'Quantitative Ceasing': Reverse Quantitative Easing and its Effect on U.S. Corporate Credit Markets

JACK DEPERRIOR

Economics, CCAS '19, jdeperrior1@gwu.edu

ABSTRACT

Since the U.S. Federal Reserve Bank has begun gradually unwinding its $4.5 trillion balance sheet, investors are anxious to see how credit markets will react to the end of U.S. quantitative easing and the dawn of tighter monetary policy. This paper tests if corporate credit markets are behaving differently now that the total stock of assets on the Federal Reserve's balance sheet is declining; the research employs a sum of least-squares time series regression that aims to measure the causal relationship between Federal Reserve assets and three different corporate credit spreads (investment grade, BBB and high yield) before and after the policy change. The results indicate that the basic correlation between Federal Reserve assets and corporate credit spreads is altered by the policy change. However, when controlling for other explanatory variables, the analysis shows that the causal relationship remains unchanged. This paper therefore concludes that there are stronger explanatory forces that are keeping corporate credit spreads low despite declining Federal Reserve assets.

INTRODUCTION

In the heat of the 2008-2009 Financial Crisis, the Federal Reserve Bank of the United States (Federal Reserve) purchased substantial quantities of government sponsored enterprise (GSE) debt, non-performing mortgage backed securities (MBS) and United States Treasury debt on the secondary market to provide stimulus to the U.S. economy and liquidity to its vital financial markets. The process, known by investors across the globe as "quantitative easing," can be an effective monetary policy tool for central bankers to use when policy rates are already at or approaching zero. The policy has proven quite useful in the United States as all the major market indices are now well above pre-crisis highs, unemployment is the lowest it has been in two decades and the economy is growing at an impressive rate of 3.5% so far in 2018.

Amidst the economic recovery, the Federal Reserve Bank announced in late October 2017 that it was planning to reduce the bank's stock of reserve assets from $4.5 trillion to approximately $3 trillion by 2020. To avoid disrupting secondary markets, the Federal Reserve's plan is to gradually allow the bonds and other securities on its balance sheet to come due without reinvesting the proceeds rather than flooding the secondary market with billions of dollars in securities all at once. As of September

2018, the Federal Reserve has successfully shed close to $200 billion in assets off its balance sheet.

Since the Federal Reserve is now pivoting to a less aggressive monetary policy by allowing assets to mature without refinancing and hiking its trademark Federal Funds Rate - which directly affects cost of overnight bank borrowing and indirectly affects institutional and retail lending – there are several essential questions that investors should be asking themselves: (1) How are the prices of riskier credit securities responding to the Federal Reserve's policy change? (2) Are the prices of credit instruments reacting differently according to the risk associated with the underlying quality of debt? (3) If credit spreads are still decreasing despite the Federal Reserve's transition to tighter monetary policies, what is causing them to do so?

Since Figures 1, 2 and 3 show that corporate credit spreads are continuing to decline despite the Federal Reserve's decision to raise rates and sell off assets, this paper hypothesizes that the inverse relationship between corporate credit spreads and Federal Reserve Assets has been disrupted and the two variables are now positively correlated. If true, it could imply that investors are not accounting for enough credit risk in the corporate debt markets and are therefore mispricing the securities that fall within each of the three sub-asset classes.

The next section describes relevant research

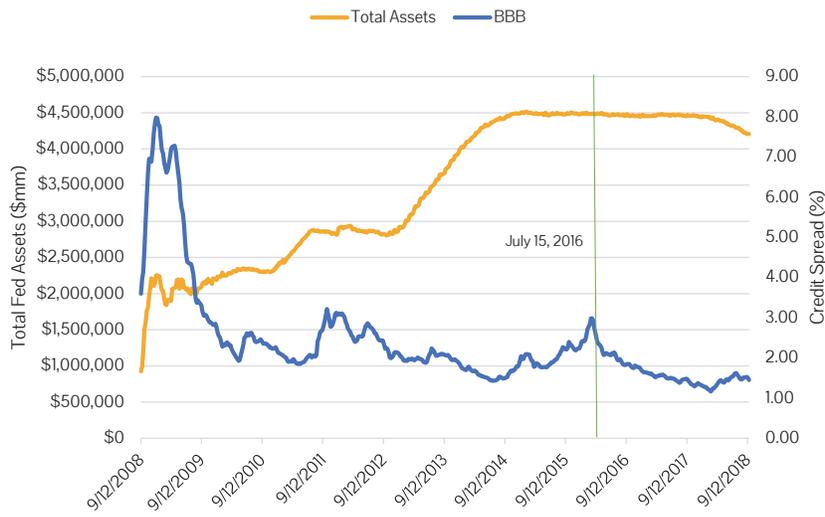**FIGURE 1.** | *High yield spread vs. total fed. assets*

FIGURE 2. | *BBB spread vs. federal reserve assets*
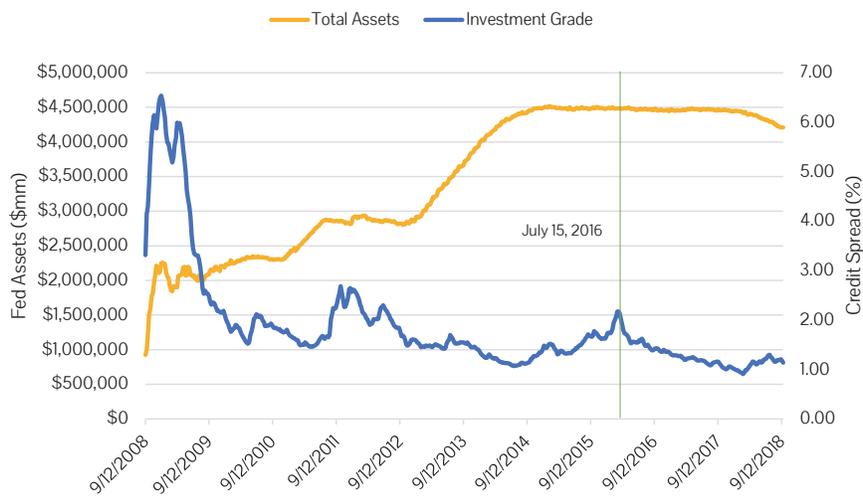

FIGURE 3. | *Investment grade spread vs. federal reserve assets*

completed in the past, followed by Section 3 which introduces the data, Section 4 which describes the methodology, Section 5 which highlights important regression results, Section 6 which discusses the implications of the results and finally, Section 7 which offers a conclusion to the paper.

LITERATURE REVIEW

Although the scope of this analysis does not include the impact that U.S. large scale asset purchases (LSAP) had on foreign corporate bond markets as does Lo Duca, Nicoletti and Martinez (2015), their framework addresses questions that are fundamental to this paper's topic. According to the market segmentation theory, market interest rates are determined by the supply and demand forces at different maturities along the yield curve. Lo Duca et al. (2015) hypothesize that LSAP left significant supply deficiencies on the longer-term end of the yield curve that caused long term rates to drop and corporate borrowers to fill in for the lost supply. While this manipulation of the yield curve certainly stimulates the economy, it also attracts riskier borrowers to issue debt that they wouldn't have otherwise. The authors use a time variable regression model to test if US quantitative easing caused a significant increase in global corporate bond issuance. The model divides its results into corporate credit issuances in developed and developing countries and distinguishes between the stock and flow of U.S. assets in its regression model. Their findings conclude that large scale asset purchases (LSAP) executed by the Federal Reserve caused sharp increases in corporate credit issuances in the years directly following the financial crisis in '08 and '09, then continued to trigger above expected corporate credit issuances for the years following, through 2015. A crucial differentiating factor in Lo Duca et al. (2015) is the author's distinction between stock and flow effects. Where stock is defined as the total balance of assets held by the Federal Reserve, the flow is defined by the change in the total balance of assets over time. The analysis goes even further to show that the overall stock of assets had an observably stronger effect on corporate credit issuances in emerging markets, while the flow of assets had a stronger effect on the issuance of developed market corporate credit issuance.

Despite the gap filling effect being the theoretical focal point of the entire paper, the phrase is alluded to only once, in reference to a previous work written by Robin Greenwood in (2010). This metric communicates the significant lack of theoretical context which leaves this paper pale in comparison to similar works. Nonetheless, the econometric analysis performed by Lo Duca et al. (2015) strengthens the arguments of numerous other authors who write about the "gap-filling" effect first mentioned by Greenwod, Hanson and Stein (2010). Foley-Fisher, Ramcharan, and Yu (2016), expand on the gap-filling effect argument by proving that the Federal Reserve's LSAP had a clear and deliberate downward impact on the long-term interest rates paid by household borrowers taking out home mortgage loans as well as corporate borrowers issuing longer maturity bonds.

Foley-Fisher, Ramcharan, and Yu (2016) argue, however, that the Maturity Extension did have its faults. They postulate that the MEP instituted by the Federal Reserve caused greedier investors to "reach for yield" or – in other words – purchase riskier assets to receive a higher return. Their argument is rooted in a working paper by Guerrieri and Kondor (2012), which shows that professional investors' risk preferences are affected by a so called "reputational premium," which pushes uninformed investors to safer products when default risk is high but riskier products when default risk declines. Greenwood et al. (2014) also test how the MEP affected investor's decision making processes but attribute investors' increasing risk appetite to decreases in term premiums rather than some unforeseen category of premium. Alternatively, Kimura and Small (2004) show that the quantitative easing implemented by the Bank of Japan in 2001 caused spreads on riskier assets such as low grade corporate bonds and equities to increase. Both Krishnamurthy and Vissing-Jorgensen (2011) and Eggertsson and Woodford (2003) weigh in on whether or not asset purchases consisting mostly of government affect spreads on riskier debt securities by arguing that although these purchases may have a "signaling effect" on the riskier assets, government debt purchases should not directly cause spreads on riskier assets to change.

Whereas Lo Duca et al. (2015) test the impact that LSAP had on global corporate issuances, Gilchrist and Zakrajsek (2013) test how these LSAP affected credit default risk within the United States. These two works are intertwined via their econometric models that mutually control for a multitude of the same exogenous variables and their applied theory, stating that supply shocks implicitly cause markets to react by demanding higher prices and lower yields. However, the argument made by Gilchrist and Zakrajesk (2013) does not necessarily always hold true.

Before the Great Recession in '08 and '09, most people had never heard of Credit Default Indexes or Credit Default Swaps -- and for good reason. These indexes reflected the basket values of complicated products that could throw even the most competent independent investors for a loop. Once homeowners around the world began to default on their mortgages and the cancerous practices within the Mortgage Backed Securities Industry were exposed, even non-investors began to hear whispers of these products that shielded a fortunate few from the perils of the crisis. Gilchrist and Zakrajesk (2013) use various credit default indexes as metrics to measure Wall Street's immediate reaction to LSAP announcements and the level of perceived credit default risk in the

markets. They use an event-study heteroscedasticity model which varies the error term across populations to determine how the Federal Reserve's announcements of LSAP-I, LSAP-II and the Maturity Extension Program (MEP) affected the credit default indexes of a diverse set of borrowers. The findings demonstrate that each of the first two stages of the LSAP announcements triggered a significant drop in the credit default indexes. However, after the MEP announcement – the credit default indexes increased, reflecting a higher level of default risk. Gilchrist and Zakrajesk (2013) brush off the paradoxical outcome as simply being caused by Wall Street's disappointment with the scale of the program. However, would it not make more sense for the credit default indexes to decrease at a lesser magnitude than the first two announcements if this was the case? Foley-Fisher et al. (2016) would dispute Gilchrist and Zakrajesk's (2013) assumption and cite their test on the impact of MEP on investors' "reach for yield" as evidence that the MEP pushed investors into, not away from, riskier assets as Gilchrist and Zakrajesk (2013) argued. Furthermore, Foley-Fisher et al. (2016) and Krishnamurthy and Vissing-Jorgensen (2011) would likely credit the different test results to Gilchrist and Zakrajesk (2013) using CDI and CDS as their dependent variables. Although these indexes are precise reflections of default risk, they are also extremely unique and complex products that can be manipulated by any number of unforeseen exogenous variables.

Despite the above-mentioned shortcomings, Gilchrist and Zakrajesk (2013) deserve immense credit for their implementation of heteroscedastic controls to adjust for simultaneity bias that exists between credit default spreads and market interest rates directly following LSAP announcements. In statistics, simultaneity bias describes a scenario in which the independent variable shares a causal relationship with the dependent variable, and the same could be said in reverse. Another use case for a heteroscedastic model, articulated in Rigbon (2003), explains that a methodology involving heteroscedasticity is extremely effective when you observe changes in variability linked to two different regimes. In other words, heteroskedastic effects can quell sudden changes in volatility derived from an event or random occurrence.

Corporate credit premiums are composed of several sub-risk channels that add up to the rate at which investors are compensated to purchase corporates rather risk-free treasury bonds. Gilchrist and Zakrajesk (2013) take a deep dive on the relationship between LSAP and credit default risk - one key risk channel within the corporate credit premium structure. Krishnamurthy and Vissing-Jorgensen (2011) take a more holistic approach by testing the impact that LSAP had on each of the corporate credit risk channels. Their methodology uses an event-driven regression analysis to test how LSAP announcements caused each of the different risk channels to fluctuate. The findings indicate that the initial round of quantitative easing (also referred to as QE1 or LSAP-I) had a stronger effect on default risk premiums and than the secondary round of quantitative easing (also referred to as QE2 or LSAP-II) had a stronger effect on the signaling and expected inflation channels. From these results, the authors conclude that because QE1 was composed of mostly MBS purchases, it applied stronger downward pressure on the yields of riskier assets such as MBS and high-yield corporate credit. On the other hand, since in QE2 the Federal Reserve purchased more treasury securities, the purchases applied greater downward pressure on the yields of risk-free or marginally risky securities such as treasuries or agency credit securities. Using these findings, Krishnamurthy and Vissing-Jorgensen (2011) justify the portfolio balancing theory which states that investors with specific duration, maturity and risk preferences, such as pensions and insurance companies, do not stray from their demand for risk free or marginally risky assets because of LSAP programs. This conclusion directly contradicts the argument made by Foley-Fisher et al. (2016) which states that low supply of long-term treasury securities post-MEP announcement caused institutional investors to move into riskier corporate credit assets to replace the depleted supply of treasury bonds. Greenwood et al. (2010) further disputes the concept that corporate debt is an imperfect substitute for treasury bonds by arguing that corporations with significantly positive long-term debt supply elasticities serve as attractive substitutes for long-term government debt.

DATA

To ensure accuracy and robustness of an asset price model, it is important to include all variables that could have a significant effect on the asset's market price. For corporate credit instruments, there are four key explanatory variables that need to be controlled for to isolate the impact of an unprecedented market event: (1) expected GDP growth, (2) expected inflation, (3) market volatility and (4) the risk-free rate of return. The research model in this paper uses weekly time series data starting with the week ending September 8, 2008 and ending September 21, 2018. As seen in Figures 1, 2 and 3, the Federal Reserve's assets started to increase drastically through the Fall of 2008 and into 2009 due in large part to the Federal Reserve's large-scale asset purchase programs. From that point forward, the Federal Reserve continued to expand its holdings until finally pumping the brakes in late 2016.

Corporate Credit Spreads

Corporate credit spreads are defined as the premiums that investors pay for corporate debt securities over the risk-free rate of return. The spread itself is comprised
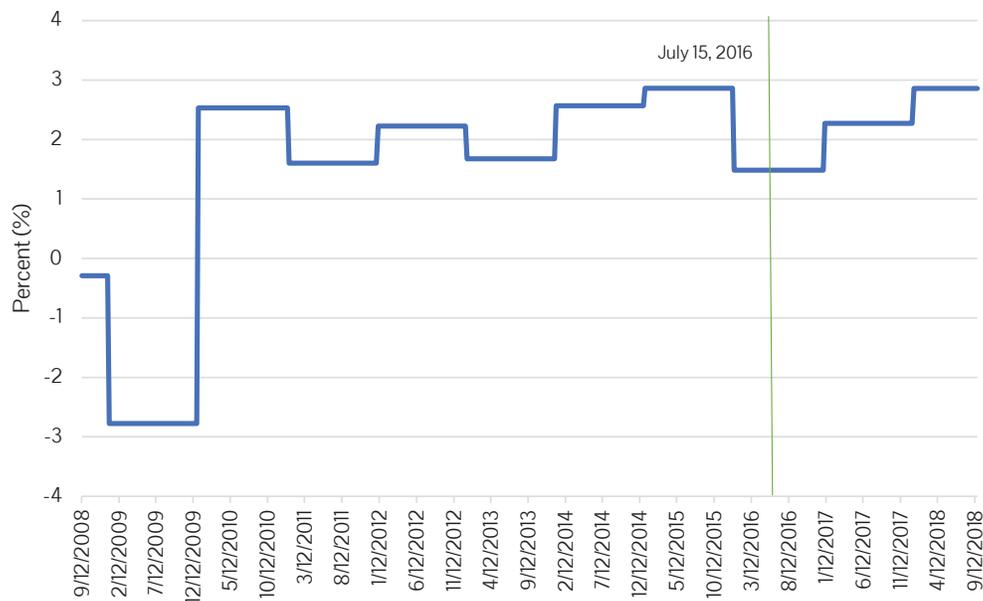
FIGURE 4. | *U.S. expected real GDP growtih*

of several sub-premiums that account for default risk, liquidity risk, maturity risk and a host of other more unique characteristics. The research uses the High Yield, BBB and Investment Grade ICE Bank of America Merrill Lynch Corporate Indexes to broadly represent the spreads found in U.S. corporate credit markets. Data sets for each of the three variables were collected from the St. Louis FRED website. All three indexes are option adjusted, U.S. dollar denominated, domestically issued, market cap weighted and only include bonds with more than one year left until maturity or call and a minimum of $100 million left outstanding.

By using corporate credit spreads to measure perceived credit risk in the market, this paper differentiates itself from articles like Foley-Fisher et al. (2016) and Lo Duca et al. (2015) which favor using new corporate credit issuances to discern how policy changes affect the market. The value created by using spreads versus issuances is two-fold. First, the three spreads clearly differentiate the policy change's effects on borrowers of varying credit worthiness; and second, the spreads are derived from investors' perceptions of credit risks, rather than the business executives who make issuance decisions.

As Figure 1, 2 and 3 illustrate, corporate credit spreads skyrocketed in the Fall of 2008 and remained relatively high until the Federal Reserve intervened in the markets and began purchasing credit securities in LSAP I and II. However, since the Federal Reserve's assets began declining in late 2016, it appears the inverse relationship between corporate credit spreads and Federal Reserve assets has broken down because spreads remain narrow (refer again to Figure's 1, 2 and 3). The core purpose of this

paper is to diagnose what has caused this relationship to change.

Expected GDP Growth

Corporate credit instruments are traded in high volume across secondary markets on a day-to-day basis. Therefore, when investors believe the U.S. economy will experience tepid conditions in the short-term, there will likely be an outflow from corporate credit instruments and credit spreads will widen. On the other hand, if investors believe the U.S. economy will prosper in the short-term, there will likely be an inflow into corporate credit instruments and credit spreads will narrow. The model follows Lo Duca et al.'s (2015) approach which uses expected GDP growth to control for fluctuations in investors' economic growth outlook. Since expected GDP growth cannot be measured on a week by week basis, the research uses the Organization for Economic Cooperation and Development's 1 year U.S. real GDP growth forecast to gauge investors' expectations for future U.S. economic growth. The OECD formulates these GDP growth forecasts by using a combination of model-based analysis and expert consultation. OECD Data offers historical data on annual 1 year GDP growth forecasts going back 50+ years. Figure 4 shows that the expected GDP growth dropped below zero in 2008 and 2009 but has since recovered higher to post-crisis levels. Therefore, the expected GDP growth will most likely be inversely related to credit spreads which have moved in the opposite direction over the same period.

Expected Inflation

The market's expectation for future U.S. inflation are represented by the spread Treasury Inflation Protected Securities (TIPS) trade at above standard U.S. Treasury 10-year bonds; weekly data on TIPS spreads was exported from the St. Louis FRED Database. Low spreads (negative or slightly above zero) indicate that investors perceive there will be low inflation or even deflation soon while relatively high spreads (>1) indicate that investors believe inflation will increase soon. Though Lo Duca et al. (2015) use OECD 1-year expected inflation rates to control for inflation, this paper uses TIPS spreads because they are derived from market participants' perspectives, not an institution's. The trend in the TIPS spreads shows that expected inflation hit highs of approximately 3% in the Fall of 2008 and then subsided to more normal levels in the years following the crisis. Therefore, the relationship between expected inflation and spreads is expected to be roughly positive.

Market Volatility

To gauge financial market volatility, investors often refer to the CBOE Volatility Index (VIX), which measures markets' expectations for 30-day volatility. The VIX is a relatively obscure dataset but weekly returns are still easily accessible via a Bloomberg Terminal. According to Lo Duca et al. (2015), controlling for the VIX compensates for any unrelated market noise that could cause corporate credit spreads to move significantly. The index generally moves in the same direction as credit spreads because as market volatility increases, investors usually demand higher yields to compensate for increasing credit default risk, especially from high yield investors. Therefore, the two variables will likely have a positive correlation.

Risk Free Rate of Return

Since the risk-free rate can be manipulated by significant changes in Federal Reserve asset holdings and is widely used in the CAPM method of valuing corporate debt securities, the yield on these instruments could have spillover effects on corporate credit spreads that need to be controlled for. Market participants prefer using the yield on U.S. Treasury 10-year yield as the risk-free rate of return because they assume that the U.S. government will never default on its debts. The yield on treasury securities follows an unorthodox trend compared to other, riskier debt securities because of their government backing. Figure 7 illustrates this phenomenon as it shows the convergence and divergence of the U.S. Treasury 10-year yield and the High Yield Spread at times throughout the test period.

Past research reaffirms the inconsistent relationship illustrated in Figure 7 as there is no clear consensus on whether the relationship between government debt yields and credit spreads is positive, negative or neutral. Krishnamurthy and Vissing-Jorgenson (2012) show that the U.S. Treasury 10-year yield caused corporate spreads to decrease after the 2008-2009 U.S. Financial Crisis via what they refer to as a "signaling effect". However, Kimura and Small (2003) observed a different relationship between government debt yields and credit spreads in Japan in 2001. Rather than the corporate credit spreads falling with the yields on government debt - as they did
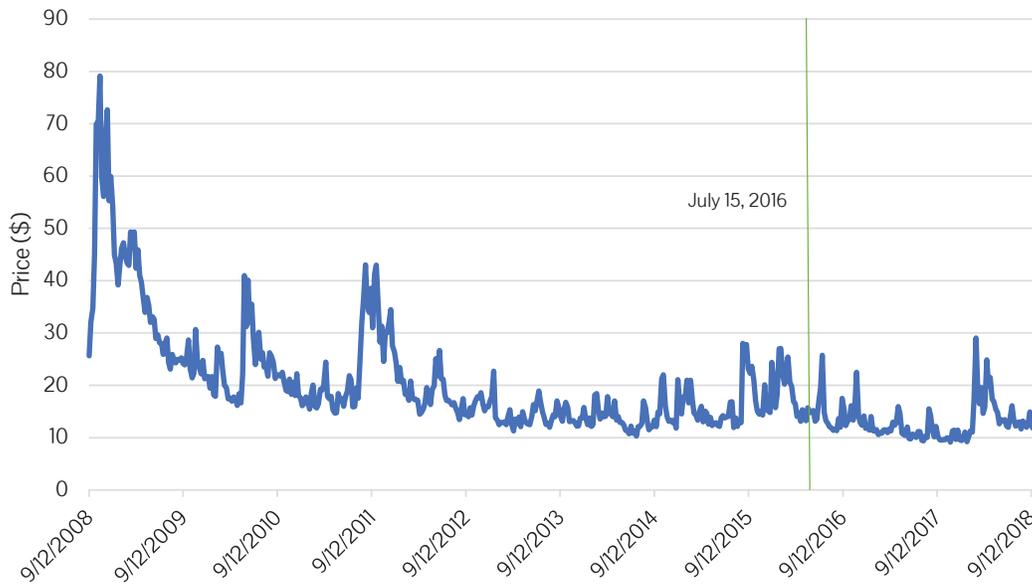

FIGURE 5. | *TIPS spread*

FIGURE 6. | *VIX*

FIGURE 7. | *10 year U.S. Treasury yield*

in the U.S. - the spreads climbed higher. Therefore, the expected relationship between yields and corporate credit spreads is unclear.

EMPIRICAL MODEL

The empirical model shown in equation (1) represents three separate sum of least squares time series regressions in which the dependent variable is represented by the log of the respective corporate credit spread (y_t) while the independent variable is equal to the log of Federal Reserve assets (x_t); logarithms are used in this model to make regression statistics easier to interpret. Lo Duca et al. (2015) use a similar linear regression model but do not include dummy and interaction variables that our incorporated here. Dt represents the dummy variable that is included in the model to reflect the Federal Reserve's pivot to tighter monetary policies. In addition to the policy variable, a series of control variables (γz_t) are added to the regression to isolate the causal effects logged Federal Reserve Assets have on logged corporate credit spreads.

The date at which the policy variable changes from 0 to 1 is determined by testing for a structural break within the original regression. The test rejects the null hypothesis that there is no structural break in the data and indicates that there is a structural break in the data after July 15, 2016 (Table 2). The result of the structural break test is contradictory to this paper's hypothesis because, if the hypothesis were correct, the structural break would occur immediately following the initial decline in Federal Reserve assets (which is shown to occur later in 2016 by Figures 1,2 and 3).

The model also includes an interaction term between the policy variable and the log of Federal Reserve Assets; the coefficient of this term (β_2) will indicate if and how the relationship between Federal Reserve Assets and corporate credit spreads changes after the policy change. If this paper's hypothesis is correct, β_1 will be negative but β_2 will be positive, indicating that decreasing Federal Reserve Assets are causing corporate credit spreads to remain level or decrease slightly. To control for heteroscedasticity, the model uses robust standard errors that are also applied in Gilchrist and Zakrajesk (2013), Lo Duca et al. (2015) and Krishnamutrhy and Vissing-Jorgenson (2012).

$$y_t = \alpha_1 + \beta_1 x_t + \beta_2 x_t D_t + \gamma z_t + \alpha_2 D_t + \epsilon_t \quad (1)$$

y_t = Log of ICE BAML Investment Grade, BBB and High Yield credit spreads
β_1 = Coefficient of Logged Federal Reserve Assets
β_2 = Coefficient of the interaction between Log of Federal Reserve Assets and the policy dummy
x_t = Log of Federal Reserve Assets
$\gamma_1 z_1$ = Price of VIX Index
$\gamma_2 z_2$ = Spread on Treasury Inflation Protected Securities Index
$\gamma_3 z_3$ = Yield on Treasury 10yr yield
$\gamma_4 z_4$ = Expected GDP Growth as predicted by the OECD
D_t = If t < 15july2016, Dt = 0; if t > 15july2016, D_t = 1

RESULTS

Per the results from the high yield regression in Column 1 of Table 3, the regression excluding all control variables suggests that the initial hypothesis may be correct. β_2=4.593 is significant at the 1% level and β_1=-.785 also at the 1% significance level, indicating that Federal Reserve assets were negatively correlated with high yield credit spreads before the policy change but are now positively correlated with the spreads after the policy change. However, the model only explains 55.8% of variance from the mean and therefore lacks robustness. The BBB and investment grade regressions excluding control variables reaffirm the results of the high yield regression. Column 3 of Table 3 (BBB) states that β_2=1.71 and β_1=-.785 while Column 5 (Investment Grade) shows

β_2=1.482 and β_1=-.922, indicating that the correlation between Federal Reserve assets and BBB spreads as well as the correlations between Federal Reserve assets and investment grade spreads have turned positive since the structural break. Furthermore, since the magnitude of β_2 increases incrementally from investment grade to BBB to high yield, the data indicates that – without controls - decreases in Federal Reserve assets have a more pronounced positive effect on riskier credit spreads.

When controls are added to the regression model, however, the results change drastically. Column 2 of Table 2 indicates that β_2=-.922 when controls are added, revealing that when other explanatory variables are accounted for, the relationship between Federal Reserve Assets and corporate credit spreads is even more negative than before the policy change. Aside from the unexpected change in β_2's sign, the control variables all seem to have the expected effects on corporate credit spreads over the period. Furthermore, the model is significantly more robust than the regression model excluding control variables as its R2 = .940.

The results for the BBB and investment grade corporate credit spreads follow a similar trend as the high yield regression. Column 3 of Table 3 shows that β_2=-3.836 when controls are added to the BBB spread regression while Column 5 of the same table shows that β_2=-3.732 when controls are added to the investment grade regression. The R^2 of the BBB and investment grade regression with controls added are .932 and .933 respectively.

Since the absolute value of β_2 in the BBB and Investment grade regressions were significantly larger than the β_2 in the high yield equation, there is reason to believe that decreases in Federal Reserve assets are having the strongest effect on less risky securities. These results therefore align with the findings of Greenwood et al. (2010) which state that corporate borrowers with large, positive elasticities of debt supply – or in other words, low credit risk – are the most exposed to changes in central bank asset holdings.

DISCUSSION OF RESULTS

Although the initial hypothesis is shown to be incorrect by the model, the successful structural break test and the positive correlation between Federal Reserve assets and high yield, BBB and investment grade corporate credit spreads after the policy change, indicate there is some source of endogenous change within the model which is keeping corporate credit spreads narrow. The conclusions drawn by Gilchrist and Zakrajesk (2013) and Krishnamurthy and Vissing-Jorgenson (2011) bring to attention two possible explanations for the persistently narrow spreads: (1) one or several of the other control variables are stronger predictors of corporate credit spreads and/ or (2) the effect that decreasing Federal

Variable	Obs.	Mean	Std. Dev.	Min.	Max
High Yield Spread[1]	524	6.124	3.219	3.254	21.094
BBB Spread[1]	524	2.410	1.326	1.164	7.980
Investment Grade Spread[1]	524	1.885	1.112	0.908	6.536
Total Fed Assets ($mm)[1]	524	384780	974896.3	925725	4516077
Expected GDP Growth[2]	524	1.640	1.597	-2.776	2.862
US Treasury 10yr Yield[1]	524	2.528	0.618	1.38	4.02
VIX[3]	524	19.377	10.147	9.14	79.13

TABLE 1. | *Summary statistics*
Sources: *The St. Louis FRED Database[1], OECD Data[2], Bloomberg[3]*

Dependent Variable	High Yield Credit Spread
Exogenous Variables	Expected GDP Growth, UST 10yr yield, TIPS Spread, VIX Return
Date Output	15-Jul-16
P-Value	0.000

TABLE 2. | *Structural break test results*

Reserve assets have on corporate credit spreads is encompassed by a "signaling effect", which is controlled for by the U.S. Treasury 10-year yield.

By referring to the trend in each explanatory variable before and after the structural break occurs in the middle of 2016, one observes that Figures 4, 5 and 7 display trends that could account for persistently low credit spreads. First, by referring to Figure 5, one observes that the TIPS spread made a dramatic move upwards in the months immediately following the structural break. Gilchrist and Zakrajesk (2013) explain that significant increases in the TIPS spread – such as the period shown in Figure 5 - can be interpreted as an increase in expected inflation and cause real interest rates (and spreads) to decrease. However, Gilchrist and Zakrajesk's (2013) explanation is contradicted by the regression results in Table 3 which show that TIPS spread has a significant positive effect on each of the three unique credit spreads in the regression. So, since TIPS spread increases inflicted a positive force on spreads in the regression tests, the TIPS spread cannot be one of the explanatory variables that is upholding narrow corporate credit spreads.

Next, in Figure 7, one can see that the 10 year U.S. Treasury Bond yields increased significantly in the weeks following the structural break and continue to gradually increase through September 2018. Since the regression model shows that increases in the U.S. Treasury 10-year yield are correlated to corporate credit spread decreases, it is reasonable to hypothesize that increasing yields on treasury securities could have caused corporate credit spreads to decrease. Krishnamurthy and Vissing-Jorgensen (2011) and Eggertsson and Woodford (2003) would rebuke such an assertion because their research shows that, in the past treasury yields have not shared a direct causal relationship with corporate credit spreads. Although this may be true for the past relationship between credit spreads and treasury yields, this analysis suggests that the Federal Reserve asset unwinding has caused the relationship between Treasury yields and credit spreads to become negative.

The trend in Figure 4 shows that U.S. expected real GDP growth increased significantly in 2017 and then again in 2018, reflecting investors heightened optimism for future economic growth. Such optimism from investors

produces higher demand for riskier credit assets such as corporate debt. This phenomenon is observed within the regression results as the coefficient of expected GDP growth (γ_4) is negative and significant in each of the three regressions. Furthermore, Lo Duca et al. (2015) prove that bond issuances increase with expected GDP growth, suggesting that riskier borrowers are incentivized to move into the market to take advantage of lower rates. Therefore, it is reasonable to conclude that high expectations for future growth also played a significant role in upholding narrow corporate credit spreads since the policy change.

With respect to the second explanation for low credit spreads, Lo Duca et al. (2015), Krishnamurthy and Vissing-Jorgensen (2011) and Eggertsson and Woodford (2003) would all agree that the positive correlation between Federal Reserve assets and High Yield Spreads after the policy change is caused by the so called "signaling effect". They would argue that although the Federal Reserve is also shedding some of the riskier assets off its balance sheet, treasury securities are a much larger portion of the securities that are not being refinanced. Therefore, the policy change's impact on 10-year U.S. Treasury yields and less risky corporate debt should be greater than its impact on high yielding corporate credit spreads. Furthermore, since the change in Federal Reserve assets has a stronger impact on Treasury bonds than corporate bonds, the impact a change in Federal Reserve assets has on corporate spreads should be less pronounced when controlling for U.S. 10-year Treasury yields.

CONCLUSION

This paper contributes to existing literature on large-scale asset purchase programs and their effects on public markets by addressing a crucial, unresolved question in contemporary financial economics: what happens when asset purchase programs are reversed? For investors and business executives closely tracking movements in the corporate credit markets, this paper offers several

	Log of High Yield		Log of BBB		Log of Investment Grade	
	[1]	[2]	[3]	[4]	[5]	[6]
Log of Fed Assets	-0.785***	-0.534***	-0.806***	-0.519***	-0.922***	-.625***
	(0.058)	(0.041)	(0.057)	(0.038)	(0.057)	(0.035)
Time dummy	-70.472***	-13.919***	-26.350***	58.506***	-22.802***	56.976***
	(7.076)	(5.027)	(6.053)	(6.254)	(5.766)	(6.543)
Interaction	4.593***	-.922***	1.710***	-3.836***	1.482***	-3.732***
	(0.876)	(0.329)	(0.396)	(0.409)	(0.377)	(0.428)
Expected GDP Growth		-0.053***		-0.067***		-0.056***
		(0.005)		(0.006)		(0.006)
UST 10yr yield		-0.487***		-0.442***		-0.434***
		(0.021)		(0.022)		(0.021)
TIPS Spread		0.373***		0.324***		.313***
		(0.020)		-0.020		(0.020)
VIX Return		0.009***		0.009***		.011***
		(0.001)		(0.001)		(0.001)
Observations	524	524	524	524	524	524
R^2	0.543	0.944	0.558	0.932	0.581	0.933

TABLE 3. Regression results
Notes: The table displays the results of OLS regression. The dependent variables are Log of High Yield, Log of BBB and Log of Investment Grade.
***,**,* Statistically significant at the 1%, 5%, 10% level.

practical insights. First, the Federal Reserve's balance sheet unwind has not caused the relationship between Federal Reserve assets and corporate credit spreads to turn positive as suggested by Figures 4, 5, and 7. The analysis of the relationship between corporate credit risk and Federal Reserve asset holdings is consistent, therefore, with the findings of Krishnamurthy and Vissing-Jorgensen (2011). Second, optimistic expectations for U.S. GDP growth and the rising 10-year Treasury yield are keeping spreads narrow despite tighter monetary policy. As the business cycle matures and growth diminishes, it will be crucial for market participants to be cognizant of these factors and how they interact with corporate credit spreads. Third, low-risk corporate borrowers are more exposed to spread increases due to decreases in Federal Reserve assets than risky borrowers. This communicates to investors that the portfolio balancing theory applied in Krishnamurthy and Vissing-Jorgenson (2011) holds true for reverse quantitative easing.

Finally, it would be negligent not to acknowledge the fact that the Federal Reserve's balance sheet unwind is still in its nascent stages. To a certain extent, it may be too early to tell how corporate credit markets will respond in the future if the Federal Reserve continues down the path to a smaller, more nimble balance sheet. If nothing else, however, this paper should impress upon all investors how imperative it is to be prudent as the Federal Reserve unburdens itself from the colossal pile of assets atop of which the bank sits.

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About the Author

Jack is a senior from Rochester, NY studying Economics with minors in Business Administration and History. His research interests are in Financial Economics and American History. Jack is currently working with a team of Risk Advisory Consultants at Ernst & Young, LLC. to identify digital solutions that enable businesses to operate more efficiently.