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Analyzing the difference in excess returns between senior and covered bond pairs using a factor model approach

an empirical study

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Preface

This thesis completes a two-year masters program in Financial Economics at NTNU and was carried out in the spring of 2018. The thesis has been an interesting project both in terms of research topic and methodology. At times, the writing process has been hard and frustrating, but ultimately it has been a fun and rewarding experience.

We would like to thank our supervisor Snorre Lindset for valuable feedback. We would also like to thank Lana Krehić for taking the time to answer our many questions. And finally, Odd-Martin would especially like to thank Vanja: I could not have done this without you, you are the best.

This masters thesis is a collaboration between Fritjof Erling Røed and Odd-Martin Theimann. The views in this thesis are our own, along with any errors.

Fritjof Erling Røed & Odd-Martin Theimann
Trondheim, June 2018

Abstract

Covered bonds are investment grade bonds that are backed up by collateral. Senior bonds are unsecured, but have the highest seniority among creditors should the issuer default. Collateral is the main separator of covered bonds and senior bonds. This thesis examines if other factors than collateral have explanatory power for the difference in excess returns between senior bank bonds and covered bank bonds. It also examines the effectiveness of a covered bond collateral proxy in explaining the difference in excess return.

A matching method is used to examine the difference in excess return between the two bond types. We use a panel data set with daily and quarterly observations of paired senior bonds and covered bonds. The bonds are issued by a total of 70 different banks. The dataset ranges from January 2007 to January 2012.

We find the chosen proxy for covered bond collateral, namely a euro area real estate index, to be insignificant. When we control for the financial crisis, we find four factors not related to collateral to affect the difference in excess return between senior bonds and covered bonds: the stock market risk premium RP, the two bond market factors DEF and $TERM$, and the *iBoxx index* which is a proxy for the bond market risk premium.

Sammendrag

Dekkede obligasjoner er høyt vurderte obligasjoner med dekning i pant. Senior obligasjoner er usikrede, men har fortrinnsrett blant andre kreditorer i tilfelle utsteder går konkurs. Pant er hovedforskjellen mellom dekkede obligasjoner og senior obligasjoner. Denne masteroppgaven undersøker om det finnes andre faktorer enn pant som har forklaringskraft for forskjellen i meravkastning mellom seniorobligasjoner og dekkede obligasjoner. Oppgaven ser også på effektiviteten av en proxy for panten til de dekkede obligasjonene, til å forklare forskjellen i meravkastning.

Vi bruker en "matching metode" for å undersøke forskjellen i meravkastning mellom de to obligasjonstypene. Et paneldatasett med daglige og kvartalsvise observasjoner av parede seniorobligasjoner og dekkede obligasjoner blir brukt. Obligasjonene er utstedt av totalt 70 forskjellige banker. Datasettet strekker seg fra januar 2007 til januar 2012.

Vi finner at den utvalgte proxyen for dekkede obligasjoners pant, en husprisindeks for euroområdet, er insignifikant. Etter å ha kontrollert for effekten av finanskrisen finner vi fire faktorer, som ikke er relatert til pant til å påvirke forskjellen i meravkastning mellom dekkede obligasjoner og seniorobligasjoner: aksjemarkedsfaktoren RP, de to obligasjonsmarkedsfaktorene DEF og $TERM$, og $iBoxx\ index$ som er en proxy for obligasjonsmarkedets risikopremie.

Contents

1 | Introduction

A covered bank bond separates from a senior bank bond in that it is covered by a pool of collateral. We search for other factors than collateral that can explain the difference in return between covered bonds and senior bonds. We use factors from Fama and French's five-factor model, namely RP, DEF and $TERM$, and the Markit iBoxx EUR Benchmark bond index to explain the difference in excess return between covered bonds and senior bonds. We control for the impact of the financial crisis and find them all to be significant at a 5 % level.

Covered bonds have roots back to 1769 and Prussia (Anand, 2016), and have been commonly issued in Europe, also in modern times. After the financial crisis of 2007-08, a rise in popularity and consequently demand for covered bonds was seen (Martín, Sevillano, & González, 2014).

Literature examining yield spreads between covered bonds and government bonds exists with various interpretations. The spread is interpreted as a liquidity premium by some (including Kempf, Korn, and Uhrig-Homburg (2012) and Koziol and Sauerbier (2003)), while others find the spread to be dependent on the quality of the covered bond collateral (Prokopczuk, Siewert, & Vonhoff, 2013). As presented by Martín et al. (2014), there exists a yield spread between covered and senior unsecured bank bonds as well. However, no such studies can be found on the difference in excess return between covered bonds and corporate senior investment grade bonds. The lack of empirical research on this topic motivates us to investigate the difference in excess return between secured covered bank bonds and unsecured senior bank bonds. Collateral is the main distinction between covered bonds and senior bonds. We wish to find if other factors affect this difference in excess return. This motivates the following research question:

To what extent can other factors than collateral be found to explain the difference in excess returns between senior bonds and covered bonds?

Our main objective is therefore to seek other factors with explanatory power for the difference in excess return between senior bonds and covered bonds using a factor model approach. A secondary objective is to test the effectiveness of a euro area real estate index as a proxy for collateral.

Our panel data set consists of daily observations of bond excess return from January 2007 to January 2012. It contains both covered bond excess return and senior bond excess return. Fixed effects regressions are performed on this sample. The regressions are used as part of a selection process. We believe factors affecting both senior and covered bond excess return, can explain the difference in excess return between the bonds. We match covered and senior bond pairs with similar characteristics from the same issuer. These pairs differ only through the fact that the covered bond is backed up by collateral. Following this process, we construct a variable from the difference in excess return between bond pairs. Then we perform regressions on the difference variable to examine the explanatory power of the factors from the selection process. The results of these regressions will show if any of these factors can explain the difference in excess return between senior bonds and covered bonds.

Our thesis is divided into eight chapters. *Chapter two* presents relevant literature for covered bonds and corporate bonds. The chapter explores earlier appliances of the matching method methodology, as well as its merits in regards to explaining differences in returns and yield spreads between different bond types. *Chapter three* brings forth relevant theory. *Chapter four* presents the econometrical framework and methodologies used in our thesis, while *chapter five* presents the dataset with descriptive statistics. *Chapter six* handles the specific analysis of our gathered data, in regards to our research question. We conduct a series of robustness checks on our results in *chapter seven*. We conclude our findings and answer the research question in *chapter eight*. The chapter also includes limitations of the thesis and suggestions for further research.

2 | Literature Review

Through reviewing literature on factors that affect corporate bonds and covered bonds, we aim to understand which factors are important in explaining the difference in return between them. We also review matching methods to understand how we can compare the bonds in our sample and remove factors that differ across unsecured and secured bonds.

2.1 Corporate Bonds

Literature regarding explanations of bond returns and yield spreads can be split into two approaches, structural models and reduced-form models. Reduced-form models use statistical analysis to find explanatory factors, while structural models are to a greater extent based on financial theory. Structural bond models can be traced back to Merton (1973) and his credit risk model. We focus on reduced-form models.

Fama and French (1993) investigate explanatory factors for returns in stocks and bonds. They find three stock market factors and two bond market factors. The stock market factors explain some of the variations in bond return, but when the two bond factors are introduced, they lose explanatory power for the return on investment grade bonds. The three stock factors and the two bond factors constitute the five-factor model. Fama and French use this model to explain returns in stocks and bonds. We use the five-factor model to see if we can find the same results for return on corporate bonds in our sample. If it explains corporate bond excess return, we examine if the model also explains the difference in return between corporate bonds and covered bonds.

Unlike Fama and French (1993), Elton, Gruber, Agrawal, and Mann (2001) find that the three stock factors are partly successful in explaining corporate bond yield spreads.

2.2 Covered Bonds

Covered bonds, which originated in what is now modern day Germany, have been present in European markets for many years. Only recently has the covered bond become a global financial instrument as Martín et al. (2014) explain in their paper. They believe the reason for covered bonds' increased popularity, in part, is due to their robustness in turbulent financial times.

Prokopczuk et al. (2013) investigate the risk premium in the German covered bond market. They say that the yield spread between covered bonds and government bonds is mainly believed to be due to a liquidity premium for covered bonds. They find that the yield spread is also affected by the quality of the covered pool for the bond, and that this effect escalates in times of turbulence in financial markets. Prokopczuk et al. (2013) use quarterly data for German covered pools. German banks publish more detailed information about their cover pool composition compared to other countries, which allows for direct implementation of the covered pool in the data set. Because our covered bonds have different issuer nationalities and we do not have access to their covered pool composition, we follow Helberg and Lindset (2016) and use real estate indexes as proxies for the quality of the covered pools.

2.3 Matching Methods

Matching methods are methods used to compare financial instruments (Zerbib, 2017). Several studies use a matching method to explain differences in return between ethical and non-ethical funds (Kreander, Gray, Power, and Sinclair (2005), Renneboog, Ter Horst, and Zhang (2008) and Bauer, Koedijk, and Otten (2005)) as well as credit default swaps and corporate bonds (Longstaff and Schwartz (1995)). Amihud and Mendelson (1991) and Kamara (1994) however, examine pairs of bonds for differences in return. The paper of Helwege, Huang, and Wang (2014), "Liquidity effects in corporate bond spreads" and the paper of Zerbib (2017) "The Green Bond Premium" are the most relevant papers for our study, and will be the basis of our literature review of matching methods.

Zerbib (2017) uses a matching method to analyze premiums in green bond yield spreads compared to corporate bond yield spreads. He has a panel data set with matched pairs of similar green bonds and corporate bonds. Through matching these bonds, he creates bond pairs differing only through their labels (one a senior green bond, the other a senior corporate bond). Zerbib addresses if there exists a positive or negative premium associated with green, environmental friendly bonds[1]. Through utilizing the matching method and by using fixed effects regressions on the bond pairs, he finds an average green bond premium of -8bps.

In their article Helwege et al. (2014) use a similar methodology to that of Zerbib, to look at liquidity proxies in corporate bonds when credit risk is removed. The main difference to Zerbib (2017) is that Helwege et al. (2014) use pooled OLS and not fixed effects. They remove credit risk by constructing bond pairs from the same issuer, differing only in liquidity level measured by the proxies. Helwege et al. (2014) find that when credit risk is removed, liquidity proxies can only explain a small fraction of the differences in bond yield spreads.

We have chosen to apply a matching method equal to those mentioned in Zerbib (2017) and Helwege et al. (2014) to examine the difference between excess return for senior bonds and covered bonds. Although they investigate yield spreads, their methodology principles are equally applicable for investigating differences in excess return.

[1]Proceeds of green bonds go to funding environmentally friendly projects.

3 | Theory

In this chapter we discuss relevant theory regarding covered bonds and senior bonds. We will also present Fama and French's five-factor model.

3.1 Covered bonds

A covered bond is a bond issued by a financial institution, which is backed up by a pool of collateral. Figure 3.1 represents a simplified balance sheet for a bank. Covered bonds are backed by a covered pool which is at least equal to the face value of the bond, but is often over-collateralized. Thus, the issuing financial institution has more than the face value of the bond as collateral. Should the issuer fail, the bondholders can use their claim to access the pool of collateral. If the collateral is insufficient to cover the bondholders' claims, the remaining part can be claimed in the issuer's assets (denoted as "Other Assets" in figure 3.1) and will be rated as a senior claim (European Commision, 2015). Mainly the collateral is a diversified pool of mortgages, but can additionally contain other safe collateral.

Covered pools are kept on the company's balance sheet, therefore the collateral cannot be securitized and resold as securities. Finally, the collateral is dynamic,

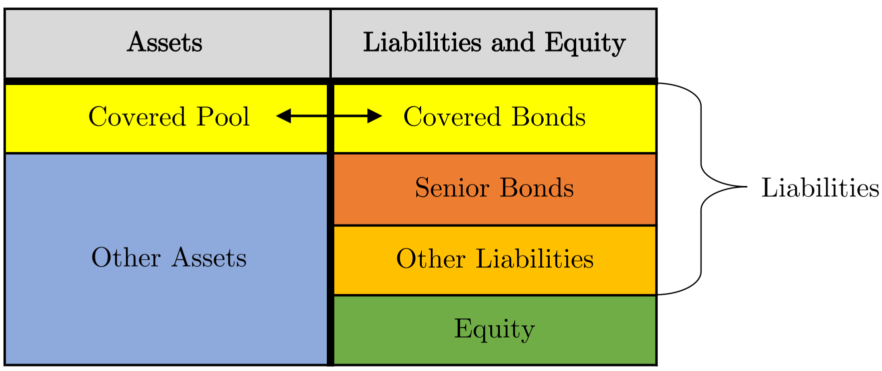

Figure 3.1: **Simplified Balance Sheet**
This figure shows a simplified representation of a bank's balance sheet. The covered pool is an asset. "Other Liabilities" includes subordinated bonds.

which means as the value of the bond changes so does the required collateral for the bond (Anand, 2016).

Until recent years covered bonds have mostly been instruments of the European markets. Both issuers and investors have mainly been European entities. As financial markets became increasingly turbulent, the demand for safer investments rose (Martín et al., 2014). As a result, during the last ten years, covered bonds have become more global in terms of use, and have become more accessible as investments.

3.2 Senior Bonds

Unlike covered bonds, senior bonds are not secured by a pool of collateral and not necessarily issued by financial institutions. Senior bonds refer to the type of unsecured bonds with the highest seniority. This gives the holder of senior bonds priority over other classes of unsecured bonds in claiming assets if a default occurs (Berk & DeMarzo, 2014, p. 840). Due to their seniority, senior bonds are less risky than other types of unsecured bonds. Holders of senior bonds receive a lower yield than holders of other unsecured bonds due to the expectations of higher recovery rates in the event of a default.

3.3 Fama and French's Five-factor Model

The three-factor model by Fama and French (1996) expands the traditional CAPM-model using two additional factors in the regression to seek to further explain stock returns. The model is given as

$$R_i - R_f = \alpha_i + b_i(R_m - R_f) + s_i SMB + h_i HML + e_i \tag{3.1}$$

where R_i is the return for stock i, R_f is the risk free rate, R_m is the market return, b_i, s_i and h_i are factor coefficents for stock i , α_i is the constant and e_i the error term for stock i. The factors are the stock market risk premium $(R_m - R_f)$[1], "small minus big" (SMB) and "high minus low" (HML).

Smaller companies tend to have higher returns than larger companies. The difference between the returns of small and big companies is represented by the SMB-factor. The "high minus low"-factor takes book-to-market value into account, by subtracting the returns of companies with high book-to-market value

[1] hereby denoted as RP.

from companies with a low book-to-market value. Fama and French (1992) find that the book-to-market equity effect is larger than the company size effect. By applying the three-factor model, pricing errors fall from around 25-30 basis points per month down to 5-10 basis points[2] (Fama & French, 1996).

Although designed for explaining stock returns, it turns out the three-factor model can also be used to explain the common variation in bond returns. In their work, Fama and French (1993) find that including either SMB, HML or RP by themselves have little explanatory power for bond returns. When these factors are included simultaneously however, they find that the factors have the ability to explain shared variations between bond and stock market returns.

Fama and French (1993) introduce two additional factors to the pre-existing RP, HML and SMB. These factors called $TERM$ and DEF are bond market factors. The $TERM$ factor is a proxy for deviations of long term returns from expected returns due to shifts in interest rates. DEF is a proxy for bond issuer default. They find that when all five factors are included, RP, SMB and HML lose all explanatory power for bond returns. On the other hand, the bond factors $TERM$ and DEF explain a high degree of bond returns. Including all factors in the same model, Fama and French find that the five-factor model explains variations in stock and bond returns.

[2] Hereby denoted as bps.

4 | Methodology

In this thesis we study if other factors than collateral can explain the difference in excess return between senior and covered bonds. The return for a bond is calculated as the change in price from one period to another. The Excess return in this thesis is calculated as the return for a bond less the return for the three-month German government bond. The factors are chosen by examining their explanatory power on excess return for the whole sample of both covered bonds and senior bonds. This is done using fixed effects regressions on our panel data. If we find a factor to have explanatory power for the whole sample, we examine if it can explain the difference in excess return. This is done by constructing a new variable which is the difference in excess return between senior bonds and covered bonds, $R_{\text{Senior}} - R_{\text{Covered}}$ from similar senior and covered bond pairs from the same issuer. R_{Senior} is the excess return for senior bonds while R_{Covered} is the excess return for covered bonds.

The factors we select from the fixed effects regressions are regressed on the difference variable $R_{\text{Senior}} - R_{\text{Covered}}$ using a matching method. Our matching method allows us to remove characteristics not relevant for our research question from affecting return on senior and covered bonds. Our dataset contains daily data. In order to examine the effect of collateral on the difference variable we aggregate the daily data to quarterly data to include the euro area real estate index as a proxy-variable for covered bond collateral.

4.1 Factors

In this section we clarify the factors we use to investigate the difference in excess return between senior bonds and covered bonds.

Bond Specific Factors: The dataset utilized in our thesis consists of pairs of similar senior bonds and covered bonds, but there are a few exceptions where the bonds differ. Firstly, they differ through the fact that covered bonds have underlying collateral, which senior bonds do not, as they are unsecured. Secondly, there are bond specific factors that differ as well. In order to have as similar bonds as possible, we control for these factors to check whether they have any effect on the excess return. The bond specific factors which differ for senior and covered bonds are rating and notional amount.

Fama and French's Stock Market Factors: Traditionally, there is little covariance between the returns of highly rated corporate bonds and the stock market. We include the three stock factors (RP, SMB and HML) to search for effects of the stock market on covered bond and senior bond excess returns. Fama and French (1993) find that the stock factors have no effect on excess return for senior bonds. We wish to examine if the same can be said for covered bonds.

TERM: $TERM$ is a proxy for deviations of long term bond returns from expected bond returns, due to unexpected shifts in interest rates (Fama & French, 1993). The factor is created by subtracting the daily return of short-term three month German government bonds for period $t-1$, from daily return for long-term German government bonds with a maturity of ten years or more for period t. We have

$$TERM = R_t^{LTG} - R_{t-1}^{STG} \tag{4.1}$$

where R_t^{LTG} is daily return for long-term government bonds in period t and R_{t-1}^{STG} is daily return for short-term government bonds in period $t-1$. We aggregate the return for short-term German government bonds and long-term German government bonds to quarterly data. We then subtract return for short-term bonds in quarter $t-1$ from return for long-term bonds in quarter t.

DEF: DEF is a proxy for default probability. The factor is created by subtracting daily return of long-term German government bonds from daily average return of a portfolio of investment grade rated, medium term, senior unsecured bonds. We have

$$DEF = R(p)_t^S - R_t^{LTG} \tag{4.2}$$

where $R(p)_t^S$ is daily return for a portfolio of investment graded senior bonds for period t and R_t^{LTG} is daily return for long-term government bonds for period t, the same as in $TERM$. Fama and French (1993) use the return of a portfolio of investment grade long-term senior bonds. Due to limitations in our data, medium term bonds are used. Dolinar, Orsag, and Suman (2015) use a DEF variable created by the return of a portfolio of medium term investment grade senior bonds, while Chen, Roll, and Ross (1986) use the return of a portfolio of "junk" bonds. Our sample contains only investment grade bonds, therefore we construct our DEF variable similar to Fama and French (1993) and Dolinar et al. (2015).

The Real Estate Index: The typical covered pool for a covered bond consists of private mortgages. This is also the case for our sample data. For this reason we chose to include the quarterly index levels of housing prices for the euro area as a proxy for change in value of the issuing bank's assets represented in the covered pool as collateral.

The EURO STOXX 50 Volatility Index: Times of volatility suggest that investors pull out of riskier investments and place their money in less risky ones (Martín et al., 2014). By adding the EURO STOXX 50 volatility index as a variable, we control for euromarket volatility. By doing this we suggest that senior bonds should react more negatively than covered bonds to an increase in volatility, as demand for senior bonds should drop more than for covered bonds. We denote the index as $VSTOXX$ in tables and figures.

The Markit iBoxx EUR Benchmark index: We include the excess return of the *iBoxx index* as a proxy for the bond market risk premium. Excess return for senior and covered bonds are expected to move in alignment with the market excess return. This variable tells us more about the market sensitivity for senior bonds and covered bonds.

Regression Intercept: The constants of the regressions performed in this thesis will be of limited value in terms of answering our research question. They cannot show if any of the factors mentioned, have any explanatory power in terms of explaining the difference in return between senior bonds and covered bonds.

4.2 Panel Data

We have a panel dataset containing excess return for senior and covered bonds, issued by 70 different banks. The panel data follows the same banks over time, hence it contains data with a time-dimension and a cross-sectional dimension. As we follow the same banks, the error term contains unobserved effects for each subject. To illustrate, consider a general model for excess return for the bonds in our sample written as

$$Excess\ Return_{it} = \beta_0 + \boldsymbol{\beta}\mathbf{X}_{it} + u_{it} \tag{4.3}$$

where β_0 is the constant, $\mathbf{X}$ is a vector of the explanatory variables, $\boldsymbol{\beta}$ is a vector for the corresponding coefficients and u_{it}, the error term. u_{it} can be written as,

$$u_{it} = \eta_i + \epsilon_{it} \tag{4.4}$$

where u_{it} is the error term, η_i is a bank specific error term and ϵ_{it} is an idiosyncratic error term. The bank specific error term captures unobserved variables that affect excess return which only vary over bank groups, but not time. The idiosyncratic error term captures unobserved variables that affect excess return and varies over both time and bank group.

We are interested in the cross-sectional dimension of the data, which can be explored using pooled OLS regressions. In order to avoid heterogeneity bias and to insure the pooled OLS regressions have unbiased estimators, the bank specific error term must be uncorrelated with the explanatory variables (Woolridge, 2016, p. 413). The bank specific effects are likely to affect to excess return. We control for possible omitted unobserved bank specific effects by performing fixed effects regressions instead of pooled OLS. This is done by including dummies for each bank group, excluding one bank group used as the reference variable. Dummies for each year is also included, to separate time specific effects. Regressions which utilize these dummies are market as such.

4.3 The Matching Method

The matching method technique is used to empirically analyze and compare two different instruments. The method is split up into three steps. First, we extract same issuer pairs of senior and covered bonds with similar characteristics. By creating these bond pairs we control for issuer credit risk and other risk components not due to difference in bond characteristics. The second step is to create a new variable, $R_{\text{Senior}} - R_{\text{Covered}}$ which is the difference in excess return between senior and covered bond pairs. Each observation in a bond pair is merged into one observation. This halves the number of observations. In the third step we perform fixed effects regressions with the difference variable as the endogenous variable. The fixed effects control for potential unobserved bank specific effects affecting the difference[1]. We can now explore if other factors than collateral have explanatory power for the difference in excess returns between senior and covered bonds.

4.4 Model Specification

We first perform fixed effects regressions as a selection process. Then, we regress the selected variables on the difference variable with the matching method. In the selection process, we interact variables with a covered bond dummy to see if the factors affect senior and covered bonds differently. The two regression models are represented as

$$R_{\text{Total}_{it}} = \beta_0 + \sum_{k=1}^{N} \beta_k factor_{itk} + \sum_{k=1}^{N} \delta_k \beta_k factor_{itk} + \sum_{j=2}^{70} D_j bank_j + \sum_{q=2}^{T} \gamma_q year_q + u_{it} \tag{4.5}$$

and

$$(R_{\text{Senior}} - R_{\text{Covered}})_{it} = \beta_0 + \sum_{k=1}^{N} \beta_k factor_{itk} + \sum_{j=2}^{70} D_j bank_j + \sum_{q=2}^{T} \gamma_q year_q + u_{it} \tag{4.6}$$

where $R_{\text{Total}_{it}}$ is the excess return for bond i at time t, R_{Senior} is the excess return for a senior bond, R_{Covered} is the excess return for a covered bond, $(R_{\text{Senior}} - R_{\text{Covered}})_{it}$ is the difference in excess return for bond pair i at time t, β_k is the coefficient for factor k, δ_k is a covered bond dummy for factor k, D_j is a dummy for bank j, γ is a dummy for year q and u_{it} is the error term. One bank and one year is left out as the reference variables.

The error term experiences clustering effects as the sample consist of the same issuers over the sample period. We control for clustering effects with the use of cluster robust standard errors. This also controls for heteroskedasticity and serial correlation [2]. If not controlled for, the problem of heteroskedasticity and serial correlation can affect statistical inference.

We test for model misspecification using the RESET test. The test[3] shows no non-linear excluded effects. The RESET test also fails to reject the hypothesis that a model misspecification exists. We conclude our model does not break the assumption of a linear model for unbiased estimators.

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[1] For comparison, pooled OLS regressions are presented in section A.4 of the appendix.

[2] A presentation of heteroskedasticity, Breusch-Pagan test specifics and results are included in B.1 of the appendix.

[3] RESET test specifics and results are included in B.2 of the appendix.

If any of the variables in the model exhibits perfect collinearity, the model will have biased estimators. $TERM$ and DEF correlate strongly, but they do not exhibit perfect collinearity. A high degree of collinearity does not break the assumption and does not cause biased estimators. This only affects statistical inference for the coefficients. Furthermore, the inclusion of two variables which correlate strongly in a regression does not affect the statistical inference of other independent variables.

Endogeneity in explanatory variables causes biased estimators. This issue occurs when

$$E(u|x_1, x_2, ..., x_k) \neq 0 \tag{4.7}$$

where u is the error term and x_1 through x_k are independent variables. Endogeneity can occur if there is measurement error in the independent variables. We deem this to be unlikely as the data are collected through automated processes.

Endogeneity can also be caused by simultaneity in independent variables. The iBoxx bond index can be viewed as the variable most prone to simultaneity as the bonds in our sample are extracted from the index. The excess return of the iBoxx index is not determined by the excess return of a bond in our sample as it contains a large amount of bonds. It is therefore unlikely that simultaneity is present in our model.

The most likely cause of endogeneity in our model is due to omitted variables. We can exclude omitted non-linear effects of the independent variables in the model through the RESET test. Through fixed effects regressions we exclude the probability of having omitted bank specific variables as well. However, there is a probability that we fail to include relevant explanatory variables even though several variables have been included.

4.5 Data Aggregation Process

In order to examine the euro area real estate index as a proxy for collateral we aggregate daily data to quarterly data. Aggregating daily excess return to quarterly excess return for a quarter can be done by using the formula

$$R_{quarter} = (1 + R_0)(1 + R_1)(1 + R_2)....(1 + R_t) - 1 \tag{4.8}$$

Where R_t is the excess return for a bond at the last day of the quarter, denoted by t. Using the formula, we aggregate the return for each bond for each quarter in the sample period. Quarterly excess return can also be calculated using linear approximation[4].

[4] Summary statistics of quarterly excess return using linear approximation can be found in section A.1 of the appendix.

5 | Data and Descriptive Statistics

In this chapter we present our dataset. We review how the data is compiled and describe the data through relevant summary statistics, correlation matrixes and graphical representations.

5.1 Data

Our data on senior and covered bond pairs is gathered and structured by Helberg and Lindset (2018). It holds 84,380 individual observations corresponding to 42,190 observations of bond pairs of daily excess returns from same-issuer covered and senior bond pairs. The data is extracted from the Markit iBoxx EUR Benchmark index[1]. The index consists of sovereign, sub-sovereign, collateralized (both covered and other securitized bonds) and corporate bonds. All bonds are investment grade rated by at least one major rating agency and a large number of different sectors are included. The largest single sector is the banking sector. Only bonds denominated in euros[2] are included in the index. This means that issuers outside Europe may be included if they issue EUR denominated bonds, and European issuers excluded if they issue bonds in another currency[3]. Markit calculates returns from bid and ask quotes, which are taken from ten major financial institutions. Markit reviews and updates the index every month, according to the listed criteria. The data is extracted to create bond pairs of covered and senior bonds from the same issuing banks. One bank may have more than one covered bond included in the index, and more than one senior bond included. Only one pair per date is chosen. Our data is extracted to minimize the time to maturity difference in the bond pairs in our sample. The sample ranges from 03.01.2007 to 31.01.2012. By creating same issuer pairs with similar time to maturities, we control for the effect of term risk influencing the returns. Figure 5.1 shows the

[1] Markit is a provider of financial data.
[2] Hereby denoted as EUR.
[3] Issuers listed by nation can be seen in A.3 of the appendix.

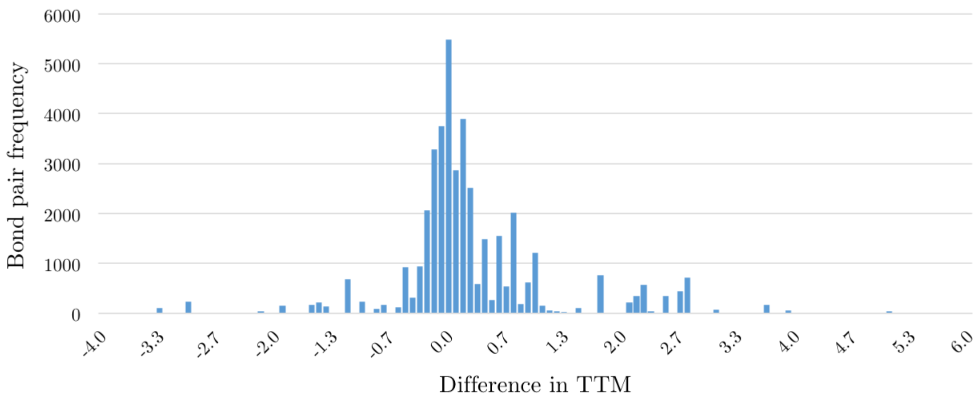

Figure 5.1: **Difference in Maturity**
In order to control for difference in term structure the data is composed to minimize the difference in term to maturity between the bond pairs. The figure contains 42,190 bond pair observations with a bin size of one month. This graphical representation of difference in term to maturity is the same as the one found in Helberg and Lindset (2018). The vertical axis shows bond pair frequency and the horizontal axis shows difference in term to maturity (TTM) measured in years.

difference in term to maturity for all bond pairs. The majority of the pairs are centered around zero difference in term to maturity. Factors we present that affect return will not be affected by term risk. Only bonds with a notional amount of 500 million EUR or more are included to retrieve the most liquid bonds. During the sample period, several macroeconomic events influence the financial markets. The biggest being the financial crisis in 2007-08 and the peak of the sovereign debt crisis in 2011-12.

The Markit iBoxx EUR Benchmark index is used as a proxy for the bond market portfolio. The variable is denoted as: $iBoxx\ index$. German treasury bonds are virtually risk free, therefore we use the three-month German government treasury bond as the risk free rate.

The data consists of daily observations of excess returns for senior bonds and covered bonds. Excess returns are used instead of yield spreads as we do not have access to yield spreads for the bonds in our sample. Nonetheless, using returns allows us to compare our results to that of Fama and French for the five-factor model.

5.1.1 Additional Data

We supplement the data provided by Helberg and Lindset (2018) with additional factors not present in the Markit index. We include Fama and French's five-factor model, consisting of the three stock factors RP, SMB and HML, and the two bond factors $TERM$ and DEF. Data for the three stock factors have been collected from French's website (French, 2018). The site collects daily data from the European stock market for all trading days. The two bond factors $TERM$ and DEF are constructed from long-term government bond returns, returns from a portfolio of senior unsecured bond returns and short-term government bond returns. Three-month German government treasury bond returns are used as the short-term government bond return. For long-term government bond returns, an index consisting of German government bonds with a ten year maturity or longer is used, extracted from Macrobond (2018). The portfolio of senior unsecured bonds returns is extracted from the the Markit iBoxx EUR Benchmark index.

We include the Euro STOXX 50 Volatility index ($VSTOXX$) as a proxy for market volatility in the euro area. $VSTOXX$ is chosen over the CBOE Volatility Index (VIX) as most of the bonds are issued by European banks in EUR. Closing prices for all trading days in our sample period are included in the data set. The VSTOXX index is calculated using the implied variance from options on the Euro STOXX 50 stock market index. It is designed to portray European market expectations[4].

From Macrobond (2018) we find an index for quarterly residential property prices for the euro area. The index is comprised from 20 different euro area countries. Housing data is compiled on a quarterly basis. We do not interpolate quarterly data to daily dates, hence the real estate index is only in our aggregated data set with quarterly variables.

5.2 Aggregated Data

To include an index for the euro area real estate market we must aggregate our daily data to quarterly data. We aggregate the excess return for senior bonds and covered bonds, and the excess return for the Markit iBoxx index using formula (4.8). For the volatility index, we include closing prices for the last trading day of the quarter. For the five-factor model, we find the mean for the quarter. After aggregating the data we have 1340 observations. We remove 140 incomplete observations to end up with 1200 observations.

Real estate data for issuer nations is retrieved from the Federal Reserve Bank of Dallas international house price database, described in Mack and Martínez-García (2011).

Including national real estate indexes for each issuer gives us at most 288 observations for one country and 8 at the lowest. Due to the low number of observations per nation the euro area real estate index is used, instead of individual

[4]STOXX (2018) has described this in detail.

country specific indexes.

5.3 Descriptive Statistics

5.3.1 Excess Return for Senior Bonds and Covered Bonds

Table 5.1 shows mean excess return for the whole sample and two subsamples consisting of only covered bonds and only senior bonds. The sample, denoted as R_{Total}, has a mean daily excess return of 1.25 bps. Covered bonds have a higher daily mean excess return than senior bonds at 1.29 bps and 1.21 bps, respectively. However, senior bond excess returns have a standard deviation of 40.90 bps, nearly 20 bps higher than the standard deviation of covered bond excess returns at 22.69 bps. Senior bonds have a lower excess return over our sample period of 5 years. This is consistent with senior bond excess returns having a higher standard deviation. Senior bond excess return also have a lower minimum return value at -3193.35 bps, lower than the minimum for covered bond excess return in our sample at -1398.01 bps.

Table 5.1: **Excess Return**
This table shows summary statistics for our sample. R_{Total} is the excess return for the whole sample, $R_{Covered}$ is the excess return for the covered bonds subsample and R_{Senior} is the excess return for the senior bond subsample. σ is standard deviation. The period ranges from January 2007 to January 2012. All numbers are presented in bps.

	mean	σ	min	max
R_{Total}	1.25	33.07	-3193.35	1281.38
$R_{Covered}$	1.30	22.69	-1398.01	1134.27
R_{Senior}	1.21	40.90	-3193.35	1281.38
Observations	84380			

Table 5.2: **Excess Return Aggregated Quarterly Data**
This table shows summary statistics for our sample for aggregated quarterly data. R_{Total} is the excess return for the whole sample, $R_{Covered}$ is the excess return for the covered bonds subsample and R_{Senior} is the excess return for the senior bond subsample. σ is standard deviation. The period ranges from January 2007 to January 2012. All numbers are presented in bps.

	mean	σ	min	max
R_{Total}	68.66	260.26	-3040.19	1232.00
$R_{Covered}$	79.19	209.76	-988.29	802.61
R_{Senior}	58.13	302.27	-3040.19	1232.00
Observations	1200			

Table 5.2 shows mean return for the aggregated quarterly data. The mean return for the whole sample, the covered bond subsample and the senior bond subsample is shown, denoted as in table 5.1. The sample has a mean quarterly excess return of 68.66 bps. Covered bonds have a mean quarterly excess return of 79.19 bps while senior bonds have a lower quarterly mean excess return of 58.13 bps. As for daily data, senior bond excess return has a higher standard deviation. It is 302.27 bps compared to 209.76 bps for covered bond excess return. Again, the lowest return value is found for the senior bond subsample at -3040.19 bps while the lowest return for the covered bond subsample is -988.29 bps.

5.3.2 Rating

Table 5.3 shows bond rating distribution for covered and senior bonds. For covered bonds, there is a strong overweight of AAA-rated bonds with a share of 86.47%. AA-rated bonds contribute 12.16%. A-rated bonds contribute 0.91% and BBB-rated bonds contribute 0.46%.

Table 5.3: **Bond Rating Distribution for Covered Bonds and Senior Bonds**
The table shows rating distribution for covered bonds and senior bonds. Table (a) shows covered bond ratings and table (b) shows senior bond ratings.

(a) **Covered Bond Ratings**

Rating	Frequency	Percent	Cum. Percent
AAA	36481	86.47	86.47
AA	5129	12.16	98.63
A	384	0.91	99.54
BBB	196	0.46	100.00
Total	42190	100.00	

(b) **Senior Bond Ratings**

Rating	Frequency	Percent	Cum. Percent
AAA	0	0	0
AA	20309	48.14	48.14
A	19126	45.33	93.47
BBB	2755	6.53	100.00
Total	42190	100.00	

There are no AAA-rated senior bonds in our sample. The most frequent senior bond rating is AA with a share of 48.14%. A-rated senior bonds are almost as frequent with 45.33%, while 6.53% of all senior rated bonds are BBB rated.

5.3.3 Correlation Matrixes

$\mathbf{R_{Total}}$**:** We examine the correlation matrix for the sample in table 5.4. The variables of the five-factor model all correlate with each other to some degree. The highest correlation coefficient is between the two bond market factors $TERM$ and DEF, at 97.2%. The three stock market factors show high correlation coefficients as well. SMB and HML correlate more with RP than between themselves. The correlation coefficient with RP and SMB is -74.4%, while between RP and HML the correlation coefficient is 54.9%. SMB and HML have a correlation coefficient

Table 5.4: **Correlation Matrix for the for the Sample**
This table shows the correlation coefficients between the excess return for the whole sample, the five-factor model, the EURO STOXX 50 volatility index and the Markit iBoxx EUR Benchmark index for daily data.

	R_{Total}	RP	SMB	HML	TERM	DEF	VSTOXX	iBoxx
R_{Total}	1							
RP	-0.153	1						
SMB	0.161	-0.744	1					
HML	-0.0916	0.549	-0.428	1				
TERM	0.255	-0.485	0.363	-0.378	1			
DEF	-0.166	0.465	-0.311	0.379	-0.972	1		
VSTOXX	0.00645	-0.155	-0.0120	-0.114	0.0824	-0.0983	1	
iBoxx	0.383	-0.275	0.311	-0.101	0.479	-0.317	0.0464	1

of -42.8%. We find correlation between the three stock factors and the two bond factors as well. The most notable correlation coefficient is between RP and $TERM$ at -48.5% and RP and DEF at 46.5%.

The excess return of the *iBoxx index* shows significant correlation coefficients with nearly all other variables. The exception is the $VSTOXX$ factor with a correlation coefficient of 4.6%. The *iBoxx index* correlates most strongly with $TERM$, at 47.9%.

The $VSTOXX$ variable shows relatively low correlation coefficients with all variables. The most notable correlation coefficient is with RP, at -15.5%.

The excess return for our sample, R_{Total},shows a correlation coefficient of 38.3% with the *iBoxx index*. We see that it also correlates moderately with $TERM$ and DEF, at 25.5% and -16.6%, but less with the three stock factors RP, SMB and HML, at -15.3%, 16.1% and -9.2% respectively. The lowest correlation is found between R_{Total} and $VSTOXX$ at 0.6%.

$\mathbf{R_{Senior}}$ & $\mathbf{R_{Covered}}$: Table 5.5 (a) shows a correlation matrix for a senior bond sub-sample and table 5.5 (b) shows a correlation matrix for a covered bond subsample. For the senior bond subsample, R_{Senior} correlates the most with the *iBoxx index* at 33.1%, $TERM$ at 19.6% and DEF at -10.2%. For the covered bond subsample, R_{Covered} correlates the most with *iBoxx index* at 52.0%, $TERM$ at 38.8% and DEF at -30.1%. The main difference between the correlation matrixes is that the correlation coefficients for the covered bond subsample have higher absolute values than for the senior bond sub-sample.

Table 5.5: **Senior Bond and Covered Bond Correlation Matrixes**
This table shows the correlation coefficients between daily excess return and the five-factor model, the EURO STOXX 50 volatility index and the Markit iBoxx index for a senior bond subsample in table (a) and a covered bond subsample in table (b).

(a) **Senior Bonds Correlataion Matrix**

	R_{Senior}
R_{Senior}	1
RP	-0.106
SMB	0.137
HML	-0.0564
TERM	0.196
DEF	-0.102
VSTOXX	-0.0147
iBoxx	0.331

(b) **Covered Bond Correlation Matrix**

	$R_{Covered}$
$R_{Covered}$	1
RP	-0.254
SMB	0.221
HML	-0.165
TERM	0.388
DEF	-0.301
VSTOXX	0.0453
iBoxx	0.520

5.3.4 Graphic Representation of Variables

The following figures show graphical representations of our data over the sample period.

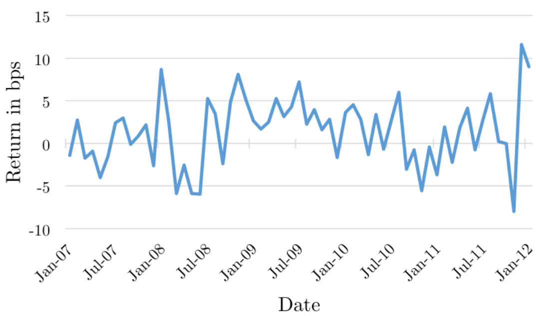

Figure 5.2: **The iBoxx index**
The graph shows mean excess return for each month in our sample for the iBoxx index. The vertical axis shows excess return measured in bps and the horizontal axis shows the sample period.

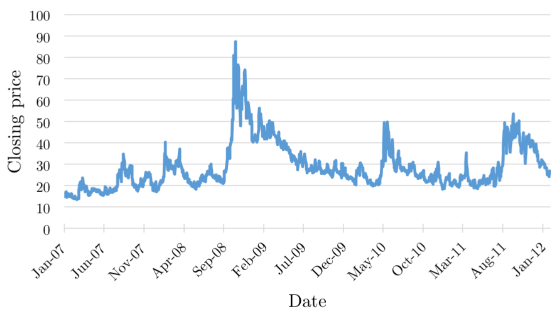

Figure 5.3: **VSTOXX**
This graph shows the development of the EURO STOXX 50 volatility index over our sample period. The vertical axis shows the closing price and the horizontal axis shows the sample period.

Figure 5.2 shows the development for monthly mean of the Markit iBoxx EUR Benchmark index. Excess return varies mostly between ±5 bps during the sample period. There are especially two periods in our dataset where we see increased volatility in returns. In the first quarter of 2008 we see a steep drop in return. Also, there is a steep drop in return around the fourth quarter in 2011, with a consequent recovery in the first quarter of 2012.

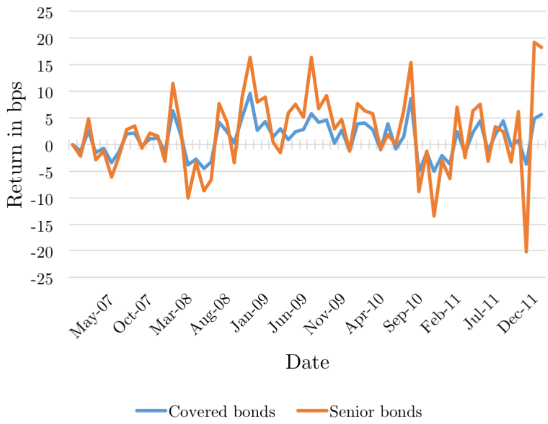

Figure 5.4: **Excess Return for Senior and Covered Bonds**
This graph shows the development of senior bond excess return and covered bond excess return in our data set over the sample period. Mean excess return for each month is graphed. The vertical axis shows excess return measured in bps and the horizontal axis shows the sample period.

Figure 5.3 shows the development in volatility. It reaches its all time high during the financial crisis. Our data shows an all time high closing price of 87.51 on the 16.10.2008. The graph indicates that the most volatile period in our sample is in the fourth quarter of 2008.

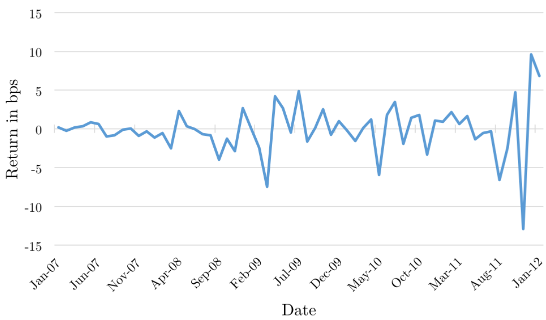

Figure 5.5: **Difference in Mean Monthly Excess Return**
This graph shows the development of difference in excess return over our sample period. The vertical axis shows mean difference in excess return measured in bps and the horizontal axis shows the sample period.

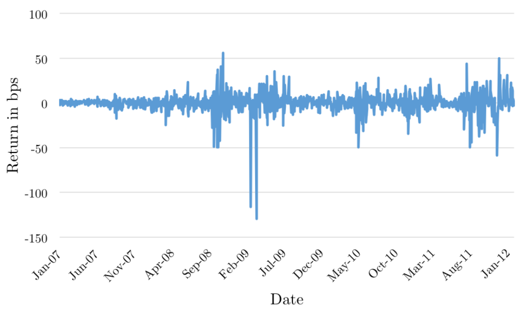

Figure 5.6: **Difference in Daily Excess Return**
This graph shows the development of difference in daily excess return over our sample period. The vertical axis shows the difference in excess return measured in bps and the horizontal axis shows the sample period.

Mean monthly excess return for senior and covered bonds are graphed in figure 5.4. We see that senior bond excess return and covered bond excess return move somewhat in tandem when averaged over a month. For senior bond excess returns we see a steep drop in the second quarter of 2008, this is also observed for the Markit iBoxx EUR Benchmark index in figure 5.2 for the same period.

Monthly difference in excess return is shown in figure 5.5 and daily difference is shown in figure 5.6. As seen from the daily data, notable amounts of variation exists in the difference variable, which varies mostly between ± 50 basis points. From the monthly average, we see that the difference variable is averaging between ± 5 basis point for each month, with a spike in the last months of our sample period.

The financial crisis is seen in all figures included, which is shown by the movement in the graphs around 2008. This is especially prominent in figure 5.3 and figure 5.6.

6 | Empirical Analysis

In this chapter we analyze our data. We perform fixed effects regressions in table 6.1 to select potential factors to explain the difference in excess return between senior bonds and covered bonds. These factors are regressed on the difference variable, $R_{\text{Senior}} - R_{\text{Covered}}$, in table 6.2 using the matching method. In table 6.3 we aggregate the data and include the euro area real estate index. The excess return for senior and covered bonds, R_{Total}, is multiplied by 10,000 in order to show excess return in bps. This is also done for the difference variable, DEF, $TERM$ and the *iBoxx index*

6.1 The Fixed Effects Selection Model

In the following section, we investigate factors affecting the daily excess returns of our sample using a fixed effects regression. To make sure we do not overlook any contradictory effects on senior bonds and covered bond excess returns, we include interaction variables in table 6.1 (4)[1]. If a factor is significant, we use it to further examine if it can explain the difference in excess return between senior and covered bonds, using the matching method. This section will be a selection process for our matching method regressions.

6.1.1 The Five-factor Model

We explore if the five-factor model can explain excess return for senior and covered bonds. Following Fama and French (1993), we first introduce the three factors to see whether they have any explanatory power for bond returns in table 6.1 (1). RP and SMB are clearly significant with t-values of -6.19 and 9.38, respectively. HML however is insignificant. Fama and French find the three factor model to explain variations in bond returns when the bond market factors are not included. Our results are somewhat similar, however we find the coefficients to have opposite

[1]This is to be read as "table 6.1, regression 4". This will be the case for the remainder of our thesis.

Table 6.1: **Fixed Effects Selection Model**
This table reports the estimated coefficients and t-values from the fixed effects regressions. The excess return is calculated in bps. The sample consists of senior and covered bonds. Interaction variables are created by multiplying all variables with a covered bond dummy. They are denoted by their variable name, multiplied by "Covered Bond". The sample consists of daily observations of senior and covered bond pairs from January 2007 to January 2012.

	(1) R_{Total}	(2) R_{Total}	(3) R_{Total}	(4) R_{Total}	(5) R_{Total}
RP	-1.347***	-0.689***	-0.554**	-0.0223	-0.0305
	(-6.19)	(-3.43)	(-2.44)	(-0.05)	(-0.07)
SMB	5.070***	-0.753	-0.911*	-0.0310	-0.0566
	(9.38)	(-1.40)	(-1.78)	(-0.03)	(-0.06)
HML	-0.481	-0.221	-0.872	0.0173	0.00264
	(-0.69)	(-0.40)	(-1.43)	(0.02)	(0.00)
TERM		0.770***	0.602***	0.999***	0.998***
		(16.44)	(7.27)	(6.45)	(6.42)
DEF		0.742***	0.582***	0.999***	0.998***
		(14.55)	(6.85)	(6.28)	(6.24)
VSTOXX			-0.000458	0.000600	-0.00250
			(-0.03)	(0.04)	(-0.17)
iBoxx			0.240***	0.0000955	0.000219
			(3.61)	(0.00)	(0.00)
RP · Covered Bond				-1.064**	-1.064**
				(-2.53)	(-2.53)
SMB · Covered Bond				-1.760**	-1.760**
				(-2.03)	(-2.03)
HML · Covered Bond				-1.779**	-1.779**
				(-2.31)	(-2.31)
TERM · Covered Bond				-0.795***	-0.795***
				(-5.40)	(-5.40)
DEF · Covered Bond				-0.834***	-0.834***
				(-5.54)	(-5.54)
iBoxx · Covered Bond				0.479***	0.479***
				(4.25)	(4.25)
VSTOXX · Covered Bond				-0.00212	-0.00212
				(-0.68)	(-0.68)
Constant	3.763***	-4.910***	-5.093***	-5.093***	-4.991***
	(33.77)	(-7.66)	(-6.37)	(-6.37)	(-6.06)
Observations	84380	84380	84380	84380	84380
Adjusted R^2	0.029	0.185	0.190	0.211	0.211
Bank dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	No	No	No	No	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

signs to that of Fama and French. When they introduce $TERM$ and DEF in their regression, RP, SMB and HML lose all explanatory power. When we introduce the bond market factors in table 6.1 (2) however, RP remains significant at a one percent level.

In table 6.1 (2), $TERM$ and DEF are very significant with t-values of 16.44 and 14.55. They also contribute to a large increase in explanatory power as adjusted R^2 shifts from 2.9% in table 6.1 (1) to 18.5% in table 6.1 (2). Fama and French find their $TERM$ and DEF coefficients to have slopes close to one, while we find less steep slopes of 0.77 and 0.74. The RP coefficient differs significantly from Fama and French, while our bond market factors are more in alignment.

We control for $VSTOXX$ and the *iBoxx index* in table 6.1 (3). RP is significant at a 5% level. It contributes negatively to excess return for the sample. From Fama and French (1993) we know that unsecured corporate bonds should not be affected by the stock factors in the five-factor model, but there are no previous results for how they affect covered bonds.

We interact variables with a covered bond dummy in table 6.1 (4) to examine if the results differ for senior bonds and covered bonds. We find the effect of a variable on covered bond excess return by adding the coefficient we are interested in with the corresponding coefficient that is multiplied with the covered bond dummy[2].

We separate the effects of the three factor model for covered bond excess returns and senior bond excess returns in table 6.1 (4). We see interesting changes in the coefficients. Firstly, all stock factor coefficients for senior bonds become insignificant. The results are now in accordance with Fama and French, who find an insignificant three-factor model for explaining corporate bond returns, when bond factors $TERM$ and DEF are introduced. The slopes of our $TERM$ and DEF coefficients for senior bonds are close to 1, which is the case for Fama and French as well. Secondly, the interaction variables between covered bonds and the different stock factors are all significant at either 1% or 5% levels. In table 6.1 (4) we see that an increase in any of the three stock market factors leads to a decrease in the excess return for covered bonds. The reason behind the negative effect does not appear from the results, but is further investigated in table 6.2 and 6.3. All three stock factors have explanatory power for covered bond returns. We select the three stock market factors and the two bond market factors based on the regressions from the fixed effects selection model. These factors are used in the matching method regressions to try to explain the difference in excess return between senior bonds and covered bonds.

[2]For example, the effect of the DEF coefficient on senior bond excess return in (5) is 0.998, while the effect on covered bond excess return is $0.998 + (-0.834)$.

We include year dummies in table 6.1 (5). There are no significant differences in adjusted R^2, the coefficients or their corresponding t-statistics, when compared to 6.1 (4).

6.1.2 The VSTOXX and iBoxx Indexes

The excess return of the Markit iBoxx EUR Benchmark bond index and the daily closing prices for the The EURO STOXX 50 Volatility index are included as variables in table 6.1 (3) and (4).

The Markit iBoxx EUR Benchmark bond index is included as a proxy for changing market conditions. The excess return from this index acts as the bond market risk premium. We believe that senior bond and covered bond excess return should move somewhat in accordance with the bond market risk premium. An increase in the bond market risk premium, caused by bond market price increase, will increase bond market return. This should lead to increased returns for our bonds as they are a part of this market. The excess return for the *iBoxx index* variable is introduced in table 6.1 (3). An increase of one bps in the index excess return increases the excess return of the bonds in our sample by 0.24 bps. The index variable is significant at a 1% level, but does not move excess return for our bonds by much. Introducing an interaction variable between the index and a covered bond dummy in table 6.1 (4) investigates if the index affects senior bond and covered bond excess returns differently. The index coefficient now has an insignificant effect on senior bond excess return, but a significant effect on covered bond excess return. A one bps increase in the index excess return does not move senior bond excess return, but leads to a 0.48 bps increase in covered bond excess return. We include year dummies in 6.1 (5), but no major changes occur. The *iBoxx index* has a clear effect on covered bonds. We use this variable in later regressions to explain the difference in excess return between senior bonds and covered bonds.

The EURO STOXX 50 Volatility Index is a proxy for market volatility. Based on the value of the standard deviation of senior bond excess return in table 5.1, we suspect senior unsecured bonds to be more affected by volatility. As Martín et al. (2014) point out, demand for safer investments increase in times of financial turbulence. We include volatility in table 6.1 (3). There is no effect of volatility on excess return as the coefficient is insignificant. If our suspicions are correct, we have contradictory effects for covered bonds and senior bonds. We check this in table 6.1 (4) by introducing an interaction variable between volatility and a covered bond dummy. However, the results do not support our suspicion, as the coefficients are insignificant for the volatility variable and the interaction variable. We include year dummies in 6.1 (5), but no major changes occur. Due to no effect on excess return, the volatility variable is not included in the regressions utilizing the matching method.

In conclusion, we exclude volatility as a potential explanatory variable for the difference in excess return between senior and covered bond pairs. Additionally, we choose to further investigate the effects of the five-factor model and the *iBoxx index* on the difference in excess return between senior bonds and covered bonds.

6.2 The Matching Method Using Daily Data

Based on our research question we hypothesize that covered bond collateral is able to explain most of the variations in the difference in excess return between senior and covered bond pairs. Therefore we expect variables from the selection process to have little explanatory power as they are unrelated to the covered bond collateral. The endogenous variable is the difference in daily excess return, between senior bonds and covered bonds. This is denoted as $R_{\text{Senior}} - R_{\text{Covered}}$, where R_{Senior} is the excess return for the senior bond and R_{Covered} is the excess return for the covered bond.

6.2.1 Data Review

Table 6.2 (1) regresses the three stock factors on $R_{\text{Senior}} - R_{\text{Covered}}$. All three variables are economically and statistically significant. However, they do not explain much of the variation with an adjusted R^2 of 0.5%.

When we consider if the five-factor model can explain the difference variable in table 6.1 (2), we see an increase in adjusted R^2 to 4.3%. The two bond factors have stronger explanatory power than the stock factors. They are highly significant, while SMB and HML become insignificant. Still, RP is significant at a 1% level.

We control for the *iBoxx index* excess return in table 6.2 (3). Among the three stock factors, RP and SMB are significant at a 5% level while HML is significant at a 10% level. Additionally the adjusted R^2 increases to 5.8%. An increase in RP of 1 percentage point increases the difference in excess return by 1.04 bps. A one percentage point increase in SMB increases the difference in excess return by 1.73 bps while for HML it leads to an increase of 1.80 bps. All factors in the three factor model show a positive effect on the difference in excess return between senior

Table 6.2: **Matching Method - Daily Data**
This table reports the estimated coefficients and t-values from the matching method fixed effects regressions. The excess return is calculated in bps. The endogenous variable is the difference between excess return on senior and covered bonds, denoted by R_{Senior}-$R_{Covered}$. The sample consists of daily observations of difference in excess return between bond pairs, from January 2007 to January 2012.

	(1) R_{Senior}-$R_{Covered}$	(2) R_{Senior}-$R_{Covered}$	(3) R_{Senior}-$R_{Covered}$	(4) R_{Senior}-$R_{Covered}$
RP	2.138***	1.311***	1.040**	1.105***
	(5.33)	(3.32)	(2.44)	(2.72)
SMB	5.486***	1.414	1.726*	1.868**
	(6.58)	(1.51)	(1.98)	(2.24)
HML	1.839**	0.494	1.795**	1.778**
	(2.57)	(0.79)	(2.33)	(2.32)
TERM		0.458***	0.795***	0.796***
		(6.10)	(5.40)	(5.36)
DEF		0.515***	0.834***	0.836***
		(6.24)	(5.54)	(5.48)
iBoxx			-0.479***	-0.479***
			(-4.26)	(-4.27)
Constant	2.695***	-3.298***	-2.905***	-1.892*
	(14.91)	(-3.32)	(-3.18)	(-1.69)
Observations	42190	42190	42190	42190
Adjusted R^2	0.005	0.043	0.058	0.058
Bank dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	No	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

bonds and covered bonds. The *iBoxx index* coefficient is also quite significant, and contributes negatively to the difference in excess return by 0.48 bps.

Coefficients which do remain consistently significant however, are the bond factor coefficients for $TERM$ and DEF. Both show positive slopes. As previously seen in table 6.1 (2), the three stock factors become insignificant when we include $TERM$ and DEF for senior bonds. However, we see that when using the matching method RP and HML remains significant when $TERM$, DEF and the *iBoxx index* are included. SMB is significant at a 10% level, but we deem this too inaccurate. We see that an increase in $TERM$ of one bps increases the difference in return by 0.80 bps. An increase in DEF by one bps increases the difference by 0.83 bps.

We include time dummies in table 6.2 (4). This shows two noteworthy changes. RP is now significant at a 1% level, while SMB is significant at a 5% level. Thus, all stock factors have explanatory power.

We consider the dynamics of the explanatory variables for the matching method regression. We see in table 6.1 that an increase in any of the three stock factors leads to a decrease in excess return for covered bonds, i.e a higher difference between senior bond and covered bond excess return. $TERM$ and DEF affect both senior bonds and covered bond excess returns positively. However, senior bond excess returns are more affected, as discovered in table 6.1. This leads to a larger difference in excess return between senior and covered bond pairs. An increase in the bond market risk premium increases the excess return for covered bonds, while excess return for senior bonds are not affected. Therefore, the difference in excess return between senior bonds and covered bonds decreases.

6.2.2 Interpretation of Results

Throughout the regressions in table 6.2 we see that the RP coefficient has explanatory power for the difference in excess return between senior and covered bond pairs. The coefficients of RP, SMB and HML have explanatory power at a 5% level, albeit with a low adjusted R^2 of 0.5% in table 6.2 (1). This means that alone, the three-factor model is barely able to explain any of the difference in excess return.

In table 6.2 (2) we clearly see that $TERM$ and DEF have explanatory power. The five-factor model explains 4.3% of variations in difference in excess return.

We include year dummies in table 6.2 (4). We find that the five-factor model and the excess return for the *iBoxx index* have explanatory power for the difference variable. The coefficients in the matching method are in alignment with the coefficients from the fixed effects selection model, where we control for a wide range of factors. Thus we conclude that they have explanatory power for the difference variable.

Previous research (Fama & French, 1993) finds that the return of investment grade corporate bonds are not affected by the stock market. We find the same for our investment grade corporate bonds. Interestingly, the return on the covered bonds in our sample are affected by the stock market even though they are rated investment grade. The stock factors RP, SMB and HML have explanatory power for the excess return on covered bonds.

The two bond factors $TERM$ and DEF are the variables with the most explanatory power in table 6.2. Senior bonds are more affected by these factors than covered bonds. Based on the regressions in table 6.2, we conclude that $TERM$ and DEF are the most important factors in our data set, in terms of explaining the endogenous variable. The *iBoxx index* also contributes to explain $R_{\text{Senior}} - R_{\text{Covered}}$.

It has a negative coefficient, because it affects covered bonds more than senior bonds.

Using the matching method on daily data, we conclude that RP, SMB, HML, $TERM$, DEF and the *iBoxx index* have explanatory power for $R_{\text{Senior}} - R_{\text{Covered}}$.

6.3 The Matching Method Using Quarterly Data

Variables in regression 6.3 have been aggregated to quarterly data, in order to include a real estate index variable. The $VSTOXX$ variable is not included, as it has no explanatory power in the selection model [3]. A drawback to aggregating the data, is that the number of observations fall drastically from 42190 using daily data to 600 when using quarterly data. Our dependent variable is now the difference in quarterly excess return between bond pairs, $R_{\text{Senior}} - R_{\text{Covered}}$.

6.3.1 Data Review

Table 6.3 (1) shows that when we only include the real estate index as an explanatory variable, it is insignificant and has an adjusted R^2 of 0.2%. It remains insignificant in table 6.3 (2), (3) and (4), when controlling for the five-factor model, the *iBoxx index*, bank dummies and year dummies.

We control for the five-factor model in table 6.3 (2). Two of the three stock factors are insignificant. RP is significant at a 5% level, which is consistent with the results from table 6.2. $TERM$ is significant at a 5% level while DEF is significant at a 1% level. The inclusion of the five-factor model leads to an increase in adjusted R^2 to 10.1%. We include the excess return of the Markit iBoxx EUR Benchmark index in table 6.3 (3). It shows that $TERM$ and DEF become significant at a 1% level, along with the *iBoxx index*. Adjusted R^2 is 12.3%. RP becomes insignificant in table 6.3 (3), diverging from the model based on daily data. None of the three stock factors are significant in table 6.3 (3), or in (4), where we introduce year dummies. Adjusted R^2 decreases from 12.3% to 12%.

From table 6.3 (4), a one bps increase in $TERM$ and DEF increases $R_{\text{Senior}} - R_{\text{Covered}}$ by 44.37 bps and 44.5 bps, respectively. A one bps increase in the excess return of the *iBoxx index* decreases $R_{\text{Senior}} - R_{\text{Covered}}$ by 0.67 bps. Note that $TERM$ and DEF have mean values of 4.66 bps and -4.04 bps, while the mean value of the excess return for the *iBoxx index* is 89.84 bps[4].

[3] Regression results concerning the $VSTOXX$ variable can be found in A.2 of the appendix.

[4] Mean effects per quarter on $R_{\text{Senior}} - R_{\text{Covered}}$ are $-0.667 \cdot 89.84 = -59.92bps$ for the *iBoxx index*, $44.37 \cdot 4.66 = 206.76bps$ for $TERM$ and $44.5 \cdot -4.04 = -179.78bps$ for DEF.

Table 6.3: **Matching Method - Quarterly Data**
This table reports the estimated coefficients and t-values from the matching method regression. The excess return is calculated in bps. The endogenous variable is the difference between excess return on senior and covered bonds, denoted by $R_{\text{Senior}} - R_{\text{Covered}}$. The sample consists of 600 quarterly observations of difference in excess return between bond pairs, from January 2007 to January 2012.

	(1) R_{Senior}-R_{Covered}	(2) R_{Senior}-R_{Covered}	(3) R_{Senior}-R_{Covered}	(4) R_{Senior}-R_{Covered}
Real Estate Index	-7.916	6.867	5.884	-10.73
	(-1.00)	(1.05)	(0.97)	(-0.81)
RP		126.1**	15.72	109.3
		(2.11)	(0.23)	(1.09)
SMB		-353.1	-187.9	-172.0
		(-1.05)	(-0.65)	(-0.54)
HML		7.713	-48.15	-99.81
		(0.04)	(-0.24)	(-0.41)
TERM		15.29**	48.74***	44.37***
		(2.41)	(3.36)	(3.38)
DEF		20.10***	50.57***	44.50***
		(2.66)	(3.70)	(3.64)
iBoxx			-0.642***	-0.667***
			(-2.79)	(-3.37)
Constant	846.7	-666.3	-535.1	1070.3
	(1.06)	(-1.02)	(-0.89)	(0.84)
Observations	600	600	600	600
Adjusted R^2	0.002	0.101	0.123	0.120
Bank dummies	Yes	Yes	Yes	Yes
Year dummies	No	No	No	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

6.3.2 Interpretation of Results

The euro area real estate index does not have any explanatory power for the difference variable. It is insignificant throughout table 6.3 and does only explain 0.2% of the variance in the data. We deem the euro area real estate index as an ineffective proxy for covered bond collateral.

Table 6.3 (2), shows that RP is the only stock factor variable with a significant coefficient. We control for the *iBoxx index* in table 6.3 (3) and include year dummies in (4). RP becomes insignificant along with SMB and HML, diverging from the daily data results. No explanatory power can be given to any of the three stock factors from table 6.3.

$TERM$ and DEF have a high degree of collinearity, because both factors are in part constructed from the long-term government bond return. This point is also made in Chen et al. (1986) where the variables are constructed in a similar manner. We control for the real estate index, the *iBoxx index* and the three stock factors at a quarterly level. $TERM$ and DEF are still significant. This supports our claim that the bond factors are important variables in explaining the difference between senior and covered bond return, despite the presence of collinearity.

At 42190 observations, the model using daily data is clearly a model with more data points compared to 600, for quarterly data. Additionally the daily data will capture more of the daily variation in the variables. When aggregating the data the variance in the sample is greatly reduced. Due to a "smoothing out" of the variance present in the daily data, the adjusted R_2 is prone to become inflated as well. Hence, the adjusted R_2 for the daily and quarterly models cannot be compared. The change in coefficients for an entire quarter is large compared to daily observations. This makes direct comparison of coefficient size not possible. We cannot compare regressions in table 6.2 and in table 6.3 directly as the endogenous variables are not the same. However, we can prefer one model over the other. For factors where results differ between daily and quarterly data, we prefer the model using daily data, which has a higher number of observations and more variation.

6.4 Final Remarks on the Explanatory Variables

The Euro Area Real Estate Index: We include the euro area real estate index as a proxy for the collateral in covered bonds. The collateral is thought to be the main component that can explain the difference in excess return between senior and covered bonds. Through the matching method, using aggregated quarterly data, we find the euro area real estate index coefficient to be insignificant. It is not an efficient proxy for collateral for the covered bonds in our sample.

Stock Factors: The three stock factors are significant on a 5% level based on our daily data, but are all insignificant when aggregated to quarterly data. We prefer the model based on daily data. Due to high correlations between the three stock factors, the bond factors and the *iBoxx index*, multicollinearity may be a problem and lead to increased standard errors. Because they all are are significant at a 5% level, the issue of larger standard errors does not affect the outcome for daily data. Hence, we conclude that the stock factors RP, SMB and HML have explanatory power for the difference variable $R_{\text{Senior}} - R_{\text{Covered}}$.

DEF: DEF is calculated using excess return for a portfolio of senior bonds extracted from the Markit iBoxx EUR Benchmark index less the returns of long-term German government bonds. As the probability of default decreases, the price of the senior bonds in the portfolio used to calculate DEF increases. This in turn leads to an increase in the DEF variable. This suggests a positive effect on the excess returns in our sample. Table 6.1 shows an increased effect of DEF on senior bonds compared to covered bonds. This suggests that DEF coefficients should have positive signs when regressed on $R_{\text{Senior}} - R_{\text{Covered}}$, which is the case for our sample. DEF exhibits explanatory power throughout the regression models. We also note that the DEF coefficient for senior bond excess return is in accordance with the results in Fama and French (1993).

TERM: $TERM$ is a proxy for deviations of long term bond returns from expected bond returns, due to unexpected shifts in interest rates (Fama & French, 1993). Government bond returns affect the bonds in our sample positively[5]. When long term returns deviate positively, the returns for our senior and covered bonds should move positively as well, which is the case. Table 6.1 shows an increased effect of $TERM$ on senior bonds compared to covered bonds. This suggests that $TERM$ coefficients should have positive signs when regressed on $R_{\text{Senior}} - R_{\text{Covered}}$, which is also the case for our sample. $TERM$ exhibits explanatory power for $R_{\text{Senior}} - R_{\text{Covered}}$ throughout the regression models.

$TERM$ and DEF exhibit explanatory power throughout the regression models. They affect senior bond excess return positively and have slopes close to one. Thus both $TERM$ and DEF are in accordance with the results found by Fama and French (1993).

The Markit iBoxx EUR Benchmark Index: For the *iBoxx index*, we expect positive signs for both the variable coefficient and correlation coefficient with excess return. The index contains government, senior, covered and other investment grade bonds. We expect the *iBoxx index* excess return to give the direction for both senior bond and covered bond excess return. When utilizing fixed effects regressions our results are partially in line with this intuition. There is no significant effect in terms of explaining senior bond excess returns, but there is a significant effect on covered bond excess returns. The DEF variable is made up of excess return on a portfolio of medium term senior bonds extracted from the *iBoxx index*. Because the excess return of a portfolio of senior bonds is

[5]Results concerning this effect is shown in the appendix table A.5

controlled for in the *DEF* variable, we find it probable that this is the reason the *iBoxx index* variable is unable to explain the excess returns for senior bonds in our sample. This is not the case for covered bonds, where the index can, in part, explain excess return. These results are the same for daily and quarterly data. Based on daily and quarterly data for the matching method, the *iBoxx index* excess return has explanatory power for the difference variable.

7 | Robustness

In this chapter we perform several robustness checks on our data to gauge the validity of our sample and our results. We investigate bond similarity and compute variance inflation factors. Finally, we study the impact of the financial crisis and look at the validity of the housing index as a proxy for collateral.

7.1 Bond Specific Factors

Through the data extraction process we aim to select same issuer bond pairs of senior bonds and covered bonds with identical characteristics. However, some bonds differ in rating and notional amount. Through fixed effects regressions we examine if these characteristics affect excess returns for the bonds in our sample.

In the fixed effects regressions in table 7.1 we include the bond-specific factors *rating* and *notional amount* and interact them with covered bond dummies. We also check for potential non-linear effects. These regressions examine the explanatory power of bond specific factors on R_{Total}, for both senior bonds and covered bonds.

From table 7.1 we find that *rating* does not affect excess returns for the bonds in our sample. The *rating* coefficient and the interaction coefficient for covered bond excess return are both insignificant. Even though some bonds differ in rating, it does not affect excess return.

Notional amount has a statistically significant effect on the excess returns in our sample. Additionally, a non-linear relationship exists, which means that an increase in notional amount becomes less significant the higher the value of *notional amount*. However, we note that *notional amount* does not affect senior bond excess return and covered bond excess return differently. The *notional amount* interaction coefficient is insignificant. At the same time, *notional amount* cannot explain any of the variation in excess return due to a low R^2. The bond specific characteristics do not affect the endogenous variable when we utilize the matching method.

Table 7.1: **Bond Specific Factors**
This table shows the explanatory power of notional outstanding amount and bond rating on R_{Total}. Interaction coefficients with said factors and covered bonds, as well as squared values of notional amount are included. They are denoted by their variable name, multiplied by "Covered Bond". Excess return is calculated in bps. The sample consists of daily observations of senior and covered bond pairs from January 2007 to January 2012.

	(1) R_{Total}
Notional Amount	2.625***
	(2.99)
Notional Amount^2	-0.701***
	(-2.94)
Notional Amount · Covered Bond	0.168
	(0.81)
Rating	0.455
	(1.46)
Rating · Covered Bond	0.128
	(0.26)
Constant	1.524
	(1.51)
Observations	84380
Adjusted R^2	0.003
Bank dummies	Yes
Year dummies	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

7.2 The Variance Inflation Factor

The Variance Inflation Factor (VIF) indicates the extent of multicollinearity in our regressions [1]. A large VIF shows that a coefficient experiences a large increase in variance due to collinearity.

In practice, there have been set certain rules of thumb regarding the value of the VIF, and when it becomes a problem. The values range from 5-10, but there is no definitive value to what is acceptable and what is not. Therefore it is important to put the results of the calculated VIF in context to what is being researched. A large VIF suggests that multicollinearity is a problem, but this does not necessarily mean that variables should be removed from the model. Thus looking at the size of the VIF alone is of limited use (Woolridge, 2016, p. 86).

Using the VIF, we confirm our suspicions of collinearity between $TERM$ and DEF in the sample. In table 7.2 we see VIF values of 44.16 and 37.72, which

[1] Formula and specifics for the Variance Inflation Factor can be found in section B.3 of the appendix.

Table 7.2: **VIF**
The table shows the regression coefficients for the matching method for daily data in the first column (denoted as R_{Sen}-R_{Cov}) and the corresponding VIF in the second column.

	R_{Sen}-R_{Cov}	VIF
RP	1.060***	2.88
SMB	1.758**	2.38
HML	1.783***	1.50
TERM	7950.3***	44.16
DEF	8344.4***	37.72
iBoxx	-4796.9***	2.71
Constant	0.128	
Observations	42190	

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

according to the test shows clear evidence of collinearity. For RP, SMB, HML and $iBoxx$, no collinearity is indicated.

We acknowledge the presence of collinearity in $TERM$ and DEF. As previously discussed the presence of collinearity does not constitute the removal of the variables, as they are both statistically and economically significant.

7.3 Excluding the Financial Crisis From Matching Method Regression

The financial crisis of 2007-08 covers a significant portion of our sample. Table 7.3 shows the mean daily excess return, standard deviation, as well as minimum and maximum values for the period. We see increased volatility during the financial crisis. The standard deviation of R_{Covered} is especially influenced by the crisis, at 28.62 bps in table 7.3, compared to the sample period standard deviation of 22.7 bps in table 5.1. The standard deviation for R_{Total} for the subperiod of the financial crisis is 35.08 bps, compared to 33.1 bps for the whole sample period. We also see a large difference in mean daily excess returns for senior bonds. During the crisis, senior bonds have a mean daily excess return of 0.65 bps compared to 1.21 bps for the whole sample period.

Given the increased volatility in financial markets during this period, we choose to examine the effect of excluding the observations of 2007 and 2008 from our sample[2]. We conduct summary statistics and perform matching method regressions on a subsample, ranging from January 2009 to January 2012. This is done to investigate whether the explanatory power of the factors are caused by the financial

[2]We remove 17824 observations from the original total amount of observations of 84380. This is equivalent to about 21% of our total observations.

Table 7.3: **Excess Return During the Financial Crisis**
This table shows summary statistics for our sample during the financial crisis. R_{Total} is the excess return for the whole sample, R_{Covered} is the excess return for the covered bonds subsample and R_{Senior} is the excess return for the senior bond subsample. σ is the standard deviation. The period ranges from January 2007 to December 2008. All numbers are presented in bps.

	mean	σ	min	max
R_{Total}	0.91	35.08	-1610.41	1134.27
R_{Covered}	1.17	28.62	-1398.01	1134.27
R_{Senior}	0.65	40.52	-1610.41	1132.81
Observations	17824			

Table 7.4: **Excess Return Excluding the Financial Crisis**
This table shows summary statistics for our sample, when the financial crisis is excluded. R_{Total} is the excess return for the whole sample, R_{Covered} is the excess return for the covered bonds subsample and R_{Senior} is the excess return for the senior bond subsample. σ is the standard deviation. The period ranges from January 2009 to January 2012. All numbers are presented in bps.

	mean	σ	min	max
R_{Total}	1.35	32.52	-3193.35	1281.38
R_{Covered}	1.33	20.83	-393.06	518.69
R_{Senior}	1.36	41.00	-3193.35	1281.38
Observations	66556			

crisis.

Summary statistics excluding the financial crisis for R_{Total}, R_{Senior} and R_{Covered} are found in table 7.4. When comparing these results to those found in table 5.1, the largest change is seen in senior bond excess returns, with an increase from 1.21 bps to 1.36 bps when the financial crisis is removed. Excess return is higher for senior bonds than for covered bonds in this subperiod. However, we are more interested in the change in standard deviation. Standard deviation for R_{Total} changes from 33.1 in table 5.1, to 32.5 in table 7.4, R_{Covered} from 22.7 to 20.8 and R_{Senior} from 40.9 to 41.0. This shows that the financial crisis does contribute to larger standard deviations in our sample. The largest change is seen in R_{Covered}, where standard deviation is reduced by 8.2% when the financial crisis is removed from the sample period.

When we exclude the financial crisis in our matching method regressions in table 7.5, $TERM$, DEF and the *iBoxx index* are significant at a 1% level. For these variables there are no significant changes in coefficients or significance levels when we compare the subsample with the original sample.

In table 7.5, RP is now significant at a 1% level, while HML is significant only at a 10% level along with SMB. The stock market risk premium RP has

Table 7.5: **Matching Method Excl. the Financial Crisis**
This table reports the estimated coefficients and t-values from the matching method regression excluding the financial crisis. The excess return is calculated in bps. The endogenous variable is the difference between excess return on senior and covered bonds, denoted by R_{Senior}-$R_{Covered}$. The sample consists of daily observations of difference in return between bond pairs, from January 2009 to January 2012.

	R_{Senior}-$R_{Covered}$
RP	1.455***
	(3.14)
SMB	2.019*
	(1.78)
HML	1.192*
	(1.79)
TERM	0.789***
	(6.27)
DEF	0.831***
	(6.42)
iBoxx	-0.488***
	(-4.70)
Constant	3.053**
	(2.34)
Observations	33278
Adjusted R^2	0.073
Bank dummies	Yes
Year dummies	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

explanatory power throughout the sample period, while the explanatory powers of SMB and HML deteriorates when the financial crisis is removed. Thus, the financial crisis is not the reason for the significance of the RP coefficient in our original sample period from January 2007 to January 2012. SMB and HML decline in significance when the financial crisis is removed from the sample. Thus we have an observable effect of removing the financial crisis. Namely, SMB and HML are no longer significant at 5% levels. We deem the decline in t-value and significance a reason to not state that SMB and HML have explanatory power for the difference in excess return between senior and covered bond pairs.

The reason for RP increasing the difference in excess return is the negative effect it has on covered bond excess return, as we see in table 6.1 (4). The financial crisis is not the reason that the stock market risk premium affects covered bond returns. We note that Okunev, Wilson, and Zurbruegg (2000) find a nonlinear causal unidirectional relationship from the U.S stock market to the U.S real estate market. However, we are not able to perform any test on our dataset to investigate if such a reasoning can explain the significance of RP.

7.4 Country Specific Residential Real Estate Indexes

We use the euro area real estate index as a proxy for collateral. However, the development of real estate prices in Europe differ between countries. The pairs of senior and covered bonds are issued in EUR, but are not necessarily issued by a European bank. As a result, the European housing index does not represent all bank covered pools.

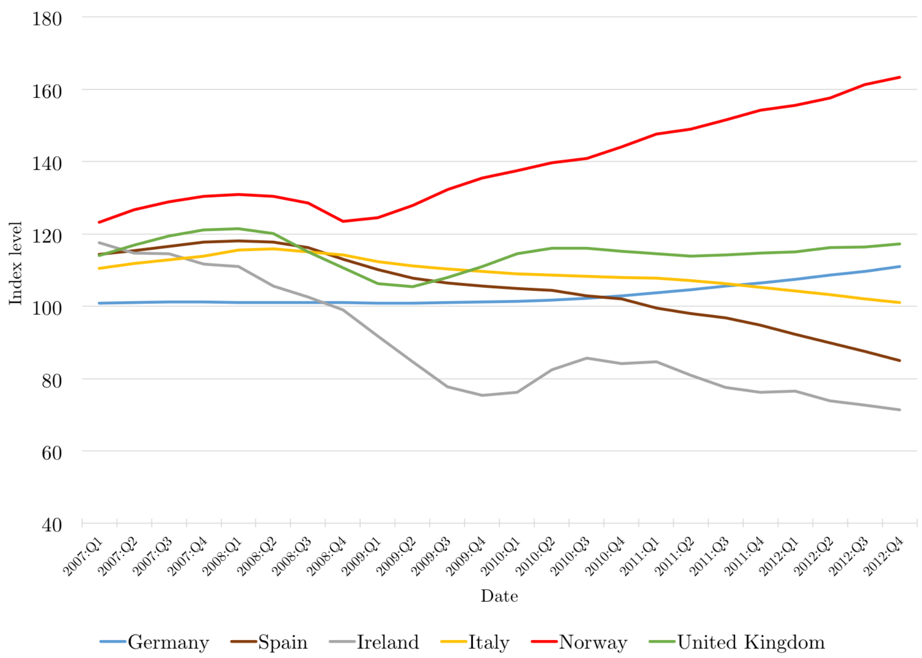

Figure 7.1: **Real Estate Indexes**
The figure shows development in real estate indexes for Germany, Spain, Ireland, Italy, Norway and the United Kingdom. The indexes are compiled on a quarterly basis, from Q1 2007 to Q4 2012, with Q1 2005 as initial index value equal to 100. The vertical axis shows index level and the horizontal axis shows the date in quarterly format. Source: Mack and Martínez-García (2011) from the Federal Reserve Bank of Dallas international house price database.

During the financial crisis, housing markets in European countries responded very differently depending on preliminary economic conditions. This country specific variation in covered bond collateral is not captured in our real estate index, as it averages development of the whole euro area. Figure 7.1 displays the development in national real estate indexes from 2007 to 2012 for six of the European countries in our sample. We graph these six real estate indexes to show that European housing markets develop differently throughout our sample period. Notice especially the index levels of Norway and Ireland, which are the two “outlier” nations in our sample. Country specific real estate indexes should be used as proxies for covered bond collateral as the euro area real estate index does not capture all the variations in real estate development. However, due to a limited number of observations per issuer nation, we are not able to include country specific real estate indexes.

8 | Conclusion

In our thesis we explore the research question: *To what extent can other factors than collateral be found to explain the difference in excess returns between senior bonds and covered bonds?*

We examine daily data and use fixed effects regressions to select potential factors to explain the difference in excess return. RP, SMB, HML, $TERM$, DEF and the *iBoxx index* are selected. Through the matching method we construct the difference variable $R_{\text{Senior}} - R_{\text{Covered}}$, which is the difference in excess return between senior and covered bond pairs. The variables selected in the fixed effects regressions are regressed on the difference variable, for both daily and quarterly data.

Previous research finds that the stock market risk premium RP has no explanatory power for investment grade corporate bond returns. We see the same results for our investment grade corporate bonds. For our investment grade covered bonds however, we find that RP affects the excess return negatively. A one percentage point increase in RP increases the difference in excess return by 1.06 bps.

Senior bond excess returns are more affected by unexpected interest rate changes than covered bond excess returns. A one bps increase in $TERM$ increases the difference in excess return between senior and covered bonds by 0.80 bps.

Senior bonds are unsecured, and more affected by changes in default probability. An increase in DEF by one bps increases the difference by 0.84 bps.

Covered bond excess returns are more affected by changes in the bond risk premium than senior bond excess returns. An increase in the *iBoxx index* by one bps decreases the difference in excess return between senior and covered bonds by 0.48 bps.

Our secondary objective is to test the validity of the euro area real estate index as a proxy for covered bond collateral in our sample. We find it to be an ineffective proxy for collateral. This is because the euro area real estate index does not account for country specific developments in real estate markets.

After we control for the financial crisis, we find four factors other than collateral affecting the difference in return between senior and covered bonds, namely RP, DEF, $TERM$ and the excess return of the *iBoxx index*.

8.1 Limitations and Further Research

One of the main limitations of our thesis is the exclusion of country specific real estate indexes as collateral proxies. Due to a limited number of observations for country specific real estate indexes per issuer nation, the euro area real estate index is chosen as the proxy for covered bond collateral. Further research should incorporate real estate indexes for every issuer nationality as proxies for covered bond collateral. This should be done in order to include country specific covered pools, which will reflect the development of the banks' collateral in a more exact manner.

Our sample period includes events causing periods of financial turbulence. Unusual market activity might affect the sample period, which is the case for the period containing the financial crisis. As a robustness check we exclude the financial crisis from the sample period. The drawback however, is that this reduces the number of observations for the period significantly. Further research should collect data with a longer sample period and compare periods with and without the presence of financial instability.

We find that the stock market risk premium, RP, affects the difference in excess return between senior bonds and covered bonds. This is because it affects excess return for covered bonds. Further research should investigate if this relationship holds for longer periods and why RP affects covered bond excess return. The unidirectional causal relationship Okunev et al. (2000) find between the U.S stock market and the real estate market should be examined for European markets. This should be done to investigate if RP affects covered bond excess return due to ties to the real estate market.

References

Amihud, Y., & Mendelson, H. (1991). Liquidity, maturity, and the yields on us treasury securities. *The Journal of Finance*, *46*(4), 1411–1425. doi: 10.2307/2328864

Anand, K. (2016, September). *Covered bonds – safe assets with side effects?* (No. 6). Retrieved 29.04.18, from https://www.bundesbank.de/Redaktion/EN/Downloads/Bundesbank/Research_Centre/2016_06_research_brief.pdf?__blob=publicationFile

Bauer, R., Koedijk, K., & Otten, R. (2005). International evidence on ethical mutual fund performance and investment style. *Journal of Banking & Finance*, *29*(7), 1751–1767. doi: 10.1016/j.jbankfin.2004.06.035

Berk, J., & DeMarzo, P. (2014). *Corporate finance* (3rd ed.). Essex: Pearson Education Limited.

Chen, N.-F., Roll, R., & Ross, S. A. (1986). Economic forces and the stock market. *The Journal of Business*, *59*(3), 383–403. doi: 10.1086/296344

Dolinar, D., Orsag, S., & Suman, P. (2015). Test of the chen-roll-ross macroeconomic factor model: Evidence from croatian stock market. *UTMS Journal of Economics*, *6*(2), 185–196.

Elton, E. J., Gruber, M. J., Agrawal, D., & Mann, C. (2001). Explaining the rate spread on corporate bonds. *the journal of finance*, *56*(1), 247–277. doi: 10.1111/0022-1082.00324

European Commision. (2015). *Report on article 503 of regulation (eu) no 575/2013.* Brussels: European Commision. Retrieved 01.03.18, from https://ec.europa.eu/info/business-economy-euro/banking-and-finance/financial-supervision-and-risk-management/managing-risks-banks-and-financial-institutions/covered-bonds_en

Fama, E. F., & French, K. R. (1992). The cross-section of expected stock returns. *the Journal of Finance*, *47*(2), 427–465. doi: 10.2307/2329112

Fama, E. F., & French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, *33*(1), 3–56. doi: 10.1016/

0304-405X(93)90023-5

Fama, E. F., & French, K. R. (1996). Multifactor explanations of asset pricing anomalies. *The journal of finance*, *51*(1), 55–84. doi: 10.2307/2329302

French, K. (2018). *Data library.* Retrieved 05.03.18, from http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Helberg, S., & Lindset, S. (2016). Risk protection from risky collateral: Evidence from the euro bond market. *Journal of Banking & Finance*, *70*, 193–213. doi: 10.1016/j.jbankfin.2016.06.001

Helberg, S., & Lindset, S. (2018). *Collateral affects return risk: Evidence from the euro bond market.* Norwegian University of Science and Technology: Unpublished paper.

Helwege, J., Huang, J.-Z., & Wang, Y. (2014). Liquidity effects in corporate bond spreads. *Journal of Banking & Finance*, *45*, 105–116. doi: 10.2139/ssrn.1364681

Kamara, A. (1994). Liquidity, taxes, and short-term treasury yields. *Journal of Financial and Quantitative Analysis*, *29*(3), 403–417.

Kempf, A., Korn, O., & Uhrig-Homburg, M. (2012, 05). The term structure of illiquidity premia. , *36*. doi: 10.1016/j.jbankfin.2011.12.003

Koziol, C., & Sauerbier, P. (2003, March). Valuation of bond illiquidity: An option-theoretical approach. *EFA Annual Conference Paper*(354), 38. doi: 10.2139/ssrn.424282

Kreander, N., Gray, R. H., Power, D. M., & Sinclair, C. D. (2005). Evaluating the performance of ethical and non-ethical funds: a matched pair analysis. *Journal of Business Finance & Accounting*, *32*(7-8), 1465–1493. doi: 10.1111/j.0306-686X.2005.00636.x

Longstaff, F. A., & Schwartz, E. S. (1995). A simple approach to valuing risky fixed and floating rate debt. *The Journal of Finance*, *50*(3), 789–819. doi: 10.1111/j.1540-6261.1995.tb04037.x

Mack, A., & Martínez-García, E. (2011). *A cross-country quarterly database of real house prices: a methodological note* (Globalization and Monetary Policy Institute Working Paper No. 99). Dallas: Federal Reserve Bank of Dallas. Retrieved 19.04.18, from https://EconPapers.repec.org/RePEc:fip:feddgw:99

Macrobond. (2018). (Data retrieved 20.02.2018 from the Macrobond application database)

Martín, R. A., Sevillano, J. M. M., & González, L. R. (2014). Covered bonds: The renaissance of an old acquaintance. *Banco de España Estabilidad Financiera*, *24*, 67–87.

Merton, R. C. (1973). An intertemporal capital asset pricing model. *Econometrica*, *41*(5), 867–887. Retrieved from http://www.jstor.org/stable/1913811 doi: 10.2307/1913811

Okunev, J., Wilson, P., & Zurbruegg, R. (2000). The causal relationship between real estate and stock markets. *The Journal of Real Estate Finance and Economics*, *21*(3), 251–261. doi: 10.1023/A:1012051719424

Prokopczuk, M., Siewert, J. B., & Vonhoff, V. (2013). Credit risk in covered bonds. *Journal of Empirical Finance*, *21*, 102–120. doi: 10.2139/ssrn.1686787

Renneboog, L., Ter Horst, J., & Zhang, C. (2008). Socially responsible investments: Institutional aspects, performance, and investor behavior. *Journal of Banking & Finance*, *32*(9), 1723–1742. doi: 10.1016/j.jbankfin.2007.12.039

STOXX. (2018). *Stoxx® strategy index guide* (34th ed.). Retrieved 25.04.2018, from https://www.stoxx.com/document/Indices/Common/Indexguide/stoxx_strategy_guide.pdf

Woolridge, J. M. (2016). *Introductory econometrics: A moden approach* (6th ed.). Boston: Cengage Learning.

Zerbib, O. D. (2017). *The green bond premium.* Tilburg School of Economics and Management: Unpublished paper. Retrieved 19.03.2018, from https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2889690

A | Appendix

A.1 Linear Approximation

Table A.1 shows the summary statistics for quarterly excess return when using linear approximation. The approximation is done by summarizing daily excess returns for a quarter. We see that excess return based on linear approximation deviates slightly from excess return calculated using the formula in chapter 4.5. This is due to linear approximation not accounting for the convexity in the curve for excess return.

Table A.1: **Excess Return Aggregated Quarterly Data - Linear Approximation**

This table shows summary statistics for our sample for aggregated quarterly data using linear approximation. R_{Total} is the excess return for the whole sample, $R_{Covered}$ is the excess return for the covered bonds subsample and R_{Senior} is the excess return for the senior bond subsample. σ is standard deviation. The period ranges from January 2007 to January 2012. All numbers are presented in bps.

	mean	σ	min	max
R_{Total}	68.56	259.39	-2970.54	1293.88
$R_{Covered}$	78.37	208.36	-1014.47	774.89
R_{Senior}	58.75	301.79	-2970.54	1293.88
Observations	1200			

A.2 Fixed Effects Regressions For Quarterly Data

Table A.2 shows fixed effects regressions on aggregated quarterly data. The table contains all the variables from table 6.1 and the euro area real estate index. These variables are still in the regression but are dropped from the table. The $VSTOXX$ coefficient is insignificant throughout the regression table, as is the case for fixed effect regressions for daily data. Therefore, $VSTOXX$ is not selected as a potential factor to explain the difference in excess return for quarterly data.

Table A.2: **Fixed Effects Selection Model Quarterly Data**
This table reports the estimated coefficients and t-values from the fixed regression for quarterly data. The excess return is calculated in bps. The sample consist of both senior and covered bonds. Interaction variables are created by multiplying all variables with a covered bond dummy. They are denoted by their variable name, multiplied by “Covered Bond”. This table contains the same variables as table 6.1 and the euro area real estate index, but is collapsed to show the effects of VSTOXX for senior and covered bond excess return. The sample consists of quarterly observations of senior and covered bond pairs from January 2007 to January 2012.

	(1) R_{Total}	(2) R_{Total}	(3) R_{Total}
VSTOXX	-1.182	-0.446	-0.383
	(-0.90)	(-0.27)	(-0.16)
VSTOXX · Covered Bond			-0.126
			(-0.08)
Observations	1200	1200	1200
Adjusted R^2	0.396	0.405	0.439
Bank dummies	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.3 Bankgroup and Country of Origin

Table A.3 shows each issuer and its corresponding country of origin. There is a total of 70 issuers. The issuer countries of origin are mainly European, but the sample also includes Australia, New Zealand, the United States and Canada.

Table A.3: **Bank and Country of Origin**
The table shows every bank present in our sample with the corresponding country of origin. The sample has a total of 70 individual banks.

Bank	Country	Bank	Country
ABN Amro	Netherlands	Danske Bank	Denmark
ANZ	Australia	Den Norske Bank	Norway
Abbey National	UK	Deutsche Apotheker - und Aertzebank	Germany
Allied Irish Banks	Ireland	Deutsche Bank	Germany
BAWAG	Austria	Deutsche Postbank	Germany
BBVA	Spain	Dexia	Belgium
BNP	France	Erste Group Bank	Austria
BNZ	New Zealand	HSBC	UK
BP Milano	Italy	HSH Nordbank	Germany
BPCE	France	HVB	Germany
Banca Carige	Italy	Handelsbanken	Sweden
Banca Intesa	Italy	ING	Netherlands
Banca Monte dei Paschi di Siena	Italy	LBBW	Germany
Bancaja	Spain	La Caixa	Spain
Banco Comercial Portugues	Portugal	Landesbank Rheinland-Pfalz	Germany
Banco Espirito Santo	Portugal	Lloyds	UK
Banco Popolare	Italy	Nationwide	UK
Banco Popular Espanol	Spain	Nordea	Sweden
Banco Sabadell	Spain	Northern Rock	UK
Banco Santander Totta	Portugal	Nykredit	Denmark
Banesto	Spain	OTP Bank	Hungary
Bank of America	US	Pohjola Bank	Finland
Bank of Ireland	Ireland	Raiffeissen Bank	Austria
Bank of Scotland	UK	Royal Bank of Canada	Canada
Barclays	UK	Royal Bank of Scotland	UK
BayernLB	Germany	SEB	Sweden
Berlin Hyp	Germany	SNS Bank	Netherlands
Bradford & Bingley	UK	Santander	Spain
Caisse d'Epargne	France	Societe Generale	France
Caixa Geral de Depositos	Portugal	Swedbank	Sweden
Caja Madrid	Spain	UBI Banca	Italy
Commerzbank	Germany	UBS	Switzerland
Credit Agricole	France	UniCredit	Italy
Credit Mutuel	France	WestLB	Germany
Credit Suisse	Switzerland	Westpac	Australia

A.4 Pooled OLS

Pooled OLS uses regular OLS estimation on a panel data set. A linear regression line is fitted on the whole sample. Pooled OLS focuses on the cross-sectional dimension of the data and neglects the time-dimension of the data.

If the data exhibits heterogeneity, the pooled OLS estimators are effected by heterogeneity bias. Heterogeneity bias might exist if there are unobserved effects due to differences in the banks issuing the bonds. If these bank specific variables are omitted, the pooled OLS estimators will be biased. Results from fixed effects and pooled OLS regressions on our sample are quite similar. However, we choose to use fixed effects to account for possible omitted bank and time specific effects.

Table A.4: **Matching Method - Daily Data**
This table reports the estimated coefficients and t-values from the matching method pooled OLS regression. The excess return is calculated in bps. The endogenous variable is the difference between excess return on senior bonds and covered bonds, denoted by R_{Senior}-$R_{Covered}$. The sample consists of daily observations of difference in return between bond pairs, from January 2007 to January 2012.

	(1) R_{Senior}-$R_{Covered}$	(2) R_{Senior}-$R_{Covered}$	(3) R_{Senior}-$R_{Covered}$
RP	2.167***	1.340***	1.060**
	(5.46)	(3.44)	(2.52)
SMB	5.540***	1.464	1.758**
	(6.65)	(1.58)	(2.04)
HML	1.824**	0.480	1.783**
	(2.55)	(0.77)	(2.32)
TERM		0.458***	0.795***
		(6.11)	(5.40)
DEF		0.514***	0.834***
		(6.25)	(5.54)
iBoxx			-0.480***
			(-4.26)
Constant	0.0497	-0.274**	0.128
	(0.54)	(-2.18)	(1.60)
Observations	42190	42190	42190
Adjusted R^2	0.006	0.044	0.059

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

A.5 Slope of Return on Government Bonds

Table A.5 shows the long-term German government bond returns regressed on R_{Total}. We see that an increase in the long-term bond return of one bps increases excess return for our sample by 0.12 bps. There is a statistically significant positive contribution from the government bond returns.

Table A.5: **Effect of Government Long Term Return**
This table shows the fixed effects regression of return on long term government bonds on the excess return of the bonds in the sample. Calculated in bps.

	R_{Total}
German Government Long-term Bond Return	0.118***
	(77.06)
Constant	0.0000732***
	(5.92)
Observations	84380
Adjusted R^2	0.068
Bank dummies	Yes
Year dummies	Yes

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

B | Appendix

B.1 Heteroskedasticity

The linear regression model is given by

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u \tag{B.1}$$

where β_0 is the constant, β_1 the coefficient for variable x_1, β_2 the coefficient for variable x_2, and generally β_k the coefficient for variable x_k. u is the error term. When the assumptions of homoskedastic error terms holds then

$$Var(u|x_1, x_2, ..., x_k) = \sigma^2 \tag{B.2}$$

This means that the variance of the error term is constant over all variables and time. If the error term is not constant over all variables and time, it can be said to be dependent on the particular value of x_i. Then

$$Var(u|x_1, x_2, ..., x_k) = {\sigma_i}^2 \tag{B.3}$$

With heteroskedastic standard errors the variances of the beta coefficients will be biased, and regular t-tests and F-tests are no longer valid. It is therefore important to test for the presence of heteroskedasticity.

The Breusch-Pagan test searches for heteroskedasticity in linear form, meaning it does not search for other non-linear variants of heteroskedasticity (Woolridge, 2016, p. 250). First, estimate the regression

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_k x_k + u \tag{B.4}$$

Then, square the error term of this regression, and perform the following regression

$$\hat{u}^2 = \delta_0 + \delta_1 x_1 + \delta_2 x_2 + ... + \delta_k x_k + error \tag{B.5}$$

Then, test the hypothesis $H_0 : \delta_1 = \delta_2 = ... = \delta_\text{k} = 0$, versus the alternative hypothesis of $H_1 : Not\ H_0$. The F-statistic for this test is calculated as

$$F = \frac{R^2_{\hat{u}^2} \ / \ k}{1 - R^2_{\hat{u}} \ / \ n - k - 1} \tag{B.6}$$

where n is the number of observations and $R^2{}_{\hat{u}^2}$ is the value of R^2 from the regression on $\hat{u}^2$ and k is the number of variables. If the null hypothesis is rejected then the presence of heteroskedasticity in the dataset is confirmed. The LM-statistic can also be used. It uses a chi-squared distribution and is given by

$$LM = n \cdot R^2_{\hat{u}^2} \tag{B.7}$$

By constructing robust standard errors one can circumvent this issue. This is easily done in Stata or any other similar regression software. The estimated variances of the beta coefficients will no longer be biased, and regular t-tests and F-tests are valid.

Test Results: Heteroskedasticity is a known issue in financial data. For our dataset we apply the Breusch-Pagan test to search for heteroskedastic error terms. For regressions using both the selection model and matching methods, we see chi-squared values of 12,8849.90 and 15,3397.64, respectively. Clear evidence of heteroskedasticity is seen, as the test values are far beyond critical values. We therefore use cluster robust standard errors for all regressions.

B.2 The RESET Test for Functional Form Misspecification

Test Specifics Consider a linear model, given by

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_\text{k} x_\text{k} + u \tag{B.8}$$

where β_0 is the estimated constant, β_1 the coefficient for variable x_1, β_2 the coefficient for variable x_2, and generally β_k the coefficient for variable x_k. u is the error term. We can perform the RESET test to examine if the model specification is correct. The test can examine if non-linear effects are missing from the model, or indicate if a logarithmic function form is more suitable.

The test is performed by saving the fitted values of the regression of the original regression model (Woolridge, 2016, p. 277). New variables of the fitted values are raised to a power. Squared and cubed fitted values are common to include, but no correct answer is given to which power to raise the fitted values.

For our data, we raise the fitted values up to the power of four as this is common practice in Stata. We have heteroskedastic error terms and therefore perform the test manually as Stata does not account for robust standard errors. Including the fitted values, we get the regression

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + ... + \beta_\text{k} x_\text{k} + \delta_1 \hat{y}^2 + \delta_2 \hat{y}^3 + \delta_3 \hat{y}^4 + u \tag{B.9}$$

The regression equation tests whether important non-linear effects are excluded through the coefficients of $\hat{y}^2$, $\hat{y}^3$ and $\hat{y}^2$. The null hypothesis is that the original regression model is correctly specified, namely $H_0 : \hat{y}^2 = \hat{y}^3 = \hat{y}^4 = 0$, tested using F-statistics. The alternative hypothesis suggest that we have functional form problems. However, it does not suggests what type of functional form problems.

Test Results: RESET tests for table 6.1 (4), table 6.2 (3) and table 6.3 (3) are performed. For table 6.1 (4) the F-statistics is 0.05, or a p-value of 0.9837. We cannot reject the null hypothesis. For the matching method regression of daily data, table 6.2 (3), the F-statistics is 0.07, or a p-value of 0.977. We cannot reject this null hypothesis either. Finally, we perform the test in the matching method for quarterly data. The F-statistics is 0.36, with a p-value of 0.7813. The null hypothesis is not rejected for any of the regressions, indicating no problem with functional form.

B.3 The Variance Inflation Factor

Test Specifics The Variance inflation factor (VIF) indicator is obtained by estimating a linear regression, where one exogenous variable is regressed on all other exogenous variables from the original regression (Woolridge, 2016, p. 86). The VIF is calculated as

$$VIF = \frac{1}{1 - {R^2}_j} \tag{B.10}$$

where ${R^2}_j$ is the explained variance from the linear regression for variable j. A high R^2 results in a high VIF. This leads to a higher variance for the coefficient, which is calculated as

$$Var(\hat{\beta}_j) = \frac{\sigma^2}{(n-1)Var(\hat{x}_j)} \cdot VIF \tag{B.11}$$

where $Var(\hat{\beta}_j)$ is the variance for the estimated coefficient j, n is the number of observations, $Var(\hat{x}_j)$ is the variance of the estimated coefficient of variable j and σ^2 the variance of the error term. The VIF shows the increase in variance for coefficient j, due to variable j correlating with the other explanatory variables.