# THE IMPACT OF QUANTITATIVE EASING ON PROFITABILITY OF THE US BANKING INDUSTRY

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ABSTRACT

The severity of the 2007 financial crisis led to the implementation of quantitative easing in many countries, including the US. Even though there have been various studies on the impact of quantitative easing, research on quantitative easing and bank profitability is still limited. This paper tries to explore this novel aspect of quantitative easing via a model of profitability of banking industry. Using aggregate quarterly data from 1992Q4 to 2013Q4, this paper provides evidence that asset purchase and bank profitability are negatively correlated. This implies that quantitative easing, by purchasing a massive amount of assets, would drive down the profitability of the US banking sector. The result is shown to survive many robustness checks. However, due to some potential problems arising from the method used in this paper, further research should be carried out to confirm the exact effect of quantitative easing on bank profitability.

## 1. Introduction and literature review

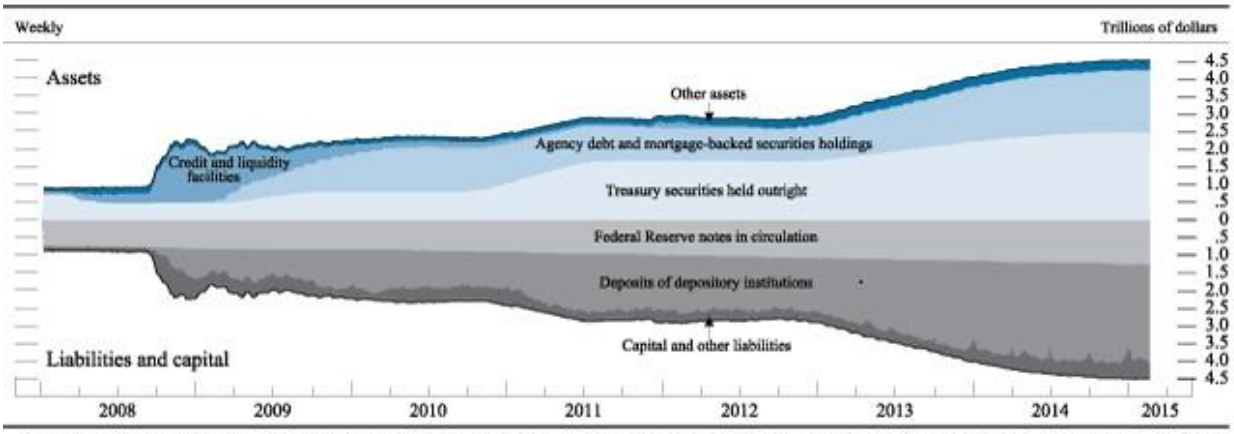
In response to the financial crisis in 2007, the Fed first utilized conventional monetary policy by decreasing the discount rate and the target federal funds rate. However, as the federal funds rate nearly reached the zero lower bound and became impossible to be lowered further, the Fed resorted to unconventional policies, including a large-scale asset purchase program (LSAP), more broadly known as quantitative easing (QE). In the case of the US, QE involves transactions between the Fed and primary dealers, and the assets the Fed purchased from or sold to these dealers include agency debt (direct obligations of Fannie Mae, Freddie Mac, and Federal Home Loan Banks), mortgage-backed securities (MBS backed by Fannie Mae, Freddie Mac, and Ginnie Mae), and long-term US Treasuries. The new money created in this process is then deposited in the Fed's balance sheet as commercial bank reserves.

From December 2008 to December 2014, the Fed implemented in total three rounds of QE, denoted as QE1 (December 2008 – July 2010), QE2 (November 2010 – June 2011) and QE3 (September 2012 – October 2014).

In November 2008, the Fed announced that it would purchase up to $100 billion of agency debt and $500 billion of MBS. However, in March 2009, these amounts were extended to $200 billion of agency debt and $1.25 trillion of MBS, plus $300 billion of long-term US Treasuries. The purchase of agency debt and MBS is expected to provide more credit for house purchase and reduce its cost, support mortgage lending and the housing market, and US Treasuries purchase is done with the purpose of improving private credit market (Board of Governors of Federal Reserve System, 2009). In November 2010, as an attempt to foster economic recovery and maintain target inflation, the Fed launched QE2, buying up to $600 billion of US Treasuries until the end of June 2011 (Board of Governors of Federal Reserve System, 2010). In September 2012, the Fed announced the adoption of open-ended QE3, starting with the purchase of $40 billion MBS per month, and three months later, the Fed announced the purchase of $45 billion long-term US Treasuries per month starting from January 2013. The Fed's objectives for QE3 were not only to strengthen the housing market and lower long-term interest rates, but also to achieve target inflation, price stability and reduce unemployment (Board of Governors of Federal Reserve System, 2012).

Before discussing the mechanism of QE, it is important to look at some stylized facts regarding asset purchases under QE to have a better understanding of the magnitude of this program. Due to the unavailability of data for the 2014 asset purchases, these facts only involve the purchase from December 2008 to December 2013. During this period, the Fed purchased in total $4.1 trillion of asset under QE policy. This $4.1-trillion-asset purchase includes agency debt, MBS and US Treasuries, with MBS purchase accounting for the largest part ($2.3 trillion, or 56 percent of the total purchase), followed by US Treasuries ($1.62 trillion, equal to 40 percent of the total purchase), and agency debt purchase ($172

billion, accounts for only 4 percent). This massive purchase increased the assets of the Fed, generating additional commercial bank reserves on the liability side. Figure 1 clearly demonstrates the expansion of the Fed's balance sheet as a result of the QE program. It is worth noting that the amount of securities held by the Fed, as well as the reserves, might be less than $4.1 trillion since the Fed reinvested the principal payments on MBS and Agency debt in US Treasuries, starting from QE2.




NOTE: "Credit and liquidity facilities" consists of primary, secondary, and seasonal credit; term auction credit; central bank liquidity swaps; support for Maiden Lane, Bear Stearns, and AIG; and other credit facilities, including the Primary Dealer Credit Facility, the Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility, the Commercial Paper Funding Facility, and the Term Asset-Backed Securities Loan Facility. "Other assets" includes unamortized premiums and discounts on securities held outright. "Capital and other liabilities" includes reverse repurchase agreements, the U.S. Treasury General Account, and the U.S. Treasury Supplementary Financing Account. Data extend through February 18, 2015.
SOURCE: Federal Reserve Board, Statistical Release H.4.1, "Factors Affecting Reserve Balances."

Figure 1 Fed's assets and liabilities (Source: Board of Governors of Federal Reserve System, 2012, Monetary Policy Report)

Among the three rounds of QE, QE1 could be considered the most significant, as many records of asset purchase were formed during this period. In particular, the year 2009 witnesses the largest amount of assets purchased in a year, with a net purchase of $1.56 trillion of agency debt, MBS and US Treasuries. Also, the Fed purchased $535 billion of assets in Q2 2009, which is the largest purchase by quarter, and $187 billion in April 2009, which is the largest purchase by month. The details of the Fed's purchase by year and quarter are represented in Figures 2 and 3 respectively.

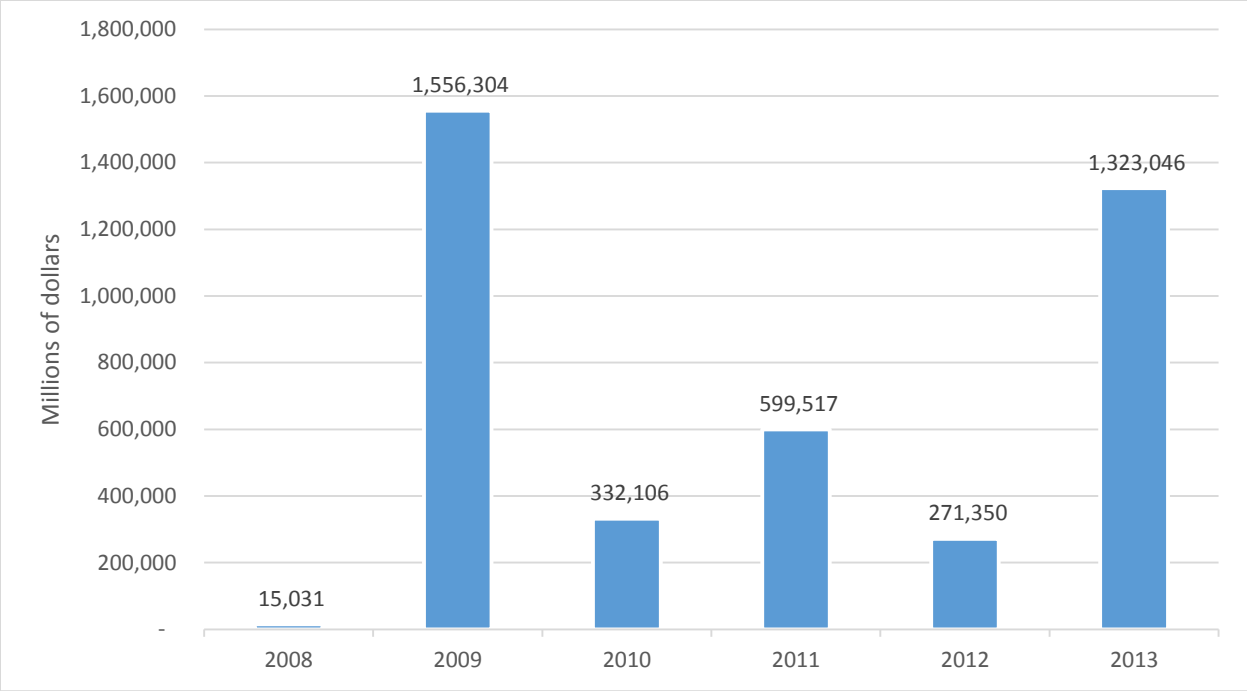



Figure 2 Fed's purchase by year (Source: Calculated based on data available on website of Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York)

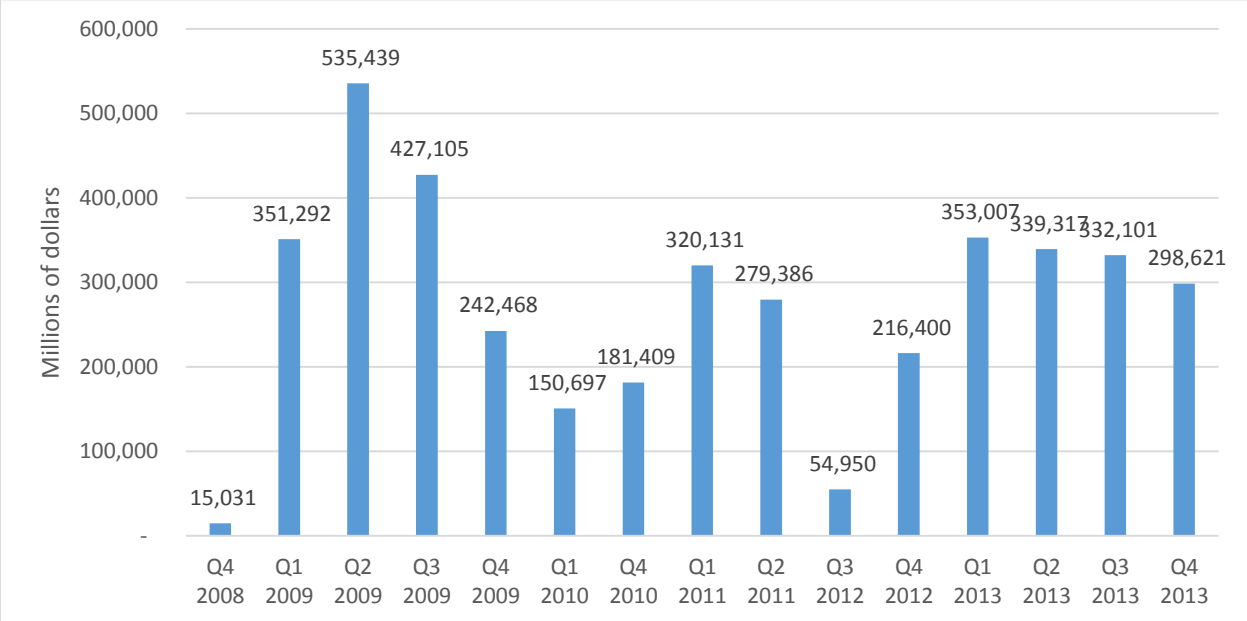



Figure 3 Fed's purchase by quarter (Source: Calculated based on data available on website of Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York)

Regarding the composition of the purchase, QE1 could be considered the most comprehensive. In fact, agency debt, MBS and long-term Treasuries were all purchased during QE1, while QE2 only involves Treasury purchase, and QE3 MBS and long-term Treasuries. In both QE1 and QE3, the majority of the total purchase is made up of MBS, with $1.25 out of $1.72 trillion in QE1 (73 percent of QE1 purchase) and $1.05 out of $1.59 trillion in QE3 (66 percent of QE3 purchase). Figures 4, 5, and 6 show the value and trend of agency debt, MBS and US Treasuries net purchase over time for all three QE rounds. It can be observed that purchases of all asset types display a downward trend in QE1, with the value of agency debt purchase varying the least among the three components. The amount of US Treasuries purchase is quite stable during QE2 and QE3, while there is still a decline in MBS purchase in QE3 over time, even though the decline is not as steep as in QE1. Another interesting point is that, while the purchase of US Treasuries in QE3 is implemented as planned (approximately $45 billion per month), the Fed purchased much more MBS than they intended to do. In fact, the Fed stated that they would purchase only $40 billion of MBS per month in QE3, but ended up purchasing around $60 billion on average during September 2012 – December 2013.

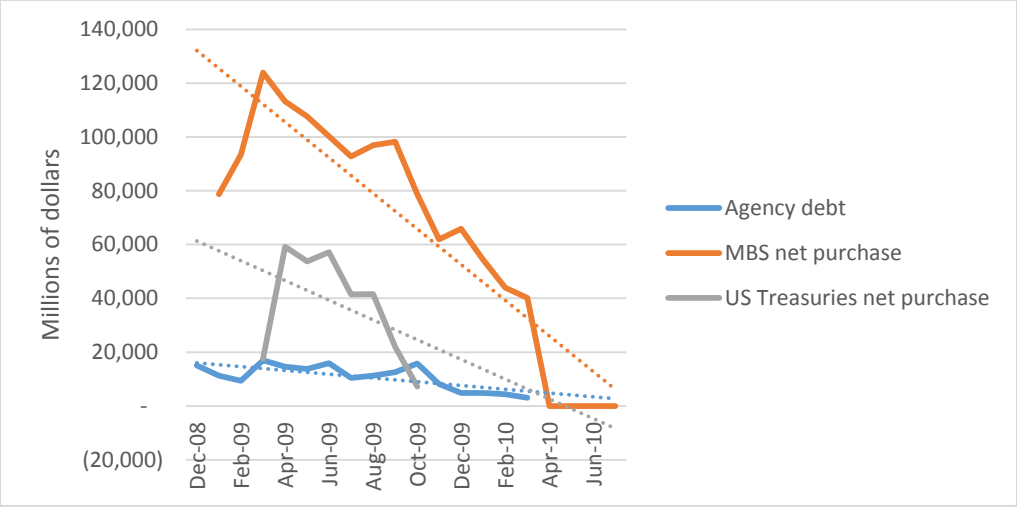



Figure 4 Amount and trend of Fed's asset purchase in QE1 (Source: Calculated based on data available on website of Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York)

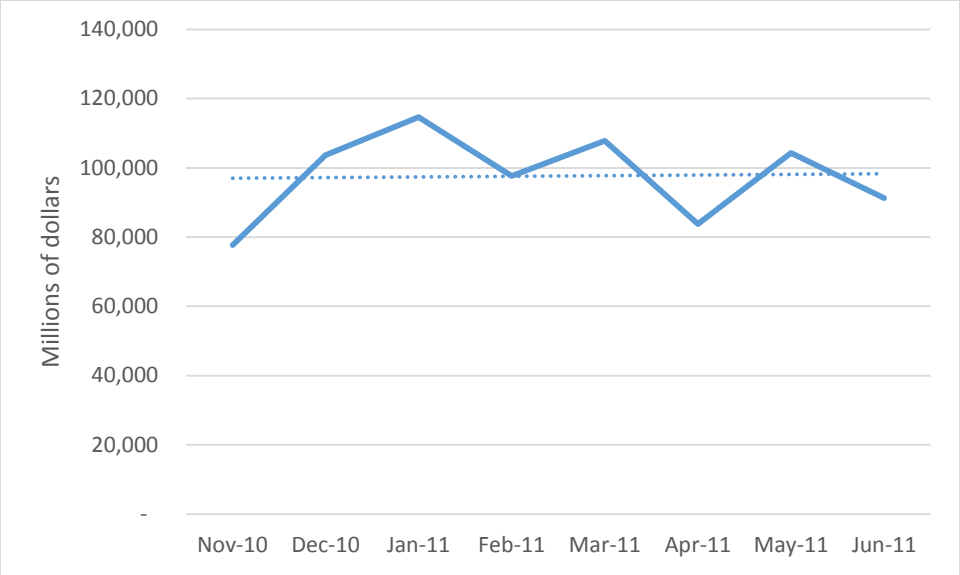



Figure 5 Amount and trend of Fed's US Treasuries purchase in QE2 (Source: Calculated based on data available on website of Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York)

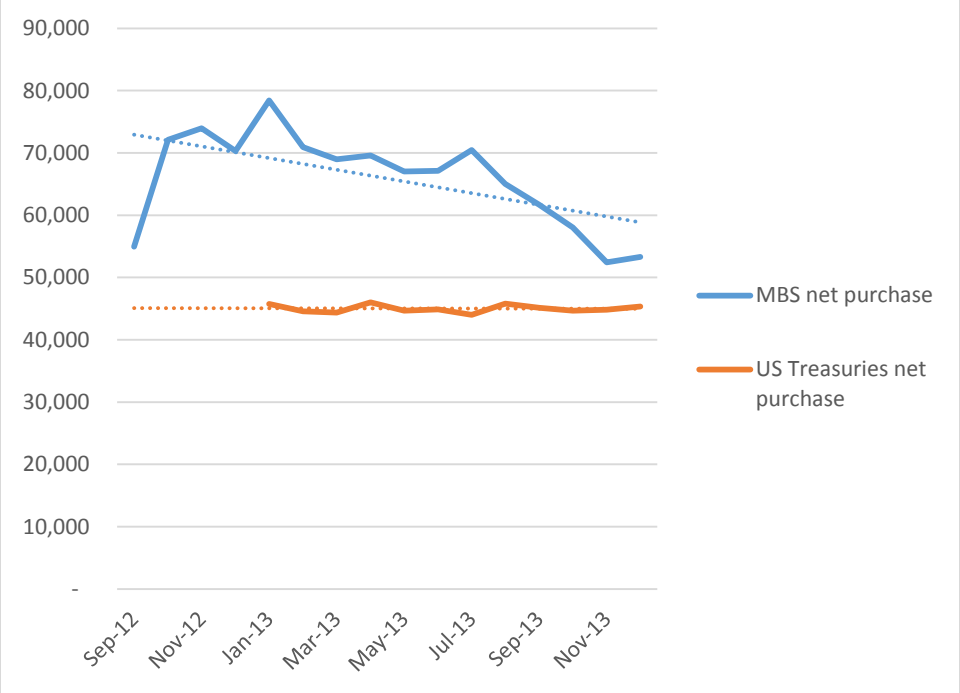



Figure 6 Amount and trend of Fed's asset purchase in QE3 (Source: Calculated based on data available on website of Board of Governors of the Federal Reserve System and Federal Reserve Bank of New York)

One mechanism in which QE is supposed to have such effects (improving financial markets and broader economic conditions) is based on traditional monetary theory. As QE leads to an increase in bank reserves, it is expected that banks would have an incentive to use the excess liquidity to increase lending or to buy other assets, thus raising asset prices and induce more consumer spending and investment (Bernanke, 2009). Another mechanism widely discussed is the portfolio balance channel, proposed by many well-known economists including Tobin and Friedman. This channel assumes that assets are imperfect substitutes, therefore QE done by purchasing agency securities (including MBS and agency debt) and long-term US Treasuries should raise the prices and lower the yields of those assets, in order for investors to accept the changes in their portfolio. Also, as investors seek to replace the assets sold to the Fed with other long-term assets, the prices of those assets would also be higher and yields lower. Higher prices and declining yields of long-term assets would eventually improve private credit market, mortgage lending and housing market, as well as macroeconomic conditions like inflation and unemployment. Another mechanism of QE is the signaling channel, in which QE can signal that the Fed is committed to keeping interest rates low, thus lowering investors' expectations of federal funds rates and decreasing long-term interest rates.

Though there have been many studies on bank lending under QE policy done by other central banks such as Bank of Japan and Bank of England (see Bowman, Cai, Davies, & Kamin, 2015; Joyce & Spaltro, 2014), the vast majority of studies on the Fed's QE address its impact on long-term interest rates and other macroeconomic variables like GDP, inflation and unemployment. Regarding long-term interest rates, Krishmamurthy and Vissing-Jorgensen (2011), using the interaction of different characteristics of assets purchased (difference-in-difference approach), showed that QE1 and QE2 lower nominal interest rates on Treasuries, Agencies, corporate bonds and MBS through the portfolio balance and signaling channels, but the effect is heterogeneous, as the purchase of US Treasuries has stronger effect on long-term safe assets while lower-rate corporate bonds are more influenced by MBS purchase.

However, they noted that QE can also increase yields of the most liquid bonds through the liquidity channel. Meaning and Zhu (2011), who studied the announcement effect of QE1 and the level of purchase in QE2, concluded that both QE1 and QE2 are responsible for the reduction of yields on many long-term securities besides those purchased, but the effect of QE1 is greater since MBS and agency debt were also purchased. In contrast to Krishmamurthy and Vissing-Jorgensen (2011), Hancock and Passmore (2010), after studying MBS purchase in QE1, pointed out that the purchase of MBS does lower mortgage rates, but the portfolio balance channel only becomes prominent after the purchase ended. Gagnon, Raskin, Remache, and Sack (2010), in both event-study and time-series analyses, found that QE1, through the portfolio balance channel, reduces long-term private borrowing rates, besides Treasuries, Agencies and corporate bonds. Christensen and Rudebusch (2012); Rogers, Scotti, and Wright (2014) looked at the purchase of government bonds (or Treasuries) in various countries, and pointed out that QE done with government bonds not only reduces government bond yields but also has spillover effect on other type of assets, though the extent of that effect varies. In general, all studies, regardless of which asset types and which countries they concentrate on, agree that QE leads to a reduction in long-term interest rates, though the channel through which this happens is still unclear.

Regarding QE's impact on financial markets and the broader economy, Fuster and Willen (2010) studied the effect of MBS purchase on the mortgage market (the market which receives great attention from the Fed due to being hit the hardest), and found that the purchase of MBS under QE improves the mortgage market via boosting mortgage refinancing activity rather than house purchase as intended by the Fed, and the benefit of QE is disproportionately skewed towards borrowers with high credit-worthiness. Engen, Laubach and Reifschneider (2015), through simulations and the FRB/US model, showed that there is a lag in the effect of QE on economic recovery (boosting GDP and inflation, reducing unemployment) due to late change in expectations, and the recovery would be faster under QE than under the case with no action if public expectations were adjusted faster. Chen, Curdia and Ferrero

(2011), using a DSGE model, concluded that QE2 leads to a small increase in GDP and inflation, and the effect on GDP is persistent. However, Williamson (2014) constructed a model of money, credit and banking, and showed that QE done with US Treasuries lowers inflation through the liquidity channel, which goes against the intention of the Fed. To summarize, even though there might be some disagreement regarding the impact of QE on financial markets and the broader economy, it is obvious that the studies mentioned above all imply that QE might not affect the economy in the way desired by the Fed.

Besides improving the US economy as stated by the Fed, Ferguson and Johnson (2009a, b) proposed a hypothesis that the main concern of the Fed when implementing QE was to prevent the fall of large banks since they are the main constituency of the Fed. In fact, it has been argued that QE can improve the profitability of banks through toxic asset removal and rising MBS prices (Montecino & Epstein, 2014; Lambert & Ueda, 2014). However, as Lambert and Ueda pointed out, QE has a dual effect on bank profit, since it can also reduce banks' revenue from loans and securities due to low interest rates and flattening yield curves. Unlike long-term interest rates and macroeconomic conditions, there have been only two studies that address the impact of QE on bank profitability. Lambert and Ueda (2014), using monetary policy surprises, found a negative or ambiguous impact of QE on bank profit in the US. This result is opposite to what is shown by Montecino and Epstein (2014), who built a model of bank profitability following Ferguson and Johnson's idea, and proved that MBS purchase under QE1 has a positive and significant effect on the profit of banks which sold MBS to the Fed, and the effect is also prominent for banks with a large proportion of MBS and large asset size.

In this paper, I will examine the effect of QE on bank profitability using a different method. Unlike the two studies mentioned above, I am interested in how QE affects the profitability of the whole banking sector, not that of individual banks. In my opinion, it is necessary to look at the banking industry rather than individual banks, since it could reflect better the broader impact of QE. Furthermore, instead

of using indirect indicators like a lagged Taylor gap and its components (Lambert & Ueda, 2014), or dummy variables (Montecino & Epstein, 2014), I will use the amount of the Fed's purchase to estimate the effect of QE. This provides a better understanding of QE's effectiveness, as it answers the question whether a more rigorous asset purchase program is better, which cannot be implied from previous studies. Furthermore, I will look at the composition of assets purchased under all three rounds of QE, rather than just one or two particular rounds, so the result presented in this paper can be used to assess the effectiveness of QE more comprehensively.

Using OLS regression to study the impact of MBS purchase, US Treasuries purchase and total purchase respectively, I find that QE has a negative impact on the profitability of the banking sector, measured by returns on equity (ROE). In detail, for all cases considered, all three coefficients of interest (to be discussed below) are negative and significant at different levels of confidence, even though the coefficients suggest a small magnitude of impact on ROE. These results withstand the test of multicollinearity, omitted variables, correlation with error terms, non-normal errors, but likely suffer from heteroskedasticity, autocorrelation, and non-stationary data problems. In order to correct for heteroskedasticity and autocorrelation, I use Newey-West standard errors, and the results are still similar. To deal with non-stationary data problem, I do the regression using the first difference of all variables in the original model, which still yields small and negative coefficients for all QE variables, but MBS purchase is no longer significant. However, when I replace ROE with net income, and the diversification ratio with non-interest income, MBS purchase becomes significant again.

The rest of the paper proceeds as follows. Section 2 provides the information on the dataset and the rationale behind the variables used to estimate QE's impact on bank profitability. Section 3 presents the regression results, and section 4 proves the validity of the results through various tests. Section 5 concludes the paper.

2. Data and variables

The four equations that capture the effect of QE on bank profitability are as follow:

(1) $ROE_t = \beta_0 + \beta_1 * LOANSASSETS_t + \beta_2 * DIVERSIFICATION_t + \beta_3 * INTERESTSPREAD_t + \beta_4 * GDPGROWTH_t + \beta_5 * MBSPURCHASE_t + \varepsilon_t$

(2) $ROE_t = \beta_0 + \beta_1 * LOANSASSETS_t + \beta_2 * DIVERSIFICATION_t + \beta_3 * INTERESTSPREAD_t + \beta_4 * GDPGROWTH_t + \beta_5 * USTREASURIESPURCHASE_t + \varepsilon_t$

(3) $ROE_t = \beta_0 + \beta_1 * LOANSASSETS_t + \beta_2 * DIVERSIFICATION_t + \beta_3 * INTERESTSPREAD_t + \beta_4 * GDPGROWTH_t + \beta_5 * USTREASURIESPURCHASE_t + \beta_6 * MBSPURCHASE_t + \varepsilon_t$

(4) $ROE_t = \beta_0 + \beta_1 * LOANSASSETS_t + \beta_2 * DIVERSIFICATION_t + \beta_3 * INTERESTSPREAD_t + \beta_4 * GDPGROWTH_t + \beta_5 * TOTALPURCHASE_t + \varepsilon_t$

with the subscript *t* denotes the time, which runs from 1992Q4 to 2013Q4. The variables are observed quarterly during the period mentioned. The variables ROE, LOANSASSETS, and DIVERSIFICSTION are calculated based on the statistics for universal banks.

For the amount of purchase under QE, I use the raw dataset released by the Board of Governors of the Federal Reserve System under the section "Agency Mortgage-Backed Securities (MBS) Purchase Program" and the Federal Reserve Bank of New York "Program Archive." The Board of Governors and New York Fed released the data on agency debt, MBS purchase and US Treasuries purchase, which include time, operation type (purchase or sale), amount of transaction, name of counterparties. Since the number of transactions is very large (around 2,000 transactions per month for each asset type), I had to recalculate the data to obtain the total purchase by quarter of each type of asset, and then add them up to generate the total purchase. As mentioned above, due to the unavailability of data on 2014

purchase – in fact, the Fed only releases the detailed information of its transactions two years after the transactions have been carried out – the effect of QE can only be estimated until December 2013. Also, based on the prime lending rate and 6-month CD rate available in the dataset "H.15 Selected Interest Rates" released by Federal Reserve Board of Governors, I calculated the interest rate spread used for this model. The data for GDP growth is available in the section "National Economic Accounts" of the Bureau of Economic Analysis, US Department of Commerce. For other explanatory variables and ROE, I use the dataset "Statistics on Banking" released by Federal Deposit Insurance Corporation (FDIC). Based on this data, I recalculated the ratio of non-interest income to total income, and loans-to-asset ratio. However, it should be noted that there are missing data in the period of 1992 – 2001, since FDIC did not report the data frequently by quarter.

As mentioned above, bank profitability is measured by return on equity (ROE). The ratio of total loans to total assets (LOANSASSETS) is included as one of the explanatory variables in this model. According to Rahman, Hamid, and Khan (2015), loans are riskier than other assets such as government securities in terms of liquidity risk, thus the returns from loans are expected to be higher than returns from other assets. Therefore, loans-to-assets ratio has a positive relationship with bank profitability. However, as more loans are made, there is also higher possibility of defaults on loans, especially when those loans are made based on easing credit standards, or when most of lending is long-term loans which pose liquidity problem for banks. This suggests that the loans-to-assets ratio can be negatively correlated to bank profitability (Sufian, 2009; Ahmed and Anees, 2012).

Another independent variable in the model is the ratio of non-interest income to total income (DIVERSIFICATION). Non-interest income has become an important source of profit for banks, especially the US banking industry, as the proportion of non-interest income in total operating income rises over time (Stiroh, 2004). In fact, it has been pointed out by Lipin and Bacon (1992) and Kurt (2007) that the change in non-interest income is responsible for most of the change in bank profitability. While it is

largely expected that non-interest income is positively correlated to bank profitability, studies related to this topic have generated mixed results. Stiroh (2002), using bank-level data, found that the ratio of non-interest income to total income has little or no relationship with ROE. Meanwhile, DeYoung and Rice (2003) found that a marginal increase in the ratio of non-interest income to total assets leads to higher profits.

Besides non-interest income, net interest income is another component of operating income. Net interest income is generated by the difference between the lending rate and the deposit rate, and the larger the difference, the higher the net interest income, thus the higher the profit made by banks. Even though banks rely less on net interest income these days (as pointed out in the previous part), it is undeniable that the interest rate spread still determines bank profitability. In fact, in 2013, profits of banks were under pressure due to lower interest spreads, which was the consequence of banks struggling to make more loans by offering lower interest rate to borrowers (Raice, 2013). In this model, the interest rate spread (INTERESTSPREAD) is calculated by the difference between the prime lending rate and the 6-month CD rate. Though I am aware that CD rates might not be the best representative for deposit rates, this is the only rate that I managed to access for the complete period.

Another explanatory variable in the model is GDP growth (GDPGROWTH). Ahmed and Anees (2012) argued that during times of slow growth, the loan retirement process is slower due to poor production, leading to a higher possibility of loan defaults. As a result, GDP growth and bank profitability should display a positive relationship. Petria, Capraru, and Ihnatov (2015) studied the EU banking industry and found out that GDP growth is positively correlated to bank profitability, as more loans and deposits are made when economic growth is high and vice versa (Table 2 shows a high simple correlation between ROE and GDP growth). However, the positive relationship might not hold, as banks can still charge high lending rates and low deposit rates when the economy is sluggish, as well as

increase non-interest income through foreign-exchange trading and securities processing (Lipin and Bacon, 1992).

MBSPURCHASE, USTREASURIESPURCHASE, and TOTALPURCHASE are the three variables that represent QE's impact. Based on the viewpoint of Ferguson and Johnson (2009a, b), the policy of QE, as measured by these three variables, results from the collapse of bank profitability (that is, the ROE), as the bank losses (due to plummeting MBS values) are what truly triggered the Fed to implement QE. Therefore, one would expect a positive initial correlation between QE variables and ROE, since QE was done with the hope of improving bank profitability. However, it is still necessary to estimate how QE, in return, affects bank profitability, since it could turn out that QE may not generate results that the Fed intended, namely that as it carried on QE it could have negatively impacted ROE.

Tables 1 and 2 provide summary statistics and correlation among variables.

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|
| roe | 58 | 10.00914 | 5.472744 | -10.15 | 15.53 |
| loansassets | 58 | .5710406 | .0263164 | .5241806 | .6143581 |
| diversific~n | 58 | .3970203 | .0371187 | .3042237 | .4473374 |
| interestsp~d | 56 | 2.675714 | .404218 | .93 | 3.1 |
| gdpgrowth | 58 | 4.331035 | 2.992517 | -7.7 | 9.3 |
| ustreasuri~e | 58 | 27948.02 | 70265.02 | 0 | 320131 |
| mbspurchase | 58 | 39728.22 | 88708.95 | 0 | 321043 |
| totalpurch~e | 58 | 70644.03 | 138114.2 | 0 | 535439 |

Table 1 Summary statistics of dependent variable and explanatory variables

| | roe | loansa~s | divers~n | intere~d | gdpgro~h | mbspur~e | ustrea~e |
|---|---|---|---|---|---|---|---|
| roe | 1.0000 | | | | | | |
| loansassets | 0.4728 | 1.0000 | | | | | |
| diversific~n | 0.4979 | 0.5130 | 1.0000 | | | | |
| interestsp~d | 0.5150 | -0.0444 | 0.1972 | 1.0000 | | | |
| gdpgrowth | 0.7362 | 0.3398 | 0.2984 | 0.4066 | 1.0000 | | |
| mbspurchase | -0.5369 | -0.4142 | -0.0466 | -0.0862 | -0.4504 | 1.0000 | |
| ustreasuri~e | -0.2795 | -0.4647 | -0.2088 | 0.1097 | -0.2240 | 0.3140 | 1.0000 |
| totalpurch~e | -0.5447 | -0.5237 | -0.1422 | -0.0245 | -0.4471 | 0.8715 | 0.7373 |

Table 2 Correlation between variables

3. Regression results and discussion

Table 3 reports the OLS estimates of the four equations. The coefficients of DIVERSIFICATION, INTERESTSPREAD, and GDPGROWTH are positive and statistically significant in all four cases, suggesting that higher economic growth rate, higher non-interest-income-to-total-income ratio, and greater interest rate spreads are expected to improve the profitability of banks. Meanwhile, loans-to-assets ratio is shown to have a positive effect, but the effect is unclear since the coefficient is positive and statistically significant in only equation (2). Considering the effect of QE, MBS purchase, US Treasuries purchase, and total purchase are negatively correlated to ROE. The small and negative coefficients point to the fact that QE done with higher amount of purchase could deteriorate bank profitability, even though the magnitude of the reduction is not substantial. While the coefficients of US Treasuries purchase are insignificant in equations (2) and (3), those of MBS purchase and total purchase are statistically significant in equations (1), (3) and (4). In other words, it can be concluded with certainty that increasing the purchase of MBS, or increasing total purchase which contains MBS, decreases the profitability of the banking industry. Even though the regression analysis only considers the purchase under the QE program (for the period without QE, I assume that the purchase is 0), it can still be applied when comparing the amount of purchase under normal period conditions with that under QE, for the following reasons. First, before 2009, the Fed did not even purchase MBS, and even during 2009 – 2013, except for the period of QE that contains MBS purchase, the MBS purchase is either insignificant or non-existent. Second, before the financial crisis, the Fed had already purchased US Treasuries on an outright basis (Federal Reserve Bank of New York). However, based on the statistics calculated from the data released by New York Fed, the purchase of US Treasuries before the financial crisis is indeed very small compared to the amount purchased under QE: from January 2006 to January 2007, there were only 39 operations in total, with $1 billion of transactions per month on average. Therefore, the estimators for MBS purchase, US Treasuries purchase, and total purchase, would not be very different from what has

been pointed out in this model. In other words, it can be said that QE, by purchasing a massive amount of assets, reduced bank profitability compared to the periods without QE when the asset purchase is minimal. In order to further consolidate this claim, it is necessary to do the counterfactual exercise to see what would happen if there is no big leap in the amount of asset purchases during 2009 – 2013. And this is also one drawback of my paper, due to my inability to produce such a simulation.

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| loansassets | 22.98582 | 42.98747* | 19.42635 | 17.95864 |
| diversific~n | 39.23485*** | 26.88615* | 39.11498*** | 35.99578*** |
| interestsp~d | 4.008983*** | 4.185625*** | 4.100912*** | 4.258416*** |
| gdpgrowth | .686452*** | .8699215*** | .6784945*** | .6990868*** |
| mbspurchase | -.0000186*** | | -.0000182*** | |
| ustreasuri~e | | -6.31e-06 | -3.67e-06 | |
| totalpurch~e | | | | -.0000122*** |
| _cons | -31.78891*** | -40.07587*** | -29.83985** | -28.2334** |
| Number of obs | 56 | 56 | 56 | 56 |
| R-squared | 0.7599 | 0.7101 | 0.7614 | 0.7560 |
| Adjusted R-squared | 0.7358 | 0.6811 | 0.7322 | 0.7316 |

*Significant at 10%, **SIgnificant at 5%, ***Significant at 1%

Table 3 Regression result of equations (1), (2), (3) and (4)

The negative coefficient of MBS purchase poses a challenge to the result of Montecino and Epstein (2014), who proposed that MBS purchase increases bank profitability through the portfolio balance channel, in which MBS purchase leads to a higher price of MBS and eventually larger capital gains, and this is true for banks trading with the Fed (or primary dealers) and banks with high MBS share (above 95$^{th}$ percentile). However, there is also a possibility that as MBS prices increase and banks start to make profits with it, the continuation of the Fed's MBS purchase could be detrimental to bank profitability in the sense that it also removed the non-toxic and profitable assets from banks. In other

words, bank profitability might in fact decrease if QE continues for a long time (which is the case of QE in the US), and this negative effect might not have been noticeable at the beginning of QE. Therefore, it is reasonable that Montecino and Epstein got the positive relationship between MBS purchase and bank profitability, since the time frame considered in their paper is only 2008Q1 – 2009Q4, which does not even contain the whole MBS purchases during the QE1 period (since the Fed continued purchasing MBS until the end of 2010Q1 for QE1). One may argue that this was insufficient to estimate the longer-term effect of MBS purchase. Furthermore, the results of Montecino and Epstein do not guarantee that the profits of those banks would keep increasing as the Fed increases the amount of MBS purchase during QE1, since it is possible that they can have higher profits at first, but then the profits decrease while still remaining higher than other banks. In general, due to the use of dummy variables and a short time frame, it is unclear from Montecino and Epstein's paper how MBS purchase would affect bank profitability in the longer-term, as well as how profits of banks move as the Fed continues to purchase MBS. However, in order to further strengthen the result offered in my paper, it is necessary to look at the bank loss statistics to see if MBS purchase really causes losses, but this is not possible due to the unavailability of such data. In fact, only net revenue data is accessible, which might incorporate the effect of bank losses without indicating the source of the declining revenues.

This result implies that QE might not affect the economy through the mechanism proposed by the Fed. According to the Fed's belief, QE is expected to increase bank lending and lower interest rates, which help improve investment and GDP growth. And since the coefficients of LOANSASSETS and GDPGROWTH are positive, this suggests that if QE were to have such desired effects, it should have displayed a positive relationship with ROE by increasing loans-to-assets ratio and GDP growth rate. However, based on Table 2, QE variables and loans-to-assets ratio are hardly correlated, and this result is the same for QE and GDP growth. This suggests that the mainstream theory – which states that QE can boost bank lending and economic growth – is refuted. Another evidence against the mainstream

theory is that in all four cases considered, QE is shown to either reduce bank profitability, or have an ambiguous effect on bank profitability. In general, this result indirectly supports the argument made by previous studies that how QE affects the economy is unclear, and QE might not work as the Fed intended.

4. Robustness check

As stated above, GDP growth rate can be correlated to loans-to-assets ratio, as during times of economic boom, more loans are made and vice versa. Also, due to data being time-series, autocorrelation and heteroscedasticity problems can arise, which yields invalid conclusion about the effect of explanatory variables. In order to check for the validity of the regression results, it is necessary to carry out tests for correlation between independent variables and residuals, normality, multicollinearity, heteroscedasticity, omitted variables, autocorrelation and non-stationary data. Table 4 presents the results of the Breusch-Godfrey test for autocorrelation, Ramsey RESET test for omitted variables, Breusch-Pagan/Cook-Weisberg test for heteroscedasticity, Shapiro-Wilk test for normality and VIF for multicollinearity. As implied from the VIF statistics, the problem of multicollinearity is not substantial (or not even present) in all four regressions. Except for regression (2), all other regressions display no non-normality in error terms. Furthermore, despite no omitted variables, autocorrelation and heteroscedasticity are a big concern of this model. In fact, all but regression (2) are exposed to heteroscedasticity, and autocorrelation is present in all four regressions. In order to correct for this, I carried out regressions using Newey-West standard errors, and the results are shown in Table 5. From Table 5, it can be observed that there is no great change in the significance of the coefficients, and the same conclusion about the impact of each variable can still be drawn, compared to OLS regression in Table 3.

Figures 7, 8 9, and 10 show the relationship between residuals and each explanatory variable in all four OLS regressions. The graphs plot the explanatory variable against residuals, which can be used to

diagnose if explanatory variables and error terms are correlated. This type of correlation could render coefficients biased and inconsistent, thus leading to misinterpretation of each variable's impact. From the graphs, it can be seen that the points are randomly distributed and do not follow any pattern, which implies that there is no correlation between explanatory variables and error terms. In general, Table 5 and Figures 7, 8, 9, 10 further solidify the results pointed out by OLS regression, that the higher amount of asset purchase under QE lowers profitability of US banking industry.

(c) Test for heteroskedasticity, omitted variables, multicollineary, non-normal errors, autocorrelation

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| Breusch-Godfrey test | 15.122 | 16.188 | 15.899 | 16.551 |
| | (0.0001) | (0.0001) | (0.0001) | (0.0000) |
| Ramsey RESET test | 0.91 | 1.15 | 0.86 | 0.82 |
| | (0.4430) | (0.3372) | (0.4696) | (0.4902) |
| Breusch-Pagan/ Cook-Weisberg test | 4.85 | 1.87 | 4.67 | 3.72 |
| | (0.0276) | (0.1711) | (0.0306) | (0.0538) |
| Mean VIF | 1.58 | 1.47 | 1.58 | 1.63 |
| loansassets | 1.84 | 1.79 | 2.02 | 1.99 |
| diversific~n | 1.58 | 1.46 | 1.59 | 1.53 |
| interestsp~d | 1.31 | 1.34 | 1.34 | 1.32 |
| gdpgrowth | 1.65 | 1.45 | 1.66 | 1.64 |
| mbspurchase | 1.52 | | 1.54 | |
| ustreasuri~e | | 1.31 | 1.34 | |
| totalpurch~e | | | | 1.66 |
| Shapiro-Wilk test | -1.399 | 3.105 | -1.034 | 0.237 |
| | (0.91907) | (0.00095) | (0.84935) | (0.40628) |

Note: Breusch-Godfrey test for autocorrelation: H0: no serial correlation
Ramsey RESET test for omission of relevant variables: H0: no omitted variables
Breusch-Pagan/ Cook-Weisberg test for heteroskedasticity: H0: constant variance
Shapiro-Wilk test for normality: H0: data is normally distributed
The statistics reported for those tests contain test statistics and p-value in the brackets.

Table 4 VIF and test statistics for autocorrelation, omitted variables, heteroscedasticity, and normality

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| loansassets | 22.98582 | 42.98747* | 19.42635 | 17.95864 |
| diversific~n | 39.23485** | 26.88615* | 39.11498** | 35.99578** |
| interestsp~d | 4.008983*** | 4.185625*** | 4.100912*** | 4.258416*** |
| gdpgrowth | .686452*** | .8699215*** | .6784945*** | .6990868*** |
| mbspurchase | -.0000186** | | -.0000182* | |
| ustreasuri~e | | -6.31e-06 | -3.67e-06 | |
| totalpurch~e | | | | -.0000122** |
| _cons | -31.78891*** | -40.07587*** | -29.83985*** | -28.2334*** |

*Significant at 10%, **SIgnificant at 5%, ***Significant at 1%

Table 5 Regression results using Newey-West standard errors

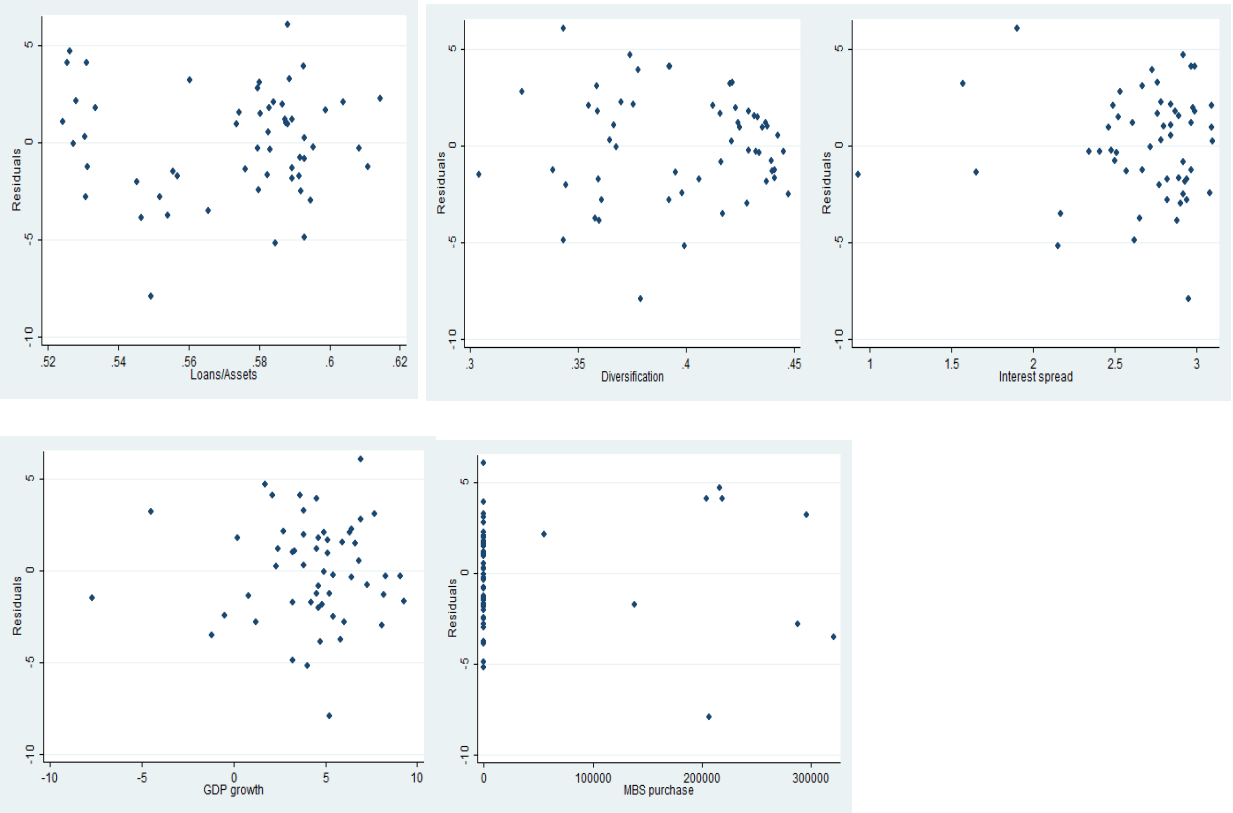



Figure 7 Residuals and explanatory variables for equation (1)

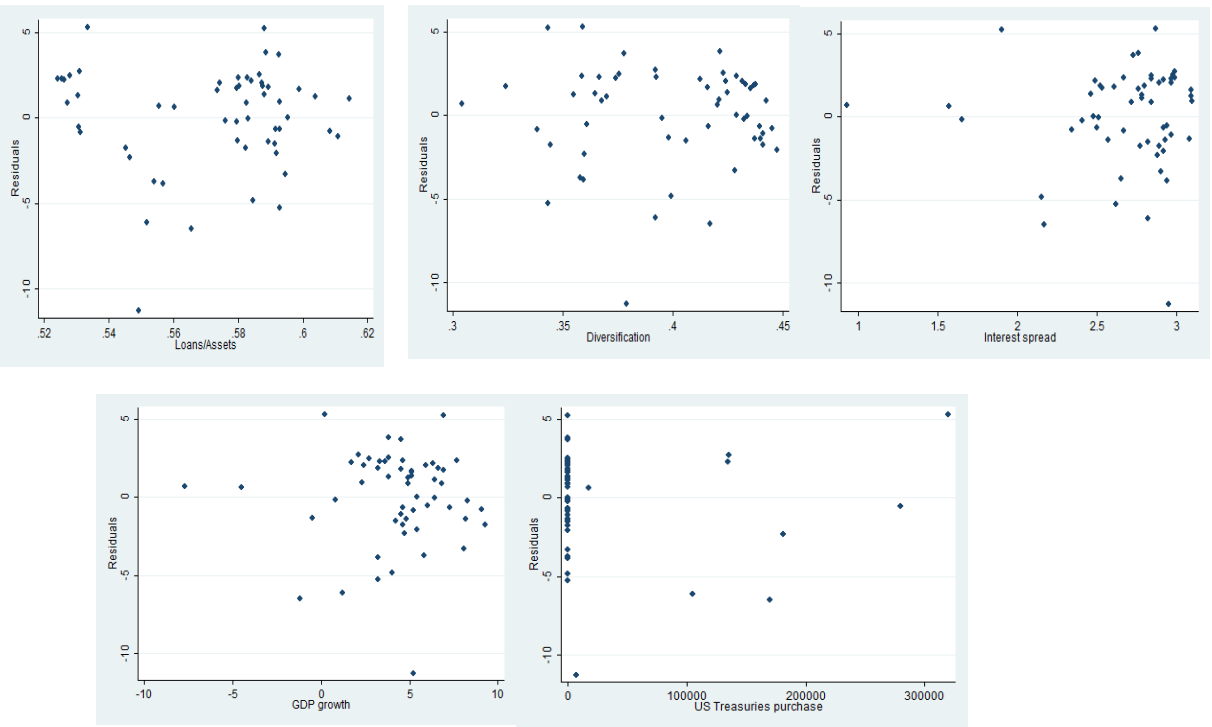



Figure 8 Residuals and explanatory variables for equation (2)

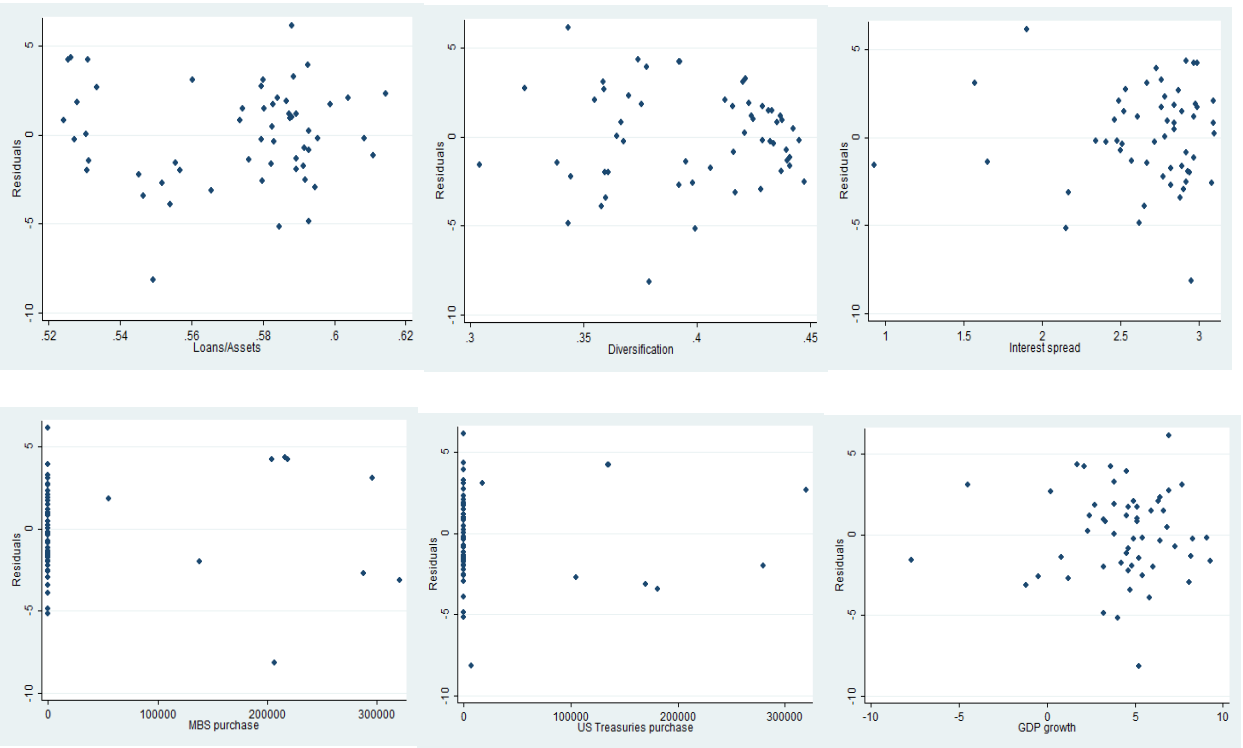



Figure 9 Residuals and explanatory variables for equation (3)

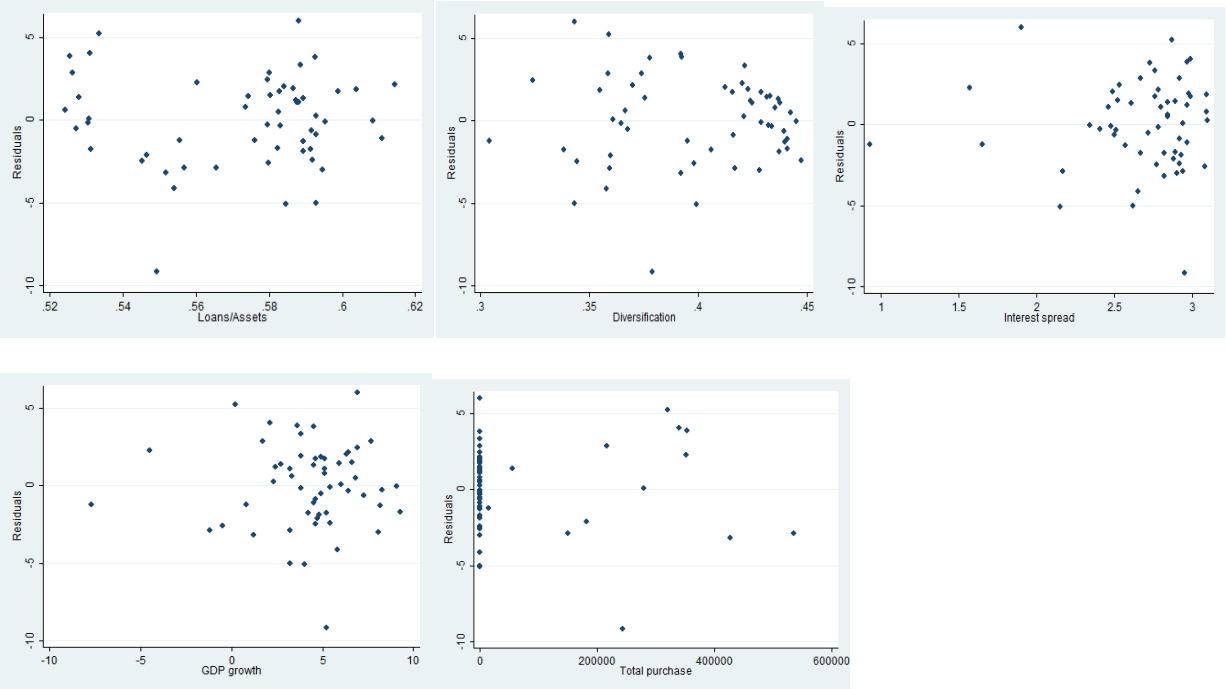



Figure 10 Residuals and explanatory variables for equation (4)

In order to check for non-stationary data, I use the augmented Dickey – Fuller test with lag equal to 1, and the result is presented in table 6. According to the table, ROE, LOANSASSETS and DIVERSIFICATION are non-stationary, and the remaining variables are stationary. To alleviate the problem of non-stationary data, I take the first difference of all variables in the original specifications and do the OLS regression again. Even though there are only three variables subject to non-stationary data problem, I decide to take the first difference of not only those three variables, but all variables for the following reasons. First, the augmented Dickey – Fuller test is very sensitive to the number of observations and the number of lags. In fact, by using different lags, the results could change, and some variables stationary under lag equal to 1 can become non-stationary if the number of lags increase. Therefore, to ensure that all variables are stationary under any circumstance, it is better to consider the first difference of stationary variables, in addition to non-stationary ones. Furthermore, taking the first difference of all variables generates a more coherent results, compared to the case in which only non-stationary variables are changed using first difference.

| | Test statistics | 1% Critical value | 5% Critical value | 10% Critical value | MacKinnon p-value |
|---|---|---|---|---|---|
| roe | -1.322 | -3.572 | -2.925 | -2.598 | 0.6191 |
| loansassets | -0.370 | -3.572 | -2.925 | -2.598 | 0.9149 |
| diversifica~n | -2.384 | -3.572 | -2.925 | -2.598 | 0.1462 |
| interestspr~d | -3.094 | -3.574 | -2.927 | -2.598 | 0.0270 |
| gdpgrowth | -2.981 | -3.572 | -2.925 | -2.598 | 0.0367 |
| mbspurchase | -2.941 | -3.572 | -2.925 | -2.598 | 0.0408 |
| ustreasuri~se | -4.500 | -3.572 | -2.925 | -2.598 | 0.0002 |
| totalpurchase | -4.060 | -3.572 | -2.925 | -2.598 | 0.0011 |

H0: the variable has unit root
Ha: the variable does not have unit root

Table 6 Augmented Dickey – Fuller test for non-stationary data

The result of the OLS regression using first difference is displayed in Table 7. It can be observed that there are some changes regarding the significance of coefficients, as the coefficient of LOANSASSETS becomes insignificant in equation (2), and coefficients of INTERESTSPREAD and GDPGROWTH are no longer significant in all four cases. Regarding QE variables, the coefficients are still small and negative, suggesting that the impact of QE is still the same after correcting for non-stationary data problem. While the coefficient of USTREASURIESPURCHASE remains insignificant and that of TOTALPURCHASE significant, MBSPURCHASE coefficient changes from being significant at one percent to insignificant. In general, this result further strengthens the result of original OLS regressions, which states that QE has a negative, though insubstantial, impact on bank profitability. To see if this result is still valid when using different variables, I do a simple exercise of replacing ROE with net income (NETINCOME), and DIVERSIFICATION with non-interest income (NONINTERESTINCOME), and perform the regression. The result of this regression, after eliminating non-stationary data problem, is presented in Table 8. This table points out that the effects of QE variables are similar to those indicated by the original specifications, even though the significance of MBS purchase and total purchase is slightly altered.

| roeD | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| loansassetsD | -8.959886 | -7.209357 | -5.150364 | -4.836186 |
| diversifica~D | 71.11641*** | 64.33403*** | 71.29862*** | 71.39312*** |
| interestspr~D | 1.352578 | 1.368758 | 1.414272 | 1.412694 |
| gdpgrowthD | .0728308 | .0939961 | .0709466 | .0691193 |
| mbspurchaseD | -7.86e-06 | | -7.28e-06 | |
| ustreasurie~D | | -6.32e-06 | -5.88e-06 | |
| totalpurcha~D | | | | -6.79e-06* |
| _cons | -.115189 | -.117095 | -.1003815 | -.0999095 |

*Significant at 10%, **significant at 5%, ***significant at 1%

Table 7 OLS regression using first difference of all variables

| netincomeD | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| loansassetsD | -27397 | -23981.09 | -15618.12 | -14379.14 |
| noninterest~D | 1.027596*** | .8870389*** | 1.028491*** | 1.008765*** |
| interestspr~D | 5224.908** | 5181.438** | 5423.604** | 5409.617** |
| gdpgrowthD | 191.725 | 263.784 | 187.2939 | 192.2419 |
| mbspurchaseD | -.0317989* | | -.0299249* | |
| ustreasurie~D | | -.0199237 | -.018124 | |
| totalpurcha~D | | | | -.0236337** |
| _cons | -262.5452 | -207.7229 | -217.1469 | -209.2495 |

*Significant at 10%, **significant at 5%, ***significant at 1%

Table 8 Regression using different variables

## 5. Conclusion

To alleviate the consequence of the 2007 financial crisis, multiple countries (the US, UK, Canada) resorted to unconventional monetary policy like quantitative easing. Among the countries mentioned above, the extent of QE done in the US is considered the greatest both in size and in length, with a total of more than $4 trillion of asset purchase from December 2008 to October 2014. Despite numerous

studies on how QE impacts on interest rates and other macroeconomic variables in the US, only two studies are devoted to its impact on the profitability of the banking industry.

Using quarterly aggregate data of the US banking industry from 1992Q4 to 2013Q4, I build a model of bank profitability for the US banking industry and argue that as the Fed increases the amount of asset purchase under QE, the profitability of the whole banking sector would be reduced. This result applies for MBS purchase and total purchase, while the effect of US Treasuries purchase remains uncertain. Furthermore, this result is robust in a sense that it withstands various statistical tests, and the result still holds after making small adjustments to the original model. However, the result in this paper might be under challenge due to missing data on the Fed's 2014 purchase and banking statistics during 1992 – 2001. Also, more research should be carried out to better understand the mechanism behind QE's negative impact on bank profitability, and the extent to which the results are still valid beyond QE periods.

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Appendix

| Variable | Meaning | Note | Source |
|---|---|---|---|
| ROE | Return on equity. Calculated as $\frac{Net\ income}{Average\ total\ equity}$ | Total equity includes preferred common stocks, surplus and undistributed profits. The quarterly average is calculated as mean of previous quarter and current quarter equities. | Statistics on Banking, Federal Deposit Insurance Corporation. https://www5.fdic.gov/SDI/SOB/ |
| LOANSASSETS | $\frac{Total\ loans}{Total\ assets}$ | Total assets include all assets owned by banks (e.g. cash, loans, securities), excluding off-balance-sheet accounts. Total loans include real estate loans, farm loans, commercial and industrial loans, loans to individuals, other loans and leases. | Statistics on Banking, Federal Deposit Insurance Corporation. https://www5.fdic.gov/SDI/SOB/ |
| DIVERSIFICATION | $\frac{Total\ noninterest\ income}{Total\ operating\ income}$ | Total noninterest income include fiduciary activities, service charges on deposit | Statistics on Banking, Federal Deposit Insurance Corporation. |

| | | | |
|---|---|---|---|
| | | accounts, trading account gains and fees, and additional noninterest income including investment banking service fees and commissions (e.g. advisory, brokerage), net gains/ losses on sales of assets. Total operating income is the sum of total noninterest income and total interest income (generated from lending activities). | https://www5.fdic.gov/SDI/SOB/ |
| INTERESTSPREAD | $Lending\ rate - Deposit\ rate$ | The lending rate is the prime lending rate. The quarterly rate is calculated as average of three months in the quarter. The monthly rate is posted by top 25 US commercial banks. The deposit rate is 6-month CD rate, the quarterly rate is calculated as average of three months in the quarter. The rates are issued by top-tier banks. | H.15 Selected Interest Rates, Federal Reserve Board of Governors. https://www.federalreserve.gov/releases/h15/ |
| GDPGROWTH | Percent change of GDP from preceding period | | National Economic Accounts, Bureau of Economic Analysis, US Department of Commerce. http://www.bea.gov/national/Index.htm |
| MBSPURCHASE | Total purchase – Total sale of MBS | The data is calculated based on quarterly observations. The Fed purchased fixed-rate MBS issued by Fannie Mae, Freddie Mac and Ginnie Mae. Also, the type of MBS purchased by the Fed are mostly 15-year and 30-year | Agency Mortgage-Backed Securities (MBS) Program, Federal Reserve Board of Governors. http://www.federalreserve.gov/newsevents/reform_mbs.htm Program Archive, Federal Reserve Bank |

| | | | |
|---|---|---|---|
| | | securities. | of New York. https://www.newyorkfed.org/markets/funding_archive/lsap.html |
| USTREASURIESPURCHASE | Total purchase – Total sale of US Treasuries | The data is calculated based on quarterly observations. In QE1, the Fed concentrated its purchase on "2- to 10-year sectors of the nominal Treasury curve," and the purchase ranges from nominal Treasury to TIPS yield curves. | Program Archive, Federal Reserve Bank of New York. https://www.newyorkfed.org/markets/funding_archive/lsap.html |
| TOTALPURCHASE | Total purchase – Total sale of total purchase, which includes agency debt, MBS purchase, US Treasuries purchase | The data is calculated based on quarterly observations. Agency debt is defined as direct obligations of housing-related government-sponsored enterprises (GSEs), namely Fannie Mae, Freddie Mac, and Federal Home Loan Banks. The type of debt purchase is fixed-rate, non-callable, senior benchmark securities issued by the three GSEs mentioned above. | Program Archive, Federal Reserve Bank of New York. https://www.newyorkfed.org/markets/funding_archive/lsap.html |