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The Response of Corporate Bond Yields to Quantitative Easing: Implications of the Default Risk and Liquidity Channels in the United States

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Abstract

As part of its response to the financial panic during the Sub-prime mortgage crisis, the Federal Reserve in the United States partook in unconventional monetary policy through large-scale asset purchases known as quantitative monetary easing (QE). These actions aimed to improve liquidity and credit conditions in the economy by increasing the amount of total reserves in the financial system. The Fed directly purchased treasury and mortgage backed bonds, but due to changes in liquidity and credit, QE also influenced corporate bonds. This paper brings attention to how corporate bonds with different credit ratings responded differently to QE in the US. As reserves increase, yields on bonds fall. This paper found that the declines in yields are conditional on a corporate bond's credit rating. Due to the improved credit conditions, the low rated CCC corporate bonds benefited more than higher rated BBB bonds and these benefited more than AAA bonds. This result shows that QE operates through both a default risk and liquidity channel. As the United States and other developed countries responded to this economic downturn swifter and with larger measures than ever before, this research will help institutional investors and corporations better respond to Fed actions.

Keywords: corporate bond yields, quantitative easing

1. Introduction

As part of responding to the 2007 to 2009 financial crises, the Federal Reserve in the United States (Fed) increased the amount of total reserves in a practice called Quantitative Monetary Easing (QE). This paper addresses how QE influenced corporate bond yields. Changes in these yields effect the behavior of corporations, financial institutions, investors, and policy makers. Two channels that QE works through are analyzed in their influence on yields. First, the credit default channel shows how QE reduces default risk. Second, the liquidity channel shows how QE improves market liquidity. This paper shows these channels impact on corporate bonds in the United States from 2005 to 2015, the period before, during, and after the financial crises.

This paper opens with the background of the financial crises, QE, and corporate bonds. Then, the rational for this research is given. The literature review introduces the credit default and liquidity channels and states the proposed hypothesizes. After this, the methodology explains the process and limitations of hypothesis testing. Findings are presented and discussed in the final section along with, the summary, conclusion, and recommendations.

2. Background of the Problem

2.1 Panic of 2007-09 and the Mortgage Market

The global financial crisis began in The United States in the summer of 2007. The crisis began from a financial panic, a systematic run on short term money market securities. Liquidity shortages at systematically important global institutions then led to a global crisis concentrated in advanced economies[1]. One view of understanding the crisis is to place the crisis in context with arguably simpler bank runs of the National Banking Era. Gorton uses this frame work to emphasis the importance of liquidity in crisis response[2]. Viewing the panic as lack of liquidity suggests that monetary policy should focus on restoring liquidity.

The US housing market was at the center of the run on repo. US housing prices hit an all-time high in 2006 after seeing constant gains over the previous ten years. These inflated prices caused an asset bubble. Sub-prime mortgages where packaged into mortgage backed securities that did not deserve an AAA credit rating. These assets where then used in the repo market where the liquidity run first appeared. US mortgage debt as asset class is generally considered safer post crisis, but as it is the world's largest asset class (at $26 million it is larger than the US stock market) and should be continually monitored for improvement.

Responding to the panic of 2007-2009 differed from previous crisis situations in two important ways. First, the government responded quicker than in previous crisis situations. This quick response attests to the US's strong legal and economic institutions. Second, governments took broader policy measures than before, especially in unconventional monetary policy. Monetary expansion was significantly higher in the 2007-09 crisis compared with past crisis. The median monetary expansion of about 6.0% significantly exceeds the historical median of about 2.3% for advanced economies[3].

2.2 The Zero Bound Problem

Central banks usually conduct monetary policy through controlling short-term nominal interest rates. As inflation expectations do not immediately increase to changes in nominal interest rates, central banks can also control real interest rates over the short and medium term. During a quite economic period, monetary policy aims to keep both inflation and employment in a target range. Because monetary policy changes short term real (inflation-adjusted) interest rates, central banks can influence asset prices. Real interest rates determine asset prices in a way that alters the willingness firms to invest and banks to lend; thus, changes in short-term real interest rates can influence the level of economic output and employment.

Individuals can always physically hold currency instead of investing; this suggests that short-term nominal rates cannot fall below zero. The zero bound limits the effectiveness of the conventional monetary policy. Concerns about the zero bound date at least to Keynes in 1936 and many believed that central banks become helpless once rates approach the zero bound[4]. Others have argued that central banks can still influence prices and output near the zero bound by increasing liquidity. In 1996 Mishkin disproved the view that central banks can do nothing once rates near zero[5].

Central banks experimented with zero bound policy in Japan in the early 2000's and then after the panic of 2007-09 in the United States, the United Kingdom, the euro area, and Japan. In these examples, central banks pursued quantitative easing (QE) to increase liquidity through an expanded monetary base. The next item describes how QE came to be the solution for central banks near the zero bound.

2.3 How QE Solves The Zero Bound Problem

Central banks normally conduct monetary policy through the purchases and sales of short-term debt securities. Referred to as open market operations, a central bank may purchase these debt securities to increase the monetary base and place downward pressure on short-term interest rates, or sell these securities to decrease the monetary base and place upward pressure on short-term rates. These conventional open market operations can potentially influence the economy through price channels[6].

Price channels rely on expansionary monetary policy to affect asset prices such as stock prices and exchange rates. Higher stock prices may increase consumption through consumer wealth and may increase business investment from lucrative stock offerings. A larger monetary base will devalue the local currency and encourage other countries to purchase those goods on the global market. Price channels can encourage consumption and investment.

The above channels explain how conventional monetary policy works. When faced with a zero bound, central banks have resorted to unconventional polices that drastically increase the monetary base to alleviate illiquidity and stimulate the economy. These unconventional policies fall into to the following two categories: lending to specific short-term credit markets, or purchasing long-term with the aim to reduce real, long-term interest rates. Quantitative easing follows the second aim.

The below equation (1) explains how long-term interest rates can be effected[7]. $Y_{t,t+n}$ represents the expected real yield of a bond at time *t* on a *n* year bond. $\acute{Y}_{t,t+n}$ shows the average expected overnight rate at the next *n* years at *t* time. $TP_{t,n}$ is the bond's term premium at *n* years at *t* time. Finally, $E_t\pi_n$ shows expected average inflation over the next *n* years at *t* time.

$$Y_{t,t+n} = \acute{Y}_{t,t+n} + TP_{tn} - E_t\pi_n \quad (1)$$

There are three ways that real-long term interest rates can lower. First, expected inflation can increase. Second, the policy can change the expected overnight rate. Third, the term premium can fall. Central banks can act to affect all three of these variables. To summarize: QE aims to lower long-term interest rates during a zero bound situation.

2.4 Defining QE

According to the New York Fed, the stated goal of quantitative easing (QE) is to spur economic growth through the reduction of long-term interest rates. This goal is achieved by replacing low liquidity mortgage-backed bonds or treasuries with high liquidity cash reserves. QE is a swap of assets. This swap results in the expansion of balance sheets. The Fed increases its ownership of debt securities and the receiving financial institutions have increased cash reserves. Following this train of thought, QE is defined as the increase of system-wide total reserves created by the Fed[8].

From this definition, QE is indifferent to what assets are purchased. QE aims to influence all assets and not target a certain sector or market. For these reasons, it is important to distinguish QE from the policy of credit easing. Credit easing targets specific interest rates and liquidity shortages in specific market segments. Credit easing may appear similar to QE because both programs can include central bank purchases of bonds and asset back securities. One initial difference between credit easing and QE is that they occur in different environments. QE is only considered at or near the zero bound, credit easing can occur above the zero bound[9]. Credit easing also does not focus on the quantity of system-wide total reserves[10]. QE focus on system-wide reserves while credit easing focuses a specific target. As such, credit easing distinguishes between markets that are struggling verses markets that functioning better. This shows that credit easing is concerned with asset's risk. In theory, QE is blind to risk.

2.5 QE In The United States Responding To The Financial Crisis

The United States engaged in QE operations in three rounds commonly referred to as QE1, QE2, and QE3. QE1 began in November of 2008 and lasted for 17 months, ending in April of 2009. During this time, the Fed purchased $1.7 trillion of mortgage-backed securities. The purchase of these mortgage backed securities removed illiquid assets from financial institutions and provided these institutions more reserves for lending. Seven months after the end of QE1, the Fed began QE2. QE2 lasted seven months from November 2010 to June 201. The second round of QE differed from the first as the Fed purchased about $85 billion of U.S. treasuries per month instead of purchasing mortgage-backed securities. QE2's only focus was to increase reserves, not to remove illiquid assets from institutions. Over a year after the end of QE2, the Fed announced QE3[11]. QE3 was structured differently than the previous periods. It introduced an ambiguous clause that suggested that further purchase of mortgage-backed securities would continue without limits on an as needed basis. QE3 purchased both treasuries and mortgage-backed securities at a monthly average consistent with QE2 of about $85 billion.

Some commentators declared U.S. QE operations as not pure QE, but 'endogenous credit easing[12]. Because different types of assets were purchased at different times, observers believe that the U.S. acted similarly to credit easing by targeting mortgage-backed securities in both QE1 and QE3. It is important to note that the Fed both targeted mortgage backed securities and responded to a zero bound problem. As this paper analyzes corporate bonds, it is important to note that corporate bonds where not targeted, and therefore can be studied independently. The existence and timing

of a mortgage easing agenda should not impact the default risk and liquidity effects on corporate debt. As that is what this paper aims to study, all three periods and beyond of QE are acceptable to study changes in US corporate debt.

2.5 Characteristics Of Bonds

2.5.1 bonds and yields

Bonds are the claim of ownership on the repayment of debt that an entity borrowed. The issuing entity becomes indebted to the investor and contractually states the interest rate (or coupon payment) and the time when the loaned funds (principal) will be returned to the investor. Bonds are usually issued at par value and then actively bought and sold in the secondary market. In the secondary market, bond prices (and, therefore, yields) fluctuate inversely with market interest rates.

As QE increases total reserves, bond yields fall. To demonstrate, see the below equation of how bonds are priced by discounting the future cash flows that the bond would produce. This present value process depends on interest rates and, therefore, depends on total reserves. Thus QE influences the discount rate, variable *r*, in the equation. When an investor considers purchasing a bond, a specific rate of return is not promised. The investor must use the bond price, coupon payment, and the maturity date to calculate the inferred return, the yield to maturity. The yield to maturity is found by solving for *r* in the below equation (2)[13].

$$\text{Bond Value} = \sum_{t=1}^{T} \frac{Coupon}{(1+r)^t} + \frac{Par\ Value}{(1+r)^T} \quad (2)$$

2.5.2 corporate bond ratings and treasury spreads

Corporate bonds are issued by a company that needs to raise funds. Although the bond promises re-payment cash flows, the investor cannot guarantee that the issuing company will not default on its obligation. Corporate bonds are categorized by their risk of default. Bond default risk, called credit risk is measured by Moody's Investor Services, Standard & Poor's Corporation, and Fitch Investors Services. These organizations rate corporation's ability to meet debt obligations and provide financial information on the rated firms. There are two groups of rated bonds. The first group includes bonds with the top rating of AAA or Aaa to the rating of BBB or Bbb (investment grade bonds). Everything rated below investment grade is referred to as speculative, sub-prime, junk, or high yield bonds. It is not uncommon for these bonds to default. Almost half of bonds rated CCC by Standard & Poor's at issue defaulted over a ten-year period[14].

Corporations offer a default premium to compensate investors for the possibility of default. The greater the credit risk, the higher the default premium. This premium is part of the yield difference between the corporate bond and an otherwise identical government bond. The spread between a corporate and treasury security is also impacted by differences in liquidity and name recognition. Investors demand compensation for the fact that a corporate bonds trade less frequently and that they do not have the reputation of the government. All of these factors contribute to the spread. The literature review will discuss how QE changes these conditions and impacts the spread.

2.6 US Corporate Debt Market, 2000 to Present

Corporate debt markets have changed tremendously since the year 2000. From 2000 to 2013, corporate debt markets almost tripled, reaching a value of $49 Billion in 2013. During this time, companies used a higher proportion of bond financing than before. This transition shows corporate bonds becoming increasingly important for long term financing. With this increase in corporate bond supply, there is also an increase in corporate bond demand.[15]

As the Fed has lowered interest rates to near zero, investors have turned to corporate bonds seeking higher yields. As more investors are seeking higher yields in the growing corporate debt market, below investment grade bonds receive extra attention because of their higher yield. Investment in high yield debt has grown to about 30% of the corporate bond market. These high yield corporate securities are a small, but significant part of the capital markets. The added attention from investors makes them a target of study as Fed actions change market conditions.[16]

2.7 Rational

This research aims to show that US corporate bonds responded to QE due to the changing liquidity and credit conditions. First the relationship between quantitative easing and corporate bond yields over the ten-year period from 2005 to 2015 is established. Afterward, the effect of QE is shown on bonds with different credit rating over this same time horizon. This research emphasizes how lower credit rating bonds saw larger yield decreases and higher price increases. Although the paper frequently mentions CCC debt, the focus is on the relationship that applies across all credit ratings. During this time period a comparatively small amount of debt was rated CCC; $2.2 trillion, or about 40% of the US corporate debt market, is speculative grade, rated BB+ or below. Institutional investors dominate this market. At the most basic level, the rational is to inform institutional investors about how their portfolio's will respond to QE.

Financial markets have never before responded to such quick or large central bank actions. Researching the bond market during this period is important so that policy makers may can see if they have achieved targeted results or created negative externalities. Other commentators have mentioned that monetary policy actions have not included targets for corporate bonds even though their actions significantly influence them. This needs to be addressed.

This research builds upon previous proof of QE operational channels in the literature review. Previous research relays heavily on event study analysis, this research reaches beyond the events to show the effects in the time period. Further, post the end of QE 3 in September of 2012, there has been continued asset purchases, this period has not been included in the previous analysis. This research adds further studies implication for researching credit default premium reduction in times of financial distress. As 40% of corporate bonds are rated Baa or below, this reduction plays a large role in bond markets[17].

3. Review of the Literature

There is evidence that QE has the potential to reduce long-term interest rates. Multiple event study papers point to QE lowering these rates. An event study of QE1 shows significant reductions in interest rates on dates where there were positive QE announcements[18]. A different study goes back before the recent financial crisis to the Fed's 1961 operation twist. The study on operation twist shows further evidence of reduced rates[19]. Besides these event study papers, others have shown a causal influence on interest rates from the supply of treasury bonds[20].

These studies suggest that QE accomplishes one of its major goals: this paper discusses the default risk channel and liquidity channel to explore how QE affected different graded bonds differently. Before these two channels are introduced, the preliminary hypothesis establishes the relationship between QE measured by reserves and bond yields. The first hypothesis is as follows: H1: There is a positive association between Federal reserves and future credit spreads.

3.1 The Default Risk and Liquidity Channels

The default risk channel implies that lower rated corporate bond yields fall more than the yields of higher rated bonds. This occurs because low-rated bonds carry a higher default risk. If QE succeeds in stimulating the economy, then the default risk of corporations will decrease, and then the yields of low-rated bonds are expected to decrease more than those of high-rated bonds. Furthermore, asset pricing models expect investor risk-aversion falls as the economy recovers. Investors becoming less risk-averse further implies a lower default risk premium. A strong default risk channel will show that safer assets see less yield reduction.

The liquidity channel states that as QE increases, it replaces less liquid assets with more liquid assets, there is a reduction in price premium investors are willing to pay for highly liquid assets and thus the yields on the most liquid assets rise. Another way to express this is that an investor who previously was willing to pay a premium for an AAA bond now will not pay the premium because there is a higher supply of treasury bonds. As their preference changes, yields on AAA bonds face upwards pressure. This will partially offset downward pressure from other channels. Overall all yields are falling, but the AAA bonds fall less. A strong liquidity channel shows the highest rated yields falling the least[21]. The default risk and liquidity channels both lead to the following hypothesis: H2: Low-rated bonds are more sensitive to QE than high-rated bonds.

4. Methodology

The methodology used simple multiple regressions to test both the hypothesis This section begins with data retrieval, then discusses hypothesis testing, and concludes with limitations. All data was obtained from the Federal Reserve Economic Data (FRED) database of economic research at the Federal Reserve Bank of St. Louis. This paper analyzes all data in a monthly frequency from January 1st, 2005 to June 1st, 2015. Data is for the United States only. Below shows the retrieved data set and the variable it was used to measure.

Table 1. Bond Yield Data Source

Bond Yield Data Source	
Variable	*Retrieved FRED Dataset*
Aaa Yield	Moody's Seasoned Aaa Corporate Bond Yield
Baa Yield	Moody's Seasoned Baa Corporate Bond Yield
CCC Yield	BofA Merrill Lynch US High Yield CCC or below Total Return Index Value
1 Month T. Yield	1-Month Treasury Constant Maturity Rate
3 Month T. Yield	3-Month Treasury Constant Maturity Rate
1 Year T. Yield	1-Year Treasury Constant Maturity Rate
10 Year T. Yield	10-Year Treasury Constant Maturity Rate

Table 2. Macroeconomic Data Source

Macroeconomic Data Source	
Variable	*Retrieved from FRED Dataset*
PPI	Producer Price Index for All Commodities
CPI	Consumer Price Index for All Urban Consumers
Total Reserves	Total Reserve Balances Maintained with Federal Reserve Banks

Table 3. Descriptive Statistics

Descriptive Statistics					
Variable	Mean	Standard Deviation	Minimum	Maximum	N
1m treasury yield	1.3179	1.8557	0.0000	5.2100	126
3m treasury yield	1.3765	1.8929	0.0100	5.1600	126
1y treasury yield	1.5630	1.8844	0.1000	5.2200	126
10y treasury yield	3.2725	1.0345	1.5300	5.1100	126
AAA yield	4.8422	0.7426	3.4000	6.2800	126
Baa yield	5.9710	1.0000	4.5000	9.2100	126
CCC yield	10.3189	5.7671	4.3700	38.0700	126
CPI	218.3506	13.3427	191.6000	237.7530	125
PPI	185.7198	16.9818	150.9000	208.3000	126
Total Reserves	1,060.1860	955.8554	7.4340	2,786.8670	126

Table 4. Rate Of Change Descriptive Statistics

Rate of change Descriptive Statistics					
Variable	Mean	Standard Deviation	Minimum	Maximum	N
Δ1m treasury yield	0.0933	0.7143	-1.0000	4.5000	125
Δ 3m treasury yield	0.0413	0.4999	-0.8421	3.3333	125
Δ 1y treasury yield	0.0085	0.1384	-0.5421	0.6154	125
Δ 10y treasury yield	0.0019	0.0727	-0.3144	0.1920	125
Δ AAA yield	0.0012	0.0312	-0.1748	0.1307	125
Δ Baa yield	0.0007	0.0355	-0.0847	0.2148	125
Δ CCC yield	0.0084	0.1010	-0.2563	0.6139	125
Δ CPI	0.0017	0.0036	-0.0177	0.0138	124
Δ PPI	0.0017	0.0036	-0.0177	0.0138	124
Δ Total Reserves	0.0895	0.5706	-0.2001	5.4582	125

Table 5. Correlation Table

Correlation Table					
	Δ AAA yield	Δ Baa yield	Δ CCC yield	Δ CPI	Δ Reserves
Δ AAA yield	1.0000				
Δ Baa yield	0.7858	1.0000			
Δ CCC yield	-0.1419	0.3067	1.0000		
Δ CPI	0.3013	0.1757	-0.0472	1.0000	
Δ Reserves	0.1408	0.4768	0.5396	-0.2386	1.0000

4.1 Hypothesis Testing

This experiment used simple multiple regressions. The model shows changes in bond yields as a function of changes of reserves and changes in inflation. Total Reserve Balances Maintained with Federal Reserve Banks is used to measure QE (from the earlier definition of QE as "as the increase of system wide total reserves created by the Fed"). Both changes in PPI and CPI are used for inflation. Inflation is included in this model because of inflations effect on yields. Including inflation shows how much falling yields may be attributed from inflation changes and not reserve changes. The independent variables were taken back one quarter to test them as predictors of the dependent variable. The dependent variable used each credit class of bond yields respectively. Thus, the model for testing the hypothesis can be expressed as the following equation (3).

$$yields_t = \alpha + reserves_{t-1} * \beta_r + inflation_{t-1} * \beta_i + \varepsilon_t \quad (3)$$

4.1.1 limitations

One limitation to this study is a survivorship bias. If bonds where downgraded below CCC or defaulted, they fell out of the sample and the yield for the group decreased. This yield drop misleads investors because it looks like credit quality is increasing, but really more companies are defaulting. Bonds can change between all credit ratings so a ratings consistency problem exists at every rating. As the hypothesis states terms comparing riskier to safer, a survivorship bias is most relevant if credit rating groups are affected disproportionally. This study dos not account for survivorship bias and the ratings consistency problem.

Also, larger yield swings can be due to larger starting yields. For example, different initial rates that fall 10bps do not arrive at an equal end. This is called a base rate bias. Analysis that uses the log of changes will provide stronger evidence for the hypothesis and have an advantage over the current percent based regressions.

Bond data is commonly used with linear time series models such as autoregressive models and autoregressive moving average models (ARMA). This paper used multiple linear regressions and does not explore ARMA models. It possible that an ARMA model would add greater explanatory value to the data. Furthermore, it may be better to use a non-leaner model for financial time series. These non-linear models, such as the threshold autoregressive model, may be needed to capture the complexity that a large change, such as QE, brings to the bond market. These questions are not explored in this paper and possibly limit the findings.

5. Analysis of Findings

The regression analysis of the hypothesis H1 and H2 is shown below. Tables 6 to 8 document the positive association between reserves and the credit spreads in the next period. This is shown by significant p-values at an alpha of 0.05 for reserve changes while controlling for inflation across all ratings and also by the t value for $\Delta reserves_{t-1}$ fitting outside the 95% confidence interval in all three credit ratings. Fail to reject H1.

Regarding H2, the coefficient for $\Delta reserves_{t-1}$ in the CCC regression is 0.10799. This means that holding inflation constant, a one unit increase in reserve levels will change the yields by 0.10799 in the next period. The coefficient for AAA bonds is the smallest at 0.01506 and the coefficient for Baa bonds is in between at 0.03412. These coefficients show that as credit worthiness drops, the coefficient increases. All three of these coefficients have significant p-values. This provides significant evidence that lower rated bonds benefit more from QE than higher rated bonds, fail to reject H2.

The conclusion for H2 has further intuitive support as the R^2 for CCC bonds increases to 0.2982 from the AAA R^2 of 0.1387. This increase in explanatory power occurs as ΔCPI_{t-1} becomes insignificant in the CCC regression shown by a p-value of 0.374. The increase in explanatory power in the higher CCC R^2 comes from the increased coefficient of reserve changes, not from the explanatory power of inflation. This shows that 29.82% of CCC yield declines are attributable to reserve increases in the previous period.

Table 6. AAA Bond Regression Results

AAA bond yield regression results					F	6.02
					R^2	0.1387
Variable	Coef.	Std. Err.	T	P	95% Confidence Interval	
$\Delta reserves_{t-1}$	0.01506	0.0057	2.66	0.009	0.0038568	0.0262606
ΔCPI_{t-1}	3.75594	1.5949	2.35	0.020	0.5983484	6.913543
Constant	-0.00884	0.0049	-1.79	0.076	-0.0186217	0.0009465

Table 7. Baa Bond Regression Results

Baa bond yield regression results					F	21.47
					R^2	0.3162
Variable	Coef.	Std. Err.	T	P	95% Confidence Interval	
$\Delta reserves_{t-1}$	0.03412	0.0056	6.08	0.000	0.0230102	0.045221
ΔCPI_{t-1}	3.01652	0.9412	3.21	0.002	1.153232	4.879801
Constant	-0.00869	0.0034	-2.58	0.011	-0.0153667	-0.002019

Table 8: CCC Bond Regression Results

CCC bond yield regression results					F	202.59
					R^2	0.2982
Variable	Coef.	Std. Err.	T	P	95% Confidence Interval	
$\Delta reserves_{t-1}$	0.10799	0.0054	19.94	0.000	0.0972709	0.118714
ΔCPI_{t-1}	2.64111	2.9624	0.89	0.374	-3.223682	8.505891
Constant	-0.00573	0.01079	-0.53	0.597	-0.0271003	0.0156423

6. Summary, Conclusions, and Recommendations

6.1 Summary

This paper defines QE, explains how it came to be, how it was used in the United States to respond to the financial panic of 2007 to 2009, and how it influenced US corporate bond yields from 2005 to 2015. The literature review shows how QE impacts different assets differently and introduces the credit default channel and a liquidity channel. Results and implications are shown below.

6.2 Conclusion

This paper confirms the intuitive relationship that as reserves rise via QE operations, then bond yields fall. Next, it is shown that QE impacts different types of bonds differently. The credit default and liquidity channels work together to impact bond yields over the period from 2005 to 2015. These conclusions confirm previous research that documented the existence of these channels. Previous research mainly used event study analysis of each QE round, this research shows H1 and H2 in a longer time period before QE1 and in our current state of continued expanded reserve levels after QE3's official end in September of 2012.

6.3 Recommendations

Conclusions from this paper apply to financial institutions, policy makers, and further research. Financial institutions anticipate the size and timing of Fed actions. This often occurs in the futures market, where market participants have been shown to anticipate the size of Fed actions, but not the timing[22]. At the simplest level this paper could help a bond trader or portfolio manager estimate how an assets' price and yield will change due to QE. For example, one could develop a trading strategy by purchasing bonds at the beginning of a QE period and selling them after reserve levels increased and prices rise. The lower quality bonds offer more potential price appreciation. Here, analysis becomes more similar to stock analysis because the cash flows are not certain. Assessing risk adjusted return my reveal a profitable investing strategy.

These findings also raise questions for policy makers. The Fed has not discussed policy targets or implications for borrowing rates besides treasuries. As Fed actions impact bonds in ways that do not influence treasuries (via the default risk channel), it is unfitting for the Fed to only focus on treasuries. Understanding unintended consequences can better guide future Fed action[23].

Regarding further research, there are competing voices in the literature that propose many possible QE channels. Typically, these event studies emphasize QE2. As QE2 only purchased treasuries, it is considered pure QE and the best event to study the effects of QE (notable commentators, such as Mishkin, view QE1 only as credit easing). As a single event study has many limitations, the discussion needs to include more than QE2. Second, there needs to be a way to organize all possible channels to gain a clearer perspective of what drives changes in financial markets. Richardo Reis proposed separating channels into the following two categories: monetary policy and asset supply. The monetary theory category includes channels that affect the money supply or its expectations (such as a signaling channel). The asset supply category includes channels that concern the relative supply of assets (such as the default risk channel). Reis then recommended studying every Fed announcement of changes in debt maturity over the past twenty years. Because these changes only influence asset supply, this type of study could separate monetary policy and supply changes. This type of study takes the conversation past QE2 and provides a clearer view of when borrowing costs do and do not result from monetary expansion. As this paper showed how different assets are impacted differently

by QE. Future research like Reis's proposition bridges the gap to allow firms to know what assets are impacted to what extent from monetary expansion verses asset supply.

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8. References

1. L. Laeven and F. Valencia, "Resolution of Banking Crises: The Good, the Bad, and the Ugly," in S. Claessens and others, eds., Financial Crises: Cases, Consequences, and Policy Response (Washington DC: International Monetary Fund, 2013), 397-428.
2. G. B. Gorton, Misunderstanding Financial Crises (New York, NY: Oxford University Press, 2012).
3. L. Laevan and F. Valencia, "Systematic Banking Crisis: A New Database" IMF working paper 08/224, (Washington, DC: International Monetary Fund, 2008).
4. J. M. Keynes, General Theory of Employment, Interest and Money (London: McMillan and Company, 1936).
5. F. S. Mishkin, "The Channels of Monetary Transmission: Lessons for Monetary Policy," NBER Working Paper No. 5464, National Bureau of Economic Research, February1996.
6. B. W. Fawley and C. J. Neely, "Four Stories of Quantitative Easing," Federal Reserve Bank of St. Louis Review, 2013, 95:1, 51-88.
7. B. W. Fawley and C. J. Neely, "Four Stories of Quantitative Easing," Federal Reserve Bank of St. Louis Review, 2013, 95:1, 51-88.
8. K.D. Allen and others, "Why is the effective Fed Funds Rate below the Theoretical Floor?" SSRN Electronic Journal, January 2014, DOI:10.2139/ssrn.245913.
9. L. B. Smaghi, Speech to the International Center for Monetary and Banking Studies: Conventional and Unconventional Monetary Policy. Geneva. April 28, 2009.
10. B. S. Bernanke, Speech at the stamp lecture: the crisis and the policy response. London School of Economics. London, England. January 13, 2009.
11. B. W. Fawley and C. J. Neely, "Four Stories of Quantitative Easing," Federal Reserve Bank of St. Louis Review, 2013, 95:1, 51-88.
12. L. B. Smaghi, Speech to the International Center for Monetary and Banking Studies: Conventional and Unconventional Monetary Policy. Geneva. April 28, 2009.
13. Z. Bodie, A. Kane, and A. Marcus, Investments, 10th edition (McGraw-Hill, 2013).
14. Z. Bodie, A. Kane, and A. Marcus, Investments, 10th edition (McGraw-Hill, 2013).
15. R. Tendulkar and G. Hancock, "Corporate Bond Markets: A Global Perspective," Staff Working Paper for IOSCO Research Department, February 2014.
16. F. Koch and others, "CS Credit Strategy Weekly," Credit Suisse Fixed Income Research, February 2016.
17. A. Krishnamurthy and A. Vissing-Jorgensen, "The Aggregate Demand for Treasury Debt," working paper, Northwestern University, 2010.
18. J. Gagnon and others, "Large-scale Asset Purchases by the Federal Reserve: Did they Work?" Federal Reserve Bank of New York Staff Report, March 2010, No. 441.
19. E. Swanson, "Lets Twist Again: A High-frequency Event-study Analysis of Operation Twist and its implications for QE2," Forthcoming, Brookings Papers on Economic Activity, 2010.
20. A. Krishnamurthy and A. Vissing-Jorgensen, "The Aggregate Demand for Treasury Debt," working paper, Northwestern University, 2010.
21. A. Krishnamurthy and A. Vissing-Jorgensen, "The effects of Quantitative Easing on Interest Rates: Channels and Implications for Policy," Brookings Papers on Economic Activity, Fall 2014, 215-278.

22. K. Kuttner, “Monetary policy surprises and interest rates: evidence from the Fed funds futures markets,” Journal of Monetary Economics, June 2001, 4;37, 523-544.
23. S. Reynard, “Assessing Potential Inflation Consequences of QE after Financial Crisis” Working Paper Series, Pearson Institute for International Economics. November 2012.