# The Effects of Conventional and Unconventional Monetary Policy Surprises on Asset Markets in the United States

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# The Effects of Conventional and Unconventional Monetary Policy Surprises on Asset Markets in the United States

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**Abstract**

This study estimates the impacts of conventional and unconventional monetary policy surprises on asset markets in the United States using the heteroskedasticity-based GMM technique suggested by Rigobon and Sack (2004). Monetary policy surprises have statistically significant effects on major asset markets in both periods, yet magnitudes of responses differ notably in the unconventional period. For the unconventional period, the impacts of monetary policy surprises on stock returns and the implied volatilities in stock and bond markets are found to be lower compared to the conventional period. For most of the other asset returns however, responses are similar or higher in the unconventional period.

*Keywords:* Monetary Policy; Asset Markets; Identification through Heteroscedasticity

*JEL Classification:* E43; E44; E52

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## 1. Introduction

Omitted variable bias and endogeneity problems are two major challenges that confront researchers who want to measure the effect of monetary policy surprises on asset prices. In the related literature, the most common approach to overcome these problems is the event study (ES) approach.[1] Gürkaynak and Wright (2012) suggest using ES methodology with very high-frequency data, i.e, in a small window around the monetary policy announcement. They indicate that with a small enough window, nothing other than the announcement should be affecting asset prices. The selection of a wide window around the announcement, though, would contaminate the analysis with other shocks. On the other hand, measuring the impact of unconventional monetary policy announcements in a small window may not be appropriate. Because, it may take time for the markets to digest the information content, as these announcements are very complicated and generally made clear with press conferences afterwards (Rogers et al., 2014). Then, carrying out ES analysis with a wide window may lead to biased estimates; on the other hand, using a small window may not provide us with the full impact of the monetary policy surprise.

Rigobon and Sack (2004) (henceforth, RS) develop a heteroscedasticity-based approach that is robust to endogeneity and omitted variables problems. This methodology, called identification through heteroscedasticity (ITH), relies on much weaker assumptions than ES analysis. ES methodology basically compares asset prices immediately after monetary policy announcements with those immediately

[1] Two notable examples using the ES approach are Kuttner (2001) and Gürkaynak et al. (2005).

before, and attributes the changes to monetary policy surprises. ES approach also implicitly assumes that, in the limit, the variance of the policy shock becomes infinitely large relative to the variances of other shocks on policy dates. ITH does not require such a strong assumption; on the contrary, we only need to observe a rise in the variance of the policy shock when the monetary policy decision is announced, while the variances of other shocks remain constant.[2] Therefore, ITH is considered more reliable in the literature as it depends on much weaker assumptions.[3]

In addition to the two difficulties mentioned above, unconventional monetary policy implementations have posed a new challenge for researchers that want to measure monetary policy surprises (MPS's). During the conventional monetary policy period MPS's were simply measured by using changes in short term interest rates.[4] Identifying MPS's during the unconventional monetary policy period, however, is difficult due to the existence of the ZLB and the absence of an observable measure of policy surprise. Once the policy rate has effectively hit the ZLB at the end of 2008, the Fed has not been able to use the target federal funds rate as the main policy instrument. Instead, Fed relied on large scale asset purchase programs (LSAP) and forward guidance to affect the medium- and long-term interest rates by which they aim to stimulate consumption and investment. When the Fed

[2] RS compare the assumptions under the ES and the GMM approaches, and provide a mathematical expression for the bias in ES estimation of the announcement effect.

[3] Using a daily window, RS estimates the impact of monetary policy surprises on stock and treasury bond markets in the U.S., for January 1994-November 2001. Recently, an increasing number of studies have investigated the impact of MPS on asset markets using the ITH methodology. For examples, see Ehrmann et al. (2011) for analyses on the United States and the Euro Area; Bohl et al. (2008) for an analysis on the largest four European countries and Kholodilin et al. (2009) for an analysis on all the European countries. Using ITH, Rosa (2011) documents the effects of changes in US monetary policy on stock prices in 51 countries. Rogers et al. (2014) use this methodology to measure the impact of unconventional monetary policy on bond markets.

[4] Studies that measure the impact of monetary policy on asset markets in the conventional period used various short-term market rates. For examples, RS use Eurodollar futures, Gürkaynak et al. (2005) and Kuttner (2001) use federal funds futures to measure the MPS.

sets the policy rate effectively to zero and also aims to manipulate the long end of the yield curve through LSAP it is not possible to use the short term interest rates to measure MPS's any more. Therefore, a new literature has emerged suggesting and using alternative indicators for the monetary policy stance during the unconventional monetary policy period. For examples, Wu and Xia (2014) and Lombardi and Zhu (2014) calculate a shadow policy rate; Gilchrist et al. (2015) and Chodorow-Reich (2014) use long-term treasury rates; Wright (2012), Glick and Leduc (2013) and Rogers et al. (2014) use the first principal component of the yields on treasury futures with various maturities. In our benchmark estimations, we use the monetary policy surprise (MPS) measure suggested by Wright (2012) for the unconventional period.

Following RS, we use a daily window, and ITH methodology, where we measure the impact of monetary policy surprises on various asset markets, namely stock, treasury bond, corporate bond and currency markets. The contributions of this paper to the literature are two folds. Firstly, we compare the effects of MPS's on asset prices during conventional and unconventional monetary policy periods. There are several papers which attempt to carry out a similar comparison. Glick and Leduc (2013) compare the impact of MPS in the two periods, but focusing on the currency market. Kiley (2014) analyzes the effects of long-term treasury yields on the stock market index on days of monetary policy announcements. These studies use intraday data with a small window in order to ensure that the monetary policy announcement is the only shock within the window. Besides, they focus on only one market (currency or stock markets). Using the ITH methodology, we are able to use a larger (daily) window, which we believe to be more appropriate in line with the discussions above, for the unconventional policy period. In addition, in contrast to the papers mentioned above, we do not focus on one market; instead, we analyze the responses of all major asset markets to MPS's. Secondly, we show that using changes in ten-year treasury rates produces similar estimation results to the MPS measure suggested in Wright (2012), while measuring the impact of unconventional MPS's on asset markets.

The rest of the paper is organized as follows. Section 2 outlines the methodology and data, Section 3 reports the estimation results and Section 4 concludes.

## 2. Methodology and Data

The dynamics of the short-term interest rate and the asset price are as follows:

$$\Delta i_t = \beta \Delta s_t + \gamma z_t + \varepsilon_t \quad (1)$$

$$\Delta s_t = \alpha \Delta i_t + z_t + \eta_t \quad (2)$$

where $\Delta i_t$ is the change in the policy rate, $\Delta s_t$ is the change in the asset price and $z_t$ is an unobservable common factor which affect both $\Delta i_t$ and $\Delta s_t$. The variable $\varepsilon_t$ is the monetary policy shock and $\eta_t$ is the asset market shock. The shocks $\varepsilon_t$ and $\eta_t$ are assumed to be serially uncorrelated and to be uncorrelated with each other and with the common shock $z_t$.

In this paper, the parameter of interest is $\alpha$, which measures the impact of a change in the policy rate $\Delta i_t$ on the asset return $\Delta s_t$. To apply the heteroscedasticity-based identification technique we need to observe a rise in the variance of the policy shock when the monetary policy decision is announced, while the variances of other shocks remain constant and given that the parameters $\alpha$, $\beta$ and $\gamma$ are stable. As in RS, we use the generalized method of moments (GMM) technique in order to estimate $\alpha$. Two subsamples are essential to implement the GMM technique. Policy days are days when the policy announcements are made. Non-policy days are the days immediately preceding the policy days. As detailed in RS, GMM estimation uses a comparison of the covariance matrices of the variables on the policy and the non-policy dates. There are two parameters to be estimated, namely; $\alpha$, the parameter of interest, and $\lambda$, a measure of the degree of heteroscedasticity that is present in the data. There are three moment conditions and two parameters to estimate. Therefore, overidentification restrictions enable us to test the model as a whole.

For the conventional period, following RS, we measure the monetary policy surprises using the changes in the short-term interest rate on the nearest Eurodollar futures contract to expire, which is based on the three-month Eurodollar deposit rate at the time the contract expires.[5] Since changes in short-term rates cannot proxy MPS's at ZLB, following Wright (2012), we proxy the MPS's by the first principal component of the duration adjusted yield changes of treasury futures with two-year, five-year, ten-year and thirty-year maturities. We analyze the responses of various asset markets to policy announcements, including the stock markets (represented by the Dow Jones Industrial Average, the S&P 500, the Nasdaq, and the Wilshire 5000); treasury bond markets (constant maturity rates on one-year, two-

[5] The data on eurodollar futures contracts until December 2008 are kindly provided by Dean Scrimgeour as used in Scrimgeour (2014).

year, five-year, ten-year and thirty-year maturity bonds); corporate bond markets (higher and lower grade corporate bonds, referring to Moody's AAA and BAA); exchange rate market (values of dollar vis-à-vis the trade weighted currency basket; euro; Swiss franc; British pound and Japanese yen).[6] We also include major implied volatility indices in the stock and bond markets (VIX and MOVE). In the empirical analysis, we use differences for the interest rates and log differences for all other asset prices. As in RS, the policy days considered are days of FOMC meetings and of the Chairman's semi-annual monetary policy testimony to Congress. The sample in RS runs from January 3, 1994 to November 26, 2001 and includes 78 policy dates. We extend this sample to June 18, 2014, which includes 205 policy dates, of which five are discarded due to holidays in financial markets. In addition to the FOMC meetings and semi-annual testimonies, we also include 6 unconventional monetary policy announcements as in Rogers et al. (2014). In total, we consider 206 announcements; 144 of which are for the conventional monetary policy period and 62 of which are for the unconventional monetary policy period. Following RS, the non-policy dates are taken to be the day before each policy date.

In order to be able to use the ITH methodology, MPS's should exhibit larger fluctuations on policy days relative to the non-policy days. Figure 1 reports the rolling standard deviations of daily changes in the short rate and longer-term treasury rates on policy and non-policy dates.[7]

[Figure 1]

Until the end of 2008, the variance of changes in the short-term interest rate rises substantially on the days of monetary policy shocks, as expected. Since 2009,

[6] All financial market data are obtained from Bloomberg.
[7] The window for the rolling variances is 30 observations.

due to the ZLB, the volatility of the short-term policy rate is low and does not differ in policy and non-policy days. On the other hand, the volatilities of longer-term interest rates (treasury rates with five and ten year maturities) are still more volatile on policy days, compared to non-policy days. Hence, longer-term rates can still reflect monetary policy surprises.

## 3. Empirical Results

GMM estimates for the parameter $\alpha$ are reported in Table 1. The second column of the table reports the results for the conventional period (January 1994-November 2008), using the monetary policy surprise measure suggested in RS. The third and the fourth columns report the results for the unconventional period, where the estimations in the third column uses the MPS measure suggested in Wright (2012) and the estimations in the fourth column uses the changes in the ten-year treasury rate as the MPS.

In order to be able to compare the impact of MPS in the two periods, we calibrate the MPS to lead a 25 basis points decline on the ten-year treasury bond rate. In the fourth column, since we use changes in the ten-year rate as a proxy to the MPS, we directly impose a 25 basis points easing on the ten-year rate.

The impact of MPS on all stock market returns, all treasury bond yields, implied volatilities and most of the exchange rates are highly significant in both conventional and unconventional periods. Although monetary policy surprises have statistically significant effects on major asset markets in both periods, magnitudes of responses differ notably across periods.

Our estimation results suggest that an MPS that leads to a 25 basis points easing on ten-year treasury rate results in a 2.02-2.58 percent increase in stock indices during the conventional period.[8] In the unconventional period, however, this increase falls to 1.16-1.53 percent. The decline in stock markets' response to MPS during the unconventional period is consistent with the findings in Kiley (2014).[9] Besides, using high-frequency (intraday) data for only the unconventional period, Rogers et al. (2014) find that an MPS (measured as in Wright, 2012) that lead to a 25 basis points easing in the ten-year treasury rate causes a 0.94 increase in S&P500, which is lower than our estimate of 1.47 with ITH and daily data.

[Table 1]

Unsurprisingly, the effect of MPS on short-end of the yield curve has declined in the unconventional period. For example, response of the one-year treasury bond to a MPS that lead to a 25 basis points easing on the ten-year rate was -0.27 during conventional period, yet has declined to -0.04 in the unconventional period. Responses of two-year and five-year treasury rates have also declined recently. One striking finding is that, the sign of the response of thirty-year treasury rate is different in two periods, being negative in the conventional period and positive in the unconventional period.

Another notable finding is that the corporate bond yields were statistically insensitive to MPS during the conventional period. However, we observe a significant

[8] Using the same monetary policy proxy for the January 1994-November 2011 period, RS finds that a 25 basis points surprise easing in the policy rate leads to a 1.3 percent to 2.5 percent increase in the stock market indices.

[9] Instead of directly measuring the effect of MPS, Kiley (2014) measures the impact of long-term interest rates on equity price movements on days of monetary policy announcements. Using intraday data, he finds that the association between long-term interest rates and equity prices is substantially attenuated in the period of ZLB.

response during the unconventional period. This is probably due to the Fed's direct purchase of these bonds, in context of LSAP.

The uncertainty indicators in stock and treasury bond markets (VIX and MOVE) are also affected significantly from the MPS in both periods. An easing in monetary policy leads to a decline in the uncertainty indicators, i.e., leads to higher risk appetite in both markets. Nevertheless, the impact of MPS on these uncertainty indicators falls (in magnitude) during the unconventional period. Another interesting finding is that the effect of MPS on the risk appetite in the treasury bond market is substantially higher than the stock market during the unconventional period.

The value of the dollar vis-à-vis the currencies of major trading partners of the U.S. (the dollar index) and the dollar/euro exchange rate give similar responses to an MPS in both periods. This is consistent with the findings in Glick and Leduc (2013). Besides, in both periods, the Swiss franc gives the highest responses among other currencies. However, the responses of British pound and Japanese yen differ substantially across the two periods. During the conventional period, the impact of MPS on the value of the dollar vis-à-vis the yen was relatively small (in magnitude) and insignificant. The impact of MPS on yen becomes significant in the unconventional period. The reverse happens for the pound.

Since the aim of the Fed is to affect the medium- and long-term interest rates during the unconventional monetary policy period, monetary policy surprises are mostly reflected in these interest rates, among other asset prices. In fact, our estimation results (consistent with the findings in Rogers et al., 2014) show that, among the treasury rates with various maturities, ten year treasury rate gives the highest response to monetary policy news. Hence, we also compare the empirical findings obtained with principal component measure with the change in ten-year treasury rate.[10] Strikingly, the estimation results, which are given in the third and fourth columns of Table 1, are surprisingly similar.[11] In other words, using the MPS measure suggested by Wright (2012) does not provide substantially different outcomes than using the changes in the ten-year treasury rate.

Table 2 reports the diagnostic tests. For all the cases considered here, the t-statistics on the coefficient $\lambda$ show that the change in the volatility of MPS on the policy date is satisfactory for the ITH estimation. Besides, for all the cases, the over-identification test results do not indicate any over-identification problem. Finally, an important finding is that the Hausman (1978) test results that question the validity of the ES assumptions point to significant biases for most of the ES estimates.

[Table 2]

## 4. Conclusion

This study estimates the impacts of conventional and unconventional monetary policy surprises on asset markets in the United States using the heteroskedasticity-based GMM technique suggested by Rigobon and Sack (2004). During the unconventional period, the impact of monetary policy surprises, measured as in Wright (2012), on asset markets is still strong although magnitudes differ from the conventional monetary policy period. For the unconventional period, the impacts of monetary policy surprises on stock returns and the risk appetites in stock and bond markets are found to be lower compared to the conventional period.

[10] As has been shown by Swanson and Williams (2014), ten year treasury rate has not been constrained by the existence of the zero lower bound.

[11] Examples of other papers which measure the effects of medium- and long-term treasury rates on asset markets during the unconventional policy announcement dates are Gilchrist et al (2015), Chodorow-Reich (2014) and Kiley (2014).

For most of the other asset returns however, responses are similar or higher in the unconventional period. Using the changes in ten-year treasury rates as monetary policy surprises leads to surprisingly similar results with the measure suggested by Wright (2012). We also show that, using a daily window, event study estimates of the impact of monetary policy on asset markets are significantly biased.

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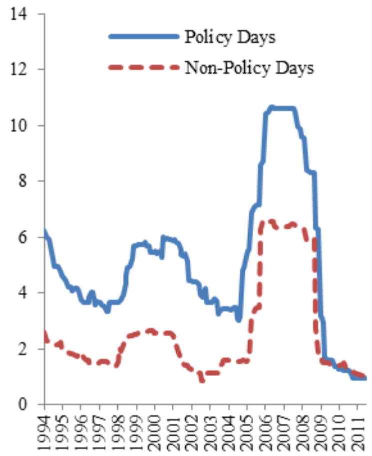
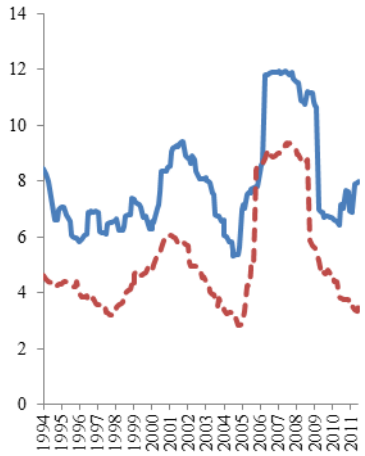
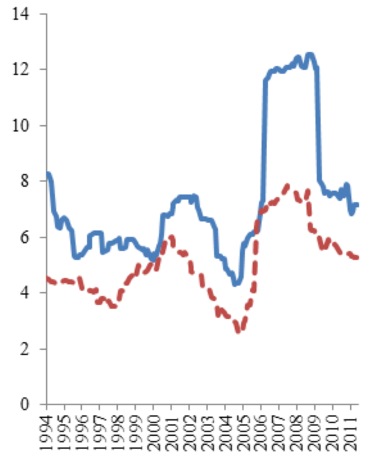
Figure 1. Rolling standard deviations of selected interest rates on policy and non-policy days

| Volatility of short-rate | Volatility of 5 year treasury rate | Volatility of 10 year treasury rate |
|---|---|---|
|   |  |  |

Notes: Each window includes 30 observations. The full sample runs from January 1994 to June 2014.

Table 1. Responses to MPS that lead to a 25 bp easing in 10yr treasury rate

| | Conventional (Jan94-Nov08) Reaction to ED3 | Unconventional (Dec08-Jun14) Reaction to MPS in Wright (2012) | Unconventional (Dec08-Jun14) Reaction to 10yr Treasury Rate |
|---|---|---|---|
| | estimate (std dev) | estimate (std dev) | estimate (std dev) |
| ***Stock Market Returns*** | | | |
| SP500 | 2.33 (0.84) | 1.45 (0.37) | 1.47 (0.41) |
| WIL5000 | 2.17 (0.77) | 1.53 (0.38) | 1.54 (0.42) |
| NASDAQ | 2.58 (0.79) | 1.50 (0.37) | 1.47 (0.41) |
| DJIA | 2.02 (0.83) | 1.16 (0.29) | 1.16 (0.32) |
| ***Treasury Bond Yields*** | | | |
| 1-year Treasury | -0.27 (0.04) | -0.04 (0.00) | -0.04 (0.00) |
| 2-year Treasury | -0.35 (0.05) | -0.11 (0.01) | -0.11 (0.01) |
| 5-year Treasury | -0.34 (0.05) | -0.24 (0.01) | -0.25 (0.01) |
| 10-year Treasury | -0.25 (0.05) | -0.25 (0.01) | -0.25 |
| 30-year Treasury | 0.08 (0.02) | -0.14 (0.02) | -0.13 (0.01) |
| ***Corporate Bond Yields*** | | | |
| Corp: Higher Grade | -0.00 (0.03) | -0.17 (0.02) | -0.16 (0.02) |
| Corp: Lower Grade | -0.02 (0.03) | -0.16 (0.01) | -0.17 (0.02) |
| ***Implied Volatility Indices*** | | | |
| VIX | -13.30 (4.53) | -4.61 (2.44) | -5.14 (2.14) |
| MOVE | -12.78 (1.48) | -8.86 (1.30) | -8.89 (1.22) |
| ***Exchange Rate*** | | | |
| Dollar Index | -0.96 (0.15) | -1.11 (0.27) | -1.14 (0.23) |
| Dollar vs EURO | -1.28 (0.22) | -1.22 (0.34) | -1.26 (0.30) |
| Dollar vs GBP | -1.15 (0.19) | -0.72 (0.21) | -0.58 (0.17) |
| Dollar vs CHF | -1.47 (0.28) | -1.25 (0.37) | -1.36 (0.37) |
| Dollar vs JPY | -0.75 (0.46) | -1.16 (0.32) | -1.22 (0.30) |

Table 2. Diagnostic Tests

| | Conventional (Jan94-Nov08) Reaction to ED3 | Unconventional (Dec08-Jun14) Reaction to MPS in Wright (2011) | Unconventional (Dec08-Jun14) Reaction to 10yr Treasury Rate |
|---|---|---|---|
| | test stat [p-value] | test stat [p-value] | test stat [p-value] |
| ***Stock Market*** | | | |
| Test of Heterogeneity | 7.72 [0.00] | 2.43 [0.02] | 2.95 [0.00] |
| Test of O.I.Restrictions | 1.52 [0.99] | 1.68 [0.99] | 1.51 [0.99] |
| Test of GMM vs ES | 60.70 [0.00] | 18.18 [0.00] | 12.18 [0.00] |
| ***Treasury Bonds*** | | | |
| Test of Heterogeneity | 8.57 [0.00] | 37.30 [0.00] | 53.16 [0.00] |
| Test of O.I.Restrictions | 11.91 [0.22] | 7.96 [0.72] | 3.93 [0.97] |
| Test of GMM vs ES | 1.87 [0.12] | 14.19 [0.00] | 594.25 [0.00] |
| ***Corporate Bonds*** | | | |
| Test of Heterogeneity | 6.08 [0.00] | 14.68 [0.00] | 18.46 [0.00] |
| Test of O.I.Restrictions | 8.24 [0.14] | 0.36 [0.99] | 1.15 [0.95] |
| Test of GMM vs ES | 11.34 [0.00] | 2.39 [0.10] | 1.59 [0.21] |
| ***Implied Volatility Indices*** | | | |
| Test of Heterogeneity | 7.32 [0.00] | 2.33 [0.02] | 2.62 [0.01] |
| Test of O.I.Restrictions | 0.014 [0.99] | 1.17 [0.95] | 0.97 [0.96] |
| Test of GMM vs ES | 89.44 [0.00] | 44.56 [0.00] | 26.35 [0.00] |
| ***Exchange Rate*** | | | |
| Test of Heterogeneity | 7.84 [0.00] | 2.48 [0.02] | 3.80 [0.00] |
| Test of O.I.Restrictions | 1.00 [0.99] | 6.14 [0.86] | 5.43 [0.91] |
| Test of GMM vs ES | 0.90 [0.48] | 16.14 [0.00] | 0.81 [0.55] |

Notes: Test of heterogeneity is a t-test on the coefficient $\lambda$. The test statistic for the over-identifying restrictions has a chi-squared distribution with the degrees of freedom being the number of over-identifying restrictions. The Hausman test-statistic for the validity of the ES assumptions has an F distribution with (N, T-1) degrees of freedom, where N denotes the number of coefficients being estimated and T is the number of observations in the estimation sample.