The effect of the latest asset purchase program by the ECB on the European corporate bond market: evidence from a difference-in-difference approach.

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Abstract

This paper analyses the effect of the latest asset purchase program by the ECB on the yield to maturity of European corporate bonds with a BBB- and BB+ credit rating. This is done by using a difference-in-difference approach. We run multiple regressions where the bonds are divided into several subgroups, according to their geographical habitat. First, the yield to maturity of BB+ bonds is significantly higher than the yield to maturity of BBB- bonds in both periods. Moreover, evidence is found that a substitution effect is present between the bonds in some regressions (company size & South). Moreover, the overall decline in yield to maturity is higher for bonds with a BB+ rating than for bonds with a BBB- rating following the latest asset purchase program, i.e. the BB+ bonds decline more than BBB- bonds over the two time periods (before and after the start of the APP).

1. Introduction

In a time where the European economy is still 'recovering' from the credit crisis, financial institutions are trying to reacquire liquidity to renew confidence in the credit market. In order to acquire liquidity the banks need buyers for their assets. Because at times of downfall the credit market collapses. The demand for bank assets is low, no financial institution wants to buy these assets anymore. The European Central Bank (ECB) is such a buyer the banks need. In financial distress one option is to set their loan rate to zero, this means that financial institutions can lend 'freely' from the ECB. Gerlach & Lewis explore this interest rate policy in their paper, describing the policy as cutting interest rates to the zero lower bound (Gerlach & Lewis, 2013). Moreover, the ECB tries to stimulate the price level (inflation) with their monetary policy. A stable inflation over time encourages economic growth. However, the average inflation level in Europe is close to zero. In most European countries there is even negative inflation (deflation). This deflation impedes economic growth, because when prices are declining the gross domestic product (GDP) is declining too. And when GDP is declining, salaries have to be cut to account for this loss. So deflation causes a downturn in economic growth. The primary objective of the ECB is price stability (ECB, 2006). When prices are stable, economic growth can be sustained.

The goal of the ECB is to hold inflation close to two percent. The ECB has different 'techniques/monetary instruments' in times of rise and downfall of the economy to achieve this goal. When the economy is in a downfall the ECB tends to widen the money market and to tighten it when it is in an upturn. One of these 'monetary instruments' is to conduct open market operations (ECB, 2006).

One of these open market operations is to buy assets (bond/securities) to 'pump' money into the market. The ECB decided on 4 September 2014 to start an asset-backed securities purchase program (ABSPP) and a covered bond purchase program (CBPP3). These securities and bonds are often covered by collateral to secure a part of their investment in case the borrower defaults. Only asset-backed securities (ABS) with a second-best credit assessment of at least CQS3 (BBB-, Baa3, BBBI) are eligible (ECB, 2014). More precise, the ECB buys only assets with an investment grade, i.e. assets with low to moderate credit risk. Later in January of 2015 the ECB expanded these programs with a public sector purchase program (PSPP). All of these operations combined is named the expanded asset purchase program (APP) (ECB , 2015). The APP began on 9 March 2015. Until at least March 2017 the ECB will buy assets monthly from euro area central governments, agencies and European institutions. These assets are worth up to 60 to 80 million euro each month. The eligible marketable assets of the ECB are divided in several asset classes. Central government securities are their main asset class followed by (un)covered bank bonds and corporate bonds. The paper focuses only on corporate bonds. This raises the question how the intervention of the ECB influenced the corporate bond market and how demand and supply of corporate bonds changes. To examine this we use a difference in difference method. Moreover, to limit and specify the research, only corporate bonds with a BBB- and a BB+ credit rating are investigated. BBB- bonds are in the treatment group, because the ECB buys these bonds. BB+ bonds are in the other group, the control group, because these bonds are not directly affected by the intervention. We use BBB- and BB+ bonds, because they are closely related. One can verify that BB+ bonds are one grade lower than the BBB- bonds, i.e. the credit risk is close to each other (Appendix 1). However, bonds with a BBB- rating does have an investment grade while bonds with a BB+ rating do not, which makes the BB+ bonds (slightly) riskier than the BBB- bonds.

Furthermore, we assume that the yield to maturity of BBB- bonds will decline and the yield to maturity of BB+ bonds to remain at least equal over the period as the BB+ bonds are not directly affected.

Moreover, in a downfall of the economy it is more likely that the amount of bonds issued will be less than in an upturn of the economy. When the ECB announces the program, however, we assume that the demand for bonds with a BBB- rating will rise. Moreover, the demand of BB+ bonds may decline indirectly. Due to the rise in demand the price of BBB- bonds rise hence the yield to maturity declines (see formula page 9), which makes it more appealing for investors. In the remainder of the section a decline or rise of the yield to maturity is explained more precise. Furthermore, the BBB- bonds and BB+ bonds are only one grade separated, thus close substitutes, this may cause the demand for BB+ bonds to decrease as investors may swap to the BBB- bonds. The decrease in demand lowers the price hence higher the yield after intervention of BB+ bonds. The effect described above is named the substitution effect. This effect is assumed to be present in our findings.

This leads us to the following research question:

'Does implementation of the APP on 9 March 2015 by the ECB effect the yield to maturity of corporate bonds with a BBB- rating more than that of corporate bonds with a BB+ rating in Europe?'

With more we mean that either the yield of maturity of BBB- bonds decline while the yield to maturity of BB+ bonds remains the same, the yield to maturity of both BBB- and BB+ bonds decline but the decline is higher for BBB- bonds, or the yield to maturity of BBB- bonds decline while the yield to maturity of BB+ bonds rise. In the latter we obtain the substitution effect. In the remainder of the section the substitution effect is described more intensive from the yield to maturity formula point of view (page 9).

To examine the effect we will use the same difference in difference method as described in the paper by Ongena et al. (2012). In this paper they explore how a change in Swedish law affects loan terms, access to credit and bank monitoring. They find that borrowers pay a higher interest rate after the change. One difference is that we focus on corporate bonds. We ought to analyze how ECB policy effects the yield to maturity of corporate loans.

We control for credit rating. The method is explained further in the data and methodology section.

The following sub partial hypothesis is drawn to give robustness to the research question:

Hypothesis 1: 'The yield to maturity of corporate bonds with a BBB- credit rating decreases while the yield to maturity of corporate bonds with a BB+ credit rating increases following the APP intervention of the ECB. '

The results of the regressions will indicate whether or not the APP of the ECB captures the presence of the substitution effect. We assume that the demand for BBB- bonds will rise after the implementation because of the announcement. When demand increases and supply remains the same the price goes up. One can see in the formula of the yield to maturity on page 9 that the numerator goes down (market price ↑) and the denominator goes up (market price ↑), hence the yield to maturity decreases. For the BB+ bonds, however, we expect that the demand goes down and supply to remain equal, because the bonds are close substitutes. When demand decreases and supply remains equal the price goes down. As one can see, the numerator goes up (market price↓) while the denominator goes down (market price ↓) hence the yield to maturity is expected to increase. In short, we expect that the hypothesis is accepted.

The remaining sections of our paper proceed as follows, in section 2 the related literature is reviewed. In section 3 we discuss the data and methodology. The methods used in this paper are outlined. Moreover, the choice which data we use is explained. Which corporate bonds are useful to our research and which are excluded from our dataset? In section 4 we present the findings of our analyses of the effects of ECB policy on non- and investment graded corporate bonds (BBB- and BB+). In section 5 we summarize and conclude. Moreover, we discuss short comings of the paper and further research.

2. Literature review

In this section we discuss the literature related to our paper. The literature helps us to provide a base of information of the effects of asset purchase programs on (corporate) bonds. There are a limited number of papers investigating the effect of *'quantative easing'* on bonds. One of these papers is the paper by Krishnamurthy & Vissing-Jorgensen[1] (2011). Krishnamurthy & Vissing-Jorgensen (2011) analyze the effect of *'quantative easing'* by the Federal Reserve Bank in 2008-2009 and 2010-2011 on long-term treasuries and other long-term bonds. They find strong evidence that '*quantative easing'* in the US lowered nominal interest rates on Treasuries, Agencies, corporate bonds and mortgage-backed securities (Krishnamurthy & Vissing-Jorgensen, 2011). Furthermore, Krishnamurthy & Vissing-Jorgensen (2011) obtain that the level in which the lowering of the nominal interest rates occurred differed across the bonds, maturities and the two periods QE1 and QE2. They claim that there are several channels for these effects. There are some channels which directly affected corporate bonds. The default risk channel lowered the yield on corporate bonds, while a signaling channel drove down the yield on all bonds (Krishnamurthy & Vissing-Jorgensen, 2011). Gagnon et al.[2] (2011) explains how the LSAP's of 2008-2009 was implemented and how the program affected the economy (Gagnon, Raskin, Remache, & Sack, 2011). They found evidence that the LSAP's of 2008-2009 led to reductions in the longer term interest rates of securities (Gagnon, Raskin, Remache, & Sack, 2011).
The reduction in supply of the riskier longer-term assets reduced the required risk premium (Gagnon, Raskin, Remache, & Sack, 2011). The lowering in risk premium due to the reduction in supply caused the yield to drop too. Furthermore, the yield of securities that were not included also dropped. Moreover, they examine the effects of LSAP's in the UK and Japan. They obtain that the effects are similarly to that of the US. The reduction in yields is in line with the findings of Li & Wei[3] (2013). Li & Wei (2013) made a term structure model with supply factors to estimate the combined effect of the Large-Scale Asset Purchase programs (LSAPs) on Long term treasury yields.

[1] Krishnamurthy, A., & Vissing-Jorgensen, A. (2011). *The effects of quantitative easing on interest rates: channels and implications for policy* (No. w17555). National Bureau of Economic Research.
[2] Gagnon, J., Raskin, M., Remache, J., & Sack, B. (2011). The financial market effects of the Federal Reserve's large-scale asset purchases. *International Journal of Central Banking*, *7*(1), 3-43.
[3] Li, C., & Wei, M. (2012). Term structure modelling with supply factors and the Federal Reserve's Large Scale Asset Purchase programs. *Available at SSRN 2082112*.

They find that the combined effect of the LSAPs resulted into a significant reduction in the yield of long term Treasuries. D'Amico and King[4] (2013) define this effect as a 'local supply' effect in the Treasury term structure: 'the yield of a bond fell in response to purchases of that security and securities of similar maturity (D'Amico & King, 2013) However, the paper by Stroebel & Taylor[5] (2009) suggests that the contribution of the program to the decline in yield of mortgage backed securities (MBS) in 2008-2009 is statistically insignificant/small when controlled for simultaneous changes in prepayment and default risks (Stroebel & Taylor, 2009). Furthermore, Gilchrist & Zakrajsek[6] (2013) investigate the same Large Scale Asset Purchase progams (LSAPs) of the FED but then the effect on corporate credit risk. Gilchrist & Zakrajsek (2013) thus only focuses on the default risk channel. They found that the overall level of credit risk in the economy was lowered by the policy (Gilchrist & Zakrajsek, 2013). Moreover, for both investment- and speculative-grade corporate credits the policy announcements led to a significant reduction in the cost of insuring against defaults (Gilchrist & Zakrajsek, 2013). Furthermore, Joyce et al.[7] (2011) pledge in their paper about *'quantative easing'* by the Bank of England that the effect of '*quantative easing'* is difficult to isolate, because of other policy measures and economic developments (Joyce, Lasaosa, Stevens, & Tong, 2011). However, in their findings they suggests that the asset purchase program had a significant impact on the financial market as a whole. Moreover, they examine the impact on asset prices right after a QE announcement. Furthermore, there has been research by Schwaab & Eser[8] (2013) on the Securities Markets Program (SMP) by the ECB in five euro area sovereign bond markets during 2010-2011 (Schwaab & Eser, 2013). These five euro areas are Portugal, Ireland, Italy, Greece and Spain (PIIGS). These five countries have relatively the most debt in Europe. In our research we will check for these countries too as we divide the bonds in subgroups on their geographical location. Schwaab & Eser (2013) conclude that in all of these markets the asset purchase had an impact on the yield of the bonds.

[4] D'Amico, S., & King, T. B. (2013). Flow and stock effects of large-scale treasury purchases: Evidence on the importance of local supply. *Journal of Financial Economics*, *108*(2), 425-448.
[5] Stroebel, J. C., & Taylor, J. B. (2009). *Estimated impact of the Fed's mortgage-backed securities purchase program* (No. w15626). National Bureau of Economic Research.
[6]Gilchrist, S., & Zakrajšek, E. (2013). The Impact of the Federal Reserve's Large-Scale Asset Purchase Programs on Corporate Credit Risk. *Journal of Money, Credit and Banking*, *45*(s2), 29-57.
[7] Joyce, M., Lasaosa, A., Stevens, I., & Tong, M. (2011). The financial market impact of quantitative easing in the United Kingdom. *International Journal of Central Banking*, *7*(3), 113-161.
[8] Eser, F., & Schwaab, B. (2013). Assessing asset purchases within the ECB's securities markets programme.

The effect varies from approximately -1 to -2 basis points (Italy) up to -17 to -21 basis points (Greece) at a five year maturity per €1 bn of purchases across these countries (Schwaab & Eser, 2013). We will contribute to these findings by investigating the latest large-scale asset program of the ECB in 2015/2016. Moreover, we will investigate the effect for all bond markets in Europe instead of only the PIIGS countries. However, as mentioned earlier we will regress on geographical location including the PIIGS countries.

To conclude this section we discussed the related literature. There are a limited number of papers which describes several effects of asset purchase programs, both in the US and Europe, on the financial market. We will investigate if the APP of the ECB holds the same decline in yield to maturity for the BBB- bonds. Moreover, we examine the effect of the APP on the yield of maturity of BB+ bonds. Next the data and methodology of the paper is discussed.

3. Data & Methodology

The data for our research is retrieved from the Bloomberg financial database. The terminal provides all kinds of financial data. It includes all sorts of bonds and equities. In our unbalanced dataset we excluded all matured corporate bonds which means that we only use corporate bonds which are still active in the Euro zone. The time period used in the sample is 2 March 2015 till 16 March 2015. We examine this time period, because the APP started on 9 March 2015. The time period of 2 weeks is observed instead of just 1 day before and 1 day after, because the European bond market needs time to adjust to the shift.

Before we explain why the yield to maturity is used, we first need to explain what the yield to maturity is, express the formula and define concepts related to the yield to maturity and corporate bonds in order to give a broader view.

The following concepts/variables are defined:

- **Ask yield to maturity**: The ask yield to maturity is described as a composite bond rate. It contains the total return if the bond is held to the end of the lifetime/maturity. The variables which determines the yield to maturity are the market price, coupon rate, par value and maturity. In our sample we have the ask

yield to maturity and the bid yield to maturity. We use the ask yield to maturity instead of the bid yield maturity, because the ask maturity is the least return one wants to have in order to sell the bond. These are all historical end of day total returns. The formula for the yield to maturity is described as: $YTM = \frac{Coupon + \frac{Par\ value - Market\ price}{\#\ of\ Years\ to\ Maturity}}{\frac{Par\ value + Market\ price}{2}}$

- **Ask and bid price:** The ask price is the lowest price for one bond for which a seller wants to sell and the bid price is the highest price for one bond for which a buyer wants to buy.
- **Par value:** The nominal or par value is the value a bond has when the bond is first emitted, i.e. the book value. The coupon rate is based on this nominal value.
- **Coupon rate:** The annual payments to the lender by the borrower. These payments are an amount of the par value of the bond as described above.
- **Collateral:** If a bond is collateralized it means that a bond has security in the form of assets when the financial institution defaults. They obtain the ownership of the assets when the financial institution defaults.
- **Seniority:** The rank in which owners of a bond are repaid when the financial institution defaults. If a debtor is senior they will be repaid earlier than a junior. The seniority correlates with collateral. When a debtor has a senior secured bond they will obtain their money back first. If a debtor has a unsecured junior bond they are the last to obtain a part of the amount back.
- **Maturity:** The lifetime/expiration of the bond.

Later on in this section the descriptive statistics of only the variables yield to maturity and maturity in years are shown. This is because first the ask and bid price, par value and coupon rate are already captured in the yield to maturity or maturity in years. Secondly, seniority and collateral are cardinal and can only be ranked, which indicates that the descriptive statistics of these variables are not representative relative to the other variables, yield to maturity and maturity in years.

The yield to maturity is used, because the yield to maturity is the total return of a bond when held to the end of its lifetime. It takes all variables into account, respectively the price, coupon rate and par value, which makes it a better estimator than price, par value and coupon rate individually. Moreover, we use the yield to maturity as it accounts for the maturity of a bond, because in the sample the maturity in years is very variant. We retrieved the average yield to maturity by calculating the average over the historical end of day yields before and after 9 March for each bond, i.e. the average is taken over the yield observations from 2,3,4,5,6 March (t=0) and 10,11,12,13,16 March (t=1). T=0 is thus the period before the implementation and t=1 is the period after the implementation of the program. So we define an observation in the sample as a bond, BBB- or BB+, with either the average yield to maturity before or after implementation.

Moreover, as described earlier the bonds are divided into two different credit rating classes (BBB- and BB+). The one we use in our treatment group for our difference in difference method are logically the corporate bonds with a BBB- rating, because the ECB only buys assets with this credit rating. We want to analyze the effect of ECB policy on the corporate bonds with this credit rating. We assume that the yield of corporate bonds with a BBB- rating declines after the implementation, because the demand for the BBB- rise. When the demand rises and the bonds are bought the price of the bonds become higher and more stable, i.e. the yield to maturity goes down.

On the other hand, bonds with a BB+ rating are in the control group. We choose bonds with a BB+ rating over a CCC+ for example, because the BB+ does not differ much in credit risk from the BBB- rating while CCC+ bonds do. The BB+ bonds are just one grade lower in credit rating (see appendix 1), while CCC+ bonds are three grades lower. BB+ have only substantial risk, while CCC+ bonds have very high credit risk. BB+ bonds are thus better substitutes for BBB- bonds than CCC+ bonds.

The S&P credit rating index is used to divide the bonds into credit rating classes. However, one of the shortcomings of using S&P as the only credit rating index is that Bloomberg, Fitch and Moody's rate some bonds differently. This holds for example, that a certain corporate bond could be BB+ rated by S&P, but BBB- rated by Moody's.

However, the number of bonds are too limited when we account for all indices. In our sample, there are 308 corporate bonds with a BBB- rating and 153 corporate bonds with a BB+ rating.

The total number of bonds in the sample is 461, which are distributed over a total of 103 companies and 12 countries. The number of observations in the sample is the number of bonds observations times two as the bonds have an average yield observation before and after the APP, as described earlier in this section. How many companies and bonds there are for each country in the sample can be obtained in appendix 2.

To expand the research we also compare and divide the bonds on country to run multiple regressions. The two groups are divided in their geographical location (North,Mid,South,East or West), with these geographical locations also divided in economical environment (PIIGS) and size (10+ companies). The PIIGS are the five countries with relative the most debt in Europe. These countries are: Portugal, Ireland, Italy, Greece and Spain. In our sample only Greece is missing. We assume that the effect of the APP is more present in these countries, as the ECB specially aimed these markets. Moreover, this is in line with the expectation that the effect on Southern Europe countries is higher, because 4 of the 5 countries of the PIIGS are located in Southern Europe.

Moreover, we check thus on size to see how the APP effects the yield to maturity of BBB- and BB+ bonds of the 'larger' countries in Europe. This holds that we regress on countries with more than 10 different companies in the sample of the two groups (BBB- and BB+) combined (10+ companies). One can see in Appendix 2C that these 'larger' countries are Germany, Spain, France, Italy and the Netherlands. In appendix 3 one obtains a table with the descriptive statistics (yield to maturity and maturity in years) ,overall and for the different subgroups.

Appendix 3A shows the descriptive statistics for both the treatment and control group and the total of the two with and without comparing/dividing by country/geographical location. The AVG YTM is the average yield to maturity of the observations, the observations captures the two different type of bonds and the two different time periods.

The descriptive statistics for the Maturity in years, the abbreviation for the maturity denoted in years, are shown in appendix 3B. One can verify that there are some outliers in the min/max of the maturity in years. However, these outliers do not have an effect on the yield to maturity itself. In the following part we discuss the differences between the descriptive statistics of the two bonds and the differences between the subgroups mutually.

First, we begin with the overall statistics, i.e. the statistics of the treatment and control group not divided in geographical location, thus the descriptive statistics of the whole sample. One finds these statistics in the row 'overall'. The difference in statistics of the treatment and control group of the overall group is that the mean of the BB+ bonds is 1,35 percent higher than the BBB- bonds. This difference fits the expectations and is explained by the investment grade. BB+ bonds have more credit risk than BBB- bonds, because BB+ do not have an investment grade, while BBB- does. Furthermore, the maturity of the BB+ bonds are about three years longer than the BBB- bonds (appendix 3B). In short, the statistics gives insight in the differences between the two groups in total. In the next part we discuss the (differences in) descriptive statistics for the subgroups.

We obtain the same as earlier in the overall descriptive statistics for the PIIGS, i.e. the mean and maturity is higher for the control group BB+ than for the treatment group BBB-. However, the total mean of the PIIGS are lower relative to the overall mean.
This is unusual as one expects that the risk premium should be higher for corporate bonds in the PIIGS countries. Moreover, the standard deviation when both groups are combined is high relative to the mean. Furthermore, the descriptive statistics for both groups divided in the countries with 10+ companies do not differ much from each other. The mean of the BB+ bonds are higher as expected. The mean of the treatment group is almost identical to the overall mean of the treatment group, respectively 1,20 and 1,26. Moreover, the maturity in years are almost the same too for both groups divided as bonds in countries with over 10 different companies. Now we move on to the difference between North and South.

First, the difference between the mean of the treatment and control group is large in the North group. The mean of the yield to maturity for the control group is above 3 percent, while the mean of the treatment group is 1,03. When we compare the total statistics of North with the overall group we obtain that the mean for the treatment and control group combined is higher than for the mean of the overall treatment and control group. Relative to the statistics of South we see that the mean of the control group for North is higher than South. The difference between the treatment group and control group for North is also large, especially when one compares this with the difference in statistics for the treatment and control group for South. The mean is only higher for the treatment group for South relatively to North.

When we look at the descriptive statistics of Mid, we obtain that the mean of the total is a few percentile points lower. For the control group the mean of North is considerably higher relative to Mid. On the other hand the mean of the treatment group is higher for Mid than for North and South. Moreover, compared to South the total mean for Mid is higher just as it was too for North. When compared the statistics of Mid to the 'overall' means we obtain that the mean of Mid is higher for all three means. Also the difference between the treatment and control of Mid mutually is very high, about 1,14 percentile point.

Furthermore, as mentioned above the descriptive statistics for Mid and North are higher than for South. Relative to the other subgroups the means between the control and the treatment group for South does not differ much, just about 0,37 percentile points. Moreover, the average yield to maturity for both groups is just over 1 percent. Later on in the results section, we will see if the same differences are present in the regressions of North and South.

Differences between West and East are that the descriptive statistics for East are higher than for West for the groups together and individually. However, the difference in mean between control and treatment group is higher for West than for East. The difference in mean between control and treatment group is 1,71 for West, while the difference in mean between control and treatment group is 1,3 for East. Moreover, one detail is that the mean of the control group is 3 percent. Furthermore, the mean of the maturity in years is very

large for the control group in East. This is because there is one outlier with a maturity of 100 years. We now discussed the difference in the descriptive statistics between the treatment and control group itself and for the groups and subgroups mutually. The difference gives an indication of possible effects.

In the remainder of this section we discuss the underlying methodology. As described earlier we use the same difference-in-difference method as Cerquero, Ongena & Roszbach (2012) and Elton, Gruber, Agrawal & Mann (1999). The difference-in-difference method is described as a method where two groups over two periods in time are compared, one period before an event and on one period after the event (Cerqueiro, Ongena, & Roszbach, 2012). The next figure simplifies the approach.

Figure 1

ECB APP

	Baseline	9-3-2015	Follow-up
Control	BB+ 2-6 March '15		BB+ 10-16 March '15
Treatment	BBB- 2-6 March '15		BBB- 10-16 March '15

The first group is directly affected by the intervention, this group is called the 'treatment' group. Our 'treatment' group consists of corporate bonds with a BBB- credit rating, because they are bought by the ECB. The bonds are directly affected by the intervention of the ECB. Moreover, we expect that this intervention has a direct effect on the dependable variable yield to maturity. As described earlier, we expect that the event has a negative relationship on the yield to maturity, i.e. the yield to maturity is expected to decline. This is pointed out more broadly in the regression part of this section. The other group is the 'control' group, this group consists of corporate bonds with a BB+ credit rating. This group is unaffected by the intervention as they are not bought by the ECB. The yield to maturity is expected to be the same over the two periods for this group. However, there may be an indirect effect of the intervention, the substitution effect as mentioned before in the last part of the introduction.

The substitution effect may be present because the demand for bonds with a BBB- credit rating rises after the announcement of the asset purchase program, while vice versa the demand for BB+ declines. The price for a BBB- bond rises because of the rise in demand, hence the yield goes down. On the other hand, the price of the BB+ bonds remain the same or drops hence the yield remains equal or goes up. This is because the bonds only differ in one credit grade, investors switch their interest to BBB- bonds, causing the demand for the BB+ bonds to decline.

To examine the direct and indirect effects described above the following regression formula is estimated:

$$y_i = \alpha + \beta 1 * \text{Time} + \beta 2 * \text{Treatment}_i + \beta 3 * (\text{Time} * \text{Treatment}) + \varepsilon_i$$

where Y_i is the depended variable yield to maturity, α is a constant. $_i$ is a subscript which refers to a bond observation (with either the average historical end of day yield before or after implementation of the APP) in the sample. The beta indicates the weight the variables have on the yield to maturity. Time and treatment are the two dummy variables, i.e. time and treatment take the value 0 or 1. The dummy variable time is 0 in the period before 9 march and 1 after 9 march. The dummy variable 'treatment' is 1 for bonds with a BBB- credit rating and 0 for bonds with a BB+ credit rating. Time times treatment is the interaction term.

This interaction term equals one when a bond has a credit rating of BBB- and is in the period after 9 march, i.e. the two terms interact. The ε_i stands for the error term. The average of the error term has to be zero, because the 'error term represents the combined effect of the omitted variables' (Schlaifer R, 2005). For the significance of the research one does not want that these omitted variables has a (indirect) effect on the dependent variable. Furthermore, in our difference-in-difference approach we are interested in the $\beta 3$ term. This $\beta 3$ represents the weight of ECB policy on the yield to maturity of corporate bonds with a BBB- credit rating, because one obtains $\beta 3$ when the equation of the difference-in-difference method in terms of the regression formula is solved. If $\beta 3$ is smaller than zero it means that ECB policy effects the yield of maturity of BBB- bonds more, i.e. the yield of maturity declines more when ECB policy is implemented, the yield to maturity of BBB- bonds decrease while the

yield to maturity of BB+ bonds remain the same or the yield to maturity of BBB- bonds decrease while the yield to maturity of BB+ bonds increase (substitution-effect).

In our difference in difference regression formula control variables are not included, as one does not expect that there are control variables that will influence the difference in yield to maturity between the control and treatment group before and after the intervention. This is because the time window between the period before and after the implementation is too short. Due to the short time window macroeconomic control variables will not have a substantial effect on the yield to maturity.

Moreover, the difference-in-difference approach does not account for any control variables as the approach only measures the effect an event has on and between two groups, a treatment and a control group. We do not believe that in this short time window control variables are capable of causing a difference in the corporate bond market. Moreover, the bonds do not differ much from each other. The effect of control variables will be the same, indicating that the effect will be offset by the difference in difference approach. So including a control variable to the regression will either not change the effect nor have an effect on the outcome variable y (yield to maturity). Definitely not in such extent that it should be included. However, to give power to the research we do run multiple regressions where we make a distinction between the so called PIIGS countries, the geographical location and size (countries which have more than 10 different companies in the sample) as mentioned earlier in the data/methodology section. In the next section we present and analyze the results of the regressions.

4. Results

In the next table the results of the difference-in-difference estimations are displayed, which have been made in order to see what the effects are of the APP on the corporate bonds with a credit rating of BBB- and BB+.

Tabel 1: **Difference in difference estimation results**

	Overall			**PIIGS**		
Outcome var.	Ytm	st. dev	T	Ytm	st. dev	T
Baseline (t=0)						
Control	2,561			2,317		
Treated	1,205			1,061		
Diff (T-C)	-1,356***	0,147	-9,23	-1,255***	0,188	-6,69
Follow up (t=1)						
Control	2,510			2,312		
Treated	1,182			1,028		
Diff (T-C)	-1,327***	0,147	-9,03	-1,284***	0,188	-6,85
Diff-in-Diff	0,029	0,208	0,14	-0,029	0,265	-0,11
	10+ Companies			**Mid**		
Outcome var.	Ytm	st. dev	T	Ytm	st. dev	T
Baseline (t=0)						
Control	1,466			2,663		
Treated	1,215			1,372		
Diff (T-C)	-0,25*	0,142	-1,76	-1,291***	0,261	-4,95
Follow up (t=1)						
Control	1,475			2,570		
Treated	1,185			1,364		
Diff (T-C)	-0,29**	0,142	-2,04	-1,206***	0,261	-4,62
Diff-in-Diff	-0,04	0,201	-0,2	0,085	0,369	0,23
	North			**South**		
Outcome var.	Ytm	st. dev	T	Ytm	st. dev	t
Baseline (t=0)						
Control	3,395			1,539		
Treated	1,036			1,135		
Diff (T-C)	-2,359***	0,332	-7,10	-0,404***	0,143	-2,82
Follow up (t=1)						
Control	3,313			1,612		

Treated	1,020			1,097		
Diff (T-C)	-2.293***	0,332	-6,90	-0,515***	0,143	-3,59
Diff-in-Diff	0,065	0,470	0,14	-0,111	0,203	-0,55

	West			**East**		
Outcome var.	Ytm	st. dev	T	Ytm	st. dev	T
Baseline (t=0)						
Control	2,361			2,998		
Treated	1,073			1,330		
Diff (T-C)	-1,289***	0,192	-6,7	-1,669***	0,235	-7,09
Follow up (t=1)						
Control	2,286			2,998		
Treated	1,068			1,290		
Diff (T-C)	-1,219***	0,192	-6,34	-1,519***	0,235	-7,26
Diff-in-Diff	0,07	0,272	0,26	-0,04	0,333	-0,12

* 10% Significance level, p<0,1 / ** 5% Significance level, p<0,05 / *** 1% Significance level, p<0,01

In the table above we find the results of the difference in difference estimations. We will discuss these results in this part of the section. First to give an understanding of the table the baseline (t=0) refers to the period before the implementation of the APP and the follow up (t=1) refers to the period after the implementation of the APP. In the ytm column the average yield to maturity for both groups is estimated with the regression model. The diff (T-C) is the difference between the treatment and control group for the baseline or follow up. The diff-in-diff is logically the difference between the two diff (T-C). It is the difference in time and the difference between the two groups, also referred to as the β3 in the regression formula mentioned earlier. The t-value defines whether the ytm value is statistically significant. The ytm value is statistically significant if it exceeds a critical value on the t-distribution with certain degrees of freedom. The critical value for the 1%, 5% and 10% significance level are respectively 2,33 , 1,96 and 1,645. The standard deviation is a measurement for the variation in the sample as we describer earlier. Now that we have made a description of the rows and columns of the table we move on to the meaning of the outcomes in the table. We begin with the overall results, i.e. the two type of bonds that are not adjusted for geographical location.

The difference between the treatment group (BBB-) and the control group (BB+) at baseline is -1,356. This means that the average yield to maturity for BBB- bonds is 1,356 lower than the yield to maturity of BB+ bonds. This difference is statistical significant at the 1% level (-9,23 < -2,33). This is the same for the difference after the implementation of the APP (-1,327), with the same statistical significance (-9,03 < -2,33). These results fits the expectation that the yield to maturity of BB+ bonds is higher than BBB- bonds due to the investment grade. However, the diff-in-diff (0,029) is not statistically significant unfortunately (0,15 < 1,96). But we can say that there is an effect of the APP as the yield to maturity of BBB- bonds decline, however the findings suggest that the APP affects the BB+ bonds more, i.e. the decline in yield to maturity following the APP is higher for the control group (BB+ bonds).

The difference-in-difference for the corporate bonds divided into the PIIGS countries is negative indicating that the effect on BBB- bonds is higher than for BB+ bonds. However, both yields decline following the APP, this effect is the same as in the overall regression. First, the yield to maturity for BB+ bonds are higher than for the BBB- bonds in both periods as assumed. The Diff (T-C) at the baseline is -1,255, with a 1% statistical significance (-6,69 < -2,33). For the follow up this is -1,284, also significant at a 1% level (-6,85 < -2,33). However, the difference-in-difference is -0,029, which indicates that the differences between the yields of both bonds became higher after the intervention. The effect of the APP is thus larger for the BBB- bonds than for the BB+ bonds when we split the group into the PIIGS countries.

When we estimate the difference-in-difference for the bonds (BBB- and BB+ combined) on size, i.e. countries with more than 10 companies, we obtain the following results. First, we obtain that the differences in yield to maturity for the bonds in both periods do not differ much from each other in both periods relative to the other subgroups on geographical location. The difference at baseline between the control and treatment group is -0,25, with a 10% significance level (-1,76 < -1,645). At the follow up the difference is -0,29, with a 5% significance level (-2,04 < -1,96). The difference-in-difference is -0,04, with no statistical significance. However, the regression captures the presence of the substitution effect. The yield to maturity for the BB+ bonds became higher after the APP. On the other hand the yield to maturity for the BBB- bonds decreased following the APP.

The Mid difference-in-difference estimator follows the same pattern as the overall estimation. The yield to maturity of both bonds declines after the APP. However, the effect of the APP is greater for the BB+ bonds as the difference in difference is 0,085. Furthermore, the yield to maturity of the treatment group is lower than the control group for both periods. The difference between the treatment group and the control group at baseline is -1,291 percentile point, with a statistical significance of 1% (-4,95 <-2,33). At the follow up this is -1,206 percentile point, also with a statistical significance of 1% (-4,62 < -2,33).

Also interesting to see are the results that come next, the results of the North and South regressions. First, the average yield to maturity for the control group of the Northern Europe countries is above 3 percent. This is by far the highest yield to maturity obtained from the sample. The differences in the yield to maturity of both groups is large for both periods. The difference at baseline (t=0) for North is -2,359, with 1% significance level (-7,10 < -2,33). At follow up this difference is -2,294, with 1% significance level (-6,90 < -2,33). However, the diff-in-diff is positive as one can see (0,065). Both yields decline following the APP. However, the decline in yield to maturity is higher for BB+ bonds (same results as the overall group).

On the other hand, in the Southern regression the presence of the substitution effect is captured. The diff (T-C) at baseline is -0,404 with 1% significance (-2,82 < -2,33), while at follow up this is -0,515, with 1% significance too (-3,59 < -2,33). The difference-in-difference is -0,111. The yield to maturity of BB+ bonds increased, while the yield to maturity of BBB- bonds decreased (substitution effect). Unfortunately the difference-in-difference is not statistically significant. However, it does indicate that the impact of the APP by the ECB is bigger for the corporate bonds in the Southern countries than for the bonds in the Northern countries in Europe.

For West and East the effect is smaller than South. The difference at baseline for West is -1,289 with 1% significance (-6,7 < -2,33) and the difference at follow up -1,219, also significant at the 1% level (-6,34 <-2,33). As one can observe the difference-in-difference is 0,07 for west. Both the yield to maturity of the treatment and control group decreases after the APP. However, the APP affects the yield of BB+ bonds more than the yield of BBB- bonds (same as overall). For East the difference at baseline is -1,669, significant at 1% (-7,09 < -2,33) and at follow up -1,708, also with a 1% significance (-7,26 < -2,33).

The diff in diff of East is -0,04. As mentioned above the diff in diff of these two regressions are relatively small. Moreover, one detail of the East regression is that the average yield to maturity of the control group remains equal, while the yield to maturity of the treatment group declines following the APP. This in line with the assumption that the BB+ bonds are not directly affected. Furthermore, the yield to maturity of BBB- bonds is thus more affected following the APP.

Additional to the difference in difference estimates described above one can find the same results in appendix 4 for the control and treatment group but than in a setting which is more recognizable to the regression formula. In these regressions there are the coefficients β1, β2 and β3, respectively the Time, Treatment and TimexTreatment. The coefficients corresponds with the difference-in-difference estimates earlier in this section. In the last 2 rows the constant and R-squared are shown. The R-squared measures the explanatory power of the model on the outcomes, which is additional to the table above. The explanatory power of the model on the outcomes is variant, it fluctuates from 0,01 percentile point to 0,36 with an average of about 0,15. North has the most explanatory power, 36%. The explanatory power is thus relatively low. Moreover, the corresponding standard deviation is displayed in the column next to the coefficients.

We already obtained that the treatment group is significantly negatively correlated to the yield to maturity. The time coefficient (β1), however, is not significant in all regressions. This may be caused by the relatively short time period of only one week before and one week after the implementation, the time period is too short for the yield to maturity to adjust to the change after the implementation.

Therefore, relative to the treatment coefficient, the time coefficient does not influence the yield to maturity much, i.e. the coefficients of Time are small compared to the coefficients of Treatment. The lowest coefficient is the one from the bonds in the east of Europe where the coefficient is almost zero (-0,0002).

In short, the TimexTreatment coefficient is the same as the difference-in-difference in the table. We obtained that four difference-in-difference coefficients (β3) are negative and four coefficients are positive. The yield to maturity of BBB- bonds decreased in all regressions following the APP.

This indicates that in four cases the decline in yield to maturity of BB+ bonds is higher than the decline in yield to maturity of BB+ bonds. In the overall, mid, north, and west estimations this effect (decline yield BB+ > decline yield BBB-) is present. Unfortunately, this is not in line with the assumption that the APP of the ECB influences the BBB- bonds more than the BB+ bonds. On the other hand, in the PIIGS countries the decline in yield of BBB- bonds is higher than the decline in yield of BB+ bonds (decline yield BBB- > decline yield BB+).

Furthermore, in the size (10+ companies) and south estimations the substitution effect is present, i.e. the yield of BBB- bonds go down, while the yield of BB+ bonds goes up following the APP. In the east estimation the yield to maturity of BBB- bonds decline, while the yield to maturity of BB+ bonds remains the same following the APP. This is in line with the assumption that BBB- bonds are directly affected, while BB+ bonds are not. Only BB+ bonds may be indirectly affected (substitution effect) by the APP. Moreover, we obtain that the effect of the APP is more present in the southern countries.

5. Conclusion

In this section we will summarize the research, conclude the results and discuss shortcomings and further research. First, this research aims to analyze the effect of the latest purchase program of the ECB, the asset purchase program, on the yield to maturity of European corporate bonds. From 9 March 2015 to March 2017 the ECB buys corporate bonds with a credit rating of at least BBB-. To analyze the effect we used a difference in difference approach, where the BBB- bonds are obviously in the treatment group and the BB+ bonds in the control group. We expected that the APP have a negative impact on the yield to maturity of BBB- bonds, i.e. the yield to maturity decreases, because the demand of BBB- bonds goes up. When prices go up the yield decreases (formula on page 9). This is the direct effect of the APP. For BB+ bonds we expected an indirect effect. BB+ bonds are close substitutes which lowers the demand following the APP. If demand decreases the price also decreases. When prices decrease the yield to maturity goes up. The yield to maturity of BBB- bonds is more effected if the decline in yield to maturity of BBB- bonds is higher than the decline in yield to maturity of BB+ bonds, the yield to maturity of BBB- bonds decline while the yield to maturity of BB+ bonds remain the same or the yield to maturity of BBB- bonds decline while the yield to maturity of BB+ bonds rise.

The latter describes the substitution effect. Furthermore, we also divided the bonds in subgroups on their geographic location to give more power to the research.

In the next part of the conclusion we conclude the results. First, we begin with the hypothesis, should we reject or accept the hypothesis we stated in the introduction. The hypothesis that *'The yield to maturity of corporate bonds with a BBB- credit rating decreases while the yield to maturity of corporate bonds with a BB+ credit rating increases following the APP intervention of the ECB '*should be rejected as there is sufficient evidence that there are multiple regressions where the substitution effect is not present. Only in two of the eight regressions the substitution effect is present. However, we have to keep in mind that the time variable is never significant, which indicates that the differences are (relatively) small. Moreover, in the 'overall' difference in difference estimations we found that the decline in yield to maturity following the APP is higher for the BB+ bonds than for the BBB- bonds (yield BB+ ↓ > yield BBB- ↓), this indicates that the effect of the APP is larger on BB+ bonds than BBB- bonds, while we expected that this would be the opposite. Only the results of the East regression is in line with the assumption that the average yield to maturity of the control group remains the same over the two periods (not directly affected). Moreover, in the diff in diff estimates of the 10+ companies (size) and South the yield to maturity of BBB- bonds decreased while the yield to maturity of BB+ bonds increased following the APP. Thus these are the two regressions where the substitution effect is present. In the Southern countries the APP have the largest impact (-0,111). This may be because the corporations in the Southern countries anticipate more on the start of the APP. The demand of BB+ bonds dropped (substitutes), because the demand shifts to the BBB- bonds, causing the yield to increase. Lower demand means lower prices, thus yield to maturity to rise (see formula yield to maturity page 9). Vice versa demand for the BBB- bonds grow as mentioned above, which declines the yield to maturity. Moreover, in the PIIGS regression the decline in yield to maturity is higher for the BBB- bonds than for the BB+ bonds, i.e. the APP affects the BBB- bonds in these countries more. Furthermore, the diff in diff coefficient and the time coefficient are not significant unfortunately. However, the treatment coefficient (difference between treatment and control) is significant all the time, at a 1% level. The insignificance of the diff in diff and time coefficient could be because the time period may be too short for the yield to maturity to adjust to the change.

However, the findings indicate that the effect of the APP of the ECB has a larger impact on bonds in the Southern countries than on bonds in Northern and Middle Europe. The impact of the APP on the Southern countries is -0,111, this the highest diff in diff outcome as mentioned earlier.

Furthermore, for the subgroups Mid, North and West we obtain the same effect as we did for 'overall', the decline in yield to maturity is higher for BB+ bonds. On the other hand, for the subgroups PIIGS, 10+ companies, South and East we obtain that BBB- corporate bonds are more affected than BB+ corporate bonds following the APP.

In short, when we look at the effect of the APP of the ECB on 9 March 2015 on corporate bonds with a BBB- and BB+ credit rating in Europe we obtain that in half of the difference in difference estimates BBB- bonds are more affected following the APP and in the other half the BB+ bonds are more affected. In two of the eight regressions (10+ and south) the substitution effect is present (yield BBB- ↓, yield BB+ ↑). In the East regression we obtain only the direct effect on BBB- bonds, i.e. BB+ bonds are unaffected (yield BBB- ↓, yield BB+ →). In the PIIGS regression the decline in yield is higher for BBB- bonds (yield BBB- ↓ > yield BB+ ↓). In the other four regressions (overall, mid, north, west) the decline in yield is higher for BB+ bonds (yield BB+ ↓ > yield BBB- ↓).

To close the conclusion we discuss now shortcomings and further research. The most important shortcoming of the research is that the time period might be too short for the yield to maturity to adjust to the change. In further research one may expand the time period to one month or a quarter of a year for example, to see if the impact of the APP will be higher, i.e. diff in diff outcomes are larger. One other shortcoming is that we only used the S&P as credit rating index. This a shortcoming, because Moody's and Fitch rate some corporate differently, which means that a bond may be credit rated as BBB- by S&P but credit rated as BB+ by Moody's or Fitch. Furthermore, one expansion to the research could be to investigate if the results are different when the price is used instead of the yield to maturity. Moreover, additional to the research one can check for differences when collateral and seniority between the bonds mutually are taken into consideration. Furthermore, one can check for the countries in the South mutually, in which of these countries is the impact of the APP the highest for example.

Appendix

Appendix 1: An oversight of the credit ratings provided by Fitch, Moody's and Standard & Poor's.

Fitch	S&P	Moody's	Rating grade description (Moody's)	
AAA	AAA	Aaa	Investment grade	Minimal credit risk
AA+ AA AA-	AA+ AA AA-	Aa1 Aa2 Aa3		Very low credit risk
A+ A A-	A+ A A-	A1 A2 A3		Low credit risk
BBB+ BBB BBB-	BBB+ BBB BBB-	Baa1 Baa2 Baa3		Moderate credit risk
BB+ BB BB-	BB+ BB BB-	Ba1 Ba2 Ba3	Speculative grade	Substantial credit risk
B+ B B-	B+ B B-	B1 B2 B3		High credit risk
CCC+ CCC CCC-	CCC+ CCC CCC-	Caa1 Caa2 Caa3		Very high credit risk
CC C	CC C	Ca		In or near default, with possibility of recovery
DDD DD D	SD D	C		In default, with little chance of recovery

Appendix panel 2A: Small panel expressing the number of companies and bonds in the BBB- sample divided for each country.

Countries	#Companies	#Bonds
AT	2	3
BE	3	3
DE	9	32
DK	1	2
ES	7	14
FR	7	25
GB	6	19
IE	4	35
IT	7	122
LU	4	13
NL	11	39
PT	1	1
TOTAL#	62	308

Appendix panel 2B: Small panel including the number of companies and bonds for each country in the BB+ sample.

Countries	#Companies	#Bonds
AT	3	16
BE	2	3
DE	6	9
DK	1	2
ES	4	11
FR	3	12
GB	3	17
IE	5	15
IT	5	21
LU	5	24
NL	4	19
PT	2	4
TOTAL#	43	153

Appendix 2C: Small panel including the number of companies and bonds for each of the countries in the sample (both BBB- and BB+).

Countries	#Companies	#Bonds
AT	5	19
BE	5	6
DE	14	41
DK	2	4
ES	11	25
FR	10	37
GB	8	36
IE	9	50
IT	12	143
LU	9	37
NL	15	58
PT	3	5
TOTAL#	103	461

Appendix 3A: The descriptive statistics of the yield to maturity**.**

AVG YTM	**Treatment BBB-**			**Control BB+**			**Total**		
	Mean	st. dev	# obs.	mean	st. dev	# obs.	mean	st. dev	# obs.
Overall	1,19	0,83	616	2,54	2,29	306	1,64	1,61	922
PIIGS	1,04	0,62	344	2,31	2,18	102	1,34	1,29	446
10+ companies	1,2	0,85	464	1,47	1,54	144	1,26	1,06	608
North	1,03	0,59	112	3,35	2,36	68	1,91	1,89	180
South	1,12	0,67	274	1,58	1,05	72	1,21	0,79	346
Mid	1,37	1,05	230	2,62	2,51	166	1,89	1,91	396
West	1,07	0,72	298	2,32	2,18	210	1,59	1,63	508
East	1,31	0,91	318	3	2,46	96	1,7	1,59	414

#obs.: number of observations in the sample, i.e. number of observations including either a bond with a BBB- or BB+ and an average yield to maturity before or after the intervention.

Appendix 3B: The descriptive statistics of the maturity in years.

Maturity	Treatment BBB-			Control BB+			Total		
	Mean	st. dev	# obs.	mean	st. dev	# obs.	mean	st. dev	# obs.
Overall	9,27	7,49	616	11,89	13,65	306	10,14	10,04	922
PIIGS	8,01	5,04	344	10,55	12,25	102	8,59	7,4	446
10+ companies	9,66	7,89	464	10,25	10,5	144	9,8	8,57	608
North	7,9	6,45	112	13,95	22,51	68	10,19	14,97	180
South	8,81	5,33	274	12,03	14,28	72	9,48	8,13	346
Mid	10,48	9,7	230	10,99	6,95	166	10,69	8,65	396
West	8,82	7,12	298	8,2	4,66	210	8,56	6,22	508
East	9,68	7,82	318	19,97	21,32	96	12,07	13,05	414

Appendix 4: Additional yield to maturity OLS regressions.

	Overall		PIIGS		10+ Companies		Mid	
Ytm	Coefficient	st. dev	Coefficient	st. dev	Coefficient	st. dev	Coefficient	st. dev
Time	-0,052	0,262	-0,004	0,430	0,010	0,257	-0,094	0,390
Treatment	-1,356***	0,194	-1,255***	0,320	-0,250	0,188	-1.291***	0,295
TimexTreatment	0,029	0,276	-0,029	0,346	-0,040	0,268	0,085	0,414
Constant	2,561***	0,188	2,317***	0,317	1,466***	0,179	2,663***	0,278
R-squared	0,15		0,17		0,01		0,10	
	North		**South**		**West**		**East**	
Ytm	Coefficient	st. dev	Coefficient	st. dev	Coefficient	st. dev	Coefficient	st. dev
Time	-0,082	0,574	0,073	0,246	-0,075	0,302	-0,0002	0,502
Treatment	-2,359***	0,427	-0,404**	0,187	-1,289***	0,228	-1,669***	0,359
TimexTreatment	0,065	0,585	-0,111	0,259	0,070	0,313	-0,039	0,512
Constant	3,395***	0,419	1,539***	0,178	2,361***	0,221	2,998***	0,352
R-squared	0,36		0,06		0,14		0,20	

** 5% significance level, p<0,05 / *** 1% significance level, p<0,01

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