary policy shock. Specifically, I observe that the new IRF has a downward trend and that it mostly lives within the 95% confidence band of my original IRF. In general, my tests above indicate that my results are robust. Thus, it is fair to suggest that there is a negative causal relationship between monetary policy shocks and total output.

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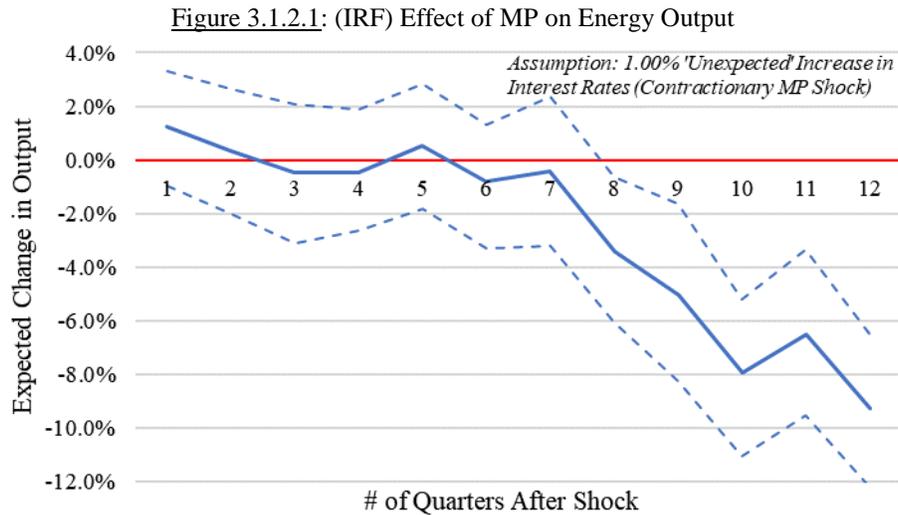
<sup>9</sup> For my analysis, these refer to the dramatic unexpected changes in the federal funds rate in 1974, to combat inflation and an oil price shock, and in 1980, during the Volker era at the Fed, also to combat high inflation.

<sup>10</sup> Source: FRED from the St. Louis Federal Reserve: Total Industrial Production Index, aggregated by quarter.

### 3.1.2 Effect on Industry Level Output

The decision to use firm-level financial data allowed me to explore the sectoral heterogeneity of output responses to monetary policy shock for a list of industries that is more representative of the U.S. economy, as opposed to simply focusing on manufacturing industries. The complete list of results for all industries can be found in Figure A.4, from which it is clear that output responses are not homogeneous across different industries. In fact, I can see there are clear differences regarding the direction, magnitude, and timing of the effect of monetary policy on output across different sectors. However, this subsection will focus on three sectors that are expected to suffer from large output losses following a contractionary monetary policy shock, and three that do not appear to be affected (or appear to be inversely affected) by monetary policy. I then describe some possible industry characteristics that could explain these results<sup>11</sup>.

#### 3.1.2.1 Energy



<sup>11</sup> This paper will use recent industry reports from IBISWorld to identify key industry characteristics that can explain the results I present.

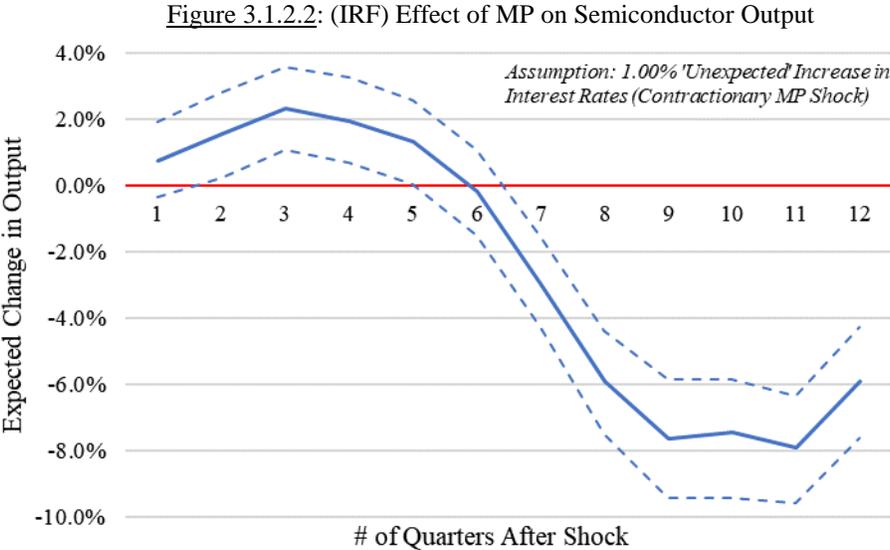
The energy industry appears to be amongst the most affected by monetary policy. Figure 3.1.2.1 suggests there is a clear negative relationship between monetary policy shocks and output in the energy industry. For example, by quarter 10, a 1.00% ‘unexpected’ increase in the target federal funds rate is expected to decrease output in the energy industry by about 8.00%. Though output appears to be unaffected for the first year after the shock, after quarter 5, energy output is expected to fall rapidly, a trend which is not reversed even 12 months after the initial shock. Thus, it appears that there is a strong and negative causal relationship between interest rate policy and output in the energy sector, which is statistically significant (as indicated by the 95% confidence bands).

Industry reports on the energy sector in the U.S. highlight some key characteristics of the business model that are helpful to understand the results above. Firstly, the energy sector is characterized by relatively high capital intensity, but most importantly, it is highly dependent on commodity and currency prices. Most firms in this sector operate internationally and deal with the foreign exchange and derivatives market on a daily basis; they often hedge on commodities, which in turn are dollar denominated. This implies energy firms’ output is directly exposed to interest rate changes. For example, if the Federal Reserve were to increase interest rates, this would likely appreciate the U.S. Dollar (and thus all asset and derivative contracts denominated in the currency). As a result of the higher price, there would be a fall in global demand for energy products. Both of these characteristics point to a high interest rate risk, which would explain the large effect that monetary policy shocks have on energy output.

### **3.1.2.2 Semiconductors**

Another industry that seems to be particularly affected by ‘unexpected’ change in the target federal funds rate is the ‘Semiconductor’ industry. Figure 3.1.2.2 shows that following a monetary

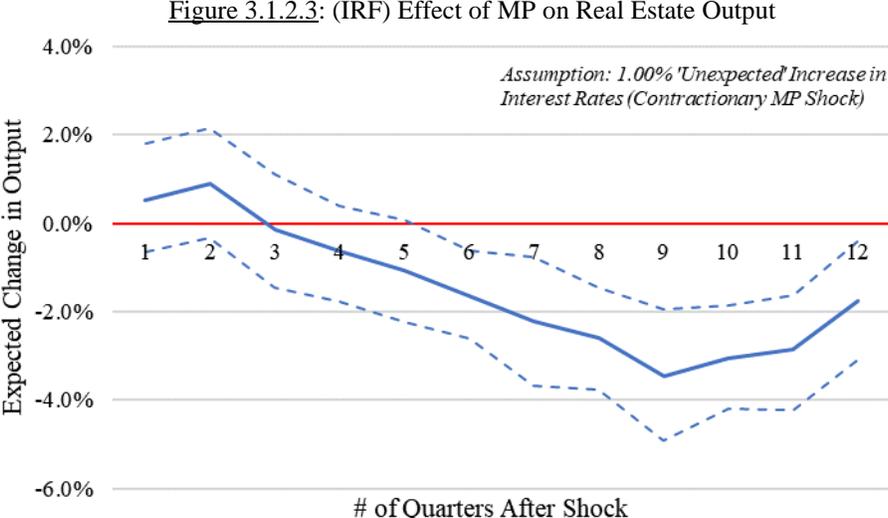
shock, I can expect a somewhat delayed, but very large output loss in the semiconductor industry. For example, by quarter 10 after the shock, I can expect a loss in output of about 8.00% (with a high degree of certainty, since the confidence bands are very narrow and also because the IRF is deep in the negative range).



Despite having low capital intensity, there are two key characteristics of this industry that can potentially explain the results above. First, the semiconductor industry is highly dependent on technological advancements, and so, it requires continuous investment (and financing) to be able to sustain production. Following a monetary policy shock, this raises the cost of borrowing, and so, makes it less profitable to undergo further investments, fueling less growth and thus, resulting in lower output. Second, it is also highly reliant on the consumer electronics sector, which is known to have a very short product lifespan. This implies that to do well, firms should have very high inventory turnovers, which requires constant financing and investment to ensure they can keep up with consumer electronics trends. Both of these characteristics point to a strong dependence on

financing (especially short-term financing), which is highly sensitive to changes in interest rates, and thus, explains why the effect of monetary shocks on this industry seems so large.

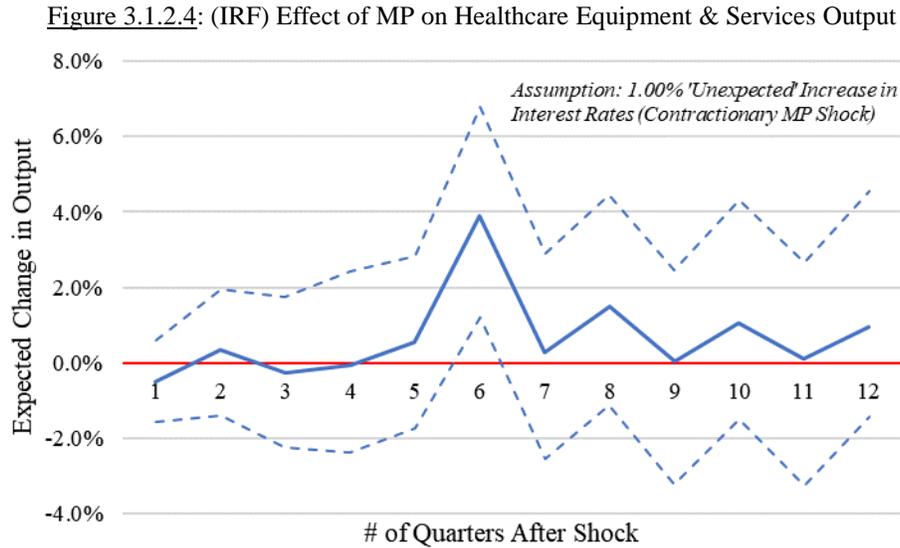
**3.1.2.3 Real Estate**



As expected by the nature of the industry, Figure 3.1.2.3 suggest there exists a clear negative relationship between monetary policy shocks and real estate output. Specifically, I find that there is an implied peak output loss of greater than 3.00%, 9 quarters after a monetary policy shock (a 1.00% ‘unexpected’ increase in the target federal funds rate). Furthermore, the results are statistically significant, as indicated by the 95% confidence bands.

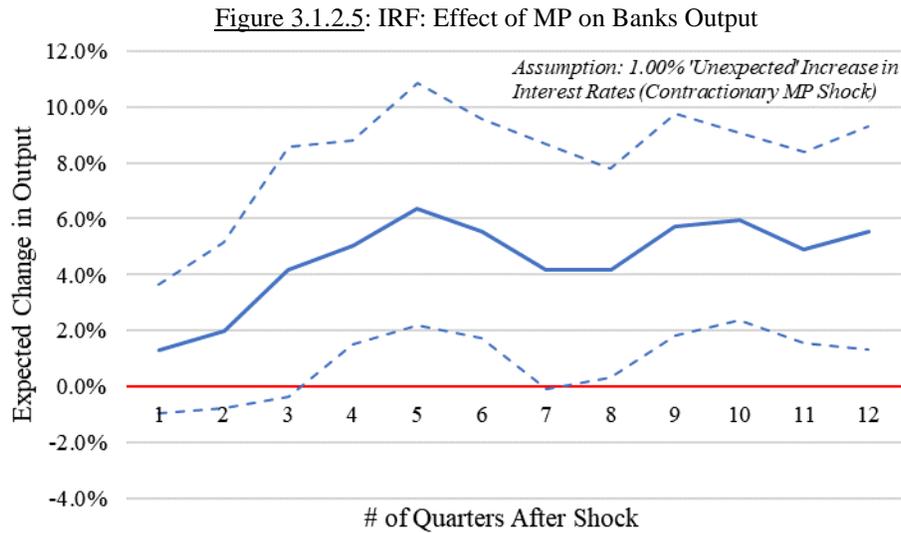
For the real estate sector, one of the most likely reasons behind this large response to monetary policy shocks lies in the business model. When the federal reserve raises interest rates, it also raises the cost of borrowing for new homeowners, and thus, reduces the demand to purchase new homes / real estate (hence resulting in lower revenues for real estate firms). Furthermore, it is an industry characterized as high capital intensity, which adds further exposure to changes in interest rates. Both of these characteristics likely explain the large negative impact that monetary policy shocks appear to have on the real estate sector.

### 3.1.2.4 Healthcare



In Figure 3.1.2.4, I can observe an industry in which there does not seem to be much of an impact of ‘unexpected’ changes in interest rates; the IRF fluctuates between zero and 1% (except for the positive expected effect on quarter 6 after the shock), and the confidence bands are wide and in both positive and negative territory. This suggests there is no clear direction that healthcare output is expected to take following a monetary policy shock, and so, can thus conclude that that healthcare output is expected to remain unaffected following a monetary policy shock. These results can be likely explained by the main source of firm revenue in this industry, namely: Medicare & Medicaid reimbursements. The healthcare sector (in this dataset) is mainly comprised of healthcare services, equipment, and pharmaceuticals, all of which obtain most of their revenues from government reimbursements. These government reimbursements are not conditional or affected by changes in interest rates directly, so it is not expected that revenues in this industry would be largely affected following monetary policy shocks.

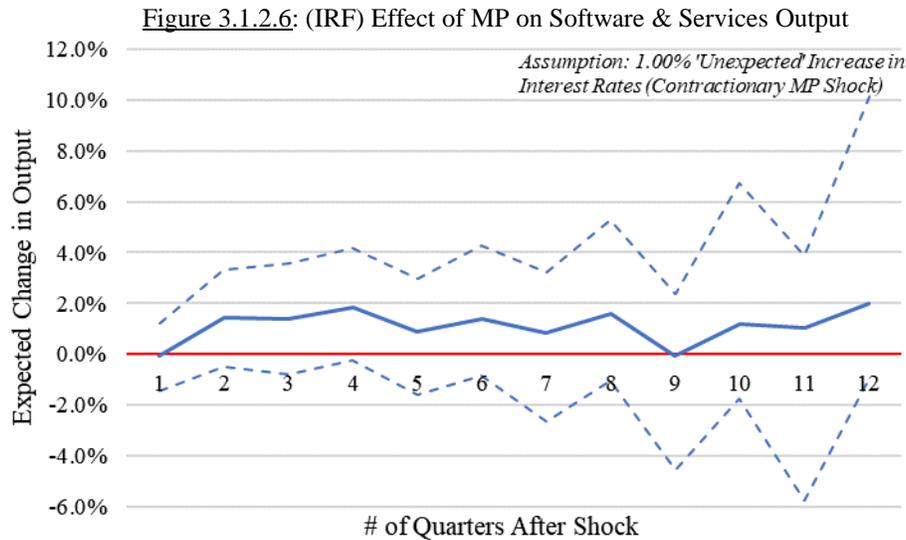
### 3.1.2.5 Banks



The implied effect of a monetary policy shock for the ‘Banks’ sector is in fact positive. Specifically, my analysis suggests that a 1.00% ‘unexpected’ increase in the target federal funds rate is likely to cause a large, positive, and statistically significant effect on Bank output. For example, by quarter 9, I expect an expansion of output by about 6.00%, and I also note that the 95% confidence bands also lie in the positive region. While these results might seem counterintuitive when compared to prior estimates, the upward direction of output following a monetary policy shock aligns with the inherent business models in the banking sector. Banks’ primary revenue stream is lending; whether commercial, mortgage or other types of loans, banking institutions make money off of the spread between the rate at which they borrow from the central bank, and the rate at which they lend to consumers and businesses. If the Federal Reserve raises interest rates, it also raises the spread, and thus, increases overall revenue. Furthermore, with higher interest rates, it also allows banks to make more money from the spread between their deposit payments to consumers, and the yield they obtain by investing in treasury notes. Hence,

the positive relationship indicated in Figure 3.1.2.5 between monetary policy shocks and Bank output is consistent with the sector’s business model.

### 3.1.2.6 Software & Services



Like Healthcare, Figure 3.1.2.6 suggests that output in the Software & Services sector remains somewhat unaffected following a monetary policy shock (both in the short and long-run). The IRF fluctuates around 0, and the confidence bands do not indicate what direction output will take after a monetary policy shock. Though the confidence band is wide, there are some key characteristics of the industry that suggest that monetary policy would not affect output; the software & services sector is understood to have low capital intensity and is largely self-financed. Both factors suggest that the sector is not heavily exposed to interest rate risk, and thus, would explain why output appears to be unaffected in my results after an assumed change in interest rates. Furthermore, Software & Services firms typically experience high growth and are valued at high public multiples. This allows them to tap into equity markets easily and obtain financing, without the need of borrowing from a bank. All these factors suggest that the results from Figure 3.1.2.6 represent the effect of monetary policy on Software & Services output accurately.

*Robustness.* – As for my results for total output, it is of interest to test the robustness of my estimates at the industry level. First, I regress changes in output on my monetary policy shock series, but this time using a regression with 16 lags on the monetary policy shock variable. I find that the results from my implied impulse response functions do not deviate much from the original estimation (and are well within the confidence bands) for all industries in this study. Second, I omit the same ‘extreme’ observations from the monetary policy shock series as before. I find that for those industries that had significant output responses to monetary policy shocks, the magnitude of their respective responses decreases. This said, most alternate estimations fall within their respective confidence bands. For the industries that remain unaffected, I do find a large variation in the estimations<sup>12</sup>. Lastly, although I cannot test for alternate data sources for each of the specific industries presented in this study (given that part of this paper’s innovation was to follow recent literature and use extended industry lists), I can compare my aggregate results for ‘Manufacturing’ with datasets<sup>13</sup> used in existing literature, such as in Dedola & Lippi (2005) and Peersman & Smets (2005). In Figure A.3, I observe how the results obtained using an alternative dataset for manufacturing output (in gold) align well with my IRF estimation, and are also contained within the 95% confidence band. Notice that the IRF for manufacturing is very similar to that of total output when using data from the FRED database. This is expected because, as mentioned, these ‘traditional’ data sources aggregate data primarily from manufacturing companies. From this analysis, I can observe that monetary policy is expected to have a substantial and persistent impact on manufacturing output.

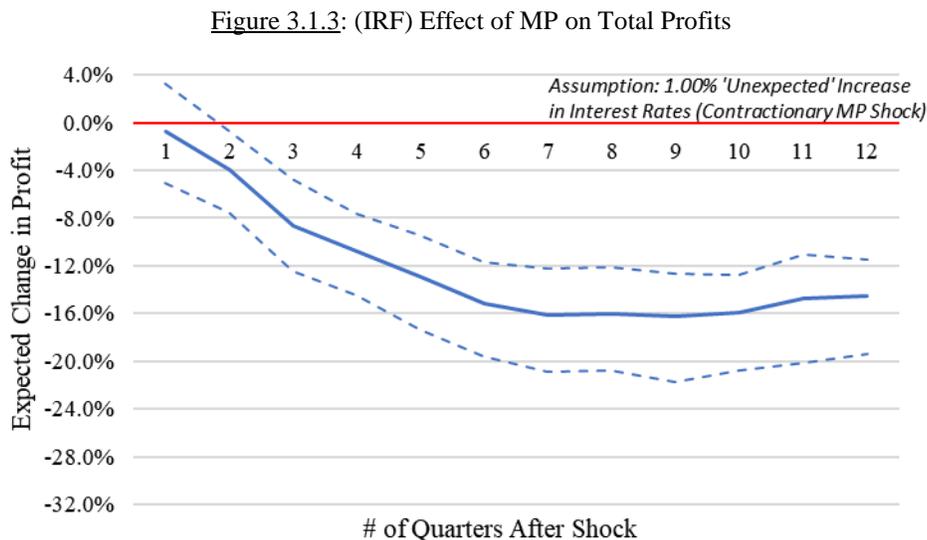
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<sup>12</sup> Note: Due to space constraints, I have not included the visual output for the robustness checks at the industry level for the alternative lag estimation and modified shock series estimation.

<sup>13</sup> FRED Industrial Production: Manufacturing Index

### 3.1.3 Effect on Profit

This paper aims to extend the understanding of industry-specific responses to monetary policy shocks by running my estimation strategy on industry profits rather than output<sup>14</sup>. This way, I can add another dimension to my understanding of the differences in responses to monetary policy shocks by different industries. Table A.2 reports the estimates from this new regression on total profits (aggregated for all sectors). Even though only half of the coefficients on the monetary policy lags are negative, these coefficients are much larger on an absolute basis than the positive coefficients. Furthermore, I also observe that the (negative) coefficients on the second and third lag are statistically significant at the 90<sup>th</sup> and 95<sup>th</sup> level. One thing to note, however, is that the standard errors from this regression are larger than for the output estimation. This is expected since net income is a line item that is historically more variable, or volatile, than revenue. To evaluate the overall impact of monetary policy on total profits, similar to output, it is crucial for me to consider the expected cumulative response of firm profits to a monetary policy shock.



<sup>14</sup> Since my dataset is constructed using firm-level financial data, I am able to obtain Net Income figures and aggregate them by industry to create a proxy for “Profit” for each industry. Note that observations with negative profits were dropped to avoid undefined growth rates in my regression estimations.

Figure 3.1.3 shows the estimated IRF for total profits, reflecting the expected change in total aggregate profits across the economy following a 1.00% ‘unexpected’ increase in the target federal funds rate. It is clear from the graph that there is a strong and persistent (at least 12 quarters) negative relationship between monetary policy shocks and total profits across the economy. For example, by quarter 7, I find that the estimated loss in profits following a monetary policy shocks is about 16.00%.

In comparison to the effect on output, my analysis suggests that monetary policy has a much stronger (negative) impact on firm profits than output across the economy. As for my conclusions on the expected output responses, it is also clear that that monetary policy shocks likely result in permanent firm profit losses. I am confident in the validity of these findings, given that the confidence band lies completely in the negative territory (the upper confidence band falls below – 12.00% levels).

My results, when compared to output, are consistent also with economic intuition. Net income (my proxy for profits) is a line item in the Income Statement below revenue, meaning that revenue, after making adjustments for expenses and other items, flows directly into the net income line. As a result, I expect profits to fall by at least as much as revenues following a contractionary monetary policy shock. Furthermore, firms also have to adjust for interest expenses before recording the final net income figure. After adjusting for interest expenses, I expect an even further decline in profits following a monetary policy shock (due to an increased cost of borrowing). This intuition completely aligns with the results shown in Figure 3.1.3.

At the industry level, I also expect similar results. In Figure A.5, I can observe each industry’s IRF modeling the expected profit response to a simulated 1.00% contractionary monetary policy shock. By comparing these charts to their respective output counterparts, I reach two main

conclusions. First, for the majority of industries, I can confirm my hypothesis, in that industry profits are expected to fall by a greater percentage amount than output, following a contractionary monetary policy shock. Industries such as ‘Materials’, ‘Consumer Durables & Apparel’, and ‘Semiconductors’ all have much larger shocks to (expected) profit than output. For example, after 8 quarters from a hypothetical 1.00% ‘surprise’ increase in the federal funds rate, industry output for ‘Materials’ is expected to fall by about 4.0%, as opposed to the expected 45.0% fall in industry profits. I find that ‘Materials’, ‘Semiconductors’, and ‘Commercial & Professional Services’ are the industries whose profits appear to be the most (negatively) affected. Although there are other line items between revenue and net income, I believe that those industries that are particularly affected also have high interest expenses. This suggests that these industries require heavy short-to-medium term financing, and / or, that these industries are considered ‘risky’ and have unusually high borrowing costs. Similar to my analysis on output responses, it is also useful to evaluate these results in the context of industry characteristics. For example, for the ‘Pharma, Biotech, & Life-Sciences’ sector, one could expect a greater response to monetary policy shocks given that firms in this industry typically require heavy funding for the development of new drugs / medical products. Nonetheless, this industry is known to primarily use equity financing<sup>15</sup>, which in turn implies firms are expected to remain unaffected by changes in interest rates.

This said, my hypothesis is not confirmed by all industry charts. Aside from the sectors that did not originally exhibit statistically significant negative expected output responses to contractionary monetary policy shocks, there are two sectors whose profits do not appear to follow the same trend as their industry estimated output responses. These are the ‘Media’ and the

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<sup>15</sup> Pharmaceutical, biotech and biopharma companies all typically use equity financing to fund the development of new drugs and treatments, mainly because they are valued at high premiums and can obtain large amounts of funding

‘Telecommunications’ industries. This paper primarily attributes this inconsistency to the volatility of firm profits (which can partly be seen by the widespread between my two confidence bands). Industries with high variability in their profits would add a significant amount of noise to the data, which could result in these ‘inconsistencies’ within my results.

*Robustness.* – Similar to my previous robustness checks, I have run alternative approaches for my analysis to test for the validity of my results and conclusions from this section. Firstly, in Figure A.1, I observe that including 16 lags of my monetary policy shock variable in my primary regression for this section, as opposed to 12, does not alter the shape of my IRF curve significantly, which still lies within the original IRF’s confidence bands. The new curve, in fact, shows a deeper expected total profit loss following a monetary policy shock, but also has a much stronger recovery (observe the reversion in the trend after quarter 7). Secondly, I again seek to test the robustness of my results on profit when omitting the same ‘extreme’ observations from the monetary policy shock series. In Figure A.2, I find that omitting ‘extreme’ dates from my monetary policy shock series noticeably reduces the magnitude of the implied profit response to these shocks. This said, I also observe that this new IRF follows the same direction as my original IRF and still reflects a deep impact of monetary policy on firm profits. Both of these checks suggest that my results are valid, and thus, that monetary policy has a sharp negative and persistent effect on total firm profits across the U.S. economy.

## 3.2 Stock Market Response to Monetary Policy Shocks

In this section of my results, I will be analyzing the reaction of the stock market to the announcement of monetary policy shocks. Specifically, I will examine how investor reactions to monetary policy shocks vary across securities belonging to different industries. For the stock market as a whole, I expect that the announcement of a contractionary monetary policy shock will prompt investors to sell proportionately more than they buy, and thus, provoke equity prices to fall on that day. This hypothesis originates in basic economic intuition, as well as results obtained in existing literature on the topic, for example, in Bernanke and Kuttner (2003). In my analysis, I will first compute the specific magnitude of investors' expected reaction to monetary policy shocks (for the stock market as a whole, and for each individual industry). Then, in an effort to explain any heterogeneity in investor responses across different industries, I will evaluate whether investors, in fact, do take into account the expected impact of a monetary policy shock on firm output and profits (using my results from section 3.1), or whether it is simply explained by each industry's expected volatility (or expectation of superior market returns, usually referred to as the *beta* of a security).

First, I will describe the empirical approach used to obtain the results for this section.

### Regression Estimation

Given the 'unexpected' nature of my monetary policy shock series, the changes in stock market prices that I observe on the day of the announcement of these shocks represent an accurate measure of 'investor responses' to an unexpected change in the Federal Funds rate. I can thus proceed to regress daily returns of individual securities (my variable of interest) directly on my original

monetary policy shock series (not aggregated by quarter), for the specific dates when they occurred:

$$(3) \quad r_{i,t} = \alpha_{i,0} + \beta_i S_t + \varepsilon_{i,t}$$

Here,  $r_{i,t}$  is the daily return for the stock price of a company  $i$ , on the day  $t$  when a monetary policy shock, sized  $S_t$ , occurred. As mentioned in the description of this dataset (section 2.3), the set of companies ( $i$ ) used in this analysis includes exclusively companies that were used for the analysis in section 3.1. I have also remained consistent in that I have used equity trading data for the January 1969 – March 2008 period. After running this regression for the complete set of companies, I proceed to run this same regression on an industry-restricted set of companies, for each of the industries considered in this paper. In other words, I aim to uncover the expected stock market reaction to monetary policy shocks for each industry represented in the dataset. The results from this analysis follow in section 3.2.1.

In an effort to explain the variability of investor reactions across different industries, following a monetary policy shock, I run the following regression:

$$(4) \quad r_{i,t} = \hat{\alpha} + \hat{\beta} S_t + \gamma X_{n,t,k} + \hat{\varepsilon}_{i,t}$$

Here, I am running an identical regression to (3), except I have included a variable  $X_{n,t}$ , where  $X_{n,t,k} := X | (S_t, \forall i \in n)$ . This variable represents the ‘expected’ change in output (or profit)  $k$  quarters after a monetary policy shock, given the industry ( $n$ ) that company ( $i$ ) belongs to, and given the actual size of the shock that occurred at time =  $t$ . This ‘expected’ change in output (or profit) is computed using my results from section 3.1, where  $X$  represents the impulse response function value (i.e. the expected cumulative output / profit response)  $k$  quarters after a monetary policy shock of size  $S_t$  occurs. By including this additional regressor, I aim to uncover

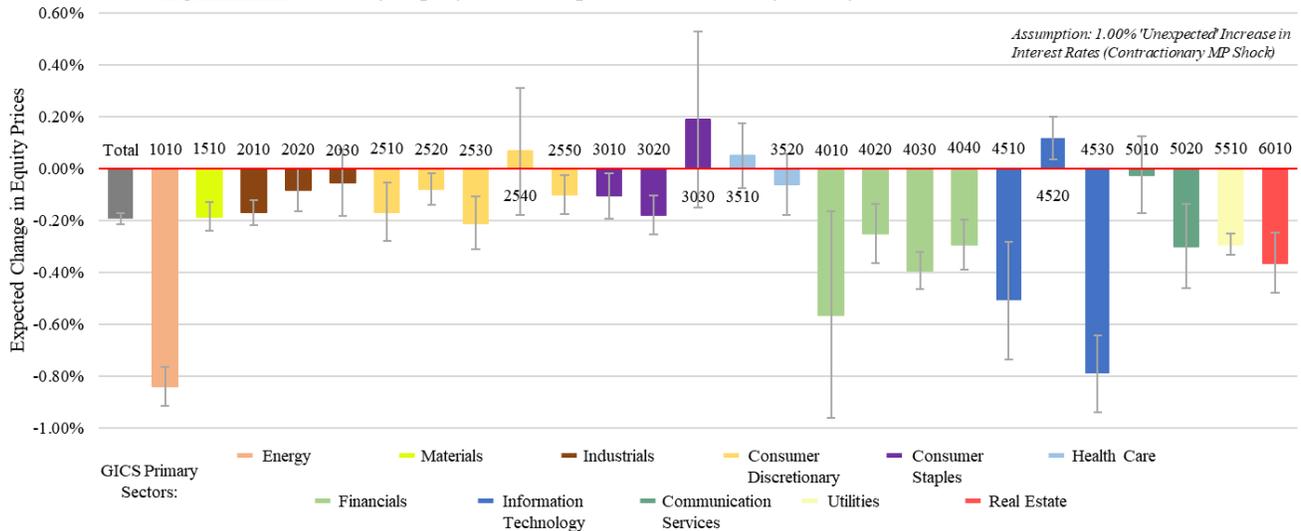
the importance that investors attribute to firms' expected output (and profit) response following a monetary policy shock.

### **3.2.1 Regression (3) of Daily Returns on Monetary Policy Shocks**

The results obtained from regressing daily stock price returns on my monetary policy shock series are in line with my hypothesized results – I find that a contractionary monetary policy shock is expected to result in negative daily returns for the overall stock market on the day of the announcement. Table A.3 includes the results from regression (3) above, using the full dataset of security returns (not restricted to any individual industry). My results suggest that the relationship between changes in monetary policy and changes in stock market prices is negative. Specifically, assuming a linear relationship between the two, I find that a 1.00% ‘unexpected’ increase in interest rates (contractionary monetary policy shock) is expected to result in a 0.19% contraction in the stock market the day of the announcement. I am confident in the validity of this estimate, not just because it is statistically significant, but also because it is aligned with economic intuition. A contractionary monetary policy shock increases the rate of borrowing across the economy, which in turn likely will put downward pressure on output, raise borrowing costs at the firm level, and raise the rate of return that investors expect from investing in the equity market. The opposite is expected to occur when considering expansionary monetary policy shocks.

I proceed by running this same regression (3), on industry-specific daily returns (i.e. where the dataset is restricted by each industry group considered in this paper). The results are documented in Figure 3.2.1:

**Figure 3.2.1: Industry Equity Price Responses to Monetary Policy Shock Announcements**



I find that across most industries, investors in the public equities market tend to sell off more than they buy after the announcement of a contractionary monetary policy shock. Specifically, my results suggest that 22 out of the 26 industries studied in this analysis are expected to suffer from negative stock returns during the day of an announcement of a contractionary monetary policy shock. Out of these 22 industries, 13 have statistically significant negative coefficients. This allows me to conclude, with a high degree of confidence, that there is a negative relationship between monetary policy shock and stock price returns (on the day of the announcement), and that stock prices for different industries will react differently to the announcement of a monetary policy shock. Note that ‘Media’, ‘Household & Personal Products’, ‘Health Care Equipment & Services’, and ‘Technology Hardware & Equipment’ are the only industries with positively-valued estimates for the expected daily stock return following a monetary policy shock. This is not worrisome, however, since these estimates are all statistically insignificant.

It is also important to question the linearity assumption between monetary policy shocks and changes in daily equity prices. In Table A.3, I have also included the results to the regression (3) above, but this time adding the square of the monetary policy variable as an additional regressor. Since the coefficient on the squared term is statistically significant, this suggests that the

relationship between monetary policy shocks and stock market responses may not be completely linear. This is not inconsistent with economic intuition since it is likely that the larger a monetary policy shock occurs, the more uncertainty and volatility will surround the market. As a result, you would expect stock market reactions to grow faster in magnitude than they would otherwise if the relationship was linear. With these results, I highlight the importance of non-linear effects in the relationship between monetary policy shocks and the expected stock market response. Having said this, this paper will proceed with the analysis with the simplifying assumption that the relationship is linear.

In the following section (3.2.2), this paper will evaluate whether the cross-industry heterogeneity that is present in my expected equity price responses, can be explained by the expected effect of monetary policy on firm financials, or whether it is merely a function of industry-specific volatility.

### **3.2.2 Regression (4) of Daily Returns on Monetary Policy Shocks**

As previously mentioned, using regression (4), I evaluate whether investors in the stock market take into consideration the expected effect that monetary policy shocks have on firm-level output and profits across different industries. If investors purely based their investment decisions on the estimates of expected output and profit responses that I obtained in section 3.1, I would expect that the coefficient ( $\gamma$ ) on the regressor  $X_{n,t,k}$  ('expected output / profit response') would capture all of the explanatory power of the monetary policy shock regressor ( $S_t$ ), and so,  $\hat{\beta}$  would drop to 0. In Table 3.2.2, I can observe the results of regression (4), using both, expected output

and expected profit responses to monetary policy shocks (which represent the expected cumulative response for 8 quarters after the shock is said to occur).

Table 3.2.2: Regression of Daily Equity Returns on Monetary Policy Shocks (Controlling for the Expected Change in Output or Profit)

	Daily Equity Returns		
	(1)	(2)	(5)
Monetary Policy Shock ( $S_t$ )	-0.00193*** (0.000206)	-0.00149*** (0.000255)	-0.00231*** (0.000339)
Expected Output Response – Baseline ( $X_{n,t,8}$ )		0.0321*** (0.00729)	
Expected Profit Response – Baseline ( $X_{n,t,8}$ )			-0.00325 (0.00205)
Control on Expected Industry Output / Profit Response	NO	YES	YES
# of Quarters of IRF (k)	N / A	8	8
Corr ( $S_t, X_{n,t,k}$ )	N / A	-0.436	-0.745

*Note* : Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .  $R^2 = 0.0$ ,  $N = 1,327,996$ .  
Sample period is Q1-1969 through Q1-2008.

In the second column, it is crucial to highlight that the coefficients of my two regressors (monetary policy shocks & ‘expected output response’) have opposite signs. The positive coefficient on the ‘expected output response’ variable reflects how companies that have greater expected losses following a monetary policy shock, will also have greater expected declines in the public equity market. The direction of this coefficient clearly follows economic intuition, and since it is also statistically significant, I can thus interpret that investors do take into consideration, to a certain degree, the expected impact that monetary policy can have on output across different industries; and, hence, will proceed to buying / selling stocks in those industries accordingly. These results are corroborated in Table A.4, where I run the same analysis as above, but using 12 lags instead of 8 for the expected output response (coefficient is both positive and statistically significant).

Nevertheless, I also see that the coefficient on the ‘expected profit response’ variable has the same sign as the coefficient on the monetary policy shock variable, even if it is not statistically significant. In addition, in Table A.4, I also notice that the coefficient on the expected profit response variable (using 4 lags for the expected response) is negative and statistically significant. These two results do not align with my previous estimates (using output responses), and also do not follow the economic intuition I outlined in the previous paragraph. There are two explanations that I attribute this inconsistency to. First, by observing the impulse response functions for profits (as opposed to those for output), I can observe that the profit responses to monetary policy shocks are noticeably more delayed – there are many industries for which I expect profit to start falling 4 or 5 quarters after the simulated shock. A few industries even have responses that move in the opposite direction you would expect (for example, ‘Pharma, Biotech, & Lifesciences’ and ‘Banks’). A combination of the two could explain the opposite sign on the coefficient of expected profit responses (for 4 quarters). Secondly, referring to the lack of statistical significance of some of the coefficients of interest (on the expected output / profit response variable), I note that profits are, in general, a lot more variable than revenues. This applies not only for an individual company year-over-year, but also across different companies in an industry. In other words, companies in one same industry will likely be subject to similar trends in output, but I expect that profit margins are very different across firms and subject to different forces. This then would result in increased noise in the data that would prevent me from obtaining statistically significant solutions.

Now, to further evaluate the validity of my expected output (or profit) response variable as a useful regressor, I refer to Figure A.5, where I plot the expected output response against the expected stock price response following the announcement of a monetary policy shock, for each industry in my sample. Here, I can observe that the grand majority of the industries in this analysis

are either in the 1<sup>st</sup> or 3<sup>rd</sup> quadrant, meaning that the two variables have a positive relationship (which aligns with my conclusions above). On the right, I can observe a similar relationship for profits, aside from a greater spread, even though I originally did not have statistically significant coefficients on the ‘expected profit response’ regressor.

*Robustness.* – In an effort to validate my results from this section, I have re-run my analysis to test whether outliers influenced the estimates and conclusions I have obtained. Specifically, I have chosen to re-run this analysis on a restricted dataset, where entries with  $|daily\ returns| > 15.0\%$  have been omitted<sup>16</sup>. In Table A.5, I can find the estimates of the regression of daily returns on my monetary policy shock variable, and on my expected output and expected profit response variables. When comparing these estimates with those obtained in section 3.22, I observe that even though the estimates in Table A.5 are smaller in magnitude, the same conclusions can be made; the sign and statistical significance of each coefficient remain unchanged.

Before I can conclude with certainty that the industry heterogeneity of equity price responses can be explained, at least in part, by the expected effect of monetary policy on financials, I have to test whether it can be explained by industry-specific volatility. In other words, I seek to analyze whether the estimated equity price responses I observe for each industry are proportional to each industry’s market ‘beta’. For this analysis, this paper will employ the approach introduced in Bernanke & Kuttner (2004). They approach this question by regressing industry ‘excess returns’ ( $y_{i,t}$ ) on the general market excess returns ( $y_{M,t}$ ):

$$(5) \quad y_{i,t} = \alpha + \beta_i y_{M,t} + v_t$$

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<sup>16</sup> Reasoning behind this approach is included in section 2.3.

Here, the  $\beta_i$  are exactly the ‘betas’ for each industry ( $i$ ), a measure of how ‘volatile’ industry returns can be, in comparison to the general stock market volatility (equivalent to  $\beta = 1.00$ , and where anything above that represents greater-than-market volatility). For this paper, I have run this regression for the entire time period considered Q1-1969 – Q1-2008 and obtained estimates for the ‘beta’ of each industry in my analysis.

Using these estimates, again, similar to the approach in Bernanke & Kuttner (2004), I can calculate the expected industry equity price response to a monetary policy shock implied by the relative equity price volatility of each industry (i.e. the ‘beta’). In section 3.2.1, I estimated the expected equity price response following a monetary policy shock for the market as a whole. I can then multiply this estimate (the ‘expected market equity response to a monetary policy shock’, say a 1.00% ‘unexpected’ increase in interest rates) by each of the industry betas to obtain an ‘implied’ equity price response to that same monetary policy shock, by industry. Figure A.8 plots this ‘implied’ equity price response, with the actual estimate for the equity price response for each industry. The red dotted line in the graph represents the 45-degree line that the points would lie on if it were the case that all of the industry heterogeneity in equity price responses was explained by their respective volatility or ‘beta’. Although the points lightly follow the path of this line, it is definitely not sufficient to state that the variation I find across industries in equity price responses is solely explained by their respective market volatility.

My findings in this section suggest that there is a significant amount of cross-industry variation when analyzing equity price responses to monetary policy shock announcements. I have also observed how investors most likely take into account the expected effect of monetary policy shocks on output and profits and do not simply react based on industry volatility.

### 3.3 Implications for Company Valuation

For this last section, I wish to take my analysis one step further and test the relationship between my estimates from section 3.1 and companies' intrinsic valuation. I do have to premise this analysis by stating that given the limitations of my dataset, I will make many simplifying assumptions. My end goal is to compute implied changes in valuation based on expected changes to firm-level output and profits and then regress daily returns on the implied valuation changes to discover to what degree changes in market prices reflect intrinsic prices. Below, I have broken down my assumptions, empirical approach, and the regression I will run to test this relationship.

#### Regression Estimation & Empirical Approach

In existing literature on firm valuation, the intrinsic value of a company is traditionally estimated using the Dividend Discount Model, or more commonly used in practice, the Discounted Cash Flow Analysis, whereby the intrinsic value (i.e. 'price') of the company is assumed to equal the sum of a company's future projected cash flows. To avoid calculating the infinite series, I can compute the following:

$$(6) \quad P = \sum_{k=1}^{\infty} \frac{CF_k}{(1+r)^k} = \sum_{k=1}^n \frac{CF_k}{(1+r)^k} + \frac{CF_n \times (1+g)}{r-g}$$

Where the intrinsic value of the company ( $P$ ), is equal to the sum of its discounted future cash flows until year  $n$ , and of its 'terminal value', where  $g$  is the terminal growth rate, or perpetuity growth rate, and  $r$  is the discount rate used. In this same equation,  $CF_k$  refers to the company's unlevered free cash flow on year  $k$ .

I am now going to outline some of the key assumptions I will make to estimate the value of P:

1. For the data sample used in this analysis, the data required to compute unlevered free cash flows was not fully available. Note that there are multiple inputs that go into the calculation of free cash flow (such as capital expenditures, interest expense, and net change in working capital). These financial items were not available as often as revenue and net income. Ideally, I could have computed the analysis of section 3.1 on unlevered free cash flows, alongside revenue and net income. However, not only is there not enough data, but the free cash flow amounts themselves are very volatile. This adds a lot of noise to the analysis, which prevents me from getting direct estimates that I can then use for valuation purposes. Instead, I have chosen to use revenue and net income as proxies for this FCF measure (I denote these by  $y_k$ , instead of  $CF_k$ ). I am aware that calculating valuations using these two measures as proxies is not completely accurate when computing the intrinsic value of a company, but it nonetheless allows me to observe the general direction in which valuation is expected to move given a monetary policy shock.
2. For each industry, I assume that the company under consideration is in a steady state with regards to output & profit (so  $y_k = \bar{y}, \forall k$ ), which then implies that the value of  $g$  is zero, and thus, the terminal value is equal to  $\frac{\bar{y}}{r}$ , where  $r$  is the discount rate. It is clear that most companies will not be in a steady state, however, this assumption allows me to discover the effect that a monetary policy shock has on a company's valuation that is in steady state, for each industry. Since I will use the same approach for all industries, the implied changes in valuation expected following a monetary policy shock will be helpful to compare and evaluate whether they explain the industry heterogeneity that I observed in equity price responses (in section 3.2). In addition, I am also assuming that the terminal value amount,

$\frac{\bar{y}}{r}$ , will be unaffected by changes in monetary policy (thus, limiting how much of a ‘permanent’ effect monetary policy has on expected output and profit responses). This last assumption allows me to be more conservative with my approach towards computing valuation, since I have less certainty about the impact of monetary policy on output and profits, on quarters 13 onwards after a shock occurs.

3. For the discount rate,  $r$ , I will use the formula described by the Capital Asset Pricing Model (CAPM). Specifically, I assume that the discount rate is equal to the cost of equity, computed as:  $r = r_{rf} + \beta_i(ERP)$ , where  $r_{rf}$  is the risk-free rate (which I assume to be the yield on a 1-Year Treasury Bill, for each of the days in the time period considered<sup>17</sup>),  $\beta_i$  are the industry ‘betas’ I constructed in section 3.2.2, and  $ERP$  refers to the ‘equity risk premium’. This ERP measure calculates the additional (annual) return that investors expect to receive by investing in the stock market, as opposed to a safe investment in government bonds (say in a treasury bill for example)<sup>18</sup>. To be completely accurate with the construction of the discount rate, for revenue, I would need to use the weighted average cost of capital, whereby I also include the cost of debt for a given industry, relative to the amount of debt in the capital structure. Since net income is a line item that is ‘levered’ (where interest expenses have already been paid), it is acceptable to use the cost of equity as my discount rate. However, since capital structure data is not widely available for my set of companies for the time period considered, I have chosen to use the cost of equity as a discount rate for both approaches (when using output and profits).

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<sup>17</sup> Used the 1-Year Treasury Constant Maturity Rate series in the Federal Reserve Bank of St. Louis datasets.

<sup>18</sup> For this analysis, I have used a base  $ERP = 5.00\%$ , which is within the historical range of U.S. equity risk premia in Damodaran (2012), and in Arnott and Bernstein (2002). In my analysis, I compute ERP as my base ERP plus the size of monetary policy shock at time  $t$ . For example, for a contractionary monetary policy shock of 25 basis points, the ERP I would use for the computation of the discount rate would be 5.25%.

Now that I have clarified the main assumptions for my analysis, I first outline the calculations required to obtain my measure of ‘implied’ change in valuation, after a monetary policy shock is said to occur. Note that I am using quarterly figures and have set the projection period to 12 quarters (quarters for which I have calculated the expected output and profit responses to monetary policy shocks).

$$P_{old} = \sum_{k=1}^{12} \frac{\bar{y}}{(1+r)^{\frac{k}{4}}} + \frac{\bar{y}}{r}$$

$$P_{new} = \sum_{k=1}^{12} \frac{\bar{y} + \Delta y_k}{(1+r)^{\frac{k}{4}}} + \frac{\bar{y}}{r} = \sum_{k=1}^{12} \frac{\bar{y}}{(1+r)^{\frac{k}{4}}} + \frac{\bar{y}}{r} + \sum_{k=1}^{12} \frac{\Delta y_k}{(1+r)^{\frac{k}{4}}} = P_{old} + \sum_{k=1}^{12} \frac{\Delta y_k}{(1+r)^{\frac{k}{4}}}$$

$$(7) \Rightarrow \% \Delta P = \frac{P_{new} - P_{old}}{P_{old}} = \frac{1}{P_{old}} \cdot \sum_{k=1}^{12} \frac{\Delta y_k}{(1+r)^{\frac{k}{4}}}$$

The percentage change in price measure constructed above gives me an indication of what I can expect the percentage change in the stock price to be, given that I know what happens to output exactly at each quarter (for  $k = 1, \dots, 12$ ). In this section, I will refer to this as the implied change in valuation.

From my analysis in section 3.1, I can use my estimates from my impulse response function for each industry to compute the expected changes in  $\Delta y_k$ , for each quarter  $k$ , and then estimate the implied percentage change in the intrinsic value of the company, given that a monetary policy shock occurred. I thus generate a series of the implied changes in valuation for each company in my dataset, for all of the dates when a monetary policy shock was announced. In Table 3.3.1, I proceed to regress these implied changes in valuation on my monetary policy shock series.

Table 3.3.1: Regression of (Implied) Changes in Intrinsic Valuation on Monetary Policy Shocks

	Intrinsic Valuation Using Expected Output Response ( $\Delta y_k$ )	Intrinsic Valuation Using Expected Profit Response ( $\Delta y_k$ )
Monetary Policy Shock ( $S_t$ )	-0.00288*** (1.83e-05)	-0.0141 *** (7.49e-05)
Constant	-7.17e-06*** (1.00e-06)	-7.04e-05*** (4.02e-06)
$R^2$	0.387	0.481

Note: Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ . N = 1,327,996.

I observe that both of the coefficients on the monetary policy shock variable are negative and statistically significant. This is not surprising, given that the implied changes in valuation were constructed using my output and profit response estimates from section 3.1, which in turn, have a negative relationship with my monetary policy shock variable. Since the response estimates from section 3.1 were much larger for profit than those for output, it makes sense that the coefficient on the monetary policy shock variable is larger when valuation is constructed using profit response estimates.

In Figure A.9, I can observe the size of expected implied valuation changes, on an industry-specific basis, following a monetary policy shock. In other words, the size of the bars represents the coefficient on the monetary policy shock variable from the regression run in Table 3.3.1, but restricting my dataset by industry. From the chart, it is clear that monetary policy is expected to affect industry valuations differently. Certain industries, such as ‘Materials’, ‘Transportation’ and ‘Semiconductors’, are expected to suffer from the largest drops in valuation, following a contractionary monetary policy shock. On the other hand, industries such as: ‘Media & Entertainment’ and ‘Pharma, Biotech & Life Sciences’ are not expected to suffer from any significant changes in valuation.

As observed, there are clear differences in the way that valuations for different industries are expected to change following a monetary policy shock. I now proceed to test whether the cross-industry variation in equity price responses to monetary policy shock announcements (in section 3.2) can be explained by the implied changes in the intrinsic valuation of each respective company. To do so, I use the series of implied changes in valuation that I constructed earlier in this section, and run the following regression:

$$(8) \quad r_{i,t} = \tilde{\alpha} + \varphi \cdot [\% \Delta P_{i,t}] + \tilde{\varepsilon}_{i,t}$$

Here,  $r_{i,t}$  is the daily return for company  $i$ , and at time  $t$ .  $\% \Delta P_{i,t}$  refers to the implied percentage change in the intrinsic valuation of company  $i$ , following the monetary policy shock that occurred at time  $t$ . The results of this regression are in Table 3.3.2 below, where changes in intrinsic valuation are computed using both my estimates on output responses and profit responses following a monetary policy shock.

Table 3.3.2: Regression of Daily Equity Returns on Implied Changes in Intrinsic Valuation

	Daily Equity Returns	
	(1)	(2)
Change in Intrinsic Valuation	0.440***	
Computed Using Expected Output Response ( $\Delta y_k$ )	(0.0455)	
Change in Intrinsic Valuation		0.0276**
Computed Using Expected Profit Response ( $\Delta y_k$ )		(0.0108)
Constant	0.00107***	0.00105***
	(6.38e-05)	(6.37e-05)

Note: Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .  $R^2 = 0.0$ ,  $N = 1,327,996$ .

I first notice that both coefficients on the ‘Intrinsic Valuation Change’ variable are positive and statistically significant. The direction of these two coefficients is consistent with economic intuition since you expect that a change of the intrinsic value of the company would move the stock price in the same direction.

The coefficient for the first regression results (1), constructed using expected output responses, is 0.44, which suggests that for every 1.00% change in the intrinsic valuation of the company as a result of a monetary policy shock, the market is expected to move 0.44% in the same direction the day the shock is announced. Though one could argue that the market is ‘underplaying’ the impact that monetary policy shocks have on firm valuation, I do not believe this claim is true, given the assumptions I have made and the differences in my approach with how corporate valuation is typically computed. It is still nonetheless a useful analysis to reflect the importance of changes in intrinsic valuation for the equity price responses across different industries.

For the second regression results (2), the coefficient on the expected change in intrinsic valuation (computed using expected profit responses), is 0.0276. This is a much smaller coefficient than that on output, which suggests that the market is only reacting by a small fraction of the implied change in valuation, calculated using my profit response estimates. Though it can be argued that net income (i.e. profit) is a better proxy for free cash flows than revenue, the key takeaway from this section is that implied changes in the intrinsic value of a company (computed using the expected changes in either firm output, or profit) have a positive and statistically significant relationship with market equity price responses. In other words, the implied changes in the intrinsic value of a company resulting from a monetary policy shock, are, to a certain degree, expected to be realized in the equity markets the day of the announcement of the shock.

I believe that the true estimate for the coefficient on the change in intrinsic valuation, in regression (8), lies in between, or above, the two coefficients provided in Table 3.3.2 (where intrinsic valuation was computed using my estimates for output and profit responses from section 3.1). This would then suggest that my estimates are overestimating the expected change in companies’ intrinsic valuations, as a result of monetary policy shocks. I state this because cash

flow metrics that are typically used for valuation, account for certain cash outflows, such as capital expenditures and the funding of ‘working capital’ (current assets – current liabilities), which are not accounted for in firm revenues and net income. I suspect that these metrics would be negatively affected by contractionary monetary policy shocks, meaning I expect lower capital expenditures and funding of working capital, whenever there is a ‘surprise’ increase in the federal funds rate (and thus, higher cost of borrowing). Thus, the ‘true’ estimate for the coefficient on the change in intrinsic valuation (computed using changes in expected future cash flows) is expected to be larger than the ones reported in Table 3.2.2. This larger estimate would help shrink the spread between the implied change in the intrinsic value of a company, and the equity market response, following a monetary policy shock.

Lastly, it is crucial to realize that my data series of implied changes in intrinsic valuation was computed as a function of a company’s industry (since I use industry-specific estimates of expected output / profit responses, as well as my industry betas from section 3.2). Given my conclusions about the relevance of my change in intrinsic valuation variable, I can thus conclude that part of the cross-industry heterogeneity in equity price responses can be explained by the differences in intrinsic valuation changes across different industries.

*Robustness.* – To validate my findings from this section, and specifically of my estimates in Table 3.2.2, I have run four alternative versions of my valuation analysis. The results from these four robustness checks can be found in Table A.5.

First, similar to section 3.2, I have re-run the analysis on a restricted dataset that excludes outliers (data entries with  $|daily\ returns| > 15.0\%$ ). The estimates of this first analysis can be found in the regression results (1) and (6). Secondly, in order to test whether my assumptions on the equity risk premium have a material impact on my results, I have set the ‘base ERP’ value to

4.0% and 6.0% (originally 5.0%); recall that the final ERP number used for the valuation computation also included the size of the monetary policy shock at time = t. The estimates of this second analysis can be found in the regression results (2) & (7) for the base ERP = 4.0% and (3) & (8) for the base ERP = 6.0%. Third, I have also reduced the projection period to 8 quarter forward (originally 12), to see how much of an impact this has on my results. The estimates are stored in the regression results (4) & (9). Lastly, I also wanted to challenge the assumption that there is no impact of monetary policy on the terminal value of a company, by instead assuming that the level of output or profit on quarter 12 after the shock is the amount used for the terminal value. In terms of the formula, the terminal value from the original equation,  $\frac{\bar{y}}{r}$ , now becomes  $\frac{\bar{y} + \Delta y_{12}}{r}$ . Given this, the analysis I run now assumes that monetary policy is expected to have a permanent effect on companies' future output and profits, and the estimates I have obtained are stored in the regression results (5) & (10), again, in Table A.5.

I can observe that for all of my alternative approaches except, the coefficients on my intrinsic valuation change variable remain positive and statistically significant. The one exception is the analysis that uses an 8-quarter projection period and calculates intrinsic valuation using my estimated profit responses. In this case, the coefficient on the intrinsic valuation change variable is not statistically significant. Furthermore, it is also worth noting that most of these approaches lower the magnitude of my coefficient of interest. For example, when looking at the analysis that assumes a permanent effect of monetary policy on output and profit, I observe that my coefficient of interest becomes significantly smaller than my original estimate. This result makes sense since a permanent effect on output & profits will result in a larger impact on the final valuation. Equity price responses would thus represent a smaller fraction of the implied changes in valuation (and

hence, a smaller coefficient). Nevertheless, these robustness checks preserve the overall direction of my results and help validate the conclusions that I have obtained in this section.

## **4 Conclusion**

Using a robust and exogenous measure of monetary policy shocks, I analyze the effect of monetary policy on the financials, equity prices, and valuations across different industries. I show that even though most industries respond to monetary policy shocks in the same general direction, the magnitude of the response varies significantly by industry.

I firstly observed how output for most industries is expected to fall following a contractionary monetary policy shock. Specifically, for a ‘surprise’ 1.00% increase in the federal funds rate, I expect economic output to fall by 1.6%, 8 quarters after the shock occurs, and by 3.1%, 12 quarters after the shock. This effect is magnified when I re-ran my analysis on firm profits, where I expect overall profits in the economy to fall by 16.0% and 14.5%, 8 and 12 quarters, respectively, after the shock occurs. This intensified effect is likely attributed to the interest rate channel through which monetary policy can affect company operations.

I then analyzed the relationship between monetary policy and equity prices. I observed that the announcement of a contractionary monetary policy shock of size 1.00% is expected to result in a 0.19% decline in the stock market that same day. I also noted how the expected response in equity prices to the announcement of monetary policy shocks varies significantly by industry. This variation can be partially explained by my results on the expected impact of monetary policy on firm output and profits. After testing the validity of this result by computing the change in intrinsic valuation for each industry following a monetary policy shock, I find that the cross-industry

variation in equity price responses to monetary policy shocks can be at least partially explained by the expected impact of monetary policy on firm-level output and profits.

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## Appendix

**Table A.1: GICS Industry Codes List**

Sector		Industry Group	
Index	Description	Index	Description
10	Energy	1010	Energy
15	Materials	1510	Materials
20	Industrials	2010	Capital Goods
		2020	Commercial & Professional Services
		2030	Transportation
25	Consumer Discretionary	2510	Automobiles & Components
		2520	Consumer Durables & Apparel
		2530	Consumer Services
		2540	Media
		2550	Retailing
30	Consumer Staples	3010	Food & Staples Retailing
		3020	Food, Beverage & Tobacco
		3030	Household & Personal Products
35	Health Care	3510	Health Care Equipment & Services
		3520	Pharmaceuticals, Biotechnology & Life Sciences
40	Financials	4010	Banks
		4020	Diversified Financials
40	Financials	4030	Insurance
45	Information Technology	4510	Software & Services
		4520	Technology Hardware & Equipment
		4530	Semiconductors & Semiconductor Equipment
50	Telecommunication Services	5010	Telecommunication Services
		5020	Media & Entertainment
55	Utilities	5510	Utilities
60	Real Estate	6010	Real Estate

Note: Sectors 20 - 35 are classified under 'Manufacturing'

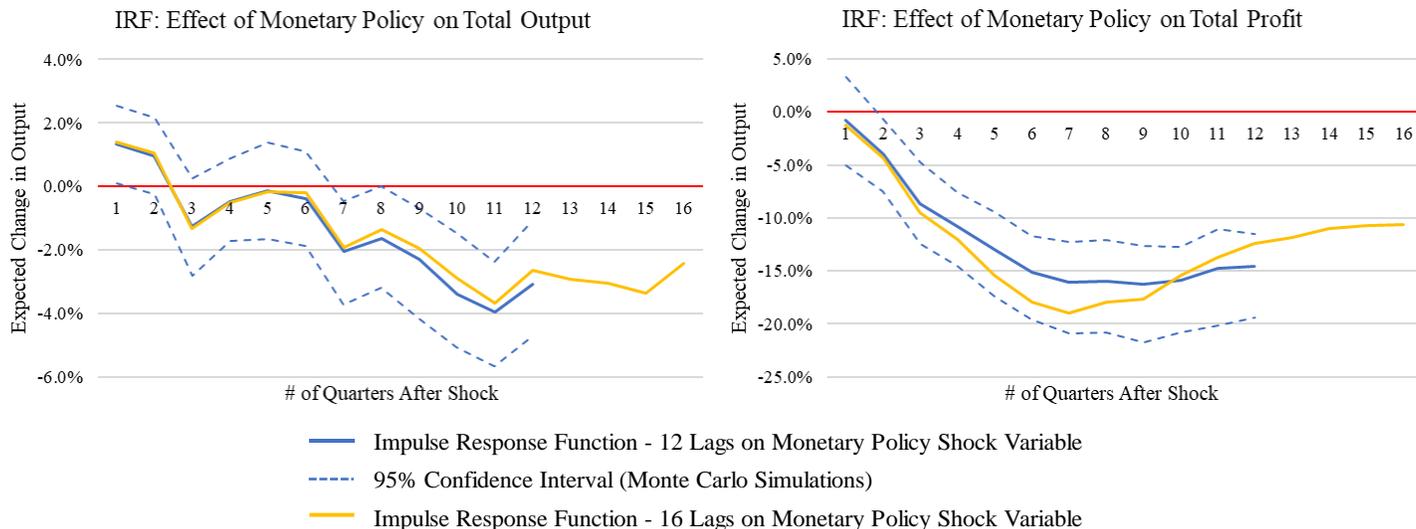
**Table A.2: OLS Regression: Effect of Monetary Policy Shocks on Total Profit**

Monetary Policy Shock Variable	Change in Log Profit	
	Coefficient	Standard Error
Lag #1: $S_{t-1}$	-0.00741	0.0251
Lag #2: $S_{t-2}$	-0.0313	0.0204
Lag #2: $S_{t-3}$	-0.0418**	0.0205
Lag #4: $S_{t-4}$	-0.00851	0.0159
Lag #5: $S_{t-5}$	-0.00483	0.0157
Lag #6: $S_{t-6}$	-0.00484	0.0152
Lag #7: $S_{t-7}$	0.0111	0.0178
Lag #8: $S_{t-8}$	0.00807	0.0190
Lag #9: $S_{t-9}$	0.00152	0.0177
Lag #10: $S_{t-10}$	0.00742	0.0138
Lag #11: $S_{t-11}$	0.0107	0.0173
Lag #12: $S_{t-12}$	-0.00328	0.0135

Notes: Robust standard errors, with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.  $R^2 = 0.853$ ,  $N = 145$ . Sample period is Q1-1969 through Q1-2008. Coefficients and SEs for dummies and lags on  $\ln(\text{profit})$  are not reported.

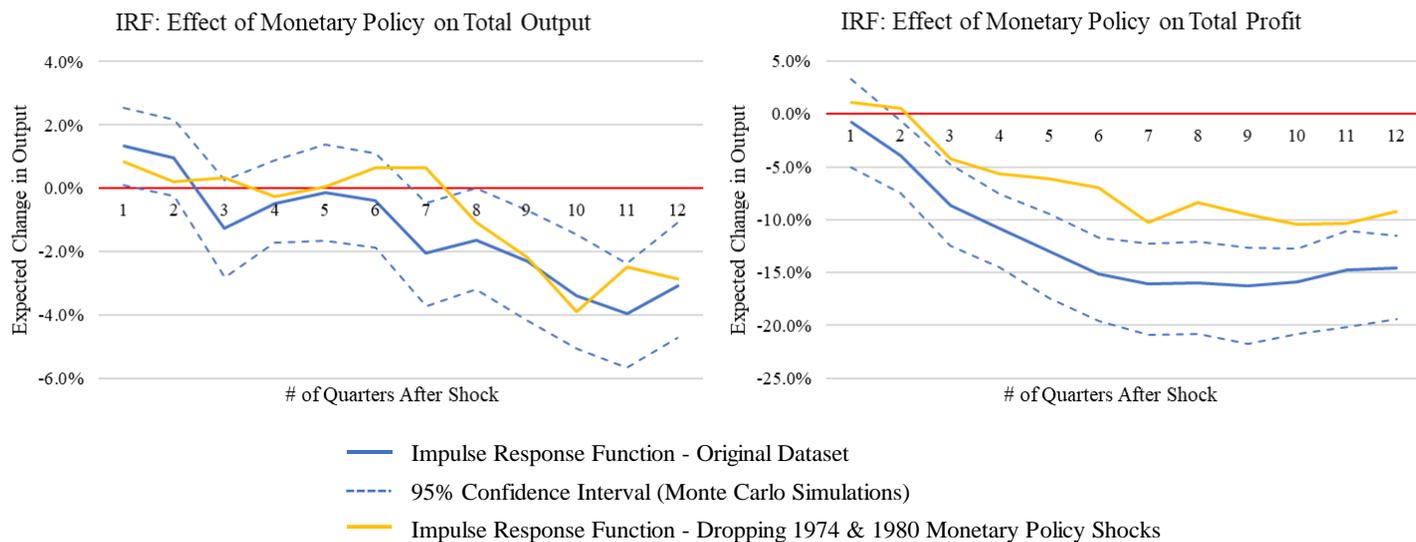
**Figure A.1: Robustness Check – 12 v. 16 Lags of the Monetary Policy Shock Regressor**

Note: Assuming a 1.00% ‘Unexpected’ Increase in Interest Rates – Contractionary Monetary Policy



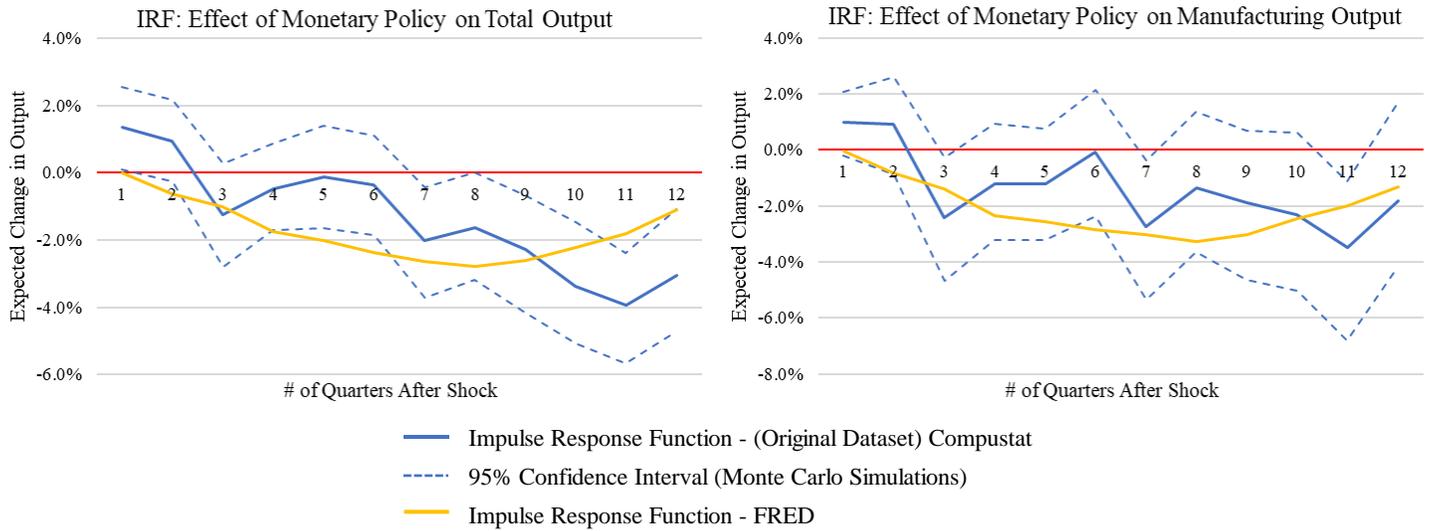
**Figure A.2: Robustness Check – Dropping Largest Monetary Policy Shock Observations (1974 & 1980)**

Note: Assuming a 1.00% ‘Unexpected’ Increase in Interest Rates – Contractionary Monetary Policy Shock

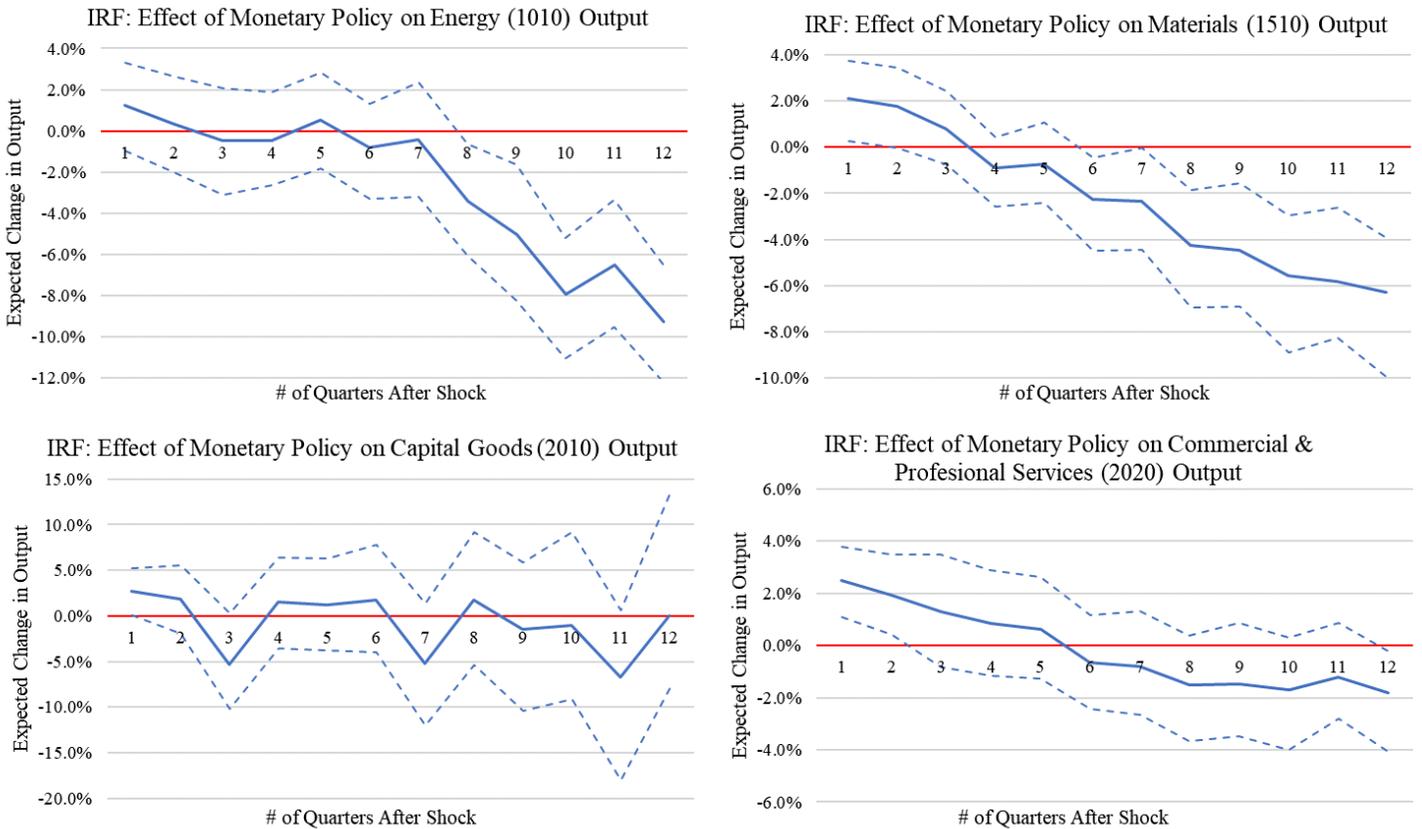


**Figure A.3: Robustness Check – Dataset Comparison: Compustat (Original) vs. FRED (Federal Reserve Economic Data)**

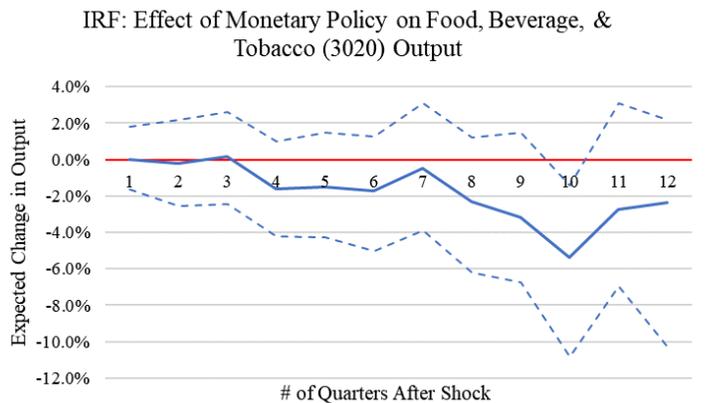
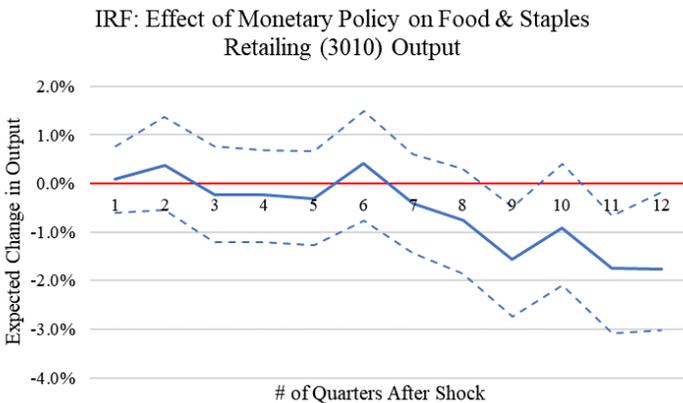
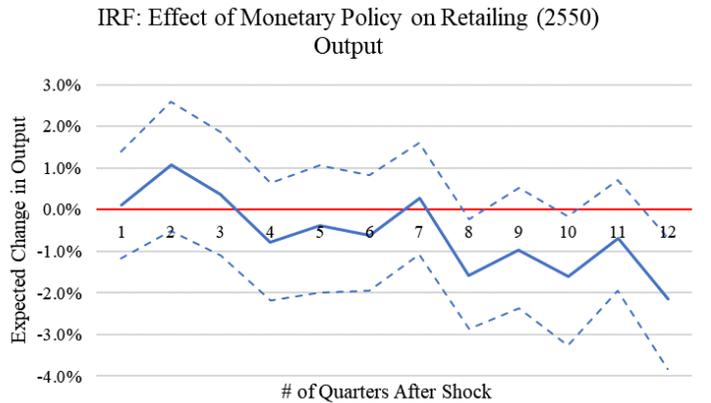
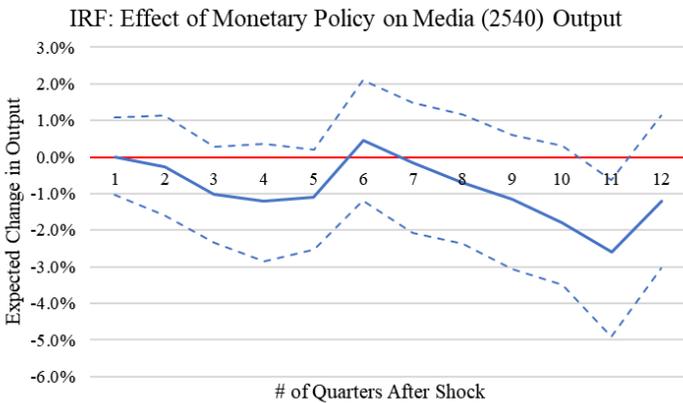
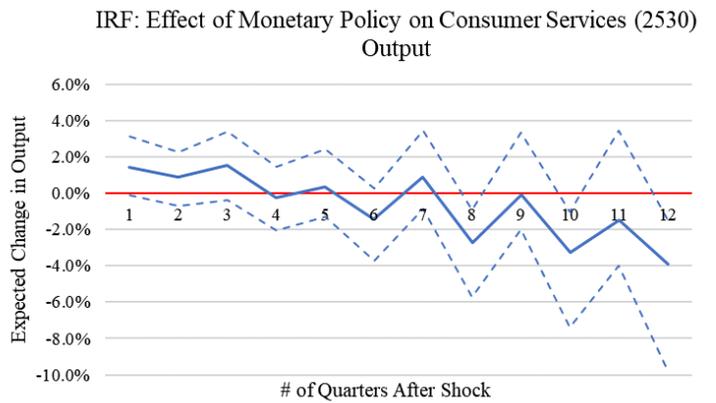
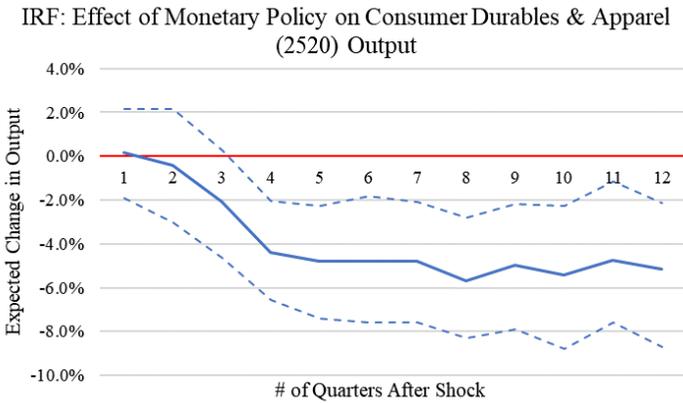
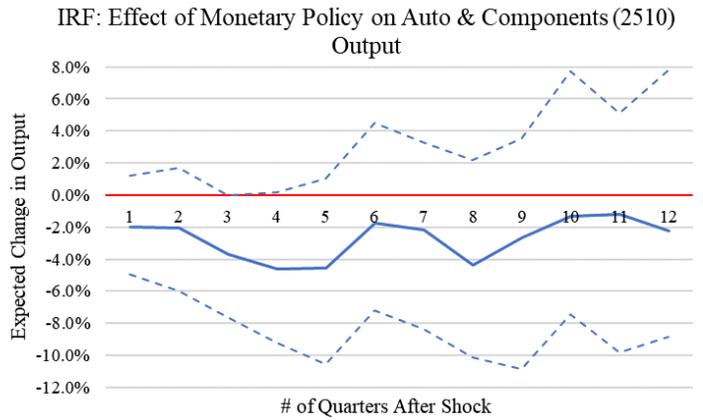
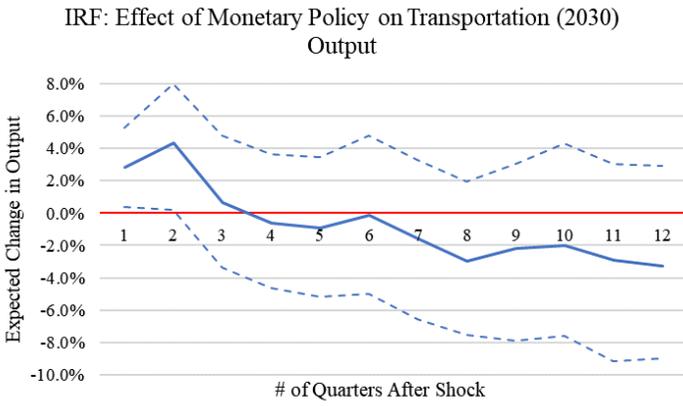
Note: Assuming a 1.00% ‘Unexpected’ Increase in Interest Rates – Contractionary Monetary Policy Shock



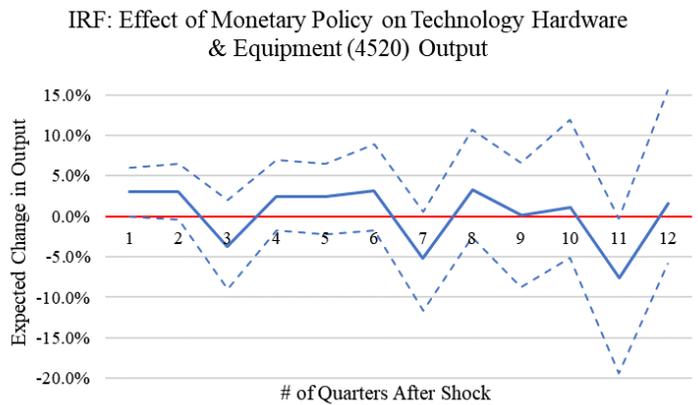
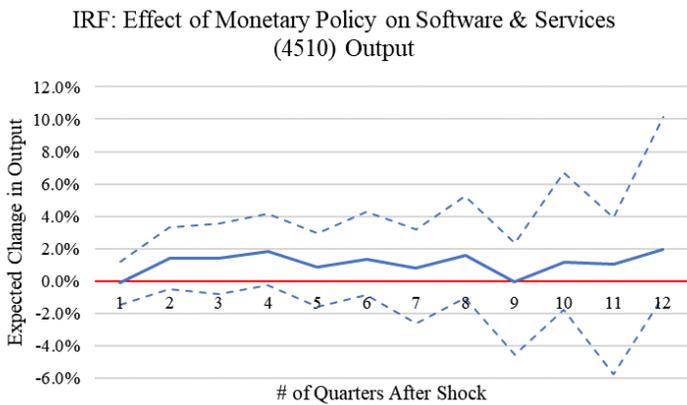
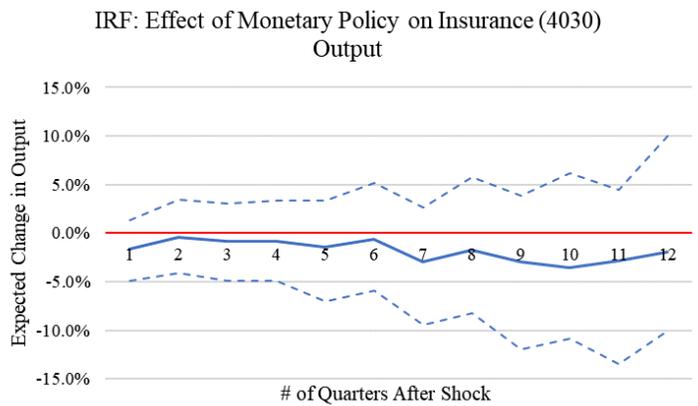
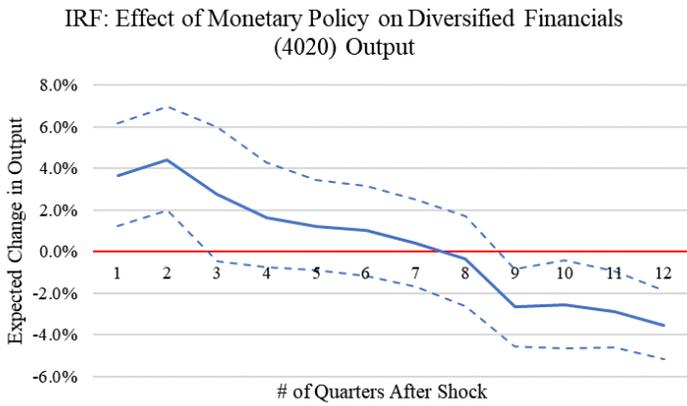
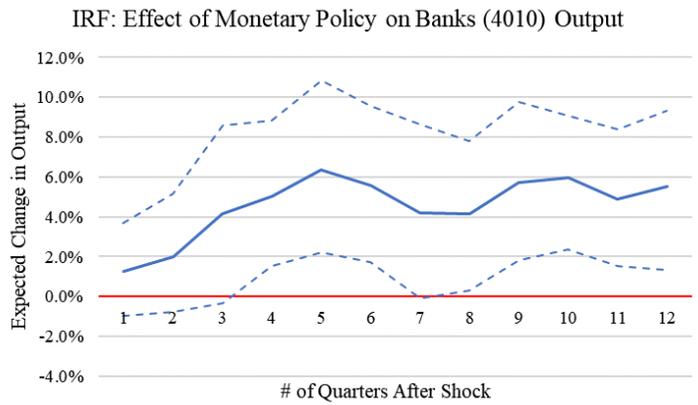
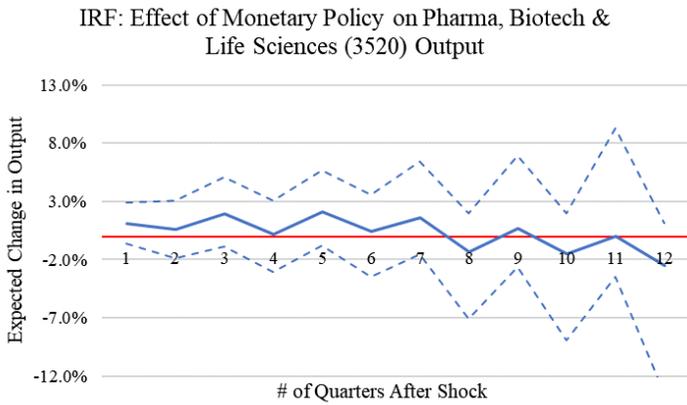
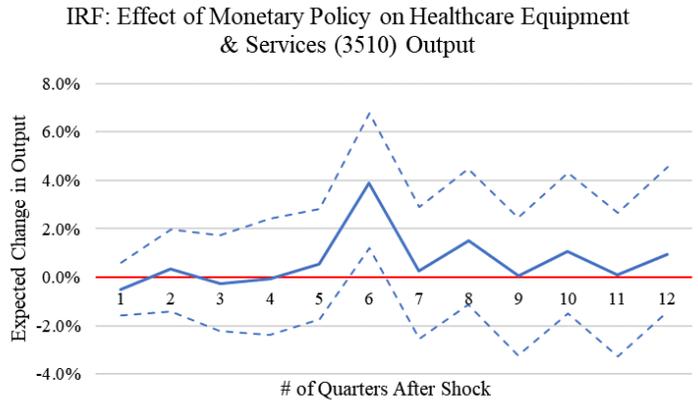
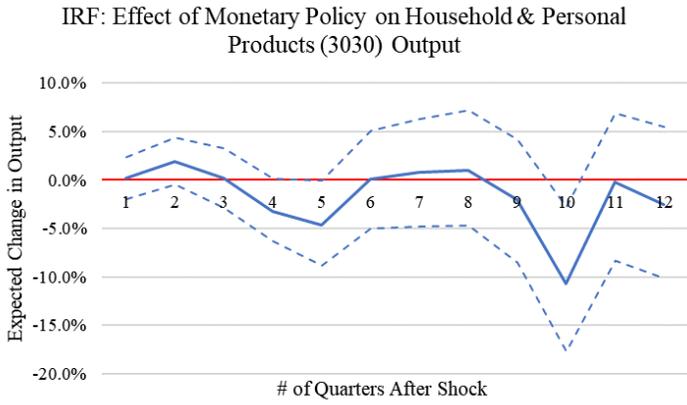
**Figure A.4: Impulse Response Functions – Effect of Monetary Policy on Output by Industry.** Note: Assuming a 1.00% ‘Unexpected’ Increase in Interest Rates – Contractionary Monetary Policy Shock, Dotted Lines Represent 95% Confidence Interval



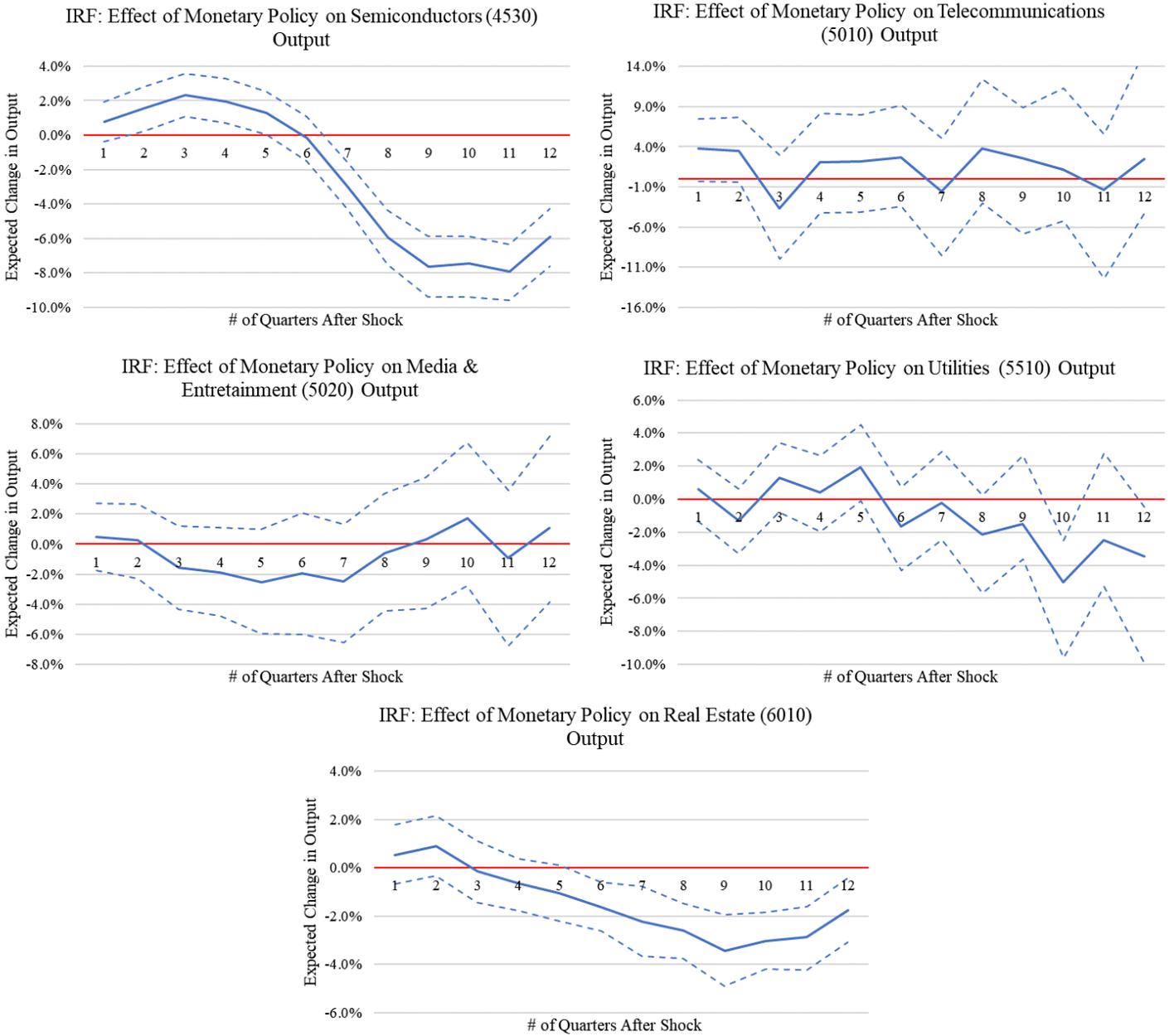
**Figure A.4: (Continuation)**



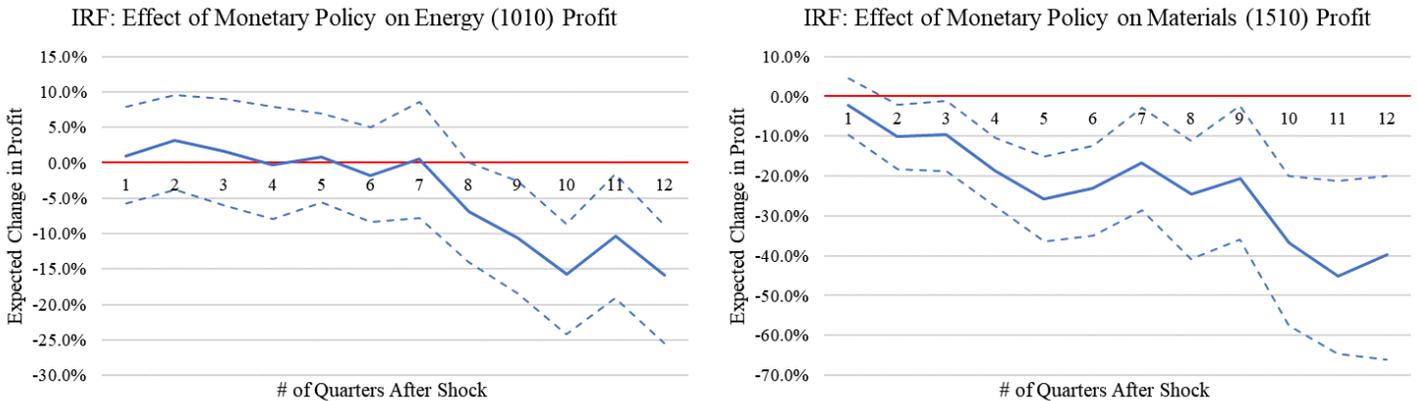
**Figure A.4: (Continuation)**



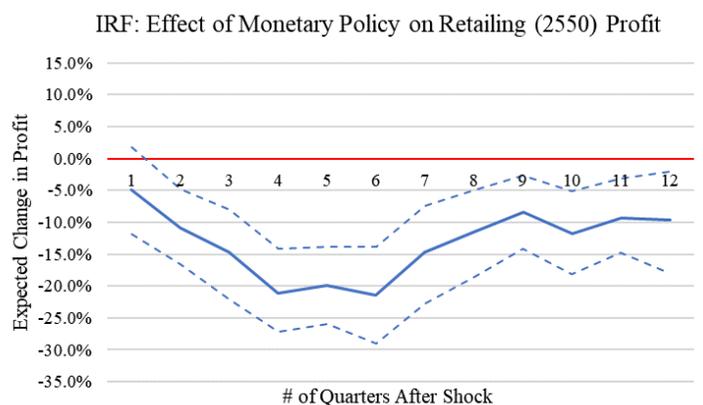
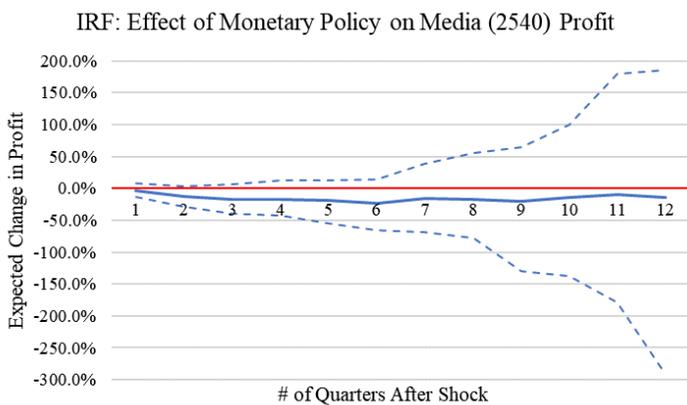
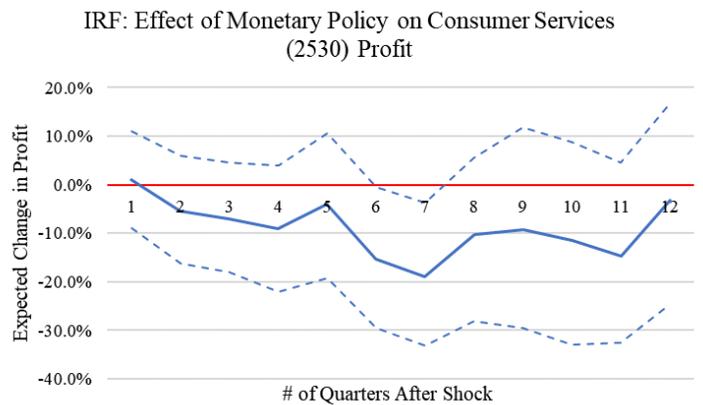
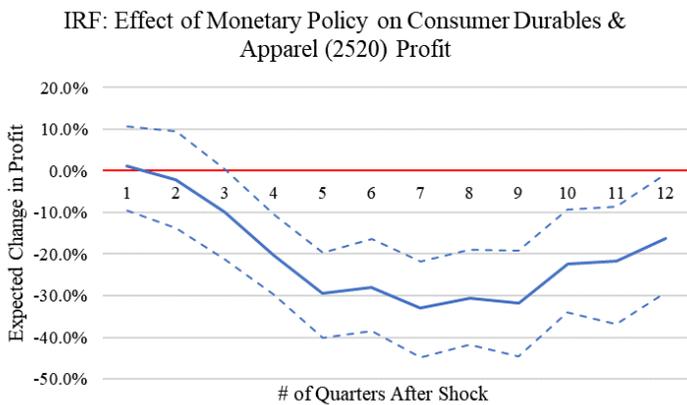
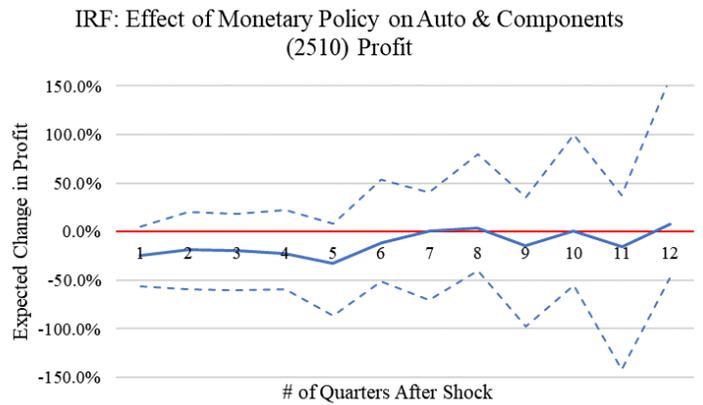
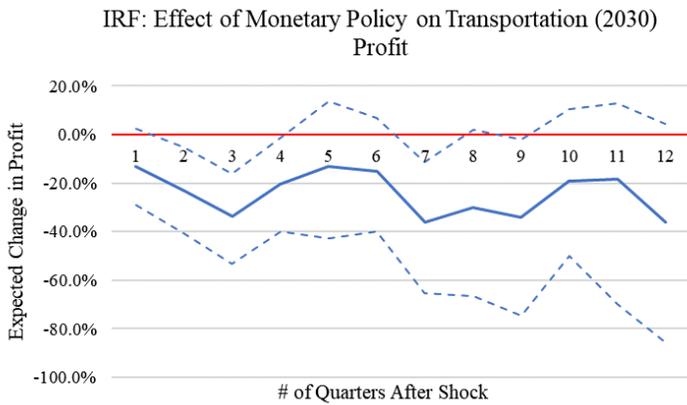
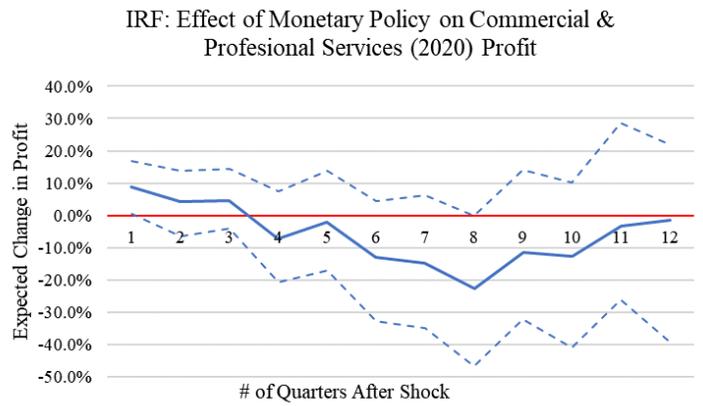
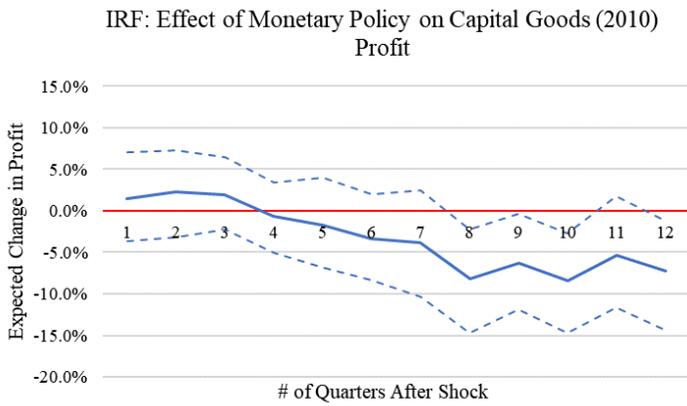
**Figure A.4: (Continuation)**



**Figure A.5: Impulse Response Functions – Effect of Monetary Policy on Profit (Net Income) by Industry.** Note: Assuming a 1.00% 'Unexpected' Increase in Interest Rates (Contractionary Monetary Policy Shock), Dotted Lines Represent 95% Confidence Interval

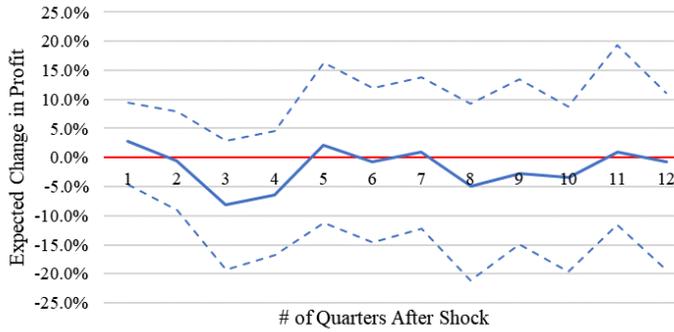


**Figure A.5: (Continuation)**

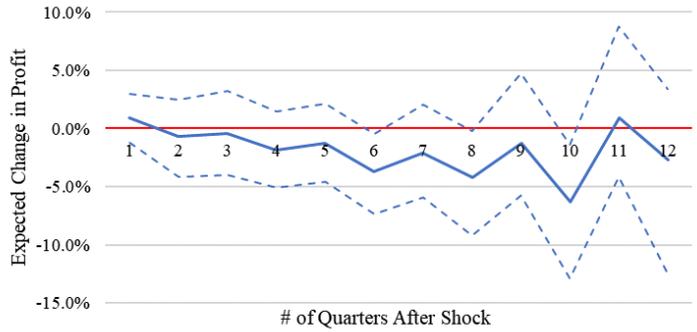


**Figure A.5: (Continuation)**

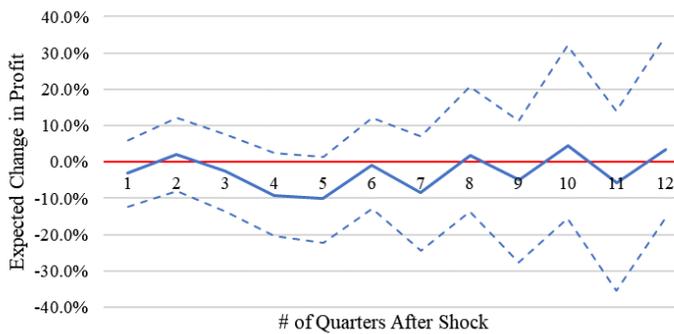
IRF: Effect of Monetary Policy on Food & Staples Retailing (3010) Profit



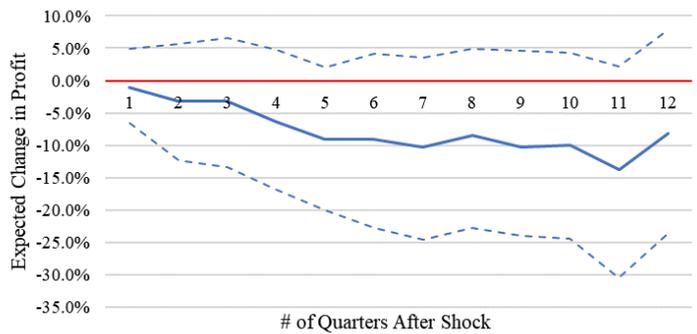
IRF: Effect of Monetary Policy on Food, Beverage, & Tobacco (3020) Profit



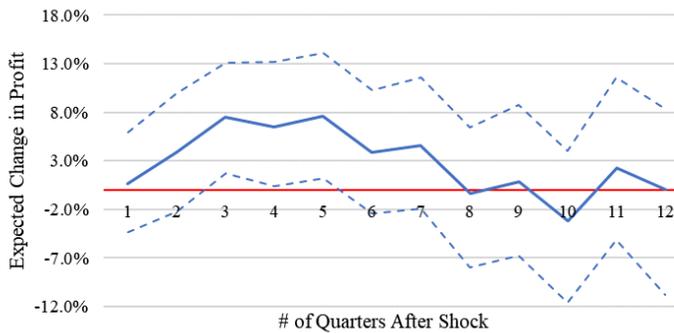
IRF: Effect of Monetary Policy on Household & Personal Products (3030) Profit



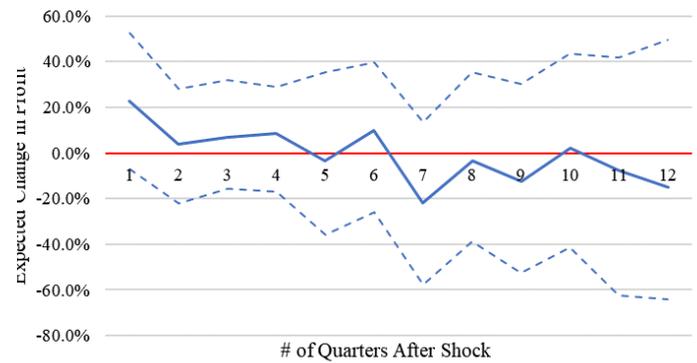
IRF: Effect of Monetary Policy on Healthcare Equipment & Services (3510) Profit



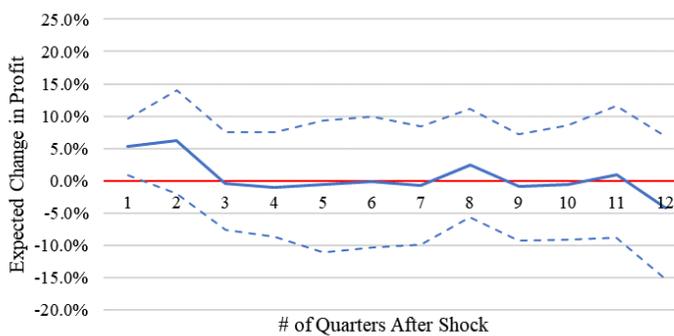
IRF: Effect of Monetary Policy on Pharma, Biotech & Life Sciences (3520) Profit



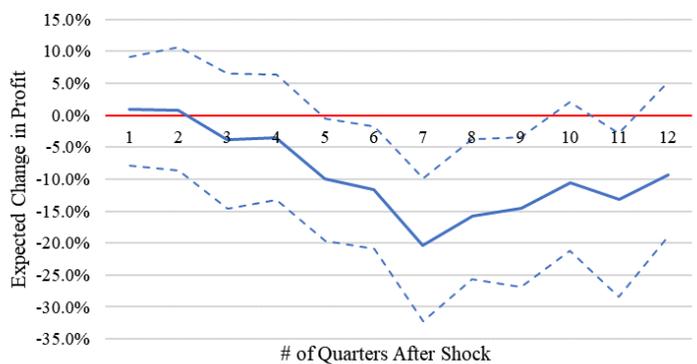
IRF: Effect of Monetary Policy on Banks (4010) Profit



IRF: Effect of Monetary Policy on Diversified Financials (4020) Profit

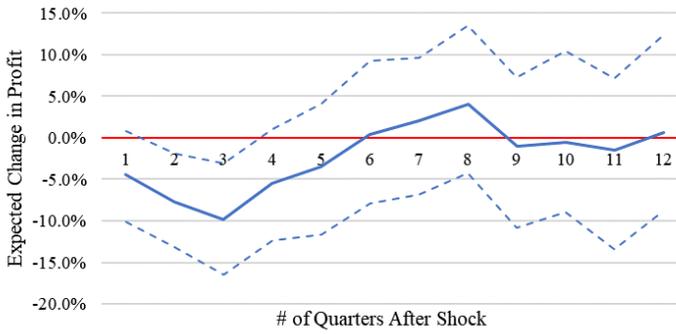


IRF: Effect of Monetary Policy on Insurance (4030) Profit

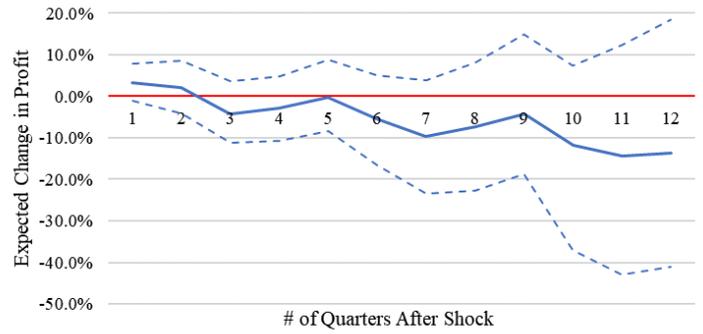


**Figure A.5: (Continuation)**

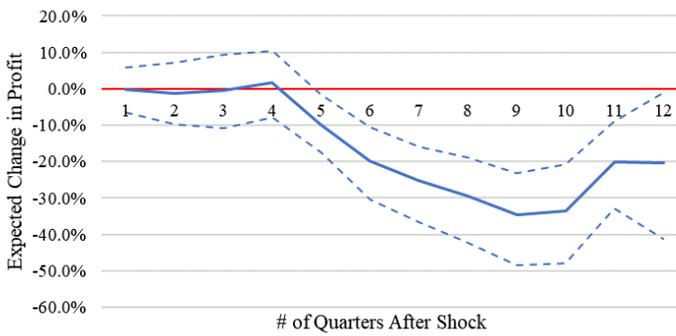
IRF: Effect of Monetary Policy on Software & Services (4510) Profit



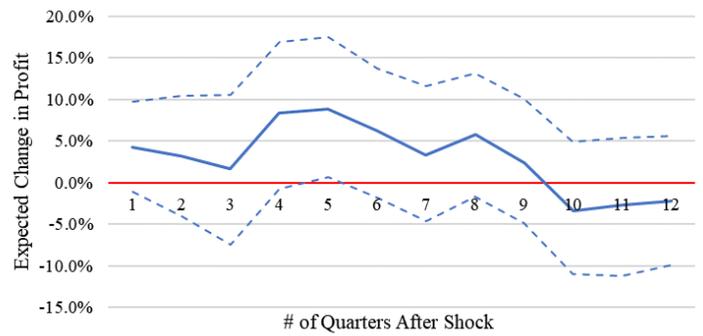
IRF: Effect of Monetary Policy on Technology Hardware & Equipment (4520) Profit



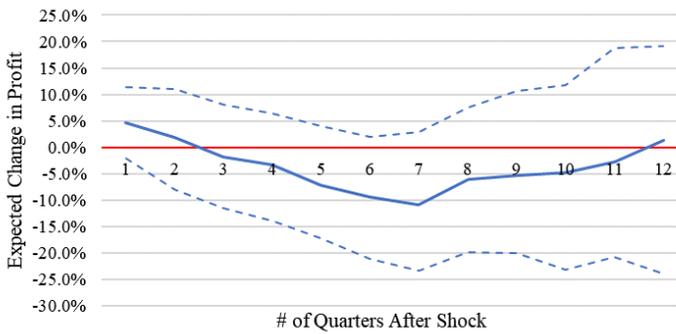
IRF: Effect of Monetary Policy on Semiconductors (4530) Profit



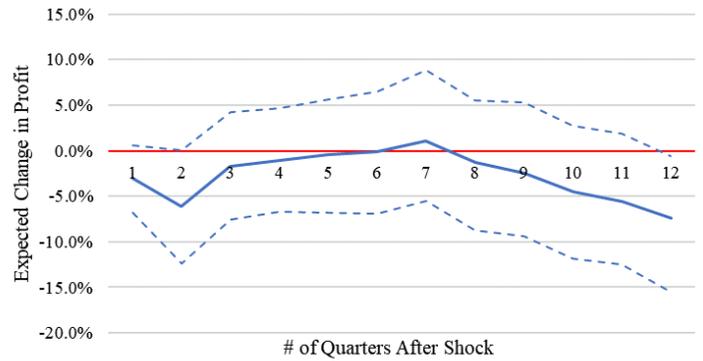
IRF: Effect of Monetary Policy on Telecommunications (5010) Profit



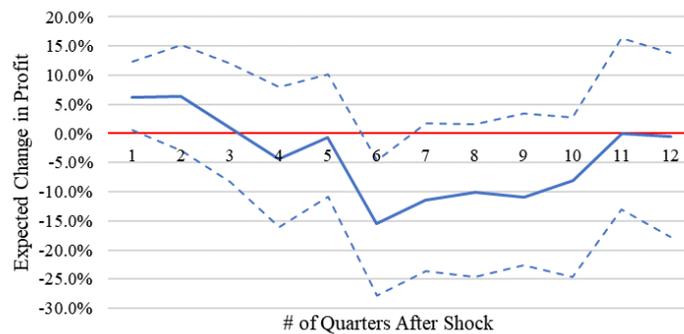
IRF: Effect of Monetary Policy on Media & Entertainment (5020) Profit



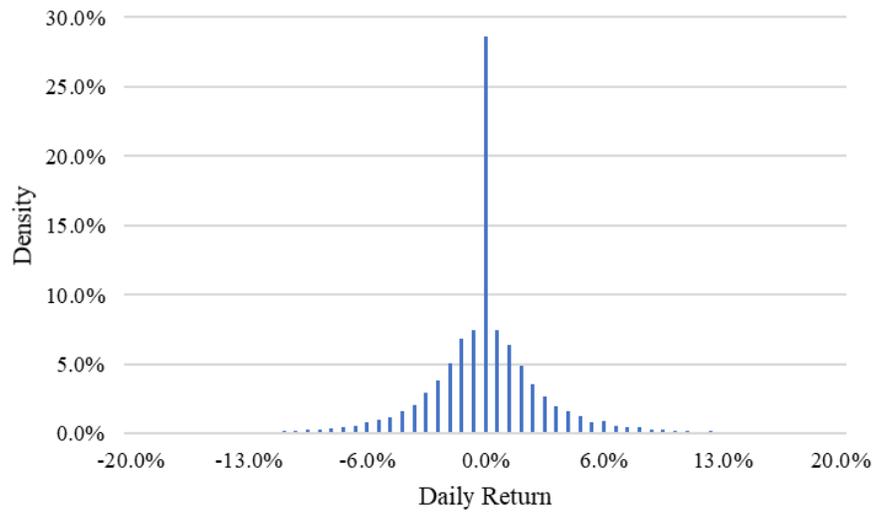
IRF: Effect of Monetary Policy on Utilities (5510) Profit



IRF: Effect of Monetary Policy on Real Estate (6010) Profit



**Figure A.6: Distribution of Daily Equity Price Returns  
(on Monetary Policy Shock Announcement Dates)**



**Table A.3: Regression of Equity Market Returns on Monetary Policy Shocks (Linear vs. Quadratic Fit)**

	Daily Equity Returns	
	(1)	(2)
Monetary Policy Shock ( $S_t$ )	-0.00193*** (0.000206)	-0.00104*** (0.000233)
Monetary Policy Shock Squared ( $S_t^2$ )		0.00207*** (0.000112)
Constant	0.00107*** (6.38e-05)	0.000868*** (6.49e-05)

*Note:* Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .

$R^2 = 0.0$ ,  $N = 1,327,996$ . Sample period is Q1-1969 through Q1-2008.

**Table A.4: (Extended Table) Regression of Daily Equity Returns on Monetary Policy Shocks**  
(Controlling for the Expected Change in Output or Profit)

	Daily Equity Returns						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Monetary Policy Shock ( $S_t$ )	-0.00193*** (0.000206)	-0.00149*** (0.000255)	-0.00193*** (0.000209)	-0.000733** (0.000309)	-0.00231*** (0.000339)	-0.00254*** (0.000258)	-0.00186*** (0.000290)
Expected Output Response – Baseline ( $X_{n,t,8}$ )		0.0321*** (0.00729)					
Expected Output Response – 4 Quarters After Shock ( $X_{n,t,4}$ )			-0.000178 (0.0112)				
Expected Output Response – 12 Quarters After Shock ( $X_{n,t,12}$ )				0.0452*** (0.00689)			
Expected Profit Response – Baseline ( $X_{n,t,8}$ )					-0.00325 (0.00205)		
Expected Profit Response – 4 Quarters After Shock ( $X_{n,t,4}$ )						-0.00814*** (0.00222)	
Expected Profit Response – 12 Quarters After Shock ( $X_{n,t,12}$ )							0.000695 (0.00163)
Constant	0.00107*** (6.38e-05)						
Control on Expected Industry Output / Profit Response	NO	YES	YES	YES	YES	YES	YES
# of Quarters of IRF (k)	N / A	8	4	12	8	4	12
Corr ( $S_t, X_{n,t,k}$ )	N / A	-0.436	-0.436	-0.436	-0.745	-0.745	-0.745

Note: Robust standard errors, with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.  $R^2 = 0.0$ , N = 1,327,996. Sample period is Q1-1969 through Q1-2008.

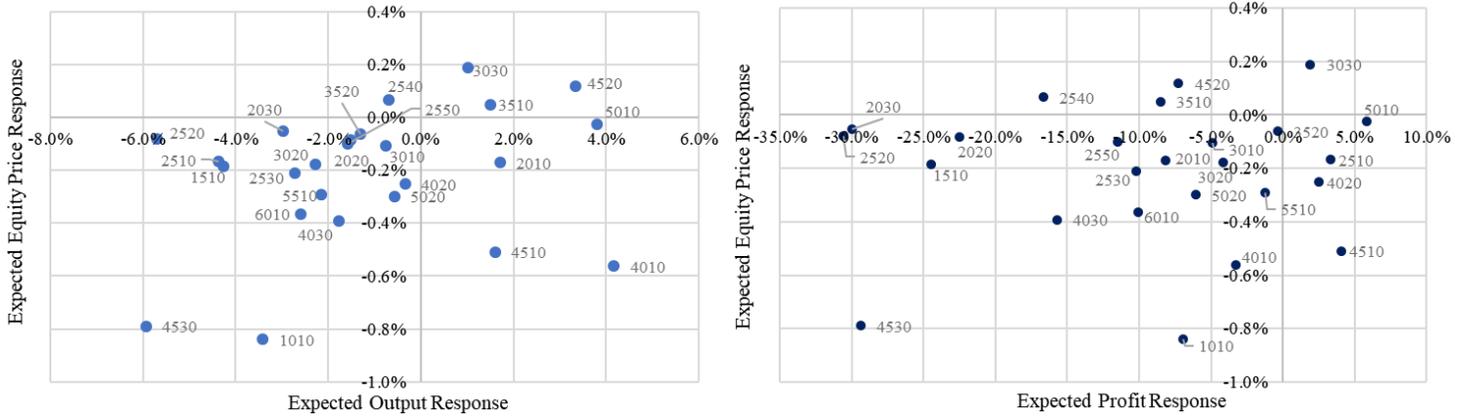
**Table A.5: (Extended Table – Robustness Check) Regression of Daily Equity Returns on Monetary Policy Shocks, Excluding the Impact of Outliers** (Omitted Entries with |Daily Returns| > 15.0%, ~19,000 Entries)

	Daily Equity Returns						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Monetary Policy Shock ( $S_t$ )	-0.00251*** (0.000106)	-0.00236*** (0.000120)	-0.00251*** (0.000107)	-0.00200*** (0.000141)	-0.00244*** (0.000159)	-0.00276*** (0.000142)	-0.00242*** (0.000142)
Expected Output Response – Baseline ( $X_{n,t,8}$ )		0.0112*** (0.00384)					
Expected Output Response – 4 Quarters After Shock ( $X_{n,t,4}$ )			-0.00103 (0.00573)				
Expected Output Response – 12 Quarters After Shock ( $X_{n,t,12}$ )				0.0193*** (0.00358)			
Expected Profit Response – Baseline ( $X_{n,t,8}$ )					0.000638 (0.00104)		
Expected Profit Response – 4 Quarters After Shock ( $X_{n,t,4}$ )						-0.00328*** (0.00124)	
Expected Profit Response – 12 Quarters After Shock ( $X_{n,t,12}$ )							0.000845 (0.000879)
Constant	0.000162*** (2.92e-05)	0.000162*** (2.92e-05)	0.000162*** (2.92e-05)	0.000161*** (2.92e-05)	0.000162*** (2.92e-05)	0.000163*** (2.92e-05)	0.000162*** (2.92e-05)
Control on Expected Industry Output / Profit Response	NO	YES	YES	YES	YES	YES	YES
# of Quarters of IRF (k)	N / A	8	4	12	8	4	12
Corr ( $S_t, X_{n,t,k}$ )	N / A	-0.438	-0.438	-0.438	-0.745	-0.745	-0.745

Note: Robust standard errors, with \*\*\* p<0.01, \*\* p<0.05, \* p<0.1.  $R^2 = 0.0$ , N = 1,308,947. Sample period is Q1-1969 through Q1-2008.

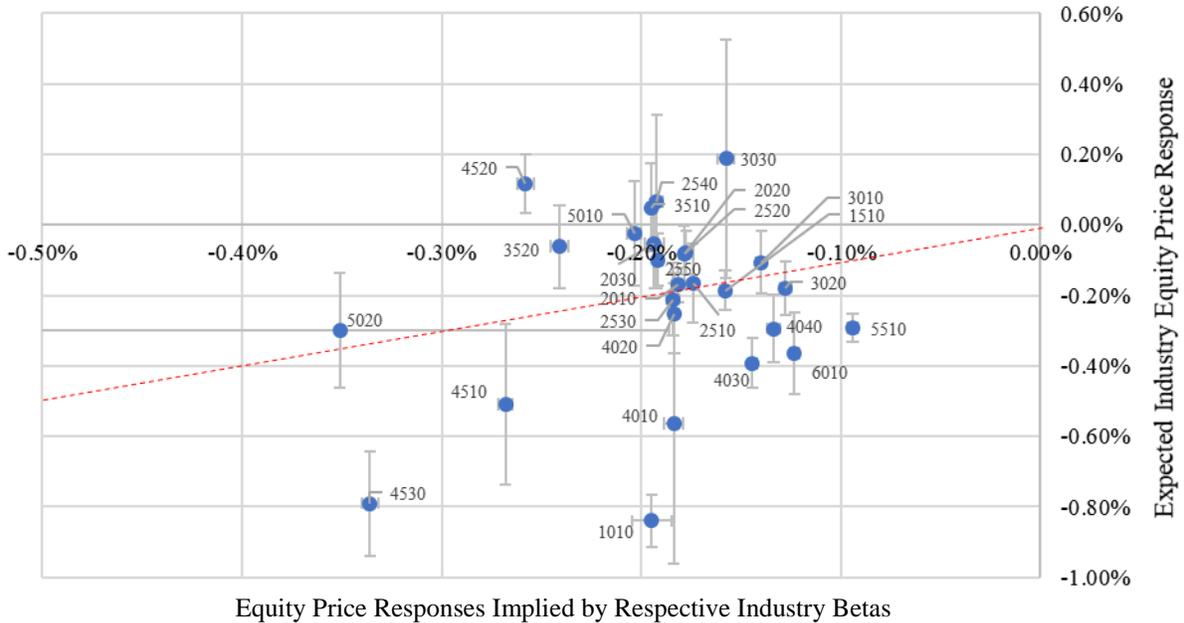
**Figure A.7: Expected Equity Price Response and Expected Output Response (Left), and Expected Profit Response (Right)**

Note: Assuming a 1.00% 'Unexpected' Increase in Interest Rates (Contractionary Monetary Policy Shock). Responses are Estimates for 8 Quarters After the Shock

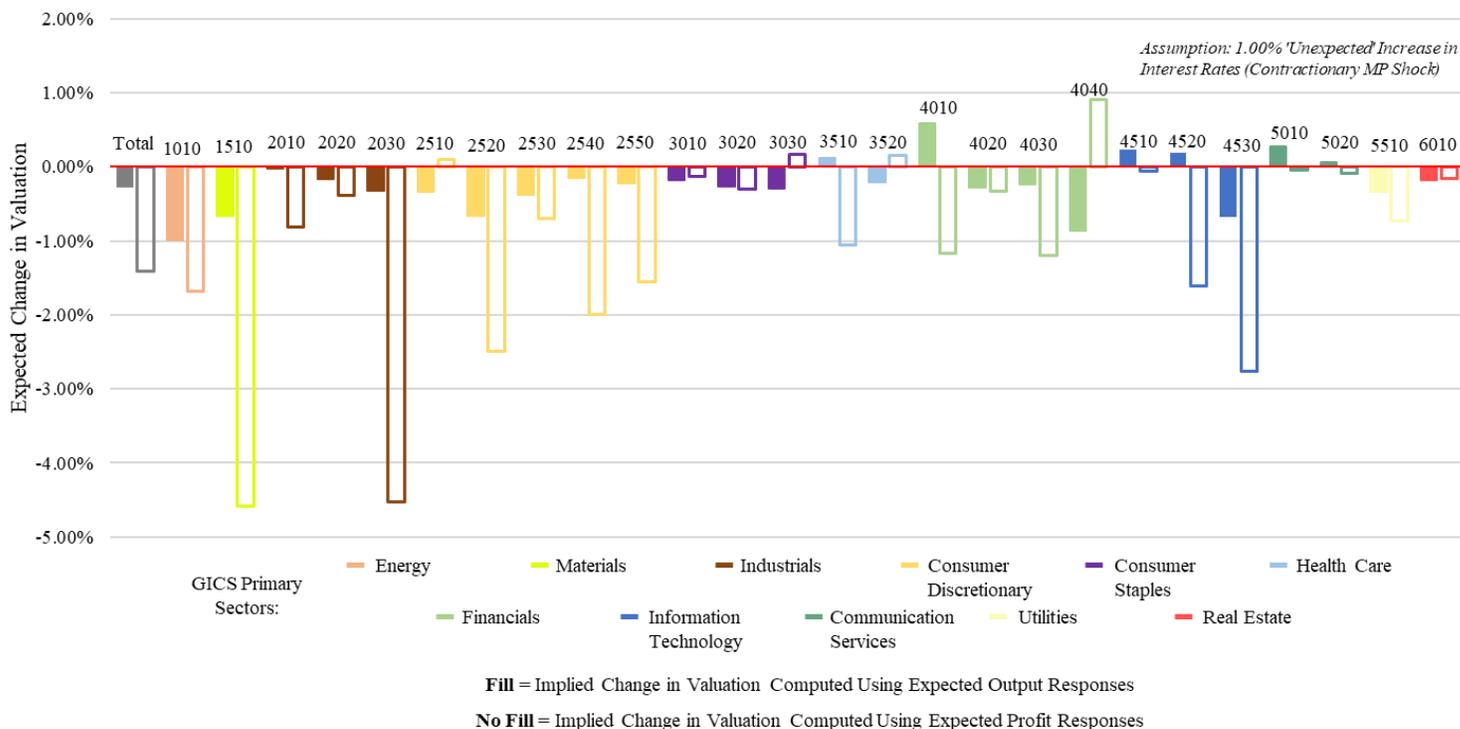


**Figure A.8: Implications of Industry Betas in Stock Market Response Estimations**

Note: Error Bars Represent the Standard Errors for Each Industry Response Estimates



**Figure A.9: Effect of Monetary Policy Shock Announcements on Intrinsic Industry Valuations**



**Table A.6: (Robustness Checks) Regression of Daily Equity Returns on Implied Changes in Intrinsic Valuation**

	Daily Equity Returns									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Change in Intrinsic Valuation Computed Using Expected Output Response ( $\Delta y_k$ )	0.390*** (0.0254)	0.455*** (0.0481)	0.427*** (0.0433)	0.409*** (0.0567)	0.0134** (0.00540)					
Change in Intrinsic Valuation Computed Using Expected Profit Response ( $\Delta y_k$ )						0.0681*** (0.00554)	0.0260** (0.0115)	0.0287*** (0.0102)	0.0165 (0.0111)	0.00930*** (0.00320)
Constant	0.000144*** (2.92e-05)	0.00107*** (6.38e-05)	0.00106*** (6.38e-05)	0.00105*** (6.39e-05)	0.00104*** (6.39e-05)	0.000144*** (2.92e-05)	0.00105*** (6.37e-05)	0.00105*** (6.37e-05)	0.00105*** (6.36e-05)	0.00104*** (6.39e-05)
Outliers Excluded	YES	NO	NO	NO	NO	YES	NO	NO	NO	NO
Equity Risk Premium	5.0%	4.0%	6.0%	5.0%	5.0%	5.0%	4.0%	6.0%	5.0%	5.0%
# of Quarters Projected	12	12	12	8	12	12	12	12	8	12
Permanent Impact of Monetary Policy on $\Delta y_k$	NO	NO	NO	NO	YES	NO	NO	NO	NO	YES

Note: Robust standard errors, with \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$ .  $R^2 = 0.0$ ,  $N = 1,327,996$ , except for when outliers are excluded, then  $N = 1,308,947$ .

In this table, we are sensitizing the exclusion of outliers from our dataset, the value of the equity risk premium (4.0 – 6.0%), the length of the projection period (8 & 12 quarters), and whether monetary policy has a permanent effect on the output or profit, thus affecting the size of a company's terminal value.