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The Effect of Monetary Policy on the European Corporate Bond Market

Evidence from the yield and credit spread curve term structure

Laura Lindberg (23373) Ida Marta Metsis (23365)

Abstract

This paper examines the effect of monetary policy mechanisms used by the European Central Bank on the euro-denominated corporate bond market. The focus of the paper is to analyse the impact of the central bank set interest rate for main refinancing operations (MRO) and two of the recent quantitative easing programmes – Public Sector Purchase Programme and Corporate Sector Purchase Programme – on the entire corporate yield curve. We achieve this by examining the changes in both the yield and the credit spread curve of the bonds through the level, slope and curvature factors. We further examine the curves of three separate credit ratings – AA, A and BBB – to get a clearer and more certain overview of the effects. The paper finds that the QE programmes push yields and credit spreads down, while a low MRO interest rate leads to decreased yields, but slightly increased credit spreads. The results of our analysis indicate that the policy mechanisms have the most universal effect on yield and credit spread curve levels, while the effect on slopes and curvatures is more varied and unclear.

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"Monetary policy is not a sequence of isolated policy actions. When forming their expectations, agents seek to capture the general pattern of monetary policies, and it is that pattern that matters in shaping their economic behaviour. Therefore, the relevant problem to solve for central banks is not so much about the size and timing of a given interest-rate move in response to a particular contingency. It is about the strategy for repeatedly adjusting the policy instrument in response to the state of the economy, whatever this may be." (Issing, 2012)

1 Introduction

Economic regimes that influence the performance of financial markets can be described through many economic environment factors. Investors can, as one option, look at economic growth, inflation, economic slack and monetary policy set by central banks to make decisions about their portfolio asset allocation (Masih & Sheikh, 2011) as the movements in these economic regime factors can have implications on the returns of different asset classes. A study on the US market shows that corporate bonds have their 'best performance' during recessions and stagnant economic situations from an investor's perspective (Sheikh, 2011), however that also means higher borrowing costs for the corporations.

Monetary policy differs from the rest of the abovementioned economic regime factors as it can be directly altered by policymakers to influence the economic situation and stability. This has an impact on the performance of financial markets, such as the credit market, which has lead us to further investigate the direct relationship between monetary policy and the corporate bond market. Shifts in the credit market have an impact on corporations as well as institutional investors and the ramifications spread to the rest of the economy through them.

Since the collapse of the Bretton Woods fixed exchange rate system in the 1970s the real and theoretical connection between currency and commodity has ceased to exist. The decisions of policymakers have taken the central position in forming the monetary system and financial markets. This holds to the idea of the leading economist of the Stockholm school Knut Wicksell[1] that the power of money can be regulated by policy, instead of only being dictated

[1] Knut Wicksell (1851-1926) was a leading Swedish economist best known for his contributions to the interest rate theory with his book "Interest and Prices" (1898)

by the "natural" market (Woodford, 2003). Since then central banks around the world have had the mission of inferring how to conduct monetary policy in an optimal way for the economy. There has been agreement in research that the conduct of monetary policy has impactful consequences on the aggregate real economic activity (Clarida, Gali & Gertler, 1999).

The central theory for modern monetary policy is the Taylor Rule[2] that indicates that the central bank should set interest rates based on economic conditions. The constructed model takes into consideration the actual inflation in relation to the optimal level of inflation as well as the economy's output gap (Taylor, 1993). In summary, the objective of this rule is to stabilize the economy short term, while still maintaining long term growth. The mechanism behind the theory dictates that interest rates are set at a lower level if there is need to stimulate the economy when the inflation is too low: enabling cheap borrowing to banks would incentivise them to transmit those lower borrowing rates to the real economy that would in turn boost spending and hence increase inflation (Bank of England, 2017). A low deposit rate should incentivise banks to not hold money, but instead lend it out. The opposite would be done in case of a need to lower inflation.

The growing theoretical framework around monetary policy has corresponded with central banks more concretely committing to set objectives in terms of inflation control. The approach of setting a target inflation level has been central since the 1990s (Bernanke, Gertler & Gilchrist, 1999) and following this objective has been relatively successful: "[Central banks] have found when they do so that not only is it easier to control inflation than previous experience might have suggested, but that price stability creates a sound basis for real economic performance as well" (Woodford, 2003). Today, most developed nations have a target inflation level of 2% year-on-year (European Central Bank, 2017c, The Federal Reserve, 2015) and the main mechanism to reach that has been setting the interest rates at an appropriate level.

Since the formation of the European Central Bank in connection to the creation of the EU unitary currency euro in 1999, the entity has been responsible of enacting monetary policy in the Eurozone. The reaction of ECB to the global financial crisis in 2008 and the sovereign debt crisis in 2012 has been immense. In accordance with the central bank's expansionary monetary policy, interest rates have been cut and since March 2016 the interest rate for main refinancing operations (MRO interest rate) is held at 0.00% with deposit rates negative at -

[2] $i_t = \pi_t + r_t^* + a_\pi(\pi_t - \pi_t^*) + a_y(y_t - \overline{y}_t)$, where i_t denotes the target short term interest rate, π_t denotes infaltion, π_t^* denotes the target inflation, r_t^* denotes the equillibrium real interest rate, y_t denotes GDP and $\overline{y}_t$ denotes is the potential output.

0.40% (European Central Bank, 2016b). The interest rates have never been so low before in ECB’s 20-year history and negative rates are a new concept globally.

During the recent crises, many central banks have struggled with reaching their inflation goals with traditional monetary policy and have therefore been increasingly incentivised to try new routes. Non-conventional measures - namely quantitative easing (QE) - have been taken by the central banks to combat low inflation and boost the economy (European Central Bank, 2015, Joyce, Tong & Woods, 2011). Quantitative easing aims to stimulate the economy and increase inflation at times on sub-zero interest rates. This consist of the central bank buying pre-determined asset classes in large amounts. The increased demand leads to pushing up the prices on the market as well as assists market liquidity through money supply (Klyuev, Imus & Srinivasan, 2009).

An initial purchasing program was set up by ECB already in 2009 with the intention to purchase covered bonds. During the sovereign debt crisis, Securities Markets Program to purchase sovereign bonds in mostly sphere markets was initiated to increase liquidity. The program ran between 2010 and 2012 (European Central Bank, 2017a).

The current Asset Purchase Program (APP) is divided into four parts by the asset classes purchased. The different sub-programs are for covered bonds, asset backed securities, sovereign bonds and, most recently, investment grade corporate bonds. From March 2015 the bank has the set intention of buying €60-80 billion of securities per week though the actual number varies from week to week. Sovereign bonds bought under the Public Sector Purchase Program (PSPP) make up the biggest share of the securities held by ECB under APP, with the held bonds valued at almost €1.4 trillion by April 2017 of the total €1.7 trillion value of the program’s assets. The value of the euro-denominated corporate bonds held through the Corporate Sector Purchase Program (CSPP) is approximately €67 billion (European Central Bank, 2017a).

The European corporate bond market is the second largest corporate bond market globally after the USD-denominated market, however it is still relatively small. There is an active secondary market for the bonds, but it is fairly illiquid and many investors on the market “buy and hold” (European Commission, 2016). The last decade has been unprecedented in the European credit markets in many ways. Since 2007, the market has experienced several turmoils, including the ‘08 financial crisis and the European sovereign debt crisis. Both situations led to increased uncertainty and higher cost of debt for market participants. However, the market has also tripled in size since 2008 and is now estimated to be valued at around €2 trillion.

Due to the novelty of non-traditional monetary policy methods, the effect on the corporate bond market is uncertain. Low risk sovereign bonds have reached negative yields at up to 12-year maturity (European Central Bank, 2017b) and in recent months, the market has even seen first corporate bonds being issued at sub-zero yields (Jackson 2016). The euro-bond market is larger than ever - the total amount of outstanding euro-denominated bonds is over €14 trillion (European Central Bank, 2017d).

We aim to analyse how the euro-denominated corporate bond market moves in different economic regimes with a focus on the effect of the monetary policy. Our main interest is recent monetary policy moves of unprecedentedly low interest rates and quantitative easing. In this analysis we intend to focus on two different aspects of bonds - the yield curve and the credit spread curve. The yield curve represents the financing cost of the companies issuing bonds. The credit spread amounts to the risk premium investors require in order to be willing to take on the extra risk associated with investing into corporate bonds instead of investing at the risk-free rate (Fisher, 1959). The goal of this paper is to examine how the yield curve moves and how the risk level is perceived through the credit spread with the different monetary policy mechanisms enacted by ECB.

The rest of the paper is structured as follows: Section 2 examines the previous literature in this field. Section 3 describes the data used for the paper's analysis. Section 4 explains the methodology of our research. Section 5 examines the results achieved. Section 6 includes a discussion on the results and suggestions for future research.

2 Theoretical Background

In this section we examine the past research that has been conducted in the area of bond yields and credit spreads. The section is structured as follows; we begin by examining the fundamental research on the structure and composition of the yield curve and the effect of different macroeconomic factors on the bonds. This is followed by an overview of literature concerning the effect of several monetary policy mechanisms on the abovementioned asset class. We conclude this section by describing how this paper attributes to the existing research.

2.1 Previous Literature

The pricing theory of corporate bonds is derived from the research regarding option pricing presented by Black and Scholes (1973) and further developed by Merton (1974). This theory has been used in a significant amount of research concerning the corporate bond markets and the term structure of yields[3].

The shape of the yield curve provides information about how different maturities are affected by different factors. There is a vast amount of research that concerns the yield curve and how different factors affect it. Litterman and Scheinkman (1991) build a three factor model to explain the variance in excess bond returns. The factors described are unobservable and named after their effect on the yield curve: level, steepness (later known as slope) and curvature. 'Level' has an effect on the overall movement of the yield curve, 'steepness' impacts short and long term bonds differently, hence changing the yield curve slope, and 'curvature' changes the convexity of the yield curve. The article finds that these three factors explain over 95% of the variance in bond returns in various securities tested. The factors are later used by Ang and Piazzesi (2003) who construct a model to explain sovereign yields through macroeconomic variables – an inflation variable and a real activity variable. Using a model consisting of both these observable factors as well as Litterman and Scheinkman's (1991) unobservable 'level', 'slope' and 'curvature' factors they found that the macroeconomic variables have very high explanatory power on yields. The existing relationship between bonds and macroeconomic factors is supported by Wu and Zhang (2008) who use a model that assumes an arbitrage free market to show that inflation has a positive correlation with corporate bond spreads. They also show that there is a negative correlation between the risk-free rate and corporate bond spreads. This is done using the effect of real output growth and observing its effect on T-bills (representing the risk-free rate) and credit spreads. They find a positive correlation between real output growth and the risk-free rate and a negative correlation between real output growth and credit spreads implying that there is a negative correlation between the risk-free rate and credit spreads.

Collin-Dufresne, Goldstein and Martin (2001) find that the main driver for changes in the corporate bond credit spreads is the market's own demand and supply shocks. Their study, that analyses the drivers of credit spreads, also finds that different macroeconomic (i.e. liquidity), firm-specific (i.e. leverage) and equity market (i.e. returns) factors do influence the

[3] Examples of other research papers that have used this theory as a starting point in their work include Longstaff and Schwartz (1995), Wu and Zhang (2008) and Amato (2005).

changes in credit spreads in a significant way. This is in line with the findings of Ang and Piazzesi (2003) and of Wu and Zhang (2008) concerning macroeconomic variables. The effect of firm specific-factors is supported by the findings of Longstaff and Schwartz (1995) who develop a model for the corporate bond spreads by using default risk and interest rate risk. The model implies that there is a negative correlation between corporate bond spreads and the level of interest rates as well as between corporate bond spreads and firm asset value. It also shows that the majority of the variation in credit spreads is due to changes in interest rates. According to the paper: "The results provide strong evidence that both default risk and interest rate risk are necessary components for a valuation model for corporate debt".

Further, Diebold, Rudebusch and Aruoba (2006) have used Litterman and Scheinkman's (1991) three factors when estimating a model that studies the relationship between monetary policy and macroeconomic variables and the yield curve. The variables studied are the federal funds rate set by FOMC, capacity utilization and inflation. They find that, when the federal funds rate is increased, the slope of the yield curve is shown to decrease. Federal funds rate has an effect on inflation expectations that in turn has an impact the level of the yield curve. The curvature factor is less affected than the slope and the level are. The following is claimed: "In principle, a surprise increase in the monetary policy rate could have two quite different effects on inflation expectations. On the one hand, if the central bank has a large degree of credibility and transparency, then a tightening could indicate a lower inflation target and a likely lowering of the level factor. Alternatively, a surprise tightening could indicate that the central bank is worried about overheating and inflationary pressures in the economy—news that would boost future inflation expectations and the level factor. Evidently, over our sample, the latter effect has dominated."

Changes in the term structure of the yield curve has also been studied by Brand, Buncic and Turunen (2010) who examine the impact of news about monetary policy on bonds. They find that bonds with different maturities are affected differently by the factors examined and the expectations on how these factors will change in the future. For example, bonds with shorter maturities are affected by immediate changes interest rates whilst changes in expectations for future interest rates affect bonds with medium- to long-term maturities.

The credit default swap (CDS) spreads are equal long term to the par fixed coupon bond credit spread under a no-arbitrage condition (Zhu, 2006). This enables us to potentially find clarification for the credit spread structure from the theoretical framework of credit default swaps. The relationship between real economy factors and CDS spreads has been studied by Amato (2005). In order to show the existence of risk aversion in CDS spreads, Amato calculates the risk premia based on default risk and loss given default and shows that there are shifts that can't be accounted for by these two variables. His result shows that the risk premia is correlated with real economy activity and risk aversion is correlated to the stance of monetary policy. Amato also indicates that expansionary monetary policy leads to higher risk-taking as it becomes cheaper for investors to increase their leverage. This implication contradicts the findings of Karadi and Gertler (2015) who study bond yields and spreads. The article analyses over 30 years of data on FOMC's monetary policy announcement and the effects of these monetary policy surprises on both corporate and sovereign yields/spreads. The article comes to the conclusion that tightening monetary policy leads to an increase in credit spreads as well as term premia. Further, Chun, Dionne and François (2014) explain how different credit spread levels and volatility levels can be divided into separate regimes and explores how those correlate with recessions and monetary policy. The article finds that spread level regime shifts correspond well to recessions and also tend to start before and outlast them. Volatility regimes, however seem to be shorter in their nature and shifts also occur during financial distress.

Further, Sensarma and Bhattacharyya (2016) give empirical evidence on the effect of monetary policy by constructing a variable based on several monetary policy mechanisms used by the Indian Central Bank and observing its effect on the Indian corporate bond market. They study its impact on corporate yield and credit spread curve level, slope and curvature. The analysis suggests that the impact of monetary policy is significant and positive on corporate yield levels, meaning that a policy tightening would lead to yields increasing and vice versa. The yield curve slope flattens as a result of monetary policy tightening and the curvature becomes more convex. The effect on credit spread levels is positive and significant, meaning a tight monetary policy would lead to credit spreads increasing.

The effect of quantitative easing (QE) on bond yields and spreads has been studied by Joyce, Tong and Woods (2011) who explored the impact of the first QE program implemented by the Bank of England. They found that UK investment grade corporate yield fell by 70 bps with the credit spreads remaining relatively stable after the QE implementation. BBB-rated bonds saw a 100 bps drop in yields and 75 bp decrease in the spread. Goodhart and Ashworth (2012) argue, however, that QE has a diminishing effect with empirical evidence from the second round of QE in the UK (QE2). Their analysis shows that rather than decreasing yields, in the aftermath of QE2, credit spreads increased by 10-20 bps.

2.2 Our Attribution

In this paper we are focusing on the effects that ECB's monetary policy has on the yield and spread curve of euro-denominated corporate bonds. The effect of monetary policy has been studied before, the some of the most recent being the detailed study on the Indian corporate bond market by Sensarma and Bhattacharyya (2016) and the study on QE by Joyce, Tong and Woods (2011). We contribute to their findings by studying the effects on the European market. Due to the novelty of sub-zero interest rates and quantitative easing as a monetary policy mechanism the literature in that area is scarce. To the best of our knowledge, no paper has studied the effects of ECB's current monetary policy on the European corporate bond market in such a thorough manner before.

3 Data

For our analysis we are using data extracted from Thomas Reuters Datastream. Our dataset covers a time period between February 2000 and March 2017. Data for all of our variables is available for this time period.

3.1 Corporate Bond Data

For the euro-denominated corporate bond market, we consider the Markit iBoxx Euro Corporate index a good measure for the market average. We have extracted data for three different credit ratings – AA, A and BBB – to isolate changes in risk premia due to downgrades/upgrades. For our analysis we are focusing on 3-year, 5-year and 7-year maturities. The iBoxx index is constructed in three year spans (1-3 years, 3-5 years, 5-7 years and 7-10 years) and therefore we construct our desired maturities by taking a equally weighted average of the two maturity bands where our desired maturity overlaps. The result is presented in basis points:

$$Yield_{3y} = \frac{iBoxx_{1-3y} + iBoxx_{3-5y}}{2}$$

$$Yield_{5y} = \frac{iBoxx_{3-5y} + iBoxx_{5-7y}}{2}$$

$$Yield_{7y} = \frac{iBoxx_{5-7y} + iBoxx_{7-10y}}{2}$$

We acknowledge the concern that the data used only has maturities between 3 and 7 years. This is a relatively short maturity span that could potentially bias our results for the dependent variables in our analysis. However, issuing very short term benchmark bonds is relatively uncommon in the corporate bond markets, so a starting point of 3 years reasonably follows market trends. Furthermore, the yield/spread curve indicators (detailed description in Section 4.1) are calculated based on the same maturities for the whole time period, so we are able draw conclusions from shifts in the indicators in a relative sense. Considering these aspects, we have made the assessment that it is reasonable to use the data described.

For the calculation of credit spreads (see Section 4.1), the choice of risk-free rate was between the euro swap rates and German sovereign bond yields. Based on findings from previous literature (Ericsson, Reneby & Wang 2006, Hull, Predescu & White 2004), we use the euro-libor swap rates. The choice of swap rate as the risk-free rate has proven to produce more accurate credit spreads in other studies due to the sovereign yield including other factors such as taxes. The swap rate also most clearly emulates the traders funding costs.

3.2 Monetary Policy and Macroeconomic Data

The central focus of this study is on the monetary policy mechanisms enacted by the ECB. For the central bank set interest rate, we use daily data on ECB's interest rate on the main refinancing operations. To examine the effect of QE we construct two dummy variables - the first indicating the activity of the PSPP (the variable value equals "1" from 9th of March 2015 and onward) and the other indicating the activity of CSPP (variable equals "1" from 8th of June 2016 and onward). We believe these programs are the most relevant to our study: PSPP due to its size (almost €1.4 trillion in assets held by ECB) and CSPP due to its direct link to the asset under our inspection - euro-denominated corporate bonds.

In order to isolate the effect of monetary policy on the corporate bond market, we use a variety of macroeconomic indicators as variables to eliminate the effect of other factors influencing the market. We focus on separating the effect of the other economic regime factors (mentioned in Masih & Sheikh (2011)) as well as a few additional indicators we assume to have an impact on the credit markets.

GDP – Economic growth is represented by monthly Eurozone GDP data. The dataset is transformed into logarithmic yearly differences in order to show the year-on-year GDP growth.

The variable (later named *GDP*) is represented in basis points and it's calculated in the following manner:

$$gdpgrowth_t = \log(gdp_t) - \log(gdp_{t-1year})$$

Inflation – In order to illustrate the market's situation in terms of the set target inflation, monthly Eurozone CPI data (YoY in %) is used to construct a variable that demonstrates the absolute deviation of inflation from its target of 2%. The variable is presented in basis points and the formula to calculate it as follows:

$$absdevcpi_t = |2\% - inflation_t|$$

Capacity utilization – To capture the effect of economic slack we use the Eurostat data on capacity utilization in the manufacturing industry. The data is quarterly and we transform the the values into first differences in percentage points to express the change happening during that time period. The formula for calculating our final variable is:

$$\Delta caputil_t = caputil_{t+1} - caputil_t$$

Equity market – There is an established correlation between the equity and credit markets. In order to capture that relationship, we have chosen the daily EuroStoxx50 price index as an indication of stock market performance. The price index is transformed into logarithmic yearly difference to demonstrate year-on-year return.

$$eurostoxx50_t = \log(eurostoxx50price_t) - \log(eurostoxx50price_{t-1year})$$

Recession – In order to capture any additional effect the two crises that fit into our timeframe might have had on the credit market, we construct a dummy variable indicating the times of recessions. The recessions are dated as Q1-2008 to Q2-2009 and Q3-2011 to Q1-2013 by the Euro Area Business Cycle Dating Committee in the Centre of Economic Policy Research[4].

[4] See Centre of Economic Policy Research (2015) for a more detailed description of how the recession time periods are set.

4 Methodology

4.1 Variables

When analysing the effect of monetary policy on the corporate bond markets we choose to conduct regressions on multiple different yield curve variables in order to incorporate several aspects that are of interest. Firstly, we choose to analyse the bonds from two angles - (a) corporate bond yields and (b) corporate credit spreads - in order to incorporate both the investors' and the corporations' perspectives. As discussed in Section 1, the yield represents the financing costs of the corporation and therefore serves as a good representative for the corporate perspective in our analysis. The yield curve consists of two parts - the risk free rate and the additional compensation that investors get for taking on the risks of the corporation. The additional compensation is the credit spread and because of this we find that the credit spread is a suitable representative of investors' perception of the risk level in the corporate bond market. Credit spread is calculated as follows:

$$Credit\ spread_t = Yield_t - riskfree\ rate_t$$

In this paper, we aim to capture the effects that monetary policy has on the entire yield curve. Therefore, we choose to separate the yield curve and the credit spread curve into three different components respectively - level, slope and curvature. This follows the method used by Sensarma and Bhattacharyya (2016) who separate the curves into these three components when studying how a constructed monetary policy variable affects the corporate bond market. The three components can be described as follows:

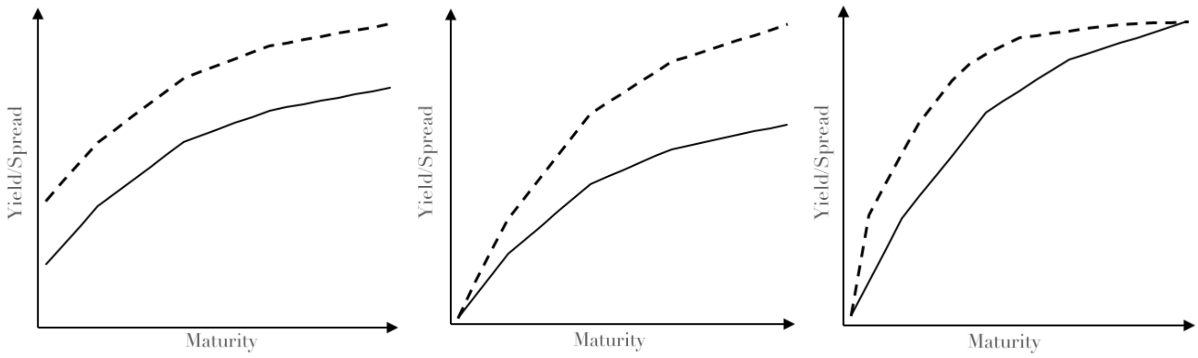
Level: A change in level would imply that the entire yield curve moves in the same way. This means that the effect of an independent variable is consistent for all maturities.

Slope: A change in slope would indicate that short maturities are affected differently than long maturities are.

Curvature: When short- and long-term maturities are affected different than "mid-term" maturities the yield curve will either flatten or become more convex - these changes are captured in the curvature variable.

Figure 1: Level, slope and curvature of the yield/spread curve

Figure 1 illustrates the movements of level (left), slope (centre) and curvature (right) of the yield/spread curve.



We choose to further separate the dependent variables by three different credit ratings of the bond – AA, A and BBB. There are several reasons to why we look at separate credit ratings. One of the reasons is to isolate the effect of possible downgrades/upgrades, to avoid the possible effects of overall shifts in default risk on the market due to other indicators. Another reason is to check whether the effects are consistent for all ratings or if some rating is affected in a different manner (if this would be the case the aggregate effect might be skewed). If all ratings show similar and significant results the risk that our results are spurious decrease.

As a result, we analyse a total of 18 separate dependant variables. These represent both the investors' and the corporate perspective and also incorporate the effects on both different maturities and different credit ratings. In summary, our dependant variables are calculated as follows:

$$Yield\ level_t^c = \frac{Yield_{3y,\ t}^c + Yield_{5y,\ t}^c + Yield_{7y,\ t}^c}{3}$$

$$Spread\ level_t^c = \frac{Spread_{3y,\ t}^c + Spread_{5y,\ t}^c + Spread_{7y,\ t}^c}{3}$$

$$Yield\ slope_t^c = Yield_{7y,\ t}^c - Yield_{3y,\ t}^c$$

$$Spread\ slope_t^c = Spread_{7y,\ t}^c - Spread_{3y,\ t}^c$$

$$Yield\ curvature_t^c = Yield_{3y,\ t}^c + Spread_{7y,\ t}^c - 2Yield_{5y,\ t}^c$$

$$Spread\ curvature_t^c = Spread_{3y,\ t}^c + Spread_{7y,\ t}^c - 2Spread_{5y,\ t}^c\ ,$$

where *c* denotes the credit rating, *t* the time point and *3y, 5y* and *7y* the time (in years) to maturity for the bond.

In addition to the 18 dependent variables we include the three independent variables of interest *MROrate, PSPP* and *CSPP* described in Section 3, into our regressions. By further introducing macroeconomic control variables into our model, we strive to reduce noise that might affect the coefficients of the independent variables in focus. The introduction of the control variables aims to increase the certainty of our results. The chosen macroeconomic variables (*GDP, absdevcpi, caputil, eurostoxx50* and *recession*) are described in detail in Section 3.

4.2 The Model

In order to obtain the relationship between the chosen monetary policy variables and the earlier described components of corporate bond yields a set of 18 (one for each dependent variable) models is constructed. Each model shows the relationship between the dependant variable in question, the three independent variables representing monetary policy and the additional five control variables representing the macroeconomic factors. The general structure of the models is as follows:

$$Y_t = \alpha + \beta_1 MROrate_t + \beta_2 PSPP_t + \beta_3 CSPP_t + \gamma\vartheta_t + \varepsilon \ ,$$

where Y_t denotes the dependent variable of interest, β the coefficients for the respective independent variable, α is the dependant variable specific constant, ϑ is the representative for our control variables, γ is the representative for macroeconomic variables' coefficient and ε is the error term.

4.3 Regression

In order to chose an appropriate regression model we conduct a series of tests on our data. This is done to ensure that the results are not biased due to an unsuitable regression model. The tests examine the multicollinearity, stationarity, heteroscedasticity and autocorrelation (serial correlation) of our data. To enable us to execute the tests we run initial OLS-regressions for the model formulated in Section 4.2. Using the results from the tests we then conclude if the OLS-regression is the Best Linear Unbiased Estimator (BLUE) for our data.

4.3.1 VIF-test for Multicollinearity

The variance inflation factor (VIF) is calculated in order to detect multicollinearity between the independent variables. As a rule of thumb a VIF-value of over 10 (Kutner, Nachtsheim & Neter, 2004) or over 20 (Greene, 2012) is considered to show an 'alarming' level of multicollinearity. The highest obtained VIF-value for our variables is 3.02 (see Appendix B). This is far below the benchmarks and therefore we do not find that the multicollinearity within our variable group is problematic. We do not make any adjustments for the variables we include based on the VIF-tests.

4.3.2 Stationarity

Stationarity is a requirement the data needs fulfil in order to retain non-spurious results from the regressions. Based on the empirical findings of Cerrato, Kim and MacDonald (2013) that support the hypothesis that interest rate series are stationary, we make the assumption that our interest rate related variables – all of our dependant variables as well as the interest rate for MRO – are stationary. The rest of our independent variables are assumed to be stationary as they are not absolute values, but rather either (first) differences (*caputil*, *absdevcpi*) or logarithmic differences (*GDP*, *eurostoxx50*).

4.3.3 Breusch-Pegan Test for Heteroscedasticity

Homoscedasticity is a prerequisite for OLS-regressions. Heteroscedasticity of data may lead to the test-statistics of the regression being biased and could also imply that there are relevant variables omitted from the regression model. In order to check for heteroscedasticity we use the Breusch-Pegan test. The null hypothesis is that the variance of the error terms given the independent variables is constant over time meaning that there is homoscedasticity.

Our Breusch-Pegan tests show p-values of 0.0000 for 13 of our 18 regressions (see Appendix A). This means that we can reject the null hypothesis - that there is no heteroscedasticity in our data - for these. The rest of our p-values are as follows; 0.0035, 0.0101, 0.0732, 0.2589 and 0.2606. For the majority of our tests we therefore reject the null hypothesis meaning that we have to take into consideration the possibility of heteroscedasticity in our data.

4.3.4 Durbin-Watson Test for Autocorrelation

In order to test the existence of serial correlation in our regressions, we run the Durbin–Watson test on the residuals from OLS regressions constructed with our variables. After comparing the Durbin-Watson test statistics for our regressions that all have values between 0.007 and 0.06

from Stata (see Appendix C) with the dL values from the Durbin-Watson table, we conclude that we can reject the null hypothesis that there is no serial correlation for all of our regressions.

4.4 The Regression

The tests conducted in Section 4.3 show that our data is subject to both heteroscedasticity and autocorrelation. In order to adjust for this we use a Newey-West estimator in our regression. The Newey-West estimator regression was constructed to deal with both heteroscedasticity and autocorrelation (Newey & West, 1987). By using the standard errors generated in the OLS-regression as estimates for the variance of the beta-values, Newey and West conduct a variance/covariance matrix. This matrix represents the estimated variance of beta. The correlation between the obtained standard errors will decrease as the time-gap between them increases: i.e. there will be less correlation between the standard errors in five years and today than there will be between the standard errors of tomorrow and today. As the time-gap grows the correlation will therefore converge towards zero.

In order to exploit the diminishing correlation with time-gap, Newey and West assign weights to the correlations based on the time-gap (the weight decrease as the time-gap increases). The model is simplified by setting the weights (and thereby also the covariance) to zero when the time-gap reaches a certain level and the correlations are small enough to be ignored. By using this matrix the variance of betas is estimated and thus a the standard errors of the regressions are adjusted. Using the Newey-West estimator in the regression does not change the beta values, but changes the standard error for the variance of betas. This estimator is then used when applying the formulas that calculate test statistics. In the case of our regressions, the p-values are impacted.

Calculating the Newey West estimator requires the choice of an appropriate number of lags after which the weight is set to zero. The choice is based on the number of observations in the dataset (Greene, 2012) and is calculated by the following formula:

$$Number\ of\ lags = (Number\ of\ observations)^{\frac{1}{4}}$$

Our dataset has 4471 observations and therefore we conduct the regressions with 8 lags.

5 Results

5.1 Descriptive Statistics

This section presents the descriptive statistics on our data. We begin by examining the summary statistics and a correlation analysis on our dependent and independent variables. This is followed by analysing time series graphs that plot out the movements of the dependant variables over the 17-year time span we observe.

5.1.2 The Summary Statistics

The summary statistics for the dependant variables representing the corporate bond market and independent variables representing the monetary policy and other macroeconomic factors are shown in Table 1. The dataset includes 4471 daily observations. Both for yields and credit spreads, we observe relatively high dispersion in the data for ‘level’ variables. The standard deviations for yield curve levels range from 169.75 to 186.43 bps, with the spread between minimum and maximum value for the BBB-rated bond reaching 836.51 bps. We examine a similar trend with credit spread levels. The mean values for levels increase with decreasing credit ratings.

The data for yield and spread curve slopes and curvatures exhibit higher standard deviations for BBB-rated bonds, the magnitude of the trend is especially high for curvatures. The dispersion of the minimum and maximum values for BBB-rated bond slopes and curvatures is noticeably higher than for the higher rated bonds, while the mean values are in a similar range for all credit ratings.

5.1.2 Correlation

Table 2 presents the calculated correlations between all of the respective independent and dependant variables. The correlations between the yield curve level variables of different credit ratings are high (0.95 to 0.98) indicating that the yields move relatively similarly. The same stands for credit spread curve level (correlations of 0.90 to 0.98). The correlations between yield and spread curve slopes and curvatures are lower and the correlations of the higher rated bonds with the BBB-rated are especially meagre (i.e. a correlation of 0.01 between the AA-rated and BBB-rated yield curve slope).

The correlation of MRO interest rate is highly positive with the yield curve levels (0.77 to 0.89) and slightly negative with the spread curve levels (-0.10 to -0.02). Both of the variables representing QE - *PSPP* and *CSPP* - have negative correlations with both yield levels (-0.60 to -0.36) and spread levels (-0.17 to -0.12).

5.1.3 Time Series

Figure 2-4 shows the movements of our dependant variables over the time period 2000-2017. Graph 1 supports the results from the correlation analysis indicating a high co-movement of the yield levels of the differently rated bonds and we also observe a similar movement to the MRO rate. In addition, we observe clear peaks in the graph during the two recession periods. The levels have a downward trend since the last recession peak and values in 2016-2017 are at the lowest in the observed time period. We observe similar peaks in credit spread curve levels during the two recessions. The spread levels since the 2012 crisis are slowly returning to their pre-recession values.

In figure 3-4 we observe the BBB-rated yield and spread curve slope and curvature experiencing a much higher level of volatility compared to the higher rated bonds. This is especially evident for yield curvatures and spread slopes and curvatures, where the observations for AA and A rated bonds are relatively ‘flat’. This supports the findings from Table 1 that showed higher standard deviations as well as value dispersions for BBB-rated bonds.

Table 1: Summary statistics

Table 3 presents the number of observations (N), mean, minimum (min) and maximum (max) values observed in the dataset and the standard deviation (sd). The table shows these values for all dependant variables (yield and credit spread curve levels, slopes and curvatures for the AA, A and BBB rated bonds) and for the nine independent variables (MRO-rate, PSPP, CSPP; GDP, absolute deviation from the target inflation of 2% (here denoted CPI deviation), eurostoxx50, recession and capital utilization). The PSPP, CSPP and recession are presented as dummies in our data. Remaining variables are presented in basis points.

	Yield level AA	Yield level A	Yield level BBB	Yield slope AA	Yield slope A	Yield slope BBB	Yield curvature AA	Yield curvature A	Yield curvature BBB
N	4471	4471	4471	4471	4471	4471	4471	4471	4471
mean	330.82	375.34	437.38	74.83	83.30	76.26	-1.08	2.24	-8.11
min	9.35	31.80	62.72	11.75	26.65	-88.10	-52.45	-36.80	-161.40
max	724.77	872.65	899.23	148.80	148.55	213.85	26.95	68.20	169.20
Sd	169.75	185.87	186.42	30.78	25.64	47.05	9.31	12.70	47.75

	Spread level AA	Spread level A	Spread level BBB	Spread slope AA	Spread slope A	Spread slope BBB	Spread curvature AA	Spread curvature A	Spread curvature BBB
N	4471	4471	4471	4471	4471	4471	4471	4471	4471
mean	53.98	97.78	160.54	18.63	27.10	20.06	2.90	6.23	-4.13
min	4.45	21.43	40.22	-8.05	-48.33	-173.60	-52.45	-36.20	-151.80
max	305.48	540.62	564.45	77.75	123.45	215.10	39.10	84.45	159.10
Sd	55.71	90.75	105.17	12.64	21.23	58.67	9.13	14.55	45.40

	MRO-rate	PSPP	CSPP	CPI deviation	Eurostoxx50	GDP	Recession	Capital Utilization
N	4471	4471	4471	4471	4471	4471	4471	4471
mean	193.96	0.12	0.05	50.00	-0.58	126.08	0.19	0.00
min	0.00	0.00	0.00	0.00	-30.39	-550.00	0.00	-6.90
max	475.00	1.00	1.00	260.00	20.22	450.00	1.00	3.20
sd	147.28	0.32	0.21	70	9.89	196.06	0.40	1.32

Table 2: Correlations

Correlations between the 18 dependent variables and the nine independent variables. The dependent variables are presented by a combination of letters: the first letter denotes whether it is a yield (Y) or a credit spread (S). The second letter denotes the level (L), slope (S) and curvature (C) factors. This is followed by the rating of the bond in lowercase letters. The independent variables are presented by MRO (*MROrate),* PSPP, CSPP, GDP, CPI (*absdevcpi*), ES50 (*eurostoxx50),* CU (*caputil)* and Rec. (*recession)*.

	YLaa	YLa	YLbb	YSaa	YSaa	YSbbb	YCaa	YCa	YCbbb	SLaa	SLa	SLbbb	SSaa	SSa	SSbbb	SCaa	SCa	SCbbb	MRO	PSPP	CSPP	GDP	CPI	ES50	CU	Rec.
YLaa	1																									
YLa	0.98	1																								
YLbbb	0.95	0.98	1																							
YSaa	-0.2	-0.1	-0	1																						
YSa	-0.1	-0	0.03	0.85	1																					
YSbbb	0.1	0.04	0	0.01	0.13	1																				
YCaa	-0.3	-0.3	-0.3	-0.3	-0.3	-0.3	1																			
YCa	-0.1	0.01	0.02	0.16	0.1	0.09	0.11	1																		
YCbbb	0.13	0.04	-0	-0.5	-0.4	0.6	-0.1	-0.2	1																	
SLaa	0.26	0.41	0.46	0.35	0.48	-0	-0.1	0.55	-0.3	1																
SLa	0.31	0.48	0.52	0.33	0.41	-0.1	-0.1	0.54	-0.3	0.98	1															
SLbbb	0.21	0.37	0.48	0.44	0.45	-0.2	-0.1	0.47	-0.4	0.93	0.95	1														
SSaa	0	0.05	0.07	0.3	0.4	0.32	-0.4	0.21	0.15	0.44	0.37	0.36	1													
SSa	0.13	0.14	0.09	-0.2	0.22	0.33	-0.2	0.01	0.31	0.34	0.24	0.13	0.64	1												
SSbbb	0.17	0.09	0.02	-0.5	-0.3	0.87	-0.1	0.03	0.75	-0.1	-0.2	-0.3	0.32	0.53	1											
SCaa	-0	0.02	0.04	0.19	0.07	-0.3	0.65	0.08	-0.4	0.01	0.05	0.08	-0.6	-0.5	-0.4	1										
SCa	0.11	0.2	0.23	0.47	0.34	0.08	-0.1	0.85	-0.4	0.57	0.57	0.53	0.08	-0.2	-0.2	0.28	1									
SCbbb	0.19	0.1	0.07	-0.4	-0.3	0.63	-0.1	-0.2	0.99	-0.3	-0.3	-0.3	0.13	0.25	0.73	-0.3	-0.3	1								
MRO	0.89	0.82	0.77	-0.4	-0.4	0.03	-0.2	-0.3	0.33	-0.1	-0	-0.1	-0.1	0.13	0.23	-0.1	-0.2	0.35	1							
PSPP	-0.6	-0.6	-0.6	-0.2	-0.1	-0.1	0.25	-0	-0	-0.1	-0.1	-0.2	-0	0.17	0.05	-0.1	-0.2	-0.1	-0.5	1						
CSPP	-0.4	-0.4	-0.4	-0.2	-0	-0.2	0.28	-0.2	-0.1	-0.1	-0.1	-0.2	-0.1	0.17	-0.1	0.04	-0.3	-0.2	-0.3	0.6	1					
GDP	0.12	-0	-0.1	-0.6	-0.4	0.11	0.15	-0.4	0.44	-0.6	-0.6	-0.6	-0.3	0.18	0.34	-0.1	-0.5	0.41	0.38	0.1	0.05	1				
CPI	-0.4	-0.3	-0.3	-0	0.03	0.2	0.06	0.35	0	0.25	0.23	0.18	0.31	0.24	0.23	-0.2	0.12	-0.1	-0.5	0.48	0.15	-0.3	1			
ES50	-0.2	-0.4	-0.4	-0.2	-0.2	0.38	0.21	-0.1	0.2	-0.5	-0.6	-0.6	-0.1	-0	0.36	0.11	-0.2	0.18	-0.1	-0	-0	0.42	-0.1	1		
CU	-0.3	-0.4	-0.4	0.1	-0	0.36	-0.1	-0.2	0.12	-0.5	-0.6	-0.5	0.02	-0.1	0.24	-0	-0.2	0.13	-0.2	0.05	0.06	0.35	-0	0.57	1	
Rec.	0.27	0.35	0.39	-0	0.09	-0.1	-0	0.38	-0	0.6	0.59	0.57	0.53	0.44	0.01	-0.2	0.21	-0.1	0.18	-0.2	-0.1	-0.3	0.1	-0.3	-0.5	1

Figure 2: Yield curve and credit spread curve levels 2000-2017

Figure 2 illustrates the movements of the yield curve (left) and the credit spread curve (right) levels 2000-2017 in basis points, where — represents the AA-rated level, — the A-rated level, — the BBB-rated level and — the main refinancing operations (MRO) interest rate. The area shaded in ■ represents the time periods of recession, the area shaded in ■ represents the time period of PSPP activity and the area shaded in ■ represents the time period of PSPP and CSPP activity.

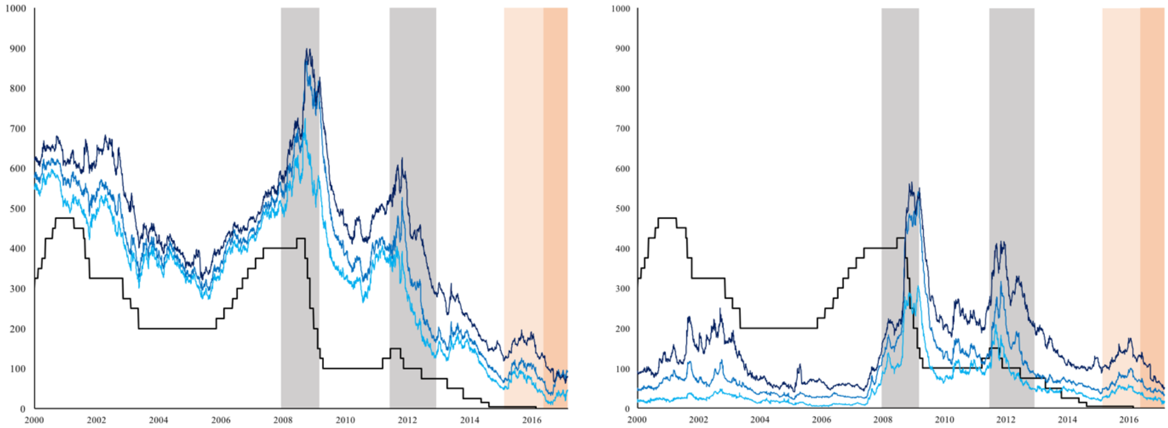


Figure 3: Yield curve and credit spread curve slopes 2000-2017

Figure 3 illustrates the movements of the yield curve (left) and the credit spread curve (right) slopes 2000-2017 in basis points, where — represents the AA-rated slope, — the A-rated slope and — the BBB-rated slope. The area shaded in ■ represents the time periods of recession, the area shaded in ■ represents the time period of PSPP activity and the area shaded in ■ represents the time period of PSPP and CSPP activity.

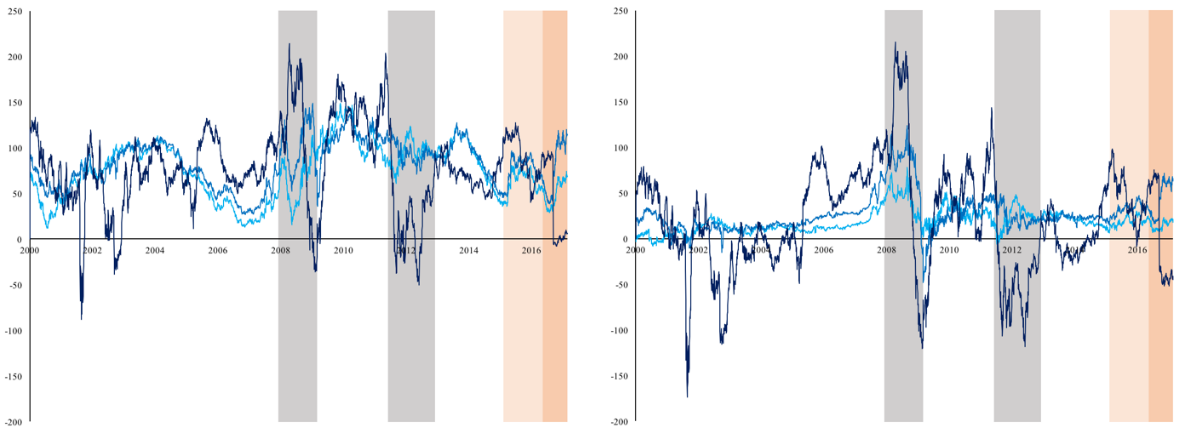
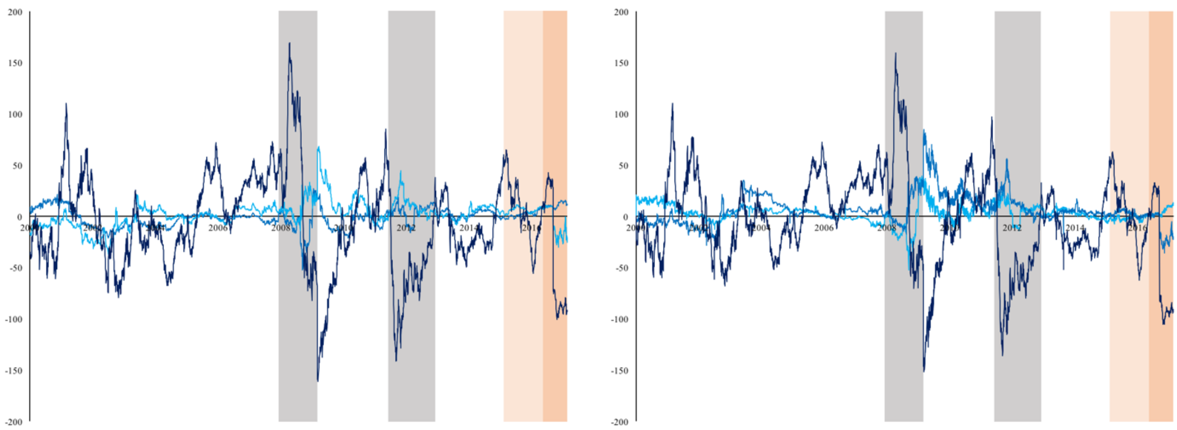


Figure 4: Yield curve and credit spread curve curvatures 2000-2017

Figure 4 illustrates the movements of the yield curve (left) and the credit spread curve (right) curvatures 2000-2017 in basis points, where — represents the AA-rated curvature, — the A-rated curvature and — the BBB-rated curvature. The area shaded in ■ represents the time periods of recession, the area shaded in ■ represents the time period of PSPP activity and the area shaded in ■ represents the time period of PSPP and CSPP activity.



5.2 Regression Results

In this section we review the findings from our 18 regressions (Table 3-4) with a focus on the three monetary policy variables – interest rate for MRO, PSPP and CSPP. Lastly we briefly discuss some of the results for the remaining control variables.

5.2.1 Interest Rate

There is a strong positive correlation between the yield level and the set interest rate. A lowering of the interest rate by 1% would lead to a decrease in yield level by 88.5 to 102.2 bps depending on the credit rating. The effect on lower rated (BBB) bonds is smaller than on those with higher credit rating.

The correlation with the level of the spread curve, however, is negative. This implies that as the interest rate goes down the spread will increase, and vice versa. This holds for all ratings although the BBB-rated bonds seem to be more affected by interest changes with an increase of 17.7 bps in case of a 1% decrease in the interest rate. The effect on higher rated bonds in case of the same change is an increase of approximately 4 to 8 bps, however the result for the A-rated bond is not statistically significant.

While the regression result for the yield slopes' correlations with *MROrate* are highly significant, they differ for the credit ratings. The result for beta is -0.114, -0.102 and 0.080 respectively in the order of decreasing credit rating. The regression results for the spread curve slope show a similar relationship between the slope and *MROrate* as observed for the yield curve slope with an increasing trend in beta as credit ratings decrease, however only results for AA and BBB rated bonds are statistically significant. The coefficient for the interest rate variable and the slope of the spread curve is -0.0085 (very close to zero) for AA rated bonds and goes up to 0.186 for BBB rated bonds.

The variable has almost no effect on higher rated bonds' yield curve curvatures (up to 2 bps of more convexity with 1% decrease in interest rate), however a slightly higher positive correlation with BBB rated bonds - we observe a 7 bps decrease in the convexity with a 1% decrease of interest rate. In the regressions for spread curve curvatures the correlation coefficients for *MROrate* are -0.0077 (AA), -0.0195 (A) and 0.0772 (BBB) implying that with a 1% decrease in the MRO interest rate, the spread curve will become more convex by 0.77 bps and 1.95 bps respectively for the higher rated bonds and flatten by 7.7 bps for BBB rated bonds.

5.2.2 PSPP

The implementation of the Public Sector Purchase Programme represented in the regression by variable *PSPP* has a negative effect on yield levels according to our regression - they are lowered by 59.11 to 82.64 bps with a stronger reaction observed for the lower credit rating (BBB).

The PSPP has a negative effect on the level of the spread curve as well. The effect of this variable is between -15.08 to -38.62 bps depending on the rating, with the highest reaction examined for BBB rated bonds.

The effect of PSPP on yield curve slopes is unclear. The regression yields a negative correlation with AA-rated bonds, a positive correlation with BBB-rated bond and a statistically insignificant result for the A-rated yield curve slope. The variable, however, has a clear steepening effect on spread curve slopes, with the slopes increasing by 8.84 (AA), 20.91 (A) and 69.23 bps (BBB) during the active stage of PSPP.

The relationship between PSPP and the yield curve curvature is unclear. The coefficient for AA rated bonds is insignificant and for the other two the regressions show vastly different coefficients (-7.714 for A-rated and 34.68 for BBB-rated). The result from spread curvature regression shows a mixed reaction to the implementation of PSPP. The coefficients are -7.204 (AA), -13.31 (A) and 29.08 (BBB), all of which are statistically significant at a 1% level.

5.2.3 CSPP

The Corporate Sector Purchase Programme variable *CSPP* has a decreasing effect on the yield levels. Notable is that the effect is much higher, almost double, on BBB rated bonds, at -83.45 bps while the effect on higher rated bonds is lower at -48.03 to -34.65 bps. There is also a negative correlation between the level of the spread curve and the CSPP programme. The magnitude of the effect increases as ratings decrease (-21.43 (AA), -22.5 (A) and -56.84 bps (BBB)).

CSPP has a negative correlation with yield slopes as well. The implementation of the programme has a flattening effect on the yield curve, with the biggest effect on BBB-rated bonds. The coefficients for this correlation are -26.33 (AA), -9.685 (A) and -56.95 (BBB) respectively. Spread curve slope regressions yielded statistically significant but mixed results. The effect of CSPP is negative on the AA- and BBB-rated spread curve slopes, but positive on the A-rated. The coefficients from the regressions are the following: -7.835 (AA), 8.808 (A) and -38.45 (BBB).

Yield curve curvature regressions show that the yield curve becomes less convex for A and BBB (-8.526 bps and -45.33 bps respectively), however more convex for AA (+11.61 bps) by CSPP. For spread curve curvatures, correlation coefficients for the CSPP decreases with rating. For the AA-rated bonds the correlation coefficient is 6.862 meaning that during the implementation of the CSPP, curvature will increase. For the A- and BBB-rated bonds there is a negative correlation between curvature and CSPP, -13.27 and -50.07 bps respectively, meaning that as a result of CSPP, the spread curve for these bonds is less convex.

5.2.4 Control Variables

While the results of the variables representing other macroeconomic factors that could have an impact on the corporate bond market are not the main focus of this paper, we will briefly inspect them.

The stock market representative *eurostoxx50* has a clear negative correlation with both yield and spread levels. This is an expected result as it is intuitive that as the market value of a corporation's assets decreases the perceived risk of default is higher, hence the increased yields and credit spreads. GDP growth also presents a negative correlation with yield and spread levels, as well as yield slope indicating that during worse economic times (lower GDP growth) the yield curve is steeper. The economic slack indicator *caputil* shows clear significant results for yield curve slopes as well as spread slopes (except for A-rated bond) – the correlation between capital utilisation and slope is positive meaning that lower levels of economic slack (a positive change in capital utilization) correspond with steeper yield and spread curves. The variable also has a negative correlation with spread levels indicating that an increase in capital utilisation can lead to lower credit spreads. The inflation variable *absdevcpi* has a statistically significant positive correlation with yield curve slopes indicating that the yield curve is steeper during times, when the economy is experiencing inflation that deviates from the target (7.3 to 13.3 bps steeper for every percentage point deviation from the target of 2%). The dummy variable *recession* has a clear positive effect on the spread curve levels and slopes, indicating that during times of recession the credit spreads increase and the slopes steepen.

Table 3: The relation between corporate bond yields and monetary policy

Table 1 presents the results from the regressions for each dependent variable concerning the corporate bond yields (including level, slope and curvature for the three ratings AA, A and BBB). The regression uses the Newey-West standard error estimator to adjust for heteroscedasticity and autocorrelation. When using a Newey-West estimator one is required to set an appropriate number of lags, the chosen number is 8 (see section 4.4 for further motivation). The independent variables used are the representatives for monetary policy (*MROrate* presenting the interest rates and the two variables *PSPP* and *CSPP* representing QE). Included in the regressions are also the control variables (*GDP, absdevcpi, eurostoxx50, caputil* and *recession*). *GDP* is the GDP growth. *absdeccpi* is the absolute deviation from the target inflation of 2%. *eurostoxx50* is the representative for the stock market performance. *caputil* is the capital utilization variable used to capture the effects of economic slack. *recession* is the representative for times of crisis. The PSPP and the CSPP are dummies that corresponds to 1 during the period that respective programme is active and 0 when they are not. The crisis variable (*recession*) is also a dummy that is equal to 1 during the recessions and 0 at all other times. Remaining variables are presented in basis points. The Newey-West estimated standard errors are presented in parenthesis. The statistical significance levels are presented as follows: *** denotes p<0.01, ** p<0.05 and * p<0.10.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
VARIABLES	levelyieldaa	levelyielda	levelyieldbbb	slopeyieldaa	Slopeyielda	slopeyieldbbb	curvatureyieldaa	curvatureyielda	curvatureyieldbbb
MROrate	0.994***	1.027***	0.900***	-0.100***	-0.0820***	0.101***	-0.0105**	-0.0277***	0.0934***
	(0.0325)	(0.0383)	(0.0411)	(0.00801)	(0.00943)	(0.0220)	(0.00409)	(0.00456)	(0.0217)
PSPP	-69.27***	-71.18***	-75.78***	-9.147**	-9.816**	-0.116	0.234	-5.634***	-0.916
	(13.01)	(14.57)	(15.89)	(4.169)	(4.536)	(7.877)	(1.194)	(1.419)	(7.056)
CSPP	-43.46***	-33.48***	-88.61***	-30.62***	-7.156	-32.37***	10.81***	-9.018***	-26.20**
	(6.143)	(8.445)	(7.750)	(3.064)	(6.035)	(9.142)	(0.890)	(2.779)	(11.68)
GDP	-0.152***	-0.238***	-0.251***	-0.0804***	-0.0316***	-0.0314**	0.00989***	-0.00534	0.0952***
	(0.0261)	(0.0314)	(0.0304)	(0.00670)	(0.00759)	(0.0137)	(0.00312)	(0.00429)	(0.0147)
absdevcpi	-0.0241	-0.0104	-0.176***	-0.157***	-0.0861***	0.255***	0.00649	0.0461***	0.203***
	(0.0565)	(0.0656)	(0.0611)	(0.0165)	(0.0191)	(0.0348)	(0.00619)	(0.00828)	(0.0363)
eurostoxx50	-0.927**	-1.810***	-3.704***	-0.803***	-0.567***	1.770***	0.316***	0.125**	0.580**
	(0.419)	(0.544)	(0.540)	(0.0920)	(0.103)	(0.242)	(0.0474)	(0.0562)	(0.246)
caputil	2.575	-4.457	3.576	8.017***	3.425**	8.858***	-2.601***	-1.463***	-0.650
	(4.190)	(5.645)	(5.356)	(1.000)	(1.462)	(2.018)	(0.681)	(0.467)	(1.377)
recession	11.00	28.94**	48.98***	1.003	7.728***	-4.211	0.724	9.720***	0.536
	(8.974)	(11.35)	(10.82)	(2.071)	(2.717)	(5.425)	(1.163)	(1.356)	(5.998)
Constant	166.6***	210.3***	309.1***	118.1***	109.3***	44.75***	-1.264	4.087***	-51.99***
	(8.326)	(10.24)	(9.606)	(1.890)	(2.473)	(5.553)	(1.064)	(1.123)	(5.560)
Observations	4,471	4,471	4,471	4,471	4,471	4,471	4,471	4,471	4,471

Table 4: The relation between credit spreads for corporate bonds and monetary policy

Table 2 presents the results from the regressions for each dependent variable concerning the corporate bond spreads (including level, slope and curvature for the three ratings AA, A and BBB). The regression uses the Newey-West standard error estimator to adjust for heteroscedasticity and autocorrelation. When using a Newey-West estimator one is required to set an appropriate number of lags, the chosen number is 8 (see section 4.4 for further motivation). The independent variables used are the representatives for monetary policy (*MROrate* presenting the interest rates and the two variables *PSPP* and *CSPP* representing QE). Included in the regressions are also the control variables (*GDP, absdevcpi, eurostoxx50, caputil* and *recession*). *GDP* is the GDP growth. *absdeccpi* is the absolute deviation from the target inflation of 2%. *eurostoxx50* is the representative for the stock market performance. *caputil* is the capital utilization variable used to capture the effects of economic slack. *recession* is the representative for times of crisis. The PSPP and the CSPP are dummies that corresponds to 1 during the period that respective programme is active and 0 when they are not. The crisis variable (*recession*) is also a dummy that is equal to 1 during the recessions and 0 at all other times. Remaining variables are presented in basis points. The Newey-West estimated standard errors are presented in parenthesis. The statistical significance levels are presented as follows: *** denotes p<0.01, ** p<0.05 and * p<0.10.

	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
VARIABLES	levelspreadaa	levelspreada	levelspreadbbb	slopespreadaa	slopespreada	slopespreadbbb	curvaturespreadaa	curvaturespreada	curvaturespreadbbb
MROrate	-0.0805***	-0.0482*	-0.175***	-0.00288	0.0155*	0.199***	-0.00847**	-0.0257***	0.0955***
	(0.0185)	(0.0258)	(0.0297)	(0.00525)	(0.00798)	(0.0238)	(0.00422)	(0.00528)	(0.0213)
PSPP	-27.92***	-31.70***	-34.43***	0.612	-0.0580	9.642	-2.263**	-8.132***	-3.413
	(6.796)	(8.884)	(10.48)	(1.748)	(2.533)	(7.706)	(1.097)	(1.819)	(7.328)
CSPP	-14.29***	-19.05***	-59.44***	-3.583**	19.88***	-5.334	4.087***	-15.74***	-32.92***
	(3.919)	(5.557)	(6.495)	(1.683)	(5.148)	(9.757)	(0.659)	(2.805)	(11.78)
GDP	-0.0386***	-0.123***	-0.137***	-0.00891**	0.0399***	0.0401***	-0.0106***	-0.0258***	0.0747***
	(0.0128)	(0.0186)	(0.0186)	(0.00431)	(0.00602)	(0.0140)	(0.00337)	(0.00523)	(0.0138)
absdevcpi	0.0953***	0.121***	-0.0566	0.0314***	0.102***	0.443***	-0.0394***	0.000219	0.157***
	(0.0300)	(0.0421)	(0.0401)	(0.00898)	(0.0155)	(0.0380)	(0.00613)	(0.0107)	(0.0351)
eurostoxx50	-1.714***	-2.634***	-4.491***	-0.0835	0.152*	2.490***	0.164***	-0.0268	0.428*
	(0.250)	(0.390)	(0.395)	(0.0552)	(0.0852)	(0.265)	(0.0493)	(0.0657)	(0.238)
caputil	-5.454**	-12.48***	-4.454	4.067***	-0.526	4.907**	-1.449**	-0.310	0.503
	(2.685)	(4.179)	(3.884)	(0.558)	(1.289)	(2.161)	(0.700)	(0.557)	(1.359)
recession	53.98***	71.54***	91.97***	21.12***	27.84***	15.91***	-5.899***	3.097*	-6.087
	(5.458)	(8.059)	(8.076)	(1.618)	(2.573)	(6.152)	(1.233)	(1.753)	(5.709)
constant	59.79***	102.7***	202.4***	13.90***	5.156**	-59.43***	10.16***	15.51***	-40.57***
	(4.866)	(7.081)	(7.196)	(1.296)	(2.432)	(6.271)	(1.054)	(1.439)	(5.309)
Observations	4,471	4,471	4,471	4,471	4,471	4,471	4,471	4,471	4,471

6 Conclusion

6.1 Discussion

The analysis conducted in this paper shows a clear link between the European corporate bond market and the monetary policy decisions made by ECB. The results indicate the most universal effect on yield and spread levels. The effect on the slopes and curvatures of the curves is more varied making it less certain and in some cases the magnitude of the effect is very low rendering the result less relevant.

The effect of the MRO interest rate on yield and spread levels is reverse – while a lower interest rate pushes yields down, it drives spreads up. The credit spread can be seen to account for default risk, loss given default and also investor risk aversion (Amato, 2005), the higher spread level could indicate the increase of one or many of these in case of lower interest rates. Longstaff and Schwartz' (1995) model implies that this movement is because of a increased default risk. Due to our study isolating different credit ratings that represent a measurement for the default risk of the corporations, we can theorise that the reason for this effect could be a heightened investor risk aversion. Central banks set interest rates low when inflation is too low (indication of recession and economic downturn), therefore this could also be a signal of more risk aversion after crises. Another reason could be that the availability of cheaper financing for corporations could be seen by the investors as a risk for future higher leverage and higher default risk (Amato, 2005).

The correlation of PSPP and CSPP with both yield and spread levels is negative. This in part supports the findings of Joyce, Tong and Woods (2011) research on the UK market as it concluded lower yield levels, but stable credit spread levels as a result of QE. The negative correlation with spreads would mean that the programmes are reducing the risk premium investors require. PSPP has a direct demand-supply effect on government bonds as demand increases dramatically with a colossal buyer entering the market, driving up the prices. In this situation getting any reasonable return on low risk government bonds is not feasible, which could in turn drive up the demand on the corporate bond market. The effect on spread is around 25-50% of the effect on yield for all credit ratings, supporting the notion that overall the programme influences the corporate yield curve from two different aspects – reducing the risk-free rate as well as the credit spread.

CSPP has a direct effect on the European corporate bonds we are examining. As the programme allows for purchases of any non-financial investment grade euro-denominated bonds with more than 1 year left until maturity that have been issued by corporations incorporated in the Eurozone (European Central Bank, 2016a), many of the underlying bonds included in the iBoxx indices of our dataset are eligible. This impacts the demand for these bonds directly as the market is relatively small and illiquid, driving up the prices. For CSPP over half of the effect on yield curve levels can be contributed to the effect of credit spreads for A- and BBB-rated bonds, indicating the demand shift is affecting the risk premium investors are able to acquire. This supports Collin-Dufresne, Goldstein and Martin's (2001) findings that the corporate bond spreads are impacted by the market's own demand (and supply) shocks.

The effect of monetary policy on slopes and curvatures of yield and spread curves is less clear. The MRO rate has a clear positive effect on both the yield and spread curve slope and curvature for the lower rated (BBB) bonds, however it has a negative effect on the higher rated bonds. This indicates that the yield (and spread) curve become steeper and less convex for higher rated bonds in case of lowered interest rates, while the opposite happens for lower ratings. Such movements imply that the perceived short term and long term risk converge for lower rated bonds in times of expansionary monetary policy and by taking into account the lower level as well we can conclude that it is the long end of the curve where the risk premium is lowered. This could be due to heightened demand on the lower rated investment grade bonds due to a "search for yield" in addition to "flight to safety". Another reason could be based on the exact bonds and maturities ECB is purchasing under both PSPP and CSPP, however the information on the purchases is limited and therefore we are unable to make certain conclusions about this theory.

Policymakers agree that the low yield environment that has resulted from ECB's expansionary monetary policy offers corporations cheaper funding, which has lead to notable growth of the European corporate bond market. They also note the value of this option considering that bank lending has been severely impacted by the crises (European Commission, 2016). Lowered yields and credit spreads, however, raise worries about investor returns, especially for institutional investors like pension funds and insurance companies who are likely to "buy and hold" investment grade corporate bonds for steady certain returns. IMF has stated: "Low interest rates add to the legacy challenges facing many insurance companies and pension funds, along with those from ageing populations and low or volatile asset returns. Heightened concern over these important long-term saving and investment institutions could encourage even greater saving, adding to financial and economic stagnation pressures." (IMF, 2016). Investment strategies have to be adjusted to take this into account, though reports do not show a clear universal shift in strategy in pension fund asset allocations and changes vary by country (OECD, 2015).

6.3 Limitations

When interpreting the results of this paper, caution should be taken due to a few possible concerns. A potential problem with the model is the possibility of omitted macroeconomic variables that might impact the corporate bond market leading to the results being biased.

Further, the PSPP and CSPP are presented as dummy-variables which could also be a cause for concern as the variables do not take into account different shifts and magnitudes in the programme, but only if they are active or not. This renders our analysis of QE less nuanced. Another predicament with the dummies is that there could potentially be other events happening during the same period of time that affect the corporate bond markets. Hence, there is a risk that the effects implied by the regressions are a consequence of other events taking place during the same period as the QE programmes are active.

6.4 Future Research

Our findings provide an initial framework for further studies into the effect of ECB's monetary policy and nonconventional mechanisms on the corporate bond market. As this study has been conducted during a time period when ECB's Asset Purchase Programme is still active, we look forward to seeing studies on the long term effect of QE once the programme has concluded. We also think it would be interesting to study the long term impact of the sub-zero interest rates on the financial markets. Furthermore, as we have only studied the investment grade corporate bond market, the effect of ECB's monetary policy on the high yield corporate bond market could be researched.

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Appendix A: Results from the Breusch-Pegan tests

Table 5: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the yield level for AA rated bonds (*levelyieldaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession*.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelyieldaa

         chi2(1)      =     3.52
         Prob > chi2  =   0.0608
```

Table 6: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the yield level for A rated bonds (*levelyielda*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession*.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelyielda

         chi2(1)      =    33.14
         Prob > chi2  =   0.0000
```

Table 7: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the yield level for BBB rated bonds (*levelyieldbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession*.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelyieldbbb

         chi2(1)      =    16.12
         Prob > chi2  =   0.0001
```

Table 8: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the yield curve for AA rated bonds (*slopeyieldaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession*.

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopeyieldaa

         chi2(1)      =    15.20
         Prob > chi2  =   0.0001
```

Table 9: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the yield curve for A rated bonds (*slopeyielda*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopeyielda

         chi2(1)      =     1.59
         Prob > chi2  =   0.2074
```

Table 10: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the yield curve for BBB rated bonds (*slopeyieldbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopeyieldbbb

         chi2(1)      =   235.99
         Prob > chi2  =   0.0000
```

Table 11: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the yield curve for AA rated bonds (*curvatureyieldaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvatureyieldaa

         chi2(1)      =    54.02
         Prob > chi2  =   0.0000
```

Table 12: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the yield curve for A rated bonds (*curvatureyielda*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvatureyielda

         chi2(1)      =    58.89
         Prob > chi2  =   0.0000
```

Table 13: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the yield curve for BBB rated bonds (*curvatureyieldbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvatureyieldbbb

         chi2(1)      =    74.03
         Prob > chi2  =   0.0000
```

Table 14: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the credit spread level for AA rated bonds (*levelspreadaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelspreadaa

         chi2(1)      =   1058.32
         Prob > chi2  =    0.0000
```

Table 15: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the credit spread level for A rated bonds (*levelspreada*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelspreada

         chi2(1)      =    997.06
         Prob > chi2  =    0.0000
```

Table 16: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the credit spread level for BBB rated bonds (*levelspreadbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of levelspreadbbb

         chi2(1)      =     38.58
         Prob > chi2  =    0.0000
```

Table 17: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the credit spread curve for AA rated bonds (*slopepreadaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopespreadaa

         chi2(1)      =  1152.72
         Prob > chi2  =   0.0000
```

Table 18: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the credit spread curve for A rated bonds (*slopepreada*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopespreada

         chi2(1)      =   918.16
         Prob > chi2  =   0.0000
```

Table 19: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the slope of the credit spread curve for BBB rated bonds (*slopepreadbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of slopespreadbbb

         chi2(1)      =    18.73
         Prob > chi2  =   0.0000
```

Table 20: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the credit spread curve for AA rated bonds (*curvaturepreadaa*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvaturespreadaa

         chi2(1)      =    33.97
         Prob > chi2  =   0.0000
```

Table 21: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the credit spread curve for A rated bonds (*curvaturepreada*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvaturespreada

         chi2(1)      =   796.96
         Prob > chi2  =   0.0000
```

Table 22: The table presents the results generated by STATA for the Breusch-Pegan test for heteroscedasticity. The dependent variable of interest is the curvature of the credit spread curve for BBB rated bonds (*curvaturepreadbbb*). The independent variables used are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

```
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of curvaturespreadbbb

         chi2(1)      =    64.08
         Prob > chi2  =   0.0000
```

Appendix B: Results from the VIF-tests

Table 23: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is yield level for AA bonds (*levelyieldaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 24: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the yield level for A bonds (*levelyielda*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 25: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the yield level for BBB bonds (*levelyieldbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 26: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the yield curve for AA bonds (*slopeyieldaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 27: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the yield curve for A bonds (*slopeyielda*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 28: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the yield curve for BBB bonds (*slopeyieldbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 29: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the yield curve for AA bonds (*curvatureyieldaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 30: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the yield curve for A bonds (*curvatureyielda*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 31: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the yield curve for BBB bonds (*curvatureyieldbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 32: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the credit spread level for AA bonds (*levelspreadaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 33: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the credit spread level for A bonds (*levelspreada*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 34: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the credit spread level for BBB bonds (*levelspreadbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 35: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the credit spread curve for AA bonds (*slopespreadaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 36: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the credit spread curve for A bonds (*slopespreada*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 37: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the slope of the credit spread curve for BBB bonds (*slopespreadbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 38: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the credit spread curve for AA bonds (*curvaturespreadaa*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 39: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the credit spread curve for A bonds (*curvaturespreada*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Table 40: Test results from the VIF-test for multicollinearity generated by STATA. The dependent variable used in the test is the curvature of the credit spread curve for BBB bonds (*curvaturespreadbbb*) and the independent variables are *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Variable	VIF	1/VIF
PSPP	3.02	0.330823
GDP	2.52	0.397114
MROrate	2.45	0.407448
caputil	1.94	0.516520
eurostoxx50	1.83	0.546911
absdevcpi	1.83	0.547652
CSPP	1.66	0.604033
recession	1.47	0.679970
Mean VIF	2.09	

Appendix C: Results from the Durbin-Watson tests

Table 41: The table shows the results from the Durbin-Watson test for autocorrelation. When constructing the test respective dependent variable is regressed with the following independent variables; *MROrate*, *PSPP*, *CSPP*, *GDP*, *absdevcpi*, *eurostoxx50*, *caputil* and *recession.*

Dependent variable	**Durbin-Watson d-statistic**
levelyieldaa	0.008455
levelyielda	0.007328
levelyieldbbb	0.008525
slopeyieldaa	0.020899
slopeyielda	0.012294
slopeyieldbbb	0.018778
curvatureyieldaa	0.027402
curvatureyielda	0.029820
curvatureyieldbbb	0.014028
levelspreadaa	0.010151
levelspreada	0.008639
levelspreadbbb	0.011311
slopespreadaa	0.058303
slopespreada	0.024347
slopespreadbbb	0.020198
curvaturespreadaa	0.069874
curvaturespreada	0.043606
curvaturespreadbbb	0.015787