Estimating the Effects of Quantitative Easing on the Real Economy

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Abstract

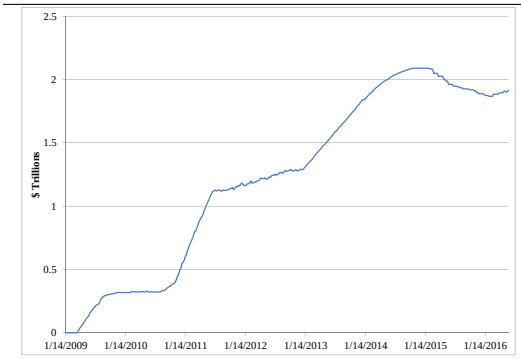
The Federal Reserve's large scale asset purchases since 2008, made as part of its Quantitative Easing programs, were one of the most significant policy responses to the Great Recession. In this paper, we estimate the effects of the Fed's asset purchases on unemployment and prices using a straightforward vector autoregression approach. Contrary to conventional wisdom and much of the related literature, we find that an innovation to asset purchases leads to a small but significant increase in the unemployment rate, and a decline in the price level. We find that these results are robust to the inclusion of numerous additional control variables and alternate specifications.

1 Introduction

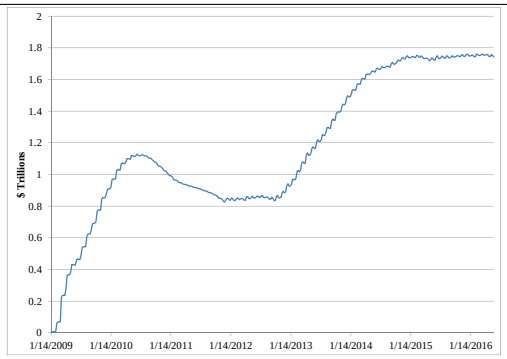
By December 2008, the Federal Reserve had exhausted its conventional response to the financial crisis and emerging recession by lowering its Federal Funds Rate target to a range just above zero. Despite then having very limited ability to further affect short term interest rates, the Fed embarked on a series of large scale asset purchases that included three rounds known as Quantitative Easing. Quantitative easing in the United States is striking both for its scope– it has ballooned the Fed's balance sheet to $4.5 trillion as of December 2016– and for the unusual mix of assets purchases– mostly mortgage backed securities and longer term Treasury Bonds instead of the traditional choice of short-term Treasuries.

Figure 1: Federal Reserve's Holdings of Non-Conventional Assets

Long-Term Treasuries



Mortgage Backed Securities



Source: Federal Reserve Bank of Cleveland

Quantitative Easing remains one of the most prominent policy responses to the Great Recession. Because of its unconventional nature, however, it has been difficult to quantify its effects on key macroeconomic variables. This paper attempts to exploit recent data using a standard Vector Autoregression Approach to determine the effects of Quantitative Easing. Surprisingly, we find that not only did QE fail to achieve lower unemployment (or higher industrial production), but we find that increases to the Fed's balance sheet lead to a significant increase in unemployment. This result is surprisingly robust to numerous alternate specifications.

The defining feature of Quantitative Easing is the continued expansion of the Fed's balance sheet despite short-term interest rates already being near zero. The Federal Reserve identified several reasonable ways by which QE might boost aggregate demand. These include increasing access to credit by increasing liquidity, spurring lending by taking risky assets such as mortgage backed securities off of private firms' balance sheets, and reducing longer-term interest rates through the purchase of longer-term securities and by reducing expectations of future short-term interest rates.

Several recent empirical papers seek to estimate the effects of Central Bank's asset purchases near the zero lower bound. These papers generally find that asset purchases increase both output and CPI, the opposite result of our paper. The closest paper to ours is Weale and Wieladek (2014). They use monthly data running from 2009M3 through 2014M5 for both the US and UK. Various Bayesian VAR identification strategies then find that asset purchases have similar effects as conventional expansionary monetary policy.[1] The main difference between their approach and ours is that they rely on announcements of asset purchases, along with GDP, CPI, and equity prices, where we use actual asset purchases. Meinush and Tillmann (2016) find a similar result for the United States using VARs that contain a binary variable for whether or not there has been an announcement of an asset purchase.

We use actual asset purchases for three reasons. First, although credible and unexpected announcements of asset purchases are likely to have larger effects than actual purchases on agents' expectations, it is difficult to identify announcements that meet these criteria. Second, some of the mechanisms by which QE may affect the real economy, such as removing risky mortgage backed securities from private firms' balance sheets, may depend on actual purchases instead of announcements. Finally, using actual purchases allows us to avoid treating purchases as a binary variable and thus exploit variation in the magnitude of purchases across months.

Other empirical are informative by using other (than the Federal Reserve) Central Bank's QE programs. Gamboacorta, Hofmann, and Peersman (2014)

[1] See, for example, Christiano, Eichenbaum, and Evans (1999) for an analysis of conventional monetary policy.

use a panel VAR over 8 countries to find that increasing central bank assets near the zero lower bound has similar effects as conventional monetary expansions. Kapetanios *et al.* (2012) use several vector autorgression based approaches and find that the Bank of England's QE program that started in 2009 likely raised both aggregate output and the price level by over 1%. The evidence from Japan, however, is less promising. As discussed in Ugai (2007), and Kamada and Sugo (2006), empirical evidence, including VAR analysis, suggests that once the Bank of Japan neared its zero lower bound, subsequent expansionary monetary policy appears to have had only small effects on either Japanese prices or industrial production.

The theoretical literature generally suggests that QE should have, at best, limited effects on aggregate demand. Wen (2014) uses a theoretical model to examine the effect of the Fed's purchases of private debt, a significant part of its asset purchases during QE.[2] He finds that this policy is only effective at boosting aggregate demand if the purchases are large, persistent, and if the inflation target is high. Using this model, it is thus unlikely that the Fed's policy between 2009 and 2015 was effective. Chen, C urida, and Ferreo (2012) use a similar model and find that the Fed's second round of QE raised GDP by about one-third of a percent and barely affected inflation. Eggertson and Woodford (2003) suggest that the effect of further asset purchases is limited to strengthening expectations of low, future interest rates.

Much of the criticism of the Fed's QE program centered on its potential for de-stabilizing prices while offering little prospect at boosting output or employment. Some argued that at near-zero interest rates, bonds are similar to money and that the Fed purchasing the former using the latter should have only small effects on the real economy. It follows from these arguments that QE may be ineffective, but that it is unlikely to be detrimental to the real economy. Although we are unaware of any formal theoretical work that predicts QE, as implemented by the Federal Reserve, would have increased unemployment, there are some plausible mechanisms where it could be detrimental.

In the voluminous New Keynesian literature and many older new-classical

[2]The exact dates and terminology regarding QE vary across sources. In this paper, we define QE in the United States as any large scale asset purchases after interest rates neared zero in late 2008.

models, a decline in output may occur if inflation fails to reach its expected value.[3] It is possible that QE may have increased inflationary expectations that, when unmet, led to a reduction in output. This possibility is consistent with data that show that popular inflationary forecasts generally overestimated inflation during the QE period.[4] We are unaware, however, of any work that formalizes this possibility.

Benhabib, Schmitt-Grohe and Uribe (2001) show that in a non-linear New Keynesian model, a second undesirable steady state exists that exhibits low inflation, low output, and low interest rates. Although this "Neo-Fisherian" steady state has been of considerable interest, no work has specifically shown that if the economy is stuck in this steady state, that further asset purchases will make the situation worse. The empirical results of this paper thus remain a puzzle.

2 Data and Results

Our methodology consists of a vector autoregression (VAR) where a simple recursive structure is employed to identify exogenous shocks to each variable. Our econometric consists of:

$$Y_t = \alpha + \sum_{i=1}^{4} A_i Y_{t-i} + u_t \tag{1}$$

where

$$Y_t = \begin{bmatrix} (Inflation)_t \\ (Federal\ Reserve's\ Balance\ Sheet)_t \\ (Unemployment\ Rate)_t \\ (Effective\ Federal\ Funds\ Rate)_t \\ (Treasury\ Bill\ Rate)_t \end{bmatrix} \tag{2}$$

We use the Akaike Information Criteria to determine that four lags are appropriate. As discussed later, different lag lengths do not affect our main results. We use the U-3 unemployment rate and the Consumer Price Index for all Urban consumers to measure the state of the business cycle, the Fed's

[3] See Woodford (2003).

[4] See Bauer and McCarthy (2015).

balance sheet to measure asset purchases, the Federal Funds rate to measure conventional monetary policy, and the ten year Treasury yield to measure long term interest rates.

The Federal Funds rate, 10-year Treasury bill rate, and (U-3) unemployment rate data are from the Federal Reserve Bank of St. Louis's Economic Database (FRED). The Federal Reserve's balance sheet is constructed by Gresham Law Database that extracts historical balance sheet data. All variables are measured monthly from January 1, 1970 to October 1, 2015. Simple descriptive statistics are reported below in Table 1.

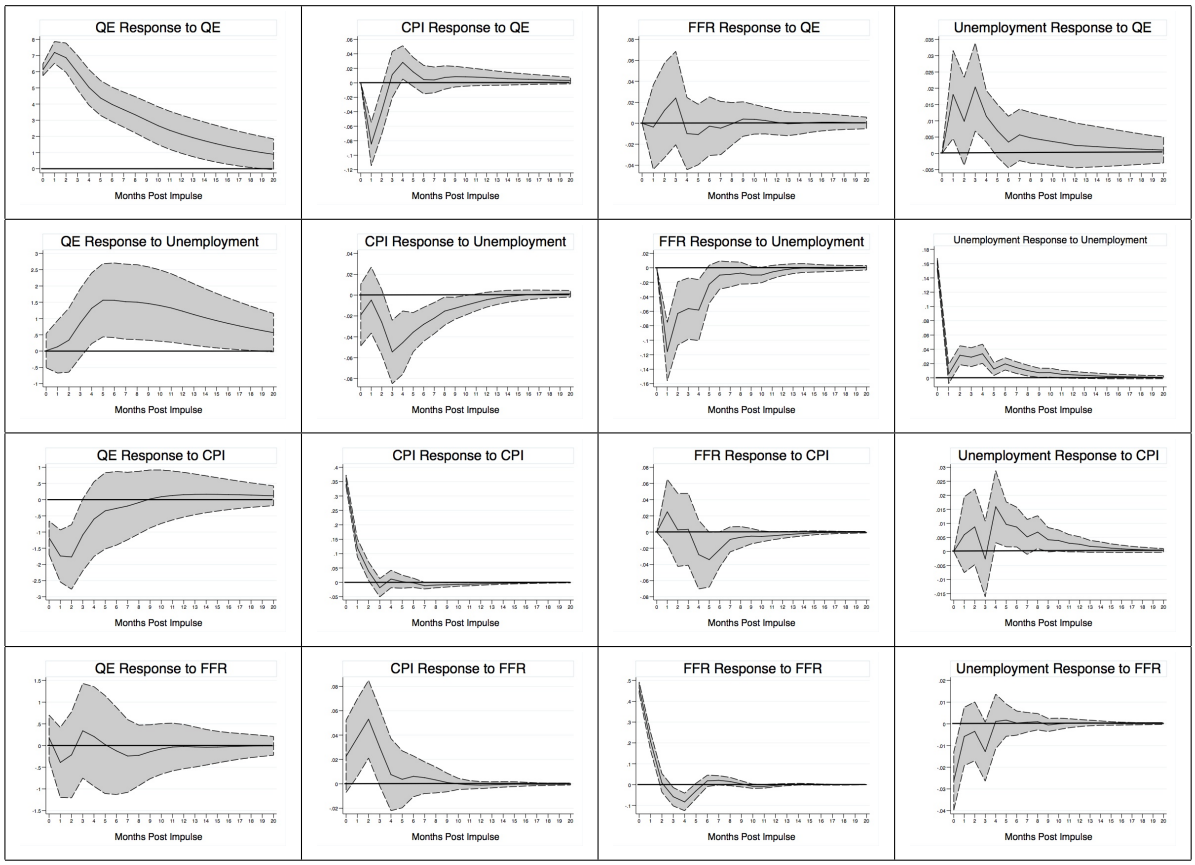
Table 1: Summary Statistics

Variable	Mean	Std.Dev.	Range
CPI	4.19	3.01	(-2 - 14.6)
Unemployment	6.38	1.54	(3.8 - 10.8)
Treasury Bill	6.69	2.92	(1.53 - 15.32)
Federal Reserve's balance sheet	10.25	18.43	(-5 - 150.9)
Federal Funds Rate	5.5	3.9	(0.07 - 19.1)

Unit root tests find a single unit root for all five of our variables. We thus rely on their first-differences. Our results, as discussed later, are largely insensitive to the ordering of our variables. The order shown in (2) is used for our main results. We list unemployment and inflation as our two most exogenous variables because, as macroeconomic aggregates, they are likely slow to adjust to monetary/financial variables. We list the Treasury yield last to represent its ability to respond very quickly to changing macroeconomic conditions. The specification thus allows our two monetary policy variables, the Fed's balance sheet and the Federal Funds Rate to respond contemporaneously to unemployment and inflation, but not long-term interest rates,

The Federal Reserve's balance sheet directly reflects the unconventional monetary policy adopted by the Fed. We are primarily interested in how innovations to the Fed's balance sheet affect the real economy. We find similar results when we estimate the VAR for the entire sample period, starting in 1970, and when we limit our analysis to the period after the Federal Funds

Table 2: Baseline Model: Impulse Response Functions

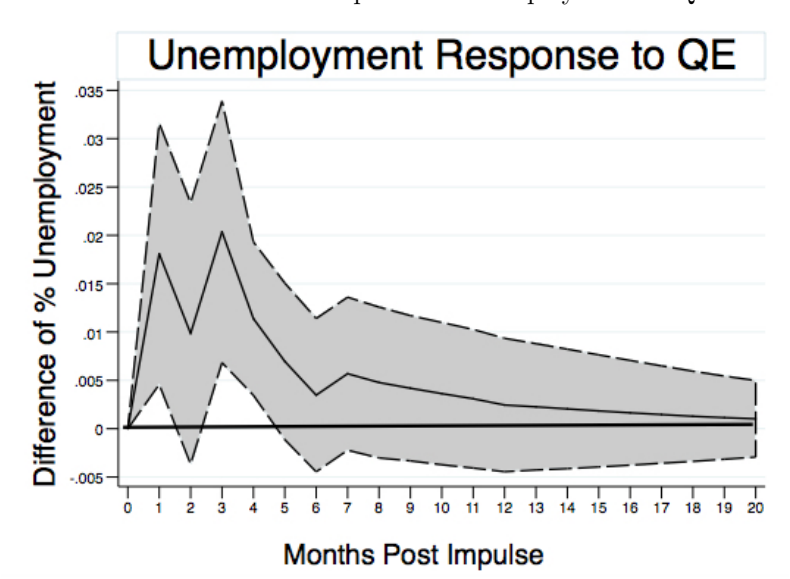


rate neared zero in late 2008. In the latter case, we drop the Federal Funds Rate from the system. Table 2 reports a one standard deviation shock for all variables; confidence intervals are displayed at the 95% level.

Our most interesting result is that asset purchases cause statistically significant increases in the unemployment rate and decreases in the price level. They thus act contrary to how expansionary monetary policy is expected to work and contrary to the related work of Weale and Wieladek (2014), who find that QE works similarly to ordinary monetary policy.

The first column of Table 2 also shows how QE responds to macroeconomic conditions. Here, higher unemployment or lower prices cause additional asset purchases. In this case, monetary policy is working as expected with the Federal Reserve purchasing more assets in response to reduced demand. If QE

Table 3: Response of Unemployment to QE



causes higher unemployment, however, then these results suggest the potential for undesirable feedback where higher unemployment and more asset purchases amplify each other,

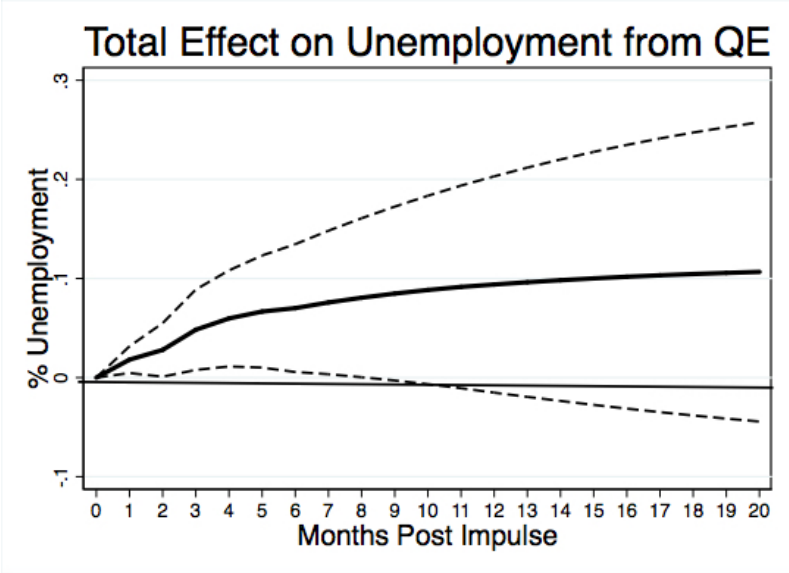
Table 3 highlights our most interesting result - that QE raises U-3 unemployment. Because we are working with first-differences, we integrate under the impulse response function to calculate the level effect on unemployment of a one standard deviation impulse to asset purchases. This cumulative response is shown in Table 4. We find that the level of unemployment ultimately rises by about 0.09%. This result casts doubt on the efficacy of QE as a means of stimulating the economy,

3 Robustness

Given the counter-intuitive nature of our results, it is natural to wonder if misspecification is to blame. This section thus considers numerous alternate specifications to our baseline mode. We continue to find similar results.

We begin by considering the possibility of omitted variable bias. We add the following variables individually to our baseline specification and re-calculate our impulse response functions: the M2 money supply, US tax revenue, govern-

Table 4: Cumulative Response of Unemployment



ment expenditure, federal debt held by the public, Broad Trade Weighted U.S. Dollar index, Financial Stress index, the Case-Schiller Housing Price index, and the Industrial Production index. Data for each of these time-series was taken from FRED.[5]

In all cases, we find that the result illustrated in Table 3 to be robust to these additional variables. The results are summarized in Table 5. The first column is the number of months that the response is positive and statistically significant at the 95% confidence level. The response in the baseline model is positive and statistically for three months and this result holds across each of the exogenous control variables. Only 1 out of the 9 robustness checks shows a decrease in the number of months where the response is significant and positive, that being the Alternate Ordering 2 specification. Overall, we see that these exogenous control variables do not have a significant effect on the number of months that the response is significant and positive. The second column in Table 5 displays the peak (maximum), response value for unemployment for each of the exogenous control variables. Using this metric we find similar results to that of the first column in that the addition of the control variables does have a meaningful impact on how unemployment responds to QE. The peak

[5]For quarterly variables, we assumed a constant value for each month within the quarter.

Table 5: How Unemployment Responds to QE: Robustness Checks

VAR with exogenous variable	# of months response > 0	Peak Response
no exogenous variables	3	0.020361
Financial Stress	7	0.025064
M2 money supply	3	0.021069
Tax Revenue	3	0.020588
Federal Debt Held By the Public	3	0.020588
Government Expenditure	3	0.020539
Broad	3	0.020695
Industrial Production Index	3	0.013051
Alternate Ordering 1[6]	3	0.020042
Alternate Ordering 2[7]	2	0.020237
Post 2008	5	0.037964

response for the baseline model is 0.020361 and the range for the additional controls is (0.0131-0.0211). The corresponding IRFs are included in Table 5 of the appendix.

We also report two alternate orderings for our VAR model. The first orders our variables from most exogenous to least exogenous as: Inflation, Unemployment, Quantitative Easing, Treasury Bill Rate, and Effective Federal Funds Rate. The second alternate ordering is: Treasury Bill Rate, Quantitative Easing, Inflation Unemployment Effective Federal Funds Rate. Once again, our main results are similar. These robustness results strengthen our confidence that our results are not simply due to misspecification. Notably, our results differ from those of Weale and Wieladek (2014) who find that QE behaves similarly to conventional monetary policy. They limit their analysis to a five year period after 2007. This does not likely explain our different findings because our results do not substantially change when we limit our analysis to a similar period. Instead, our results differ because we use the Fed's actual purchases of assets whereas they rely only on announcements of asset purchases. We leave

[6]This specification uses the following ordering: Inflation, Unemployment, Quantitative Easing, Treasury Bill Rate, and Effective Federal Funds Rate

[7]This specification uses the following ordering: Treasury Bill Rate, Quantitative Easing, Inflation Unemployment Effective Federal Funds Rate

estimation that simultaneously consider both types of policy actions to future research.

4 Conclusion

The goal of large scale asset purchases after reaching the zero lower bound was clearly to boost aggregate demand. Our results, however, suggest that not only was this policy ineffective, but that it may have backfired by increasing the unemployment rate and decreasing the price level instead. We test the robustness of these surprising results using alternative specifications and do not find meaningful differences.

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Appendix: IRFs for QE on Unemployment Adding Additional Controls

Table 6: Effect of QE on Unemployment With Control Variables