Differential Industry Response to Monetary Policy in the Zero Lower Bound Era

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**Introduction**

According to Romer and Romer, “the accuracy of estimates of the effects of monetary policy depend crucially on the validity of the measure of monetary policy that is used” (Romer & Romer, 2004). Trying to quantify the effects of monetary policy on economic fundamentals is one of the most commonly studied topics in macroeconomics. It is also a study that has become increasingly complex since the financial crisis of 2008 and the prevalence of near-zero interest rates, often referred to as the Zero-Lower Bound (ZLB) era. This phenomenon has made it more difficult to predict changes in economic fundamentals through standard measures such as the federal funds rate. We also know that, according to New-Keynesian thought, expansionary monetary policy is likely to have significantly greater effects on “sticky price” industries with high levels of debt such as industrials and energy (Dedola & Lippi, 2000). On the other hand, the performance of other industries, such as financials, may react negatively to expansionary monetary policy due to the falling value of debt payments (Nieto, 2019). From a predictive standpoint, it is more effective to breakdown the effect to a per-industry basis, as has been done by Javier Nieto (2016) and Dedola and Lippi (2002). I will employ similar methods as these studies to analyze the effect of monetary policy on a per-industry basis after 2008. A particular emphasis will be placed on the effect of “unconventional” monetary policy tools and how to measure them as these become more popular in the ZLB era.

The period we are most interested in for this analysis began during the financial crisis in October of 2008, but the structural components of this crisis were put in place many years earlier. With the success of Volcker and Greenspan’s inflation-targeting approach to monetary policy, a low-interest rate, low inflation environment was cultivated (Hetzel & Robert, 2018). In the early 2000s, this low-interest rate regime may have led to what is referred to as a “regional boom and bust cycle” in the US housing sector, the eventual catalyst of the financial crisis of 2008 (Hetzel & Robert, 2018). The discussion surrounding this became reminiscent of the theories of Hayek and the “Real Bills” theory which argued that business cycles are driven by “animal spirits” and the “madness of crowds” which fuel long speculative periods of excess. However, in terms of theoretical approaches to monetary policy at the time, the financial crisis saw the employment of many approaches that are consistent with a New-Keynesianism, which stresses the importance of considering the differential effects of monetary policy on “sticky” and “non-sticky” industries. Several events that occurred during the financial crisis indicated that a new approach was required for dealing with crises of this scale and complexion. This brought about the employment of what is known as “unconventional monetary policy” which will be the main focus of this paper.

I will cover the relevant unconventional methods that were used during the financial crisis as well as the events which prompted their use. The most prominent issue that was realized was the limitations of traditional monetary policy when operating a federal funds rate that is near zero, this is referred to as the Zero Lower Bound. This occurred for the first time in December of 2008, when, after expressing in April that this would not be the case, the Fed lowered the federal funds rate to 0.25% (Gagnon et al., 2018). Though interest rates can and have fallen below zero in the past, especially in real terms. There are several problems associated with negative rates, most prominently being that the existence of cash means that people cannot be forced to pay these interest rates, hence the effect that these rates have on current period consumption may be negligible (Bernanke, 2020). Negative rates also have the ability to worsen liquidity traps during financial crises which feed on the fear that rates will continue to fall (Glover, 2019). The motivation to avoid negative interest rates led to the adoption of our first unconventional method, quantitative easing.

           Quantitative Easing (QE) has often been differentiated from traditional monetary policy to a greater degree by its stated goals rather than the methods through which it is conducted. For the sake of simplicity, however, I will use a broad definition that is used by Ben Bernanke as this seems appropriate in a US context; the large-scale purchase of longer-term financial assets by central banks (Bernanke, 2020). This definition does not seem to delineate itself from what we would associate with traditional monetary policy if the financial assets in question are government bonds. Therefore, it is important to consider both the scale and type of asset in question when looking at QE. In terms of scale, from the beginning of the first round of QE in August of 2008 the Fed’s balance sheet grew from approximately $900 Million to $4.5 Trillion or 25% of GDP by 2015, hence prompting the term large-scale asset purchases (LSAPs). LSAPs were less restrictive in the terms of the types of assets that they applied to, including not only the traditional US Treasury Bills (though on a much larger scale) but also Mortgage-backed Securities (MBS) and private sector debt securities from government-sponsored enterprises (Bernanke, 2020). The stated goals of QE are wide-ranging with the most notable being decreasing the spread between long and short-term yields in a range of asset classes; most commonly the yield curve of US Treasury Bills. Another goal of QE is influencing the excess reserves of depository institutions, the idea here is that the level excess reserves in themselves may have spillover into the rest of the economy and the Fed even began paying interest directly on them in October of 2008 (Chen et al., 2016).

           Since QE has several easily quantifiable goals, it is relatively simple to analyze the effects of it. A study conducted by Gagnon et al. (2011) concluded that during the 5-day period following the announcement of the first round of LSAPs in March 2009, QE had significant effects on key asset prices as summarized in Table 1 of the Appendix (Bernanke, 2020). The most commonly used approximation of the US yield curve is the spread between the 10 and 2-year Treasuries. In the table, it is shown that QE would have had a strong effect on this spread that is consistent with the Fed’s goals. It must be noted that this is a very short-term study on one round of QE, studies on the long-term effects and even on the second round of QE conducted in November 2010 have found significantly smaller and even negligible effects (Vissing-Jorgensen & Krishnamurthy, 2011) (Wright, 2011).

           Forward guidance is an idea based on the rational-expectations theory. It was employed very successfully during the financial crisis yet does not involve any financial transactions in itself, only a guideline by the Fed as to the path of future short-term interest rates. This became especially important when the ZLB was reached as it gave investors and the public an approximation of what the Fed’s reaction function (given unemployment and inflation measures) looked like in an environment where the traditional and well-understood reaction functions did not apply. In August 2011, the Fed began refining the process of forward guidance to be state-dependent or “Odyssean” which meant that projections became dependent on a certain time-horizon or set of economic conditions further (Woodford, 2013). A direct result of commitments of this nature during the financial crisis was that the Fed was able to push long-term rates down even further by tracing a low-interest path into the future for short-term rates (Bernanke, 2020). In my analysis, I will use the spread between the 3-month LIBOR and US Treasury Bills to approximate market expectations of future interest rates and hence the effect of forward guidance.

**Literature Review**

           The study of industry responses to monetary policy often varies significantly in several key aspects. Emphasis will be placed on three differentiating factors; the sample population and data, identification of monetary shock response functions, and the conclusions drawn from these results. The most relevant studies on industry effects of monetary policy for our purpose are conducted by Dedola and Lippi (2000) and Javier Nieto (2016). Both of these studies use as their relevant time horizon, pre-2008 data, which is an important distinguishing factor for our analysis which will only look at data beginning in 2008.

*Dedola and Lippi (2000)*

Dedola and Lippi looked at both cross-country and cross-industry comparisons of monetary shocks in 5 countries and 21 industries. Using a recursive structural vector auto-regression allowed the authors to control for reverse causation between the explanatory variables while placing a theoretical transmission mechanism on the model. They used the short-term interest rate in each country as the policy instrument of choice and ran a SVAR(5). For the US, these explanatory variables included the short-term rate, level of industrial production, consumer price index, a commodity price index, and a monetary aggregate (M1 and M3) with the first three entering into the regression at the same time as the short-term rate. Their findings were consistent with the New-Keynesian theory of sticky prices as industries producing durable goods were significantly more sensitive to changes in short-term rates (Dedola & Lippi, 2000).

The authors also defined two important monetary transmission channels that I will utilize in my analysis; these are the interest rate and broad credit channels. The interest rate channel can be thought of as the conventional process by which monetary contractions can affect economic fundamentals. Contractionary monetary policy decreases the demand for expenditure in long-term investments and durable goods hence decreasing revenue in the companies and industries which produce these goods. The exchange rate effect can also be considered as part of the interest rate channel. The exchange rate effect describes the process by which monetary contractions can cause an increase in the relative domestic-foreign interest rates and as such an exchange rate appreciation. This leads to a fall in the relative demand for domestic and foreign goods. Capital-intensive industries are also subject to the interest rate effects as described by the limited participation model (Christiano & Eichenbaum, 1992). The second transmission method is the credit channel which refers to the agency costs associated with asymmetric information and contract enforcement. This effect is more relevant to smaller firms that typically have more limited access to financing, less value in collateral, and for whom creditworthiness is more sensitive to changes in interest rates. The credit channel has often been referred to as closer to an “amplification” of the traditional transmission methods rather than an independent effect, however, it has still been found to be statistically significant for industry-specific effects (Dedola & Lippi, 2000).

*Javier Nieto (2016)*

In his study of the differential responses of industries to monetary policy, Javier Nieto (2016) employs a similar method but uses only US firms and rather than the traditional SVAR approach. More specifically he utilizes a model developed by Romer and Romer to create an exogenous measure of monetary policy shocks. The measure regresses the intended federal funds rate onto FOMC projections of GDP, inflation, and unemployment and defines the error term as a measure of “unexpected” changes in the effective federal funds rate. The intuition behind this measure is further expanded upon in the original paper (Nieto, 2019). For measures of industry fundamentals, he examines the effect of this shock on net income, revenue, intrinsic valuation, and daily price change on the day of FOMC announcements. Nieto then employs a VAR(3) using the exogenous policy measure, seasonality dummies, and the measures of industry fundamentals with 12 quarters of lags. The results are used to create impulse response functions over twelve quarters, using the exogenous shock series as the impulse.

**Methods**

To make Romer and Romer happy, we must choose our measure of monetary policy with great care and will look at the effects of five different measures in total. Firstly, we will utilize a simplified version of the SVAR model in Dedola and Lippi’s study to examine the effects of traditional monetary policy in the ZLB. A measure of exogenous monetary shocks will then be developed using the same method as Nieto (2016) and Romer and Romer (2004). The same method will then again be used to develop a few exogenous measures of “unconventional” monetary policy by treating them as policy tools of the Fed as was done for the intended federal funds rate by Romer and Romer (2004). The first of these will be based on the shadow rate developed by Jing Wu and Fan Xia, which is a useful tool for analyzing the effect of monetary policy near the zero lower bound and has found to be more accurate than traditional methods for predicting key macroeconomic variables since 2009 (Wu & Xia, 2016). The second will represent the effect of quantitative easing by using the size and ratio of long to short-term debt on the Fed’s Balance Sheet as the policy tool. The third will capture the effect of forward guidance and will be based on the spread between the respective 3-Month rates of the London Interbank Overnight Rate (LIBOR) and US Treasury Bill. The construction of these variables will be expanded upon below.

The form of a basic vector autoregression function (VAR) is show in Figure 1 of the Appendix and will be the basis for all of our analyses. Here represents our vector of explanatory variables and represents the number of lags of each variable that are considered. The optimal number of lags was chosen as defined by each study except for in our analysis of unconventional monetary policies for which a likelihood ratio test was used through Stata’s ‘varsoc’ command. Just as in Nieto's study, a cumulative impulse response function was then constructed over 12 quarters with the given policy measure as the shock and the lags measure of industry fundamentals as the response.

The defining feature of VARs is the ability to control for and analyze interactions between the independent variables. This feature will be of particular importance in Dedola and Lippi’s model which controls not only for these interactions but for the order and structure through which are allowed to persist. This is referred to as a recursive-form SVAR and will be beyond the scope of this paper. I will only be able to control for the order through the order in which the variables enter our regression which will be the following; seasonality dummy, M1, inflation, US industrial production, EFFR, our measure of industry fundamentals. The ordering here allows previously defined variables to affect those which enter into the regression later but not vice versa. This is an unfortunate limitation as we are assuming that contemporaneous measures of the money supply, industrial production, and inflation can influence the EFFR but not the other way around. Empirically, we will be examining the percentage change in the aggregate revenue and equity price of different industries in response to a contractionary monetary policy shock. The size of the shock will be equivalent to a one standard deviation increase or approximately 1.7%.

The method employed by Nieto is an expanded version of a measure developed by Romer and Romer in 2004. I will essentially be using the same regressive form as before but without controlling for the key macroeconomic variables. This is because this has already been done in our construction of an exogenous measure. The measure is defined as the residuals on the regression of the intended federal funds rate onto FOMC projections of the following key macroeconomic variables; GDP growth, inflation, and unemployment (See Equation 1 in Appendix). These will essentially act as controls for the intended effect of monetary policy. The intuition behind this is that these are the variables considered when the Fed makes interest rate decisions, therefore, controlling for them yields the “unexpected” or exogenous effect of monetary policy. The final VAR (See Equation 2 in Appendix) assumes the following order of precedence; seasonality, Romer shock, the measure of industry fundamentals.

Accurately quantifying the effects of unconventional policy is significantly more difficult than traditional policy and current methods are beyond my abilities. I will make some simplifications to the process by looking at a few key measures of monetary policy in the ZLB era. In my analysis, I will treat all of these measures as policy tools of the Fed allowing us to employ the same method as Romer and Romer and create exogenous measure monetary policy. As previously mentioned, the three measures will be the Wu-Xia shadow rate, a measure of the size and maturity of the Fed’s balance sheet, and the spread between the respective 3-Month rates of the LIBOR and US T-Bills.

The Wu-Xia shadow rate is a measure of how interest would have moved according to the Taylor-rule in the absence of the Zero Lower-Bound. It is important to remember that the shadow rate is not an actual measure of unconventional policy, but it may have the ability to capture some of its effects during periods of near-zero interest rates as the Fed transitions from interest rate cuts to other forms of expansionary policy (Wu & Xia, 2016). The measure of quantitative easing is based on the size and make-up of the Fed’s large-scale asset purchases, more specifically, the size of the Fed’s holdings in long-term debt (maturing in more than 1 year). We know that this measure captures both the size and debt-ratio as adding another variable for these measures would be omitted for collinearity. The measure of forward guidance is based on a method developed by Lombardi and Zhu (2016) which employs the 3-month spread as it is the closest measure of a future path of interest rates outside of collecting FOMC meeting data for each quarter (Lombardi & Zhu, 2018). To build these into effective and stationary measures, each regression the policy measure is substituted for the intended federal funds rate in the same form as the Romer and Romer shock measure. A visualization of the shocks over the relevant time series is given in the appendix. Several issues arise with measures of this form, most prominently being the fact that I am no longer using a regression which focuses on the intended effect of these policies as this data is not available. Given this issue, I will use sign test-statistics to indicate whether the direction of response is concurrent with our intuition rather than looking at the magnitude of changes.

Though statistically robust results are ideal, I am going to have to make some sacrifices in this regard to carry out our analysis. Firstly, I will need a large data set of industry-specific data, however, given that Stata is restricted to 2048 variables, I am forced to restrict the analysis to companies in the S&P 500. Secondly, I am going to restrict our definitions of industries to the 11 sectors as defined by the Global Industry Classification Standard (GICS). Changes in equity prices will also be calculated using quarterly monthly returns rather than Nieto’s measure of daily change on the day of FOMC announcements as I did not consider this relevant for the long-term effect of monetary policy. I will also only look at changes in revenue and prices rather than net income as I was often finding that the response of net income failed stability conditions and often converged to infinity.

The data set for my analysis was collected using S&P Compustat Wharton Research Data Services and the Federal Reserve of St. Louis Data Services (FRED). Using S&P Compustat I acquired revenue and monthly closing price for each country in the S&P 500 (1 company dropped for data collection issues) for 2005-2020 (included 3 years of previous observations for lags). I then aggregated the company financials by sector using their GICS sector code to obtain aggregate measures of industry performance which I can run my regression on (See Appendix for a full summary of data set). Key macroeconomic data was collected through the Federal Reserve of St. Louis Economic Data Services (FRED). This included the controls for the VAR; industrial production, consumer price index, a commodity price index, and M1. FRED was also the source of our policy measures; the federal funds rate (traditional policy), federal reserve balance sheet level and makeup (QE), the spread between the 3-Month LIBOR and US Treasury Bill (Forward Guidance), and the FOMC projections which I will use to construct Romer and Romer’s measure. The Wu-Xia Shadow Rate was collected through the Federal Reserve Bank of Atlanta’s Center for Quantitative Economic Research (Wu-Xia Shadow Federal Funds Rate, n.d.).

**Results**

In our results section, I will be looking at the cumulative effect of a one standard deviation increase in each measure over 12 quarters. I don’t expect to see strong overall effects of monetary policy given that 252 of the 500 companies are part of industries that are not theoretically sensitive to interest rates. I also know that the effects of the broad credit channel are likely to be diminished in our sample given it is made up of publicly listed, high market-capitalization companies. Despite this, I was able to find significant effects under some measurement schemes. The traditional measures of monetary policy as captured by the Romer and Romer and Dedola and Lippi’s analysis do not align with our intuition. They both display near zero or positive effects for revenue while Dedola and Lippi’s also shows near-zero effects for price. On the other hand, all 3 measures of unconventional monetary policy align with our intuition for both revenue and price. Revenue and price were both positive for our measures of expansionary forward guidance and quantitative easing and an increase in the Wu-Xia shadow rate was associated with decreases of 5.7% and 7.2% for revenue and price respectively. The aggregate results are summarized in Figure 3 and 4 in the Appendix.

I will now go on to summarize the impulse response functions for each industry under each measure of monetary policy. According to the implications of the interest rate effect, the following industries should be particularly sensitive to changes in monetary policy; energy, industrials, real estate, utilities, and financials. These industries will be the focus of our analysis but any significant effects in other industries will be reported as well. The likelihood of seeing statistically significant industry-specific effects is also small since we have restricted our analysis to the S&P 500, meaning the average industry sample size is ~45 companies. The studies conducted by Nieto (2016) and Dedola and Lippi (2002) had an average of 817 and 7143 per-subindustry respectively, we do not expect to obtain results with a comparable degree of certainty.

Summaries of the impulse response functions for each industry under each measure of monetary policy as well as the intuition behind them can be found below. We will be looking at the cumulative effect of a one standard deviation increase in each measure over 12 quarters, please see the appendix for the full results.

*Energy*

Contractionary monetary policy had a strong negative effect on energy sector fundamentals and the opposite effect was observed for expansionary large-scale asset purchases and forward guidance. The energy sector was also the most responsive to monetary shocks in four out of five of our measures. Price response was even more significant, being the most volatile across all five measures. The sector responded as expected in 9 out of 10 impulse response functions, the only exception being the effect of the Romer measure on revenue. These observations are consistent with our intuition about the function of the energy sector as capital-intensive and exchange rate sensitive. The exchange rate effect may be the most prominent here for two reasons. Firstly, through the traditional function of the exchange rate effect which describes the process by which contractionary monetary policy increases the interest rate differential leading to an appreciation of the domestic currency and, in turn, less demand for US energy products. Expanding on this further, we also know that demand for US energy products is likely to be further reduced during recessions due to the role of the US dollar as the world’s reserve currency.

*Industrials*

The response of industrials was similar to that of the energy sector, yet more consistent and not as large. Industrials moved as expected in 10 out of 10 IRFs, 4 out of 10 of these had results that were significantly different from 0 (95% CI). This is also consistent with our intuition of the industrials as capital-intensive and as a producer of durable goods.

*Real Estate*

Real estate is also negatively correlated with contractionary monetary policy and moved as expected in 9 out of 10 IRFs. Interestingly, real estate revenue was particularly sensitive to changes in traditional monetary tools, displaying an overall decrease of 10.5% and -23.1% to the Dedola and Lippi and Romer and Romer measures respectively. Response to unconventional monetary policy was much more muted, with changes in revenue magnitude consistently below the S&P 500 average. This may be reflective of a very “pure” interest rate effect with demand for housing falling directly with the interest rates on mortgages rather than with the new policy tools.

*Financials*

Financials is an industry that is expected to benefit from contractionary monetary policy, at least in terms of short-run revenue. The transmission of this effect occurs through the interest rate channel as depository institutions see the gains of increased interest rate payments. The financial sector of the S&P 500 is dominated by banks which make their revenue through the spread between the rate at which they borrow from the central bank and the rate they charge customers. Since this spread is likely to rise under a contractionary monetary policy scheme, we observe increased revenue initially. As the interest rate effect works its way through the economy, however, these effects may be diminished. This effect is well captured by the response to our traditional measures which both predict statistically significant for the first 3 or so quarters followed by a slow decline to zero. When we look at our unconventional measures, the effect is clearer. We see that revenue is positively correlated with the Wu-Xia Shadow Rate and negatively correlated with our measure of expansionary quantitative easing (which decreases the interest rate on excess reserves). Another interesting observation is that prices and revenue in the financial sector moved in opposite directions in 4 out of 5 of our measures.

*Utilities*

Utilities moved in accordance with our expectations in 9 out of 10 response functions. That is, the cumulative response of revenue and price was negative for contractionary policy and positive for expansionary policy. The outlier, in this case, is the response of equity prices to the Romer and Romer shock which predicted a 19.1% increase in price. In terms of magnitude, the response of utilities was never significantly different from 0.

We have already briefly discussed the use of sign test-statistics to examine the percentage of the time that industries moved as expected. Sign test-statistics can also be used as an indication of the predictive ability of our various measures of monetary policy. In this scenario, measures that are significantly different from 0.5 is an indication of strong predictive ability and we will only consider our five most relevant industries as well as the total as is reported in the appendix. The various t-statistics for the Dedola and Lippi, Romer and Romer, Wu-Xia Shadow Rate, QE, and forward guidance measures are as follows; 0.83, 0.67, 0.92, 1, 0.92. These results represent the proportion of the time that the measures predict movements in industry fundamentals which align with our intuition from previous studies.

Conclusion

           Within the five industries we selected, our measures of unconventional monetary policy predicted responses concurrent with the transmission of monetary policy with greater accuracy than more traditional methods. The Wu-Xia shadow rate was, on average, 9% more accurate than Dedola and Lippi’s measure and 25% more accurate than Romer and Romer’s monetary shock series. This is consistent with the findings of Wu and Xia in their study of the efficacy of their measure for predicting key macroeconomic variables, but this extends it to a per-industry basis. It is important to remember that though the shadow rate is not an actual measure of unconventional policy it may have the ability to capture some of its effects during periods of near-zero interest rates as the Fed transitions from interest rate cuts to other forms of expansionary policy. Our more direct measures of unconventional methods, QE and forward guidance, were also very effective in their theoretical “predictive” ability. LSAP shocks had the expected effect on industry fundamentals across the board, with positive responses in all IRFs except financial revenue, which is expected to decrease with the depletion of the interest rate on excess reserves.

           Given these results, we must highlight some issues regarding the robustness of these results. Firstly, in defence of the studies by Romer and Romer and Dedola and Lippi, I employed only rough approximations of these methods and did not fully capture their explanatory power. Secondly, regarding my measures, these were developed only as a channel through which to analyze some important issues, not as a fully robust analysis. Many of these regressions failed stability tests indicating a possibility of divergence to infinity, though it does not appear that this was a feature of the results for revenue and price, even on longer time horizons. Stationarity conditions, defined by stable first and second moments over time, were met by all of the measures of unconventional monetary policy shocks. There is also an issue of sample size, as companies of the S&P 500 may have several specific, unmentioned qualities that could make them more or less sensitive to shocks of this nature. Given another opportunity, I would not constrict the analysis to the S&P 500 and look only at large datasets of the five most sensitive industries as well as their sub-industries.

           Our findings indicate that there are several methods of measuring unconventional monetary policy that have been to some degree more relevant to industry fundamentals since 2008 than the traditional measure. We have also found results that lend further credibility to the beneficial and statistically significant effects of expansionary quantitative easing and forward guidance on revenue and equity prices. It is important to note that this is only a result of the near-zero interest rates that have persisted since 2008, we are unaware of the degree to which these tools will be relevant in the monetary schema of the future. We have also found that, with the exception of the real estate sector, industry fundamentals have responded similarly to the new unconventional tools as they did to traditional policy in previous studies. In the face of the deep complexity of measuring the effects of monetary policy, the findings of this paper are not meant to serve as rigorous results but rather as an index of starting points and their relative validity.

Appendix

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Table 2: Effect on Revenue: Impulse = Effective Federal Funds Rate (Dedola and Lippi, 2000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | -21.0% | -36.2% (11) | 9.1% (3) | 1 |
| Industrials | -7.92% | -7.92% (12) | 3.05% (6) | 1 |
| Real Estate | -10.5% | -10.5% (12) | 11.2% (5) | 1 |
| Financials | -2.2% | -6.5% (9) | 23.2% (3) | 0 |
| Utilities | -0.26% | -2.3% (3) | 2.5% (5) | 1 |
| Total | 11.8% | 0.4% (1) | 11.8% (12) | 0 |

Table 3: Effect on Price: Impulse = Effective Federal Funds Rate (Dedola and Lippi, 2000)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | -45.5% | -45.5% (12) | 22.2% (5) | 1 |
| Industrials | -12.2% | -14.1% (11) | 22.6% (4) | 1 |
| Real Estate | -19.6% | -19.6% (12) | 37% (4) | 1 |
| Financials | 5.9% | 3.5% (1) | 31% (4) | 1 |
| Utilities | -1.9% | -1.9% (12) | 21.7% (4) | 1 |
| Total | -2.7% | -3.5% (10) | 24.2% (4) | 1 |

Table 4: Effect on Revenue: Impulse = Shadow Rate (Wu and Xia, 2016)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | -15.2% | -15.2% (12) | 24.5% (5) | 1 |
| Industrials | -10.9% | -10.9% (12) | 0.6% (6) | 1 |
| Real Estate | -1.8% | -1.8% (12) | 6.4% (4) | 1 |
| Financials | 9% | 1.7% (1) | 9% (12) | 1 |
| Utilities | -7.5% | -7.5% (12) | 0.47% (7) | 1 |
| Total | -5.7% | -5.7% (12) | -7.5% (6) | 1 |

Table 5: Effect on Price: Impulse = Shadow Rate (Wu and Xia, 2016)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | -72.5% | 4.37% (1) | 40.1% (12) | 1 |
| Industrials | -3.7% | -5.8% (3) | 13.5% (10) | 1 |
| Real Estate | -17.3% (95% CI) | -9.4% (9) | -0.6% (5) | 1 |
| Financials | -6.1% | -3.4% (1) | 6.7% (7) | 0 |
| Utilities | -4.7% | -4.7% (12) | 3.6% (5) | 1 |
| Total | -7.2% | -7.2% (12) | -0.1% (2) | 1 |

Table 6: Effect on Revenue: Impulse = Exogenous Monetary Shock Series (Romer and Romer, 2004)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | 10.3% | 10.3% (12) | 88.7% (6) | 0 |
| Industrials | -20.3% | -20.3% (12) | 16.9% (5) | 1 |
| Real Estate | -11.9% | -11.9% (12) | 10.7% (5) | 1 |
| Financials | 5.2% | 4.64% (9) | 17.4% (5) | 1 |
| Utilities | -3.9% | -3.9% (12) | 9.3% (6) | 1 |
| Total | 5.3% | 4% (1) | 22.3% (6) | 0 |

Table 7: Effect on Price: Impulse = Exogenous Monetary Shock Series (Romer and Romer, 2004)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | -75.1% (95% CI) | -75.1% (12) | 55.4% (3) | 1 |
| Industrials | -25.2% (95% CI) | -25.2% (12) | 27.1% (5) | 1 |
| Real Estate | -23.1% | -23.1% (12) | 3.3% (1) | 1 |
| Financials | -7.3% | -7.4% (12) | 27.7% (4) | 0 |
| Utilities | 19.1% | 6.1% (1) | 26.1% (9) | 0 |
| Total | -14.3% | -14.3% (12) | 15.5% (4) | 1 |

Table 8: Effect on Revenue: Impulse = Large-Scale Asset Purchases (QE)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | 232.1% | -115.4% (5) | 232.1% (12) | 1 |
| Industrials | 114.5% (95% CI) | 0.94% (1) | 114.5% (12) | 1 |
| Real Estate | 65.8% (95%CI) | -12.1% (3) | 65.8% (12) | 1 |
| Financials | -12.4% | -21.7% (10) | -8.76% (6) | 1 |
| Utilities | 27% | -2.4% (5) | 32% (10) | 1 |
| Total | 121.6% (95% CI) | -5.6% (3) | 121.6% (12) | 1 |

Table 9: Effect on Price: Impulse = Large-Scale Asset Purchases (QE)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | 289.1% | 27.3% (2) | 483.5% (9) | 1 |
| Industrials | 93% (95% CI) | -1.2% (2) | 93% (12) | 1 |
| Real Estate | 56.9% | 3.3% (1) | 76.1% (6) | 1 |
| Financials | 125.1% (95% CI) | 7.6% (2) | 125.1% (12) | 1 |
| Utilities | 35.4% | -23.9% (4) | 35.4% (12) | 1 |
| Total | 65.2% (95% CI) | 6.4% (1) | 65.2% (12) | 1 |

Table 10: Effect on Revenue: Impulse = Forward Guidance (3-Month LIBOR–US T-Bill Spread)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | 37.8% (95% CI) | -2.2% (2) | 40.1% (11) | 1 |
| Industrials | 8.4% (95% CI) | -0.8% (1) | 8.8% (11) | 1 |
| Real Estate | 4% | -2.7% (3) | 4% (12) | 1 |
| Financials | 8.6% (95% CI) | -0.76% (1) | 9.1% (11) | 0 |
| Utilities | 0.26% | -2% (1) | 2.1% (11) | 1 |
| Total | 6.4% | -2.8% (3) | 6.4% (12) | 1 |

Table 11: Effect on Price: Impulse = Forward Guidance (3-Month LIBOR–US T-Bill Spread)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Industry | Cumulative Effect | Min Value (Quarter) | Max Value (Quarter) | Sign Test-Statistic (ß) |
| Energy | 36.7% | 4.37% (1) | 40.1% (12) | 1 |
| Industrials | 9.2% | -5.8% (3) | 13.5% (10) | 1 |
| Real Estate | -2.5% | -9.4% (9) | -0.6% (5) | 0 |
| Financials | 2.1% | -3.4% (1) | 6.7% (7) | 0 |
| Utilities | 10% | -0.6% | 10% | 1 |
| Total | 5.7% | -2.8% (3) | 7.5% (10) | 1 |

Table 12: Industry Fundamentals Data Set: 504 Stocks, 1512 Variables, 96,768 Observations.

|  |  |  |  |
| --- | --- | --- | --- |
| Industry | Number of Companies | Average Share of S&P 500 Equity Price | Average Share of S&P 500 Revenue |
| Comm. Services | 25 | 4.41% | 6.11% |
| Consumer Disc. | 61 | 17.74% | 12.92% |
| Cons. Staples | 33 | 5.44% | 14.43% |
| Energy | 26 | 4.65% | 12.30% |
| Financials | 66 | 12.14% | 8.94% |
| Health Care | 62 | 14.70% | 14.74% |
| Industrials | 73 | 14.01% | 12.92% |
| Info Tech. | 71 | 10.85% | 10.17% |
| Materials | 28 | 5.31% | 3.34% |
| Real Estate | 31 | 6.66% | 0.82% |
| Utilities | 28 | 4.08% | 3.32% |

Figure 1: Basic Vector Autoregressive Formula

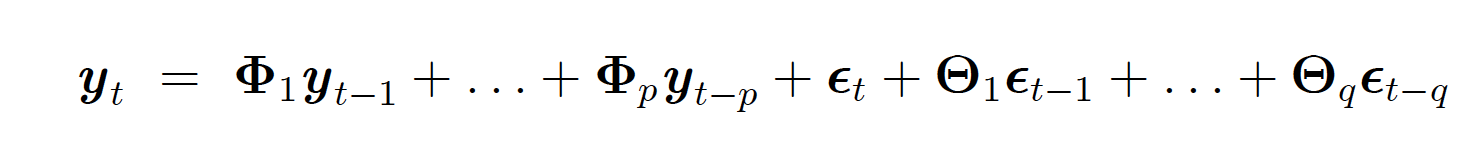


Figure 2: Monetary Shock Series



Figure 3: Aggregate Price IRFs for each measurement methods



Figure 4: Aggregate Revenue IRFs for each measurement methods



Works Cited

Bernanke, B. S. (2020). *The New Tools of Monetary Policy American Economic Association Presidential Address*. 57.

Chen, Q., Filardo, A., He, D., & Zhu, F. (2016). Financial crisis, US unconventional monetary policy and international spillovers. *Journal of International Money and Finance*, *67*, 62–81. https://doi.org/10.1016/j.jimonfin.2015.06.011

Dedola, L., & Lippi, F. (2000). The monetary transmission mechanism; evidence from the industries of five OECD countries. In *Temi di discussione (Economic working papers)* (No. 389; Temi Di Discussione (Economic Working Papers)). Bank of Italy, Economic Research and International Relations Area. https://ideas.repec.org/p/bdi/wptemi/td\_389\_00.html

Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2018). The Financial Market Effects of the Federal Reserve’s Large-Scale Asset Purchases. *24th Issue (Mar 2011) of the International Journal of Central Banking*. https://www.ijcb.org/journal/ijcb11q1a1.htm

Hetzel, & Robert. (2018). The Evolution of U.S. Monetary Policy. *Federal Reserve Bank of Richmond Working Papers*, *18*(01), 1–35. https://doi.org/10.21144/wp18-01

Lombardi, M. J., & Zhu, F. (2018). A Shadow Policy Rate to Calibrate U.S. Monetary Policy at the Zero Lower Bound. *International Journal of Central Banking*, *14*(5), 42.

Nieto, J. B. (2019). *DIFFERENCES IN INDUSTRY RESPONSES TO MONETARY POLICY SHOCKS: A STUDY OF INDUSTRY FINANCIALS, EQUITY PRICES, AND VALUATION*. 66.

Romer, C. D., & Romer, D. H. (2004). A New Measure of Monetary Shocks: Derivation and Implications. *American Economic Review*, *94*(4), 1055–1084. https://doi.org/10.1257/0002828042002651

Vissing-Jorgensen, A., & Krishnamurthy, A. (2011). The Effects of Quantitative Easing on Interest Rates. *Brookings Papers on Economic Activity*, *2*. https://doi.org/10.2139/ssrn.1784270