

Measuring the Change in Effectiveness of Quantitative Easing

Daniel Nellis, Grinnell College

In 2008, the Federal Open Market Committee (FOMC) lowered the federal funds rate to zero, forcing the FOMC to rely on non-traditional monetary policies such as Quantitative Easing (QE). QE occurs when the Federal Reserve increases its balance sheet through the purchase of long-term securities to lower long-term interest rates in order to avoid deflation, and simulate the economy. Currently, there have been three rounds of QE in the United States: QE1, QE2, and QE3. Beginning on November 25, 2008, QE1 involved the purchase of \$500 billion of agency MBS securities and \$100 billion of agency debt. QE2 which began on November 3, 2010, consisted of the purchase of \$600 billion in Treasury bonds. On September 12, 2012, the Federal Reserve introduced QE3, an open policy to buy \$40 billion of agency MBS each month without a stated ending date. This paper seeks to answer two questions: i) Has each round of QE been effective? and ii) Has QE become less effective with each additional round? With the increasing use of QE, it is possible the market began to anticipate new rounds of QE and factored them into the pricing of assets prior to their official announcement. The more anticipated a program, the less effective it becomes, since the actual reduction in interest rates will occur prior to the FOMC announcement. This paper will take investor anticipation into account in an attempt to measure and compare the effectiveness of each round of QE in lowering interest rates to determine if it should be used as a monetary policy in the future. The results indicate QE was initially effective in lowering long-term interest rates; however, additional rounds of QE became less effective as they were widely anticipated.

I. LITERATURE REVIEW

Although extensive research envisaged the potential effectiveness of QE, the policy's recent implementation finally made it possible for economists to empirically test its effectiveness. One such study was conducted by Bernanke, Reinhart, and Sack (2004) in which the authors attempted to examine the effectiveness of non-standard policies. Their results showed "large changes in the supply of securities may have economically significant effects on their yields; [however,] ... the effects of such policies remain quantitatively quite uncertain."¹ A later article by Gagnon, Rashkin, Remache, and Sack (2010) found "large scale asset purchases [QE1] caused economically meaningful and long-lasting reductions in longer-term interest rates [10-year Treasury] . . . specifically a 91 cumulative basis point decrease around announcement date."² Building on the work of Gagnon, et al. (2010), Krishnamurthy and Vissing-Jorgensen (2011) conclude both "QE1 and QE2 significantly lower nominal interest rates on Treasuries, Agencies, and highly-rated corporate bonds."³ For example, their study of QE1 found an average two day decline of 128 bps for the 30-year MBS and 107 bps for the 10-year Treasury yields which was statistically significant at the 5% level.⁴ For QE2, they found an average one day decline of about 6 bps on 10-year Treasury yields, statistically significant at the 1% level.⁵ In

¹ Bernanke, Reinhart, and Sack 2004, ii

² Gagnon, Rashkin, Remache, and Sack 2010, i

³ Krishnamurthy and Vissing-Jorgensen 2011, 30

⁴ Ibid, 42

⁵ Ibid, 45

addition to measuring the total effect of QE1 and QE2, this article identifies and measures the separate effects of seven different channels through which the interest rates on various securities are affected. Similarly, Kozicki, S., E. Santor, and L. Suchanek (2010) used time series data to conclude increase in the size of the central bank balance sheet results in a decline in long-term forward interest rates.⁶

A majority of papers analyzing QE employ an event study approach that looks at the oneday change in interest rates following an announcement of planned policy action. For example, Gagnon, et al. (2010) examined eight announcements involving long-term asset purchases to measure the one day change following the announcement of the following: 2-year and 10-year Treasury yields, 10-year agency debt yield, the current-coupon 30-year agency MBS yield, and the 10-year Treasury term premiums. Krishnamurthy and Vissing-Jorgensen (2011) employed a similar technique; however, they measured both daily and intra-day interest rates, focused on fewer announcements for QE1, and extended their analysis to QE2. They also tested the statistical significance of the cumulative effect of announcements during QE1 and QE2 and ran a "regression analysis . . . to estimate the effect of a purchase of long-term securities via the safety channel."⁷

II. CONTRIBUTION

This paper builds on the previous work of Gagnon, et al. (2010) and Krishnamurthy and Vissing-Jorgensen (2011) by analyzing the effectiveness of QE3 and comparing it to QE1 and QE2. Past analysis of QE in the United States only examined the impact of QE1 and QE2; however, the recent announcement of QE3 should be included to effectively analyze the overall effectiveness of QE. Additionally, this paper provides a more complete analysis of the overall effect of each round of QE by examining the two-week period following announcements that led to a significant decline in interest rates. In contrast, previous papers only captured a snapshot of the changes by analyzing the one or two day change in the interest rate. This paper also considers investor expectations prior to major announcements to determine the degree to which the program was expected, and the importance of investor expectations in the reaction of the market.

Although this paper draws on the methods used by Gagnon, et al. (2010) and Krishnamurthy and Vissing-Jorgensen (2011), this paper obtains different results for the total effectiveness of QE1 and QE2 because it employs a better method of identifying events and measuring their effect. For example, Gagnon, et al. (2010) identifies all FOMC announcements and minute releases as event days. From this list, they selected baseline events similar to the ones identified in this paper; however, this paper includes two additional events: the FOMC announcements on December 30, 2008 and February 23, 2009. The December 30 announcement stated QE1 purchases would begin in early January and the February 23 announcement stated the Federal Reserve would include on its website an explanation of QE1 and the purchases being made. Although neither of these announcements resulted in major changes in the yield of the 10-year Treasury or 30-year MBS, they still indicated a change in policy, or provided additional information about when a policy would be implemented, and should be included as part of the event study.

⁶ Kozicki, S., E. Santor, and L. Suchanek 2010

⁷ Krishnamurthy and Vissing-Jorgensen (2011), 27

To measure the total effect of QE1 and QE2, Krishnamurthy and Vissing-Jorgensen (2011) used only the events days with the largest one-day change in yields. In their analysis of QE1 and QE2, they excluded three QE1 events included by Gagnon et al. and included the September 21, 2010 FOMC meeting in their QE2 events despite no mention of QE in the official announcement. Additionally, they fail to include two event days for QE2: the Benjamin Bernanke speech on August 27, 2010 and the William Dudley speech on October 1, 2010. Both of these speeches suggested the implementation of QE2 in the near future and should be included as event days. The consequence of omitting important event days and including the September 21, 2010 FOMC announcement is that Krishnamurthy and Vissing-Jorgensen (2011) overestimated the effect of QE1 and QE2.

In addition to excluding important event days, Krishnamurthy and Vissing-Jorgensen (2011) test the significance of the total change in interest rates instead of testing the significance of each event day. This method provides merely a snapshot of the full effect because it ignores many of the event days and does not measure whether the effects were lasting. In contrast, this paper measures the significance of each event day, the total effect as a sum of all event days identified, and the yields of the 30-year MBS and 10-year Treasury in the two-weeks following significant event days to capture the full effect of each round of QE.

III. THEORY

When the Federal Reserve purchases long-term securities, such as 10-year Treasury and 30-year agency MBS securities, the Federal Reserve artificially increases demand for these securities. The actual purchase of these securities in the market reduces the supply of these securities in the market leading to an increase in price and decrease in yield. Therefore, any announcement by the FOMC indicating the Federal Reserve's intention to purchase, increase the amount purchased, or alluding to the possibility of future purchases of a particular security should result in a decrease in the yield of that security. Likewise, if the FOMC announces the intention to decrease the amount purchased, or that it will not purchase a security in the future, the yield on that security should increase. In addition to affecting the yield on a particular security, yields on securities with similar characteristics may also be affected through the portfolio channel. The portfolio channel relies on the assumption that if the Federal Reserve's bond purchases reduce the supply of a particular security, investors are pushed into holding other assets with similar characteristics, thus reducing the yield on those assets as well. Since QE1, QE2, and QE3 involved primarily the purchase of agency MBS, 10-year Treasuries, or some combination of the two, the yields of these assets theoretically will be affected by each round of OE and therefore are used in this paper to compare the effect of the three programs.

The concept of market expectations reducing the effect of QE is based on perfect information derived from the efficient market theory. According to the efficient market theory, when new information becomes available, the market quickly adjusts to reflect this new information. Therefore, when the Federal Reserve makes an announcement about the potential purchase of new securities, the price of these securities should adjust based on this announcement and not the actual purchase of the security. In regards to the validity of efficient market theory in practice, Fama (1970) found "the evidence in support of the efficient markets model is extensive, and (somewhat uniquely in economics) contradictory evidence is sparse."⁸

⁸ Fama 1970, 416

More specifically and importantly for this paper, Roll (1968) discovered the market for Treasury Bills is efficient and Roll's results strongly support the efficient market theory for treasuries.⁹ Additionally, Fama states authors have used different variants of the method of residual analysis to study different kinds of public announcements, and found all these studies also support the efficient markets theory.¹⁰ Based on this evidence, this paper assumes the efficient market theory applies to the securities and Federal Reserve announcements analyzed in this paper.

IV. METHODOLOGY

This paper uses an event study of QE1, QE2, and QE3 based on Federal Reserve announcements indicating possibility of or intent to purchase long-term assets, modify the amount of previously announced purchases, or change other aspects of a program. The announcements are identified by analyzing FOMC statements, Monetary Policy Press Releases, and speeches by members of the Federal Reserve. By using a systematic approach to identify events, this paper reduces the likelihood of excluding an important announcement which could lead to an "upward or downward bias depending on how QE affected the market's perception of the probability or magnitude of QE."¹¹ After identifying the events, to measure the announcement's impact on long-term nominal interest rates, I calculate the single-day changes in the 30-year agency MBS and 10-year Treasury closing rates on the day of announcement from the previous day. By using a single-day change, I hope to identify the impact of revised expectations on asset prices while limiting the possibility of other factors affecting security prices. It is assumed that all important program announcements affecting expectations are included in the analysis, and that expectations are influenced solely by these announcements.¹² Assuming the efficient market theory, measuring the effect on interest rates following the release of information regarding QE captures the true effect of QE. Other factors effecting interest rates would only be included if news surrounding these factors came out on the same day as a QE event day. However, analysis by Krishnamurthy and Vissing-Jorgensen (2011) conclude for OE1 and OE2 the events "identify significant movements in Treasury yields and Treasury trading volume and that the announcements do appear to be the main piece of news coming out on the event days."¹³ Unfortunately, this paper did not have the necessary resources to conclude a similar analysis for QE3 and therefore assumes the announcements for QE3 are the main piece of news coming out on event days.

After calculating the single-day change for all event days, I then calculate the mean and standard deviation of the changes in interest rates during the 2008-2012 period to test whether the day change in interest rates on announcement dates was statistically significant. Additionally, by analyzing the interest rates on days following the announcement, I attempt to gauge whether the effect was temporary or permanent. To compare the effects of announcements on the 10-year Treasury and 30-year MBS during the different rounds of QE, two regressions were run using the following equation:

$$\Delta IR = B_0 + B_1 SIZE + e$$

(i)

⁹ Roll 1968

¹⁰ Fama 1970, 408

¹¹ Krishnamurthy and Vissing-Jorgensen 2011, 12

¹² Assumptions adopted from: Gagnon, Rashkin, Remache, and Sack 2010

¹³ Krishnamurthy and Vissing-Jorgensen 2011, 11-12

In the first regression, IR is the single-day change of the 10-year Treasury yield for events where purchases or changes to previous purchases are announced and Size is the total amount of stimulus as a percentage of nominal GDP for the year of the announcement. The second regression uses the single-day change in the 30-year MBS yield for the IR term. The amount of stimulus is taken as a percentage of nominal GDP to control for the different years of announcements in the regression.

An additional component of the event study consisted of reviewing newspaper articles from the Wall Street Journal, Yahoo Finance, CNBC, CNN, and Reuters to evaluate public expectation of each round of QE prior to its announcement to determine how anticipation of the event affected the market. To measure the effect of anticipation of the event, I ran two regressions on the following equation where IR and Size are the same as equation (i) for each regression:

(ii) $\Delta IR = B_0 + B_1 SIZE + B_2 AMOUNT + B_3 DESIGN + B_4 DATE + e$

In analyzing market expectations, three independent factors of a program were anticipated: the amount of stimulus, the intended type of security and rate of purchase, and the date of announcement. Therefore, in my regression I include the dummy variables Amount, Design, and Date to measure the effect of each component of anticipation. The dummy variables are assigned a one in the regression if the FOMC disclosed or there was consensus amongst economists regarding the date, amount, or rate and type of security prior to the program's official announcement. If anticipation of the program reduced effectiveness, the coefficients of the dummy variables should be positive. By employing the above methodologies, I hope to capture the change in effect of QE as it is extended and people become more accustomed to and better at anticipating the policy.

V. EVENT STUDY QE1

For QE1, ten events are included in the event study:

• The FOMC November 25, 2008 announcement indicated the Federal Reserve would purchase up to \$100 billion in agency debt and up to \$500 billion in agency MBS through a series of competitive auctions over several quarters.¹⁴ The announcement was intended to "reduce the cost and increase the availability of credit for the purchase of houses."¹⁵ The Federal Reserve hoped these purchases would improve the housing market and more generally the financial markets. This event marked the beginning of QE1, a change in monetary policy unanticipated by the market. In FOMC statements and speeches leading up to the announcement, there was little evidence or hints that QE would be utilized for the first time in the United States. The announcement caught the markets off guard and "set off a chain reaction across the United States, dropping interest rates and quickly spurring a burst of refinancing activity by borrowers eager to lower their mortgage

¹⁴ FOMC Press Release Nov 25, 2008

¹⁵ Ibid

costs."¹⁶ At Bank of America Corp., "call volume was roughly twice what was expected at call centers and via the Internet."¹⁷ Although the announcement of QE1 was unexpected, the market quickly reacted, factoring the announcement into the price of assets, and resulting in significant declines in long-term interest rates.

- Chairman Bernanke's December 1, 2008 speech outlined the "purchase of longer-term Treasury or agency securities in the open market in substantial quantities" as a means for the Federal Reserve to influence financial conditions through the expansion of its balance sheet.¹⁸ He also discussed the FOMC plan to purchase up to \$600 billion in agency and MBS debts.
- The FOMC December 16, 2008 announcement stated the Federal Reserve would "purchase large quantities of agency debt and mortgage backed securities . . . and [stood] ready to expand its purchases . . . as conditions warrant."¹⁹ Additionally, the FOMC extended Bernanke's comments on the purchase of long-term Treasury securities, stating "the Committee is also evaluating the potential benefits of purchasing longer-term Treasury securities."²⁰
- The Federal Reserve December 30, 2008 announcement stated the Federal Reserve "expects to begin operation in early January [on the] announced program to purchase MBS and that it has selected . . . agents to implement the program."²¹ Although the Federal Reserve had stated it would make purchases of agency MBS and agency debt, this announcement clarified when the program would actually begin.
- In the FOMC January 28, 2009 statement, the Committee announced it would continue to keep the Federal Reserve's balance sheet at a high level and "was prepared to purchase longer-term Treasury securities if evolving circumstances indicate that such transactions would be particularly effective."²² Also, the Committee expressed its intent to purchase "large quantities of agency debt and MBS . . . and stands ready to expand the quantity of such purchases and the duration of the purchase program as conditions warrant."²³ Both the December 16, 2008 and January 28, 2009 statements divulged the possibility of additional stimulus and the types of securities likely to be involved.
- The FOMC February 23, 2009 press release provided additional information on its website designed to improve the public's understanding of the Committee's actions and offering a detailed explanation of the Federal Reserve's balance sheet, making the Federal Reserve's QE plan more transparent.²⁴
- The FOMC March 18, 2009 announcement "further increasing the size of the Federal Reserve's balance sheet by purchasing up to an additional \$750 billion of agency MBS and \$100 billion of agency debt."²⁵ Additionally, the Federal Reserve announced the

¹⁶ Hagerty, James and Simon, Ruth

¹⁷ Ibid

¹⁸ Speech by Ben Bernanke in Austin, Texas

¹⁹ FOMC Statement Dec 16, 2008

²⁰ Ibid

²¹ FOMC Press Release Dec 30, 2008

²² FOMC Press Release Jan 28, 2009

²³ Ibid

²⁴ FOMC Press Release Feb 23, 2009

²⁵ FOMC Statement Mar 18, 2009

"purchase of \$300 billion of longer-term Treasury securities over the next six months," the first time the Federal Reserve had purchased longer term treasuries in QE1.²⁶ Although there had been indication of this policy announcement in earlier statements, "many economists and traders thought action was right around the corner [following Bernanke's speech and those earlier statements], but Fed officials didn't act quickly."²⁷ Not only were economists and traders caught off guard by the timing of the announcement, the size of the announcement for both MBS and treasuries were larger than anticipated, resulting in large decline in interest rates on March 18, 2009 as the market adjusted.

- The FOMC August 12, 2009 announcement stated the Committee's belief the economy had improved enough to "gradually slow the pace of [purchases of Treasury securities] and that the full amount would be purchased by the end of October."²⁸
- The FOMC September 23, 2009 announcement stated "the Committee will gradually slow the pace of [purchases of MBS securities and agency debt] . . . and anticipates they will be executed by the end of the first quarter of 2010."²⁹ With this announcement, the FOMC effectively established the close of QE1 and made it clear that no additional purchases would be executed.
- The FOMC November 4, 2009 announcement indicated "\$175 billion of agency debt would be purchased, far less than the previously announced maximum of \$200 billion," and reiterating the program would be completed by the end of the first quarter of 2010.³⁰ The Committee followed through and by the end of March, the remaining purchases had been completed and QE1 came to a close.

VI. Event Study QE2

For QE2, four events are included in the event study:

• The FOMC August 10, 2010 announcement in which the Federal Reserve implemented a new policy to "keep constant the Federal Reserve's holdings of securities at their current level by reinvesting principal payments from agency debt and agency mortgage-backed securities in longer-term Treasury Securities."³¹ The Committee reiterated the new policy in a statement on September 21, stating the Committee "will maintain its existing policy of reinvesting of principal payments from its holdings."³² After the initial expansion of the Federal Reserve's balance sheet during QE1, the Federal Reserve did not pursue additional purchases or re-investment of MBS and agency debt which resulted in a decrease in the size of the Federal Reserve's balance sheet. The Federal Reserve changed its policy to prevent possible deflation from a decrease in the money supply.

²⁶ Ibid

²⁷ Hilsenrath, Jon

²⁸ FOMC Statement Aug 12, 2009

²⁹ FOMC Statement Sep 23, 2009

³⁰ FOMC Statement Nov 4, 2009

³¹ FOMC Statement Aug 10, 2010

³² FOMC Statement Sep 21, 2010

- Chairman Bernanke's August 27, 2010 speech explained the FOMC's decision to reinvest principal payments in Treasury securities citing that holdings of MBS had run off quicker than anticipated and "an additional \$400 billion or so" could be repaid by the end of 2011.³³ The Committee stated the policy of allowing the balance sheet to shrink was inconsistent with the policy of monetary policy necessary to support the economic recovery."³⁴ In addition to explaining the FOMC's recent policy, Bernanke revealed he "believe[s] additional purchases of longer-term securities, should the FOMC choose to undertake them, would be effective in further easing financial conditions."³⁵ Although he indicated his support for future policy, he also explained two potential drawbacks of further stimulus which created doubt as to whether future policy would be enacted. The first drawback was the lack of experience and knowledge about the "quantitative effects of changes in the Fed's holdings on financial conditions."³⁶ The second risk was the reduction in the "public confidence in the Fed's ability to exit smoothly from its accommodative policies . . . [which] might increase . . . inflation expectations."³⁷
- William C. Dudley's October 1, 2010 speech indicated he believed "further action is likely to be warranted unless the economic outlook evolves in a way that makes [him] more confident that [the United States] will see better outcomes for both employment and inflation before too long."³⁸ Not only did Dudley agree with Bernanke that additional stimulus would be effective; he made clear that QE2 should be implemented in the near future barring a change in economic conditions.
- The FOMC November 3, 2010 announcement marked the official beginning of QE2. In the announcement, the FOMC declared it "intends to purchase a further \$600 billion of longer-term Treasury securities by the end of the second quarter of 2011, [at] a pace of about \$75 billion per month."³⁹ In later announcements, no additional purchases or plans to change the program were announced, and it expired at the end of the second quarter of 2011 as planned.

Following the statements made by Bernanke, Dudley and the FOMC, "investors had been preoccupied with speculating on how much the Fed would buy."⁴⁰ Prior to the November 2010 announcement, "market participants [were] virtually certain that the Federal Reserve [would] announce a substantial amount of asset purchases at the conclusion of its November meeting."⁴¹ In fact, a November CNBC survey "found that 99 percent of the 83 respondents expected a QE announcement, up from 93 percent in October and 70 percent in September.⁴² The predicted amount of purchases ranged from \$400 billion to \$1 trillion, and the median forecast was \$500

³³ Speech by Ben Bernanke in Jackson Hole, Wyoming

³⁴ Ibid

³⁵ Ibid

³⁶ Ibid

³⁷ Ibid

³⁸ Speech by William C. Dudley, President of the New York Federal Branch, in New York City, New York

³⁹ FOMC Statement Nov 3, 2010

⁴⁰ Censky, Annalyn : "QE2: Fed Pulls the Trigger"

⁴¹ Liesman, Steve

⁴² Ibid

billion.⁴³ Therefore, when QE2 was announced as expected, and at \$600 billion close to the anticipated amount, there was little reaction in the market as the program's design, amount, and announcement date was already factored into the pricing of securities.

VII. EVENT STUDY QE3

For QE3, three events are included in the event study:

- The August 22, 2012 release of the FOMC minutes from the July 31-August 1, 2012 meeting which provided the first indication the Federal Reserve was considering QE3. The minutes indicated "participants also exchanged views on the likely benefits and costs of a new large-scale asset purchase program."⁴⁴ Although there was no consensus, "many participants expected that such a program could provide additional support for the economic recovery [and] indicated that any new purchase program should be sufficiently flexible to allow adjustments."⁴⁵ Since participants discussed whether to purchase agency MBS or Treasury securities, one would expect the rates on both those securities to decline following this announcement.
- The FOMC September 13, 2012 statement marking the official announcement of QE3. The FOMC stated it intended to purchase "additional agency mortgage-backed securities at a pace of \$40 billion per month."⁴⁶ In contrast to QE1 and QE2, no time table was given for the end of the program and the total size of the stimulus remains unknown.
- John C. Williams' November 2, 2012 speech hinted at expanding QE3, claiming "if [the FOMC] find that [FOMC's] policies aren't doing what they're supposed to do or are causing significant economic problems, [the FOMC] will adjust or end them."⁴⁷ Many interpreted his statement to mean the Committee could expand the size of the purchases under QE3; however, uncertainty about QE3 remains.

Although a majority of investors anticipated QE3, expectations of the amount and design of the program varied. According to a Bloomberg survey, "almost two-thirds of economists" anticipated the announcement of QE3.⁴⁸ As the September 12-13 FOMC meeting approached, more and more economists and investors began to predict QE3 would be announced following the meeting. For example, economists at Goldman Sachs stated on September 7 "they expect the Fed to announce plans for QE3 during [the September 12-13 meeting] . . . more than a year ahead of when they had originally anticipated the maneuver."⁴⁹ Prior to and following the announcement of QE3, the amount of stimulus remains the most uncertain element. Economists' forecasts "ranged from \$280 billion to \$3 trillion . . . with a median of around \$600 billion."⁵⁰

⁴³ Ibid

⁴⁴ Minutes of the Federal Open Market Committee, July 31-August 1, 2012

⁴⁵ Ibid

⁴⁶ FOMC Statement Sep 13, 2012

⁴⁷ Speech by John C. Williams, president of the San Francisco branch of the Fed, in Salt Lake City, Utah

⁴⁸ Kearns, Jeff and Zumbrun, Joshua

⁴⁹ Reuters

⁵⁰ Reese, Chris

Economists at Goldman Sachs predicted fairly accurately the program would be open-ended and consist of a "total of \$50 billion in purchases a month."⁵¹ However, other economists predicted QE3 might consist of MBS, or Treasury bonds, or both, and have a specified end date. Therefore, although the announcement of QE3 was anticipated, the amount of purchases and length of program remains uncertain.

VIII. RESULTS

Based on the significance analysis of the effect of individual event days in QE1 and their total effect, QE1 was effective in reducing the yield of both the 10-year Treasury and 30-year MBS. As shown in Table 1, the ten event days identified resulted in a total decline of 96 basis points for the 10-year Treasury and 104 basis points for the 30-year MBS. Additionally, QE1 had four announcements that resulted in statistically significant declines for the 10-year MBS.

Date	Event	10 Year Treasury	30 Year MBS Yields
11/25/2008	Initial Announcement	-0.24***	-0.45***
12/1/2008	Bernanke Speech	-0.21***	-0.15*
12/16/2008	FOMC Statement	-0.16**	-0.28***
12/30/2008	FOMC Statement	-0.02	-0.10
1/28/2009	FOMC Statement	-0.12**	0.07
2/23/2009	FOMC Statement	0	-0.03
3/18/2009	New Purchase Announcement	-0.51***	-0.15**
8/12/2009	FOMC Statement	0.01	0.03
9/23/2009	FOMC Statement	-0.02	-0.01
11/4/2009	FOMC Statement	0.07	0.00
Total		-0.96	-1.04

Table 1: Treasury and MBS 1-day yield change on QE1 event dates (in basis points) Note: The Treasury yields and MBS yields are from Bloomberg. *denotes significance at 10% level, ** denotes significance at 5% level, and *** denotes significance at 1% level.

Although these results capture a snapshot of the impact of QE1, Figure 1 demonstrates the decline in interest rates of the 10-year Treasury and 30-year MBS are enduring as the interest rates remained at the lower levels after the initial decline. These results are further supported by Figures 2 as the yield-on 10-year Treasury and 30-year MBS declined for the first four months of QE1. Although yields increased later during QE1, the market had already adapted to QE1 and the increase in interest rates was likely due to other factors. Based on these results, QE1 resulted in a significant and lasting decline in long-term interest rates.

⁵¹ Censky, Annalyn "QE3 Won't Create Jobs"



Figure 1: Lasting Effects of QE1 Announcements



Figure 2: QE1 period Change in Treasury and MBS Yields

In contrast to QE1, QE2 and QE3 were not effective in reducing the 10-year Treasury yield, and only QE3 effectively reduced the 30-year MBS yield. In fact, as seen in Table 2, the four events studied for QE2 resulted in a 14 basis point increase of the 10-year Treasury yield and 7 basis point increase of the 30-year MBS. Additionally, there was no single event that resulted in a statistically significant decline of the 10-year Treasury yield or 30-year MBS yield, even on QE2's official announcement day. This lack of decline is likely due to the anticipation of QE2 and adaption of the market. As seen in the Figure 3, there is about a 50 basis point decline in the yields of the two securities in early August, and this is likely the period when anticipation of QE2 was accounted for in the market.

Date	Event	10 Year Treasury	30 Year MBS Yields
8/10/2010	FOMC Statement	-0.07	-0.01
8/27/2010	Bernanke Speech	0.16**	-0.12*
10/1/2010	Dudley Speech	0.01	-0.02
11/3/2010	Official Announcement	0.04	-0.02
Total		0.14	0.07

 Table 2: Treasury and MBS 1-day yield change on QE2 event dates (in basis points)

 *denotes significance at 10% level, ** denotes significance at 5% level, and *** denotes significance at 1% level.



Figure 3: Beginning of QE2 Change in Treasury and MBS Yields

Similar to OE2, there was some anticipation of OE3; however, there was no consensus as to when QE3 would be instituted prior to its official announcement and even after it was announced, the exact total amount of stimulus was not known. This uncertainty may help explain why there was a statistically significant decline in the 30-year MBS yield following the announcement of OE3 as shown in Table 3. Additionally, the release of the July 31-August 1. 2012 FOMC minutes hinting at the possible use of QE3, resulted in a significant decline in the 30-year MBS yield. Overall, the three events examined for QE3 resulted in a 46 basis point decline of the 30-year MBS yield and based on Figure 4, the results are lasting. Similar to QE1, OE3 involved the purchase of agency MBS; however, the initial announcement of OE1 resulted in a decline of the 10-year Treasury yield whereas QE3 resulted in a 16 basis point increase. This increase suggests that the liquidity channel may outweigh the portfolio channel in OE3, as the liquidity channel predicts the yield of the most liquid assets (Treasuries) would increase.⁵² Alternatively, people may have anticipated Treasuries to be part of QE3, and when it was announced otherwise, the market reacted accordingly. In sum, QE2 and QE3 have less event days that result in significant declines of the 10-year Treasury yield and 30-year MBS yield. They also have a smaller total effect, suggesting that QE2 and QE3 were not as effective as QE1.

Date	Event	10 Year Treasury	30 Year MBS Yields
8/22/2012	Release of FOMC Statements	-0.07	-0.15**
9/13/2012	Official Announcement	0.16	-0.25***
11/2/2012	Williams Speech	0.04	-0.06
Total		0.13	-0.46

 Table 3: Treasury and MBS 1-day yield change on QE3 event dates (in basis points)

 *denotes significance at 10% level, ** denotes significance at 5% level, and *** denotes significance at 1% level.



⁵² The liquidity channel was identified in Krishnamurthy and Vissing-Jorgensen (2011). It suggests that since reserve balances are more liquid than long-term securities, QE increases the liquidity in the hands of investors and reduces the liquidity premium.



Figure 4: Lasting Effects of QE3 Announcements

The results in Table 4 further support the hypothesis that QE1 was more effective than QE2 and QE3 because QE1 had a greater change in the yield of the 10-year Treasury and 30-year MBS than predicted on its initial announcement. In contrast, the initial announcement of QE2 had less than predicted changes in both securities, and with the announcement of QE3, only the actual change in the 30-year MBS exceeded the predicted change. It is worth noting that an actual amount of QE3 has not been officially announced. In order to run a regression, I assumed the amount to be similar in size to earlier rounds of QE. As Table 5 shows, the \$600 billion is likely a lower limit, as higher amounts of stimulus will likely be necessary to achieve the same effect on interest rates realized in QE1. Additionally, QE1 also had an actual greater change in the 10-year Treasury yield for the additional stimulus announced on March 18, 2009, although the actual change in 30-year MBS was lower than the prediction of the regression equation. Based on the analysis, the effects of QE declined in the rounds following QE1.

	Predicted Change in	Actual Change in	Predicted Change	Actual Change in
Date	10 year Treasury	10 year Treasury	in 30 year MBS	30 year MBS
11/25/2008	-0.14	-0.24	-0.17	-0.45
3/18/2009	-0.43	-0.51	-0.25	-0.15
11/4/2009	0.16	0.07	-0.09	0.00
11/3/2010	-0.13	0.04	-0.17	0.02
9/13/2012	-0.12	-0.02	-0.17	-0.24

	Assumed QE3	Predicted Change in	Actual Change in	Predicted Change	Actual Change in
Date	Stimulus Amount (bn)	10 year Treasury	10 year Treasury	in 30 year MBS	30 year MBS
9/13/2012	600.00	-0.12	-0.02	-0.17	-0.24
9/13/2012	800.00	-0.19	-0.02	-0.19	-0.24
9/13/2012	1000.00	-0.24	-0.02	-0.21	-0.24
9/13/2012	1200.00	-0.26	-0.02	-0.23	-0.24

Table 4: Predicted v. Actual Change in Interest Rate

Table 5: Predicted v. Actual Change of QE3 Under Different Stimulus Assumptions

Quantitative Easing, Nellis

The results of the regression analysis show a 1 percentage point increase in the size of purchase as a percentage of nominal GDP results in substantial declines in the 10-year Treasury and 30-year MBS. The results can be seen below:

(iii)
$$\Delta 10$$
-YEAR US TREASURY = 0.1496 - 6.994 PURCHASE SIZE + e
(SE = 2.447) (T-Stat = -2.86)*⁵³ R² = 73.1%

(iv)
$$\Delta 30$$
-YEAR AGENCY MBS = 0.092 - 1.956 PURCHASE SIZE + e
(SE = 3.397) (T-Stat = -0.58) R² = 10.0%

The purchase size in regression (iii) is statistically significant at the 10% level; however, purchase size in regression (iv) is not statistically significant and the R^2 is much lower. Despite these results, the negative coefficient of the Purchase Size variable in regression (iv) indicates an increase in stimulus would lower the 30-year MBS yield.

As shown below, the coefficients of the three anticipation dummy variables in regressions (v) and (vi) are all positive except the amount anticipated in regression (vi).

(v)
$$\Delta$$
 10-YEAR US TREASURY = 0.058 - 7.130 SIZE + 0.045 AMOUNT + 0.021 DESIGN + .201 DATE + e

(vi)
$$\Delta$$
 30-YEAR AGENCY MBS = -0.014 - 10.373 SIZE - 0.482 AMOUNT +
0.718 DESIGN + 0.175 DATE + e

The positive coefficients support the hypothesis that the anticipation of a program reduces its effectiveness. The single negative coefficient of the amount anticipated dummy variable is likely a result of a small sample size and that same dummy variable is positive in the other regression. Additionally, the small sample size prevented the regression results from obtaining a standard error and t-statistic for each variable. Based on the coefficients of the dummy variables in both regression equations, anticipation of the date seems to have the greatest effect on interest rates. The results of the regression analysis suggest that anticipation of a program's announcement day, amount of stimulus, and design reduce the effects of QE on interest rates.

IX. CONCLUSION

The results of the significance tests for individual announcements demonstrate QE1 was more effective than QE2 and QE3 in lowering long-term interest rates. Additionally, the expectations analysis indicates a more anticipated stimulus package has a smaller impact when announced. Although QE3 was more successful than QE2 because it included uncertainty regarding the exact amount of stimulus and announcement date, the anticipation of both QE2 and QE3 severely reduced their intended impact. To gain a better understanding of when QE will be successful, future research should focus on identifying the economic conditions in which QE is effective. Similarly, upon the completion of QE3, a more thorough analysis of its effectiveness

⁵³ *denotes significance at 10% level, ** denotes significance at 5% level, and *** denotes significance at 1% level.

can be completed. It will then be possible to compare the ideal economic circumstances for QE to those present during QE1, QE2, and QE3 to gain a better understanding of the effectiveness of these programs.

The Federal Reserve seems to have recognized uncertainty is necessary for QE to be effective, as it did not reveal the size of the QE3. This suggests the Federal Reserve learned its lesson from QE2 which was widely anticipated and had little to no effect. Although QE can be effective if uncertainty exists, this approach contradicts the Federal Reserve's recent policy of increased transparency. In addition to requiring uncertainty, this paper predicts future use of QE will require larger amounts of stimulus to bring about the same impact on long-term interest rates which would further increase the Federal Reserve's balance sheet. After three rounds of QE, the Federal Reserve's balance sheet has exceeded \$2 trillion, resulting in expectations of higher inflation. In fact, the announcement of QE3 "[shook] the nerves of investors thinking about the potential inflation effects of all that additional money in the financial system."⁵⁴ The Federal Reserve has employed the successful monetary policy of maintaining a stable rate of inflation during the past few decades, so loosening the control of inflation for the sake of attempting an unproven monetary policy to lower interest rates and stimulate the economy seems unwise. Based on the above factors, the risks associated with QE are not worth the rewards, and the Federal Reserve should utilize other monetary policies to target interest rates in the future.

X. REFERENCES

- "After disastrous US job report, QE3 expected next week" Reuters, accessed November 24, 2012. <u>http://rt.com/usa/news/qe3-jobs-employment-labor-610/</u>
- Bernanke, Ben, Vincent Reinhart, and Brian Sack. 2004. "Monetary Policy Alternatives at the Zero Bound: An Empirical Assessment." *Brookings Papers on Economic Activity* 2004-2: 1-100. <u>http://www.federalreserve.gov/pubs/feds/2004/200448/200448pap.pdf</u>
- Bernanke, Ben, and Vincent Reinhart. 2004. "Conducting Monetary Policy at Very Low Short-Term Interest Rates," *American Economic Review*, 94(2): 85-90. Blinder, Alan. <u>http://www.bis.org/review/r040121e.pdf</u>
- Billi, R. M. and Kahn, George A. 2008. "<u>What is the Optimal Inflation Rate</u>?" *Economic Review*, Federal Reserve Bank of Kansas City, Q II: 5-28.
- Censky, Annalyn, "QE2: Fed Pulls the Trigger," CNN, accessed November 24, 2012. http://money.cnn.com/2010/11/03/news/economy/fed_decision/index.htm
- Censky, Annalyn, "QE2: Fed Pulls the Trigger," CNN, accessed November 24, 2012. http://money.cnn.com/2012/09/12/news/economy/federal-reserve-ge3-jobs/index.html
- Fama, Eugene F. 1970. "Efficient Capital Markets: A Review of Theory and Empirical Work." *The Journal of Finance*. no.2: <u>http://www.jstor.org/stable/2325486</u>

⁵⁴ Yahoo Finance

- "FOMC Press Release Nov 25, 2008," last updated November 25, 2008, http://www.federalreserve.gov/newsevents/press/monetary/20081125b.htm
- "FOMC Statement Dec 16, 2008," last updated December 16, 2008, http://www.federalreserve.gov/newsevents/press/monetary/20081216b.htm
- "FOMC Press Release Dec 30, 2008," last updated December 30, 2008, http://www.federalreserve.gov/newsevents/press/monetary/20081230b.htm
- "FOMC Press Release Jan 28, 2009," last updated January 28, 2009, http://www.federalreserve.gov/newsevents/press/monetary/20090128a.htm
- "FOMC Press Release Feb 23, 2009," last updated February 23, 2009, http://www.federalreserve.gov/newsevents/press/other/20090223a.htm
- "FOMC Statement Mar 18, 2009," last updated March 18, 2009, http://www.federalreserve.gov/newsevents/press/monetary/20090318a.htm
- "FOMC Statement Aug 12, 2009," last updated August 12, 2009, http://www.federalreserve.gov/newsevents/press/monetary/20090812a.htm
- "FOMC Statement Sep 23, 2009," last updated September 23, 2009, http://www.federalreserve.gov/newsevents/press/monetary/20090923a.htm
- "FOMC Statement Nov 4, 2009," last updated November 4, 2009, http://www.federalreserve.gov/newsevents/press/monetary/20091104a.htm
- "FOMC Statement Mar 16, 2010," last updated March 16, 2010, http://www.federalreserve.gov/newsevents/press/monetary/20100316a.htm
- "FOMC Statement Aug 10, 2010," last updated August 10, 2010, http://www.federalreserve.gov/newsevents/press/monetary/20100810a.htm
- "FOMC Statement Sep 21, 2010," last updated September 21, 2010, http://www.federalreserve.gov/newsevents/press/monetary/20100921a.htm
- "FOMC Statement Nov 3, 2010," last updated November 3, 2010, http://www.federalreserve.gov/newsevents/press/monetary/20101103a.htm
- "FOMC Statement Sep 13, 2012," last updated September 13, 2012, http://www.federalreserve.gov/newsevents/press/monetary/20120913a.htm
- Friedman, Benjamin. 1981. "Debt Management Policy, Interest Rates, and Economic Activity." National Bureau of Economic Research Working Paper No. 830. http://www.nber.org/papers/w0830.pdf?new_window=1

- Gagnon, Rashkin, Remache, and Sack 2010. "Large-Scale Asset Purchases by the Federal Reserve: Did they Work?" *Federal Reserve Bank of New York Staff Reports* Staff report no. 441. http://www.ny.frb.org/research/staff_reports/sr441.pdf
- Hagerty, James and Simon, Ruth "Fed Aid Sets Off a Rush to Refinance," Wall Street Journal, accessed November 24, 2012. <u>http://search.proquest.com/docview/399080010/13A9FB</u> <u>0E9A958B6875B/2?accountid=7379</u>
- Hilsenrath, Jon "U.S. News: Fed's Gamble: Buying Long Bonds," Wall Street Journal, accessed November 24, 2012. <u>http://search.proquest.com/docview/399095457/13A9FC860AC78</u> <u>13B4D0/9?accountid=7379</u>
- Isidore, Chris, "Goldman: Fed's QE3 could hit \$2 trillion," CNNMoney, accessed November 24, 2012. <u>http://money.cnn.com/2012/09/24/news/economy/goldman-fed-qe3/index.html</u>
- Krishnamurthy, A. and Vissing-Jorgensen, A. 2011. "The Effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," Brookings Papers on Economic Activity, 43(2): 215-287. <u>http://www.brookings.edu/~/media/Files/Programs/ES/BPEA/</u> 2011_fall_bpea_papers/2011_fall_bpea_conference_krishnamurthy.pdf
- Kearns, Jeff and Zumbrun, Joshua, "Fed Seen Starting QE3 While Extending Rate Pledge to 2015" Bloomberg, accessed November 24, 2012. <u>http://www.bloomberg.com/news/2012-09-12/fed-seen-starting-qe3-while-extending-rate-pledge-to-2015.html</u>
- Kozicki, S., Santor, E. and Suchanek L. 2010. "Central Bank Balance Sheets and Long-Term Forward Rates." Unpublished paper, Bank of Canada.
- Levine, Deborah. Market Watch, accessed November 24, 2012 on Yahoo Finance, http://finance.yahoo.com/news/tips-etf-rises-time-high-131542113.html
- Liesman, Steve, "How Much Will the Fed Decide to Ease on Wednesday?" CNBC, accessed November 24, 2012. <u>http://money.cnn.com/2010/11/03/news/economy/fed_decision/index.htm</u>
- "Minutes of the Federal Open Market Committee, July 31-August 1, 2012," last updated August 22, 2012, <u>http://www.federalreserve.gov/monetarypolicy/files/fomcminutes20120801.pdf</u>
- Roll, Richard. 1968. "The Efficient Market Model Applied to U.S. Treasury Bill Rates." Unpublished Ph.D. thesis, Graduate School of Business, University of Chicago.
- Reese, Chris, "U.S. Fed's QE3 program expected to total \$600 bln." Yahoo, accessed November 24, 2012. <u>http://finance.yahoo.com/news/u-feds-qe3-program-expected-044600093.html</u>
- "Speech by Ben Bernanke in Austin, Texas," given December 1, 2008, http://www.federalreserve.gov/newsevents/speech/bernanke20081201a.htm
- "Speech by Ben Bernanke in Jackson Hole, Wyoming" given August 27, 2010,

http://www.federalreserve.gov/newsevents/speech/bernanke20100827a.htm

- "Speech by John C. Williams in Salt Lake City, Utah" given November 2, 2012, <u>http://www.frbsf.org/news/speeches/2012/john-williams-1102.html?utm_source=frbsf-news-speeches&utm_medium=frbsf&utm_campaign=presidents-speech-2012-11-02</u>
- "Speech by William C. Dudley in New York City, New York" given October 1, 2010, http://www.newyorkfed.org/newsevents/speeches/2010/dud101001.html
- Swanson, Eric T. 2011. "Let's Twist again: A High-Frequency Event-Study Analysis of Operation Twist and its Implications for QE2." *Brookings Papers on Economic Activity*, Spring 2011: <u>http://www.ericswanson.us/papers/lta.pdf</u>