Unconventional US Monetary Policy and International Financial Market Stability

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Abstract

From December 2008 to December 2015, the Federal Reserve held interest rates at the zero lower bound. Unable to lower short term rates further, the Fed engaged in unconventional monetary policy, buying large quantities of US assets and Treasury bonds. This paper examines the international effect of these large scale asset purchases on foreign financial markets. Using a panel VAR estimation on OECD countries, I find the Fed's unconventional monetary policy decreased global stock market volatility by roughly 10% with little influence on the yield curve. I find slightly larger results for Eurozone countries. Overall, these results indicate the Fed's unconventional monetary policies had a noticeable impact on financial markets throughout the developed world.

Keywords: Panel VAR, International Spillovers, Unconventional Monetary Policy, Financial Market Volatility, Yield Curve

JEL Classification: E41, E52, F33, F42

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1 Introduction

The unconventional monetary policy undertaken by the Federal Reserve in the late-2000s and early-2010s was nothing if not controversial with wide ranging effects. In late 2008 with economic conditions worsening, the Federal Reserve lowered the Federal Funds Rate to the zero lower bound. However, economic conditions did not improve, leaving the Fed little choice but to continue to try for monetary stimulus using unconventional measures. In early 2009, the Fed began buying large amounts of mortgage backed securities and government sponsored entity debt, and told markets it would leave interest rates at zero for "an extended period of time." As economic conditions failed to improve, the Fed took extreme measures two more times, buying large amounts of Treasury securities to inject liquidity into the financial market. Over the course of the next seven years, multiple rounds of quantitative easing (QE) brought the Federal Reserve's balance sheet from roughly $800 billion in 2008 to over $4.5 trillion in 2015.

Because the Federal Reserve occupies a larger portion of the US financial market than it would have with traditional policy, it is natural for investors to look elsewhere to try to find higher yields. As investors migrate to different markets, both domestic and international, they create spillover effects of this policy. In domestic and foreign stock markets, the greater presence of investors translates to a greater pool of potential buyers, lowering volatility. In bond markets, a larger number of investors translates to higher priced bonds with lower yields. Regardless of the market, this greater number of displaced investors creates spillovers from US policy as investors change their optimal asset allocation.

This paper examines these spillover effects of the Fed's unconventional monetary policy from December 2008 to December 2015 on foreign financial markets. To examine the dynamic spillover effects across a set of OECD countries, I use a panel VAR. Results indicate that unconventional monetary policy decreased the volatility of foreign stock markets, with results slightly larger when limited to the Eurozone. The structure of the paper is as follows: section 2 reviews the literature surrounding US monetary policy spillovers and financial

market effects of quantitative easing. Section 3 details the data and discusses the panel VAR method in detail. Finally, section 4 provides the results of the panel VAR estimation both for all OECD countries and for just Eurozone countries, and section 5 concludes.

2 Literature

Even after the fall of the Bretton Woods system, US monetary policy continued to have significant effects on global markets. Iacoviello and Navarro (2018) find that US monetary policy can have spillover effects through three primary channels: the exchange rate channel, the trade channel, and the financial channel. They find that US monetary policy shocks have spillovers to advanced economies through the financial and trade channels, pointing to a global reliance on US demand and financial assets. Moreover, Miranda-Agrippino and Rey (2015) show that US monetary policy is the primary driver for the "global factor" underlying risky assets internationally. Herein US monetary policy can have another spillover effect: US policy can slow the global economy which then spreads to each member of the global economy, potentially changing the influence of US policy. Davis and Zlate (2019) show domestic responses to foreign monetary tightenings are key to understanding the magnitude of a spillover. Using a counterfactural VAR, their results show omitting domestic policy biases capital outflows and, potentially, other variables, significantly biasing the estimated effect of a foreign tightening.

The Federal Reserve's large involvement in the bond market was bound to have spillovers not seen with traditional policy. Indeed, Gagnon, Raskin, Remache, and Sack (2011) examine the effect of these large scale asset purchases (LSAPs) on US Treasury bond yields. Looking at the response of bond markets to US policy announcements, they find the unconventional policies lowered longer term bond yields by roughly 1 percentage point. What's more, Gagnon et al. find that the Fed lowered long term interest rates by lowering the term premium, rather than lowering the bonds' risk premium. They only examine policy responses

through the end of the first round of quantitative easing, so later rounds could have increased this effect. Taken further, Mallick, Mohanty, and Zampolli (2017) examine how changes in the Fed's Treasury holdings change domestic financial market conditions. They find while QE likely did not influence real outcomes in the US, the large scale asset purchases decreased US stock market volatility and term premia over a longer horizon. In contrast, traditional pre-crisis policy had no effect over market volatility or term premia. Hattori, Schrimpf, and Sushko (2016) looked at market reaction to Federal Reserve announcements during this time to examine the reason behind the lower market volatility. They find this decrease in volatility largely comes from lower perceptions of the likelihood of tail risks, thereby relaxing financial intermediaries risk bearing constraints.

The effects of QE were not limited to the US. Indeed, Fratzscher, Lo Duca, and Straub (2017) find that rounds of QE focused on US Treasury securities, QE2 and QE3, caused a global rebalancing of assets away from the US, both through the Fed's guidance and through the actual policy implementation. As the Fed occupied a larger portion of the US debt market, global investors began to look elsewhere internationally, opening unconventional monetary policy to global spillovers through the financial channel discussed in Iacoviello and Navarro (2018) or the global factor discussed in Miranda-Agrippino and Rey (2015). Bauer and Neely (2014) use a dynamic term structure model to examine the response of foreign bonds to US quantitative easing. They find developed countries saw a decline in bond yields as a result of QE, with the magnitude of the change varying widely across countries. Further, Neely (2015) finds a similar result while pointing to "jump depreciations" in the exchange rate shortly after policy announcements. This showed foreign financial markets are susceptible to unconventional monetary policy spillovers through the exchange rate channel as well as the financial channel.

3 Data and Methodology

To examine how unconventional monetary policy influenced financial market stability in developed countries, I run a panel VAR on a panel of 2008 OECD-member countries (24 countries in total) using a country's policy rate, bond yields, inflation rate, industrial production, stock market volatility, and exchange rates with the US dollar, as well as a variable to reflect changes in US monetary policy. I do not include countries that gained entry to the OECD during my sample, only countries who were already members in late 2008. Importantly, through the sample many OECD countries experience sovereign debt crises, such as Spain, Portugal, and Ireland. While traditional intuition states that, during a sovereign debt crisis, a country's bond yields and stock market volatility increase as investors respond to greater uncertainty, I include these countries in my estimation. There is large heterogeneity across the sample, and how a country responds to US policy, even in a debt crisis, is important and gives a fuller picture of how unconventional policy influenced foreign market volatility.[1] Unfortunately, the OECD data omits industrial production and inflation for Australia and New Zealand, as well as industrial production for Chile, so there are gaps in the panel for those countries.

3.1 Identification of US Monetary Policy Shocks

From December 2008 to December 2015, the Federal Funds Rate did not adequately capture developments in monetary policy such as quantitative easing because the rate was against the zero lower bound. To capture unconventional monetary policy movements, I use the Treasury holdings at the Federal Reserve. While the first round of QE focused largely on mortgage backed securities and government sponsored entity debt, the second and subsequent rounds of quantitative easing focused largely on Treasury bonds, so the growth in the Fed's Treasury bond holdings should reflect the size and scope of each round of quantitative easing. The Treasury holdings at the Fed increase during times of quantitative easing and are largely flat

[1] The results are nearly the same, regardless of whether Portugal, Spain, Ireland, and Greece are included.

between each round of QE, so this should give an accurate description of QE policy over this time period. To identify US monetary shocks, I regress the growth in the Fed's Treasury holdings on a set of current and lagged controls:

$$TH_{t,US} = \gamma_0 + \gamma_1 Z_{t,US} + \epsilon_t \tag{1}$$

where Z_t includes CPI inflation, US GDP growth, and lagged values of the policy variable, similar to the variables considered in the Taylor Rule. The size of the shock is then the residual of the above regression, ϵ_t. The size of monetary shocks over time can be seen in Figure 1.

3.2 International Data

Next, I include the interest rate of the foreign country, similar to the Davis and Zlate (2019). Including the domestic interest rate allows me to control for domestic policy movements that could potentially influence the country's bond yields. This allows me to further isolate the effect of US monetary policy on another country's bond yields. However, many of these countries' policy rates hit the zero-lower bound during the sample. Wu and Xia (2015) develop an alternative policy rate that captures the monetary policy of the time through changes in the term structure of interest rates. If the true target rate is above zero, the Wu-Xia Shadow Rate is exactly the target rate. However, when the true target rate is at the zero-lower bound, the Wu-Xia Shadow Rate is at or below zero to reflect the unconventional policies. The Reserve Bank of New Zealand uses the Wu-Xia method to calculate a shadow rate for the EU, UK, and Japan. Including this allows me to control for unconventional monetary policy undertaken by non-US central banks in a uniform way. For countries without a Wu-Xia shadow rate, I simply use the traditional domestic target rate provided by each central bank. However, it should be noted that, because many members of the OECD are in the Eurozone, many of these countries have the same movements in monetary policy.

I do not use the Wu-Xia Shadow Rate for the US for three reasons: first, the Federal Reserve conducted unconventional monetary policy largely by buying assets, often focusing on Treasury bonds. As such, movements in the Fed's Treasury holdings are closer to the Fed's actual control variable than the Wu-Xia rate. In turn, monetary shocks are calculated using the actual variable the Fed targeted, better reflecting monetary policy. Second, the Wu-Xia rate moves fairly slowly in response to rounds of quantitative easing while the Treasury holdings show the exact movements in the Fed's policy, so the Wu-Xia rate does not fully capture the start-stop nature associated with multiple rounds of quantitative easing. Finally, the Wu-Xia rate was primarily developed to allow researchers to treat policy above and below the zero lower bound as the same in their models. However, this study only examines the effect of US policy while at the zero lower bound. In contrast, the Wu-Xia rate works well for international policy as other central banks hit the zero lower bound at different points in the sample. There is, however, a moderate negative relationship between Wu-Xia rate shocks and Treasury holdings shocks with a correlation coefficient of -0.41. The negative relationship alludes to the fact that a positive Wu-Xia shock is contractionary while a positive Treasury holding shock is expansionary.

The remaining endogenous variables in the panel VAR below are each country's monthly industrial production, inflation rate, yield curve, and exchange rate, each taken from the OECD's data center. I get stock market data from the WRDS World Indices database. The database creates a market capitalization weighted index for each country from a portfolio of companies traded on the country's primary stock exchange. I take the standard deviation of each month's daily returns as the monthly market volatility. The OECD publishes 3-month bond yields as short-term yields and 10-year bond yields as long-term yields. I take the spread between 3-month bond yields and 10-year bond yields to get a better estimation for the slope of each country's yield curve. Using measures for each country's domestic economic variables, such as industrial production and inflation, allows me to account for changes in financial market stability due to changes in the domestic economy. Several exchange rates,

such as the Euro/USD and GBP/USD, are given as dollars per unit of domestic currency. For consistency across the sample I convert all exchange rates to units of domestic currency per dollar. This ensures all exchange rates can be compared similarly and makes possible uniform interpretation of results. I take log first differences of industrial production and exchange rates to ensure stationarity. Taken together, my panel covers 24 countries over 85 months, for a total of roughly 2,000 observations. Summary statistics for the data are in Table 1.

3.3 Panel VAR estimation

I estimate the effect of unconventional US monetary policy using the panel VAR method discussed in Abrigo and Love (2016) and Canova and Ciccarelli (2013). Panel VARs are very similar to standard VARs in that they allow variables to be endogenous to the model and interdependent. However, a panel VAR incorporates a cross-sectional element to a standard VAR model. A panel VAR is estimated using the equation:

$$y_{i,t} = A_{0i}(t) + A_i(\ell)y_{i,t-1} + F(\ell)W_t + u_{i,t} \tag{2}$$

$$i = 1, \ldots, N;\ t = 1, \ldots, T$$

where $y_{i,t}$ is a vector of G outcome variables for country i in time t, W_t is a $Gx1$ vector of exogenous variables, and $u_{i,t}$ is a $Gx1$ vector of random disturbances. In essence, y_{it} in (2) is a stacked matrix of outcomes, Y_t, for each country, $i = 1, \ldots, N$. A key feature of a panel VAR estimation is that it allows for the use of a panel of countries and accounts for cross sectional heterogeneities while still retaining the benefits of a VAR, such as dynamic interdependencies and unrestricted links across units. Further, a panel VAR is useful when the estimation has a low number of time observations, T. Panel VARs have been used to estimate international spillovers before in Canova et. al (2012) and propagation of disturbances between the US and EU economies in Caivano (2006). Lastly, they allow for the construction of average

effects of a shock across a panel. Importantly, the panel VAR can produce these average effects through impulse response functions. The important impulse response functions will be how stock market volatility and the interest rate spread respond to shocks from the US monetary policy measure.

I include US monetary shocks as an exogenous variable. Including US policy shocks instead of simply the US policy measure ensures the Federal Reserve does not consider spillovers when it sets policy, but international financial market participants form expectations of US policy movements based on US data and respond accordingly. This should reflect the literature's result that US monetary policy is the global hegemon, and investors treat it as such.

4 Results

The VAR uses 12 lags, and results are from a one standard deviation expansionary shock to the Fed's Treasury holdings, equivalent to an intervention the size of QE3. Figure 2 shows the response of each variable to a shock of this size. An expansionary shock to the Fed's Treasury holdings decreases foreign stock market volatility by 10% contemporaneously. Lower volatility persists for roughly the first 5 months after the policy is enacted, pointing to the effect coming from both the Fed's guidance and their larger presence in financial markets. This shows QE had similar effects internationally to the domestic effects seen in Mallick, Mohanty, and Zampolli (2017) and Hattori, Schrimpf, and Sushko (2016).

Interestingly, the spread between 10 year and 3 month government bonds does not significantly move throughout the time horizon. At first, this appears to run counter to the results in Bauer and Neely (2014) that QE depressed longer term bond prices internationally. However, as the Fed lowered interest rates to respond to the crisis and slowing economic conditions, short term (3 month) interest rates fell about as much as longer term interest rates as investors knew interest rates would be low for the duration of a short term bond.

In this, QE still depressed bond yields while causing the slope of the yield curve to remain largely the same internationally. As can be seen from the figure, QE had little effect on international output. However, it did raise inflation slightly, causing a small increase in interest rates across the panel. In turn, the dollar depreciates by about 1% across the panel.

Given that QE caused a decline in foreign bond yields and little change in the slope of the yield curve, this lower volatility suggests two things: first, international market participants relaxed their risk bearing constraints in response to greater market liquidity as discussed in Hattori, Schrimpf, and Sushko (2016). Second, because the Federal Reserve occupied a larger portion of the US bond market, many traditional US bond traders were forced to invest elsewhere, increasing the pool of potential buyers for international stocks. Taken together, these results show unconventional US monetary policy creates different spillovers than those seen from traditional policy in Iacoviello and Navarro (2018) and Miranda-Agrippino and Rey (2015).

4.1 Results for Eurozone Countries

Next, I limit the panel VAR to countries in the Eurozone. Doing this allows for each country to have the same monetary policy and exchange rate with the dollar, limiting the heterogeneity in these important measures. The results for Eurozone countries are given in Figure 3. Overall, the results mirror those for the full panel. A QE shock still has a statistically significant contemporaneous effect on volatility. However, this shock decreases volatility by roughly 15% for the Eurozone, slightly larger than the result for the full sample.

A shock to the Fed's Treasury holdings still has little influence over output while raising inflation. The ECB responds more aggressively to higher inflation than average central bank for the whole sample, increasing rates by about 12 basis points. Taken with the shock, this causes the dollar to depreciate roughly 2% relative to the Euro. Interestingly, even with the ECB increasing interest rates, the yield curve potentially steepens slightly. This points to one of two things: global investors expected the ECB to eventually lower rates, thus pricing

short term bonds higher. Alternatively, it could point to a larger presence of foreign bond investors in the European bond market as a result of the Fed's involvement in the US market. Given the consistency of this result across the sample, it is clear the Fed's unconventional policies from 2008 - 2015 had noticeable spillover effects to foreign financial markets.

5 Conclusion

This paper estimates the effect of the Fed's Quantitative Easing program on foreign financial markets. Overall, QE shocks decrease foreign stock market volatility slightly. This largely follows intuition, as the Fed crowds out bond investors in the US, they increase the potential pool of buyers in foreign markets, depressing volatility. While QE caused a noticeable depreciation in the value of the dollar internationally, it had little effect on the slope of yield curves. This points to a similar movement in short term rates in response to Fed announcements and long term rates in response to Fed involvement. QE had little effect on traditional economic outcomes throughout OECD countries. Industrial production and inflation responded only slightly to shocks to the Fed's Treasury holdings. These results largely held true when limited to Eurozone countries. European stock market volatility decreased 15% in response to a QE shock.

Taken as a whole, these results shed light on how unconventional monetary policy can have different spillover effects. Moreover, as other countries have undertaken unconventional monetary policies in recent years, it shows how such policies can influence global financial markets. These results shed light on a potential driver behind the financial channel for US monetary policy spillovers discussed in Iacoviello and Navarro (2018) and Miranda-Agrippino and Rey (2015). However, it still remains to be seen how unconventional monetary policy influences emerging market economies, both through financial sectors and through capital flows.

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Tables

Table 1: Summary Stats

Variable	**Obs**	**Mean**	**St. Dev.**	**Min**	**Max**
Treasury holding growth	2039	0.02	0.03	-0.01	0.11
Industrial Production	1784	95.72	10.18	54.14	114.53
Inflation	1869	1.68	1.93	-6.54	18.57
Home Wu-Xia Target Rate	2036	0.73	2.85	-6.75	18
Exchange Rate	2038	67.48	229.85	0.59	1448.62
Bond Yield Spread	1999	1.80	1.71	-9.34	12.63
Volatility	2039	0.01	0.006	0.002	0.06

Figures

Figure 1: Shocks to the growth rate in the Fed's Treasury Holdings

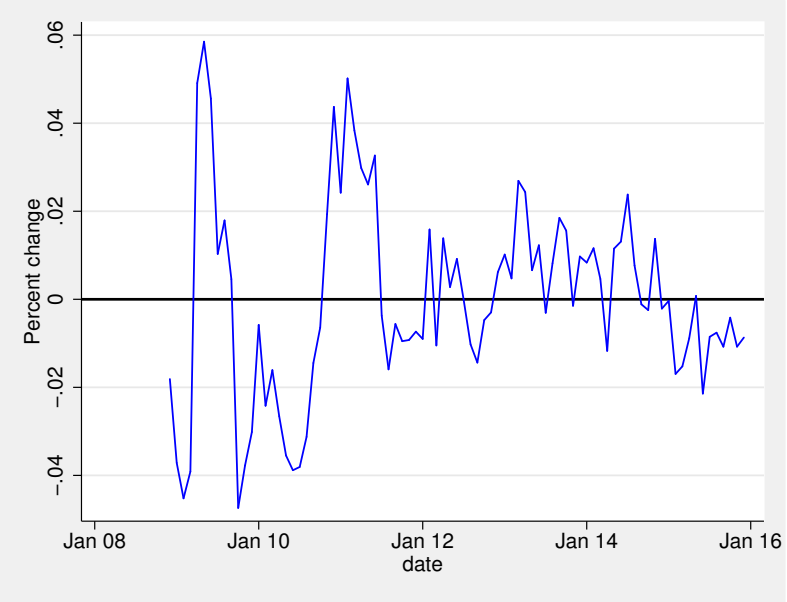

Figure 2: OECD response to a one standard deviation shock in the Fed's Treasury purchases

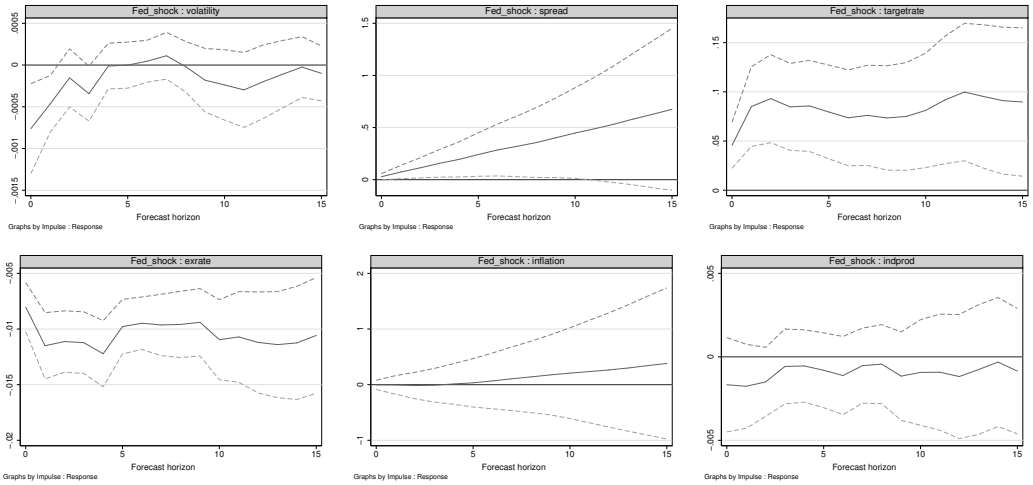

Figure 3: Eurozone response to a one standard deviation shock in the Fed's Treasury purchases