MASTER THESIS

Course code: BE305E

Candidate name: Petter Berg

Predicating the Credit Spread Difference Between Nordic and European High-Yield

Date: 18.05.2022

Total number of pages: 75

NORD University

www.nord.no

Abstract

The main objective of this thesis is to identify and measure explanatory factors of observed credit spread difference between Nordic and European High Yield Bonds. From dataset consisting of 141 Nordic bonds and 124 Euro bonds, in the period 2017-2021. I have implemented a structural model for bond pricing and credit spread in order to develop understanding of European and Nordic High Yield bond markets. The structural model estimates the part of credit spread being compensated by credit risk, consisting of default probability, and expected recovery given default. Furthermore, I estimate the differences between Nordic and European market, with respect to bond features, liquidity, correlation to equity market, and firm characteristics. Based on difference in monthly average data for all variables in both markets. The variables are evaluated trough regression analysis to interpret the relationship between variable differences, and credit spread difference between the two HY markets.

The results indicate that credit risk compensation in credit spreads is 60% in the Nordic and 70% in the European market trough the structural model. The regression model, examining credit spread difference between the two markets, indicates that differences in: official rating, monthly average coupon, monthly average maturity, liquidity, equity volatility, pay-out ratio, leverage, and credit risk, are explanatory factors in credit spread difference in Nordic and European High Yield market. Explaining 50% of the variance.

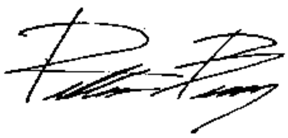
Preface

The following master thesis concludes my Master of Science in Business. The thesis accounts for 30 credits and written towards my Major in Finance and Investment at Nord University Business School.

The motivation for authoring this thesis, arose from interest in capital markets, with the desire to develop greater understanding of dynamics in Debt Capital Markets, especially foreign debt markets. Furthermore, the thesis objective arose out of willingness to prove that my knowledge trough financial and economic studies can research and tackle real financial complications.

The work around thesis have been frustrating and challenging and given me a great learning outcome towards debt capital markets and credit pricing models. The thesis would not have been possible without help and support. I would first like to thank my supervisor Frode Sættem for great feedback and quick response to questions. Furthermore, I would like to express deep gratitude to Svein Erik Nordang for supplying all Bond data vital for thesis. Lastly, I would thank Jens Kristian Berg for providing me with his contact network, information, plus tips and tricks on debt market nature.

Bodø, May 18, 2022



Petter Berg

Contents

List of Tables

List of Figures

1 Introduction

The bond market represents the worlds debt market, where corporations and governments can issue new debt to finance their operations, known as the primary market. additionally, participants within the bond market can buy and sell debt securities, referred to as secondary markets. The Nordic and European bond market presents great opportunities for companies seeking debt financing and investors willing to purchase and sell debt securities. However, on the investors side in debt markets, the Nordic high yield debt market offer a higher compensation for investing in their market compared to the European high yield market. The compensation is referred to as **credit spread**, hance the return of holding set bond, rather than government “risk-free” bonds. The credit spread difference between Nordic and European high yield have increased over the years, while of November 2021 the Norway Xover over Europe Xover notes 288 basis points (bps) reported by Sparebank1 markets (2021)

The main objective of thesis, is to find, interpret, and conclude on earlier literature approach to credit spreads. Implementing their methods to new set of data relevant to credit spreads and debt markets. To generate results and information to **Predicating the credit spread difference between Nordic and European High Yield market.**

The Nordic high yield bond market have since the turn of millennium become more diversified, as of before being dominated by banks and Oil industry, whereas today having a more developed structure, with issuers being industries within telecom, fisheries, transportation, shipping, real estate, etc. (Ytterdal & Knappskog, 2015)

Nordic and European debt markets differentiate themselves in numerous ways such as: market size, liquidity, amounts of official/unofficial ratings, tax-policies, market factors, investors risk tolerance, correlation to global financial markets, and risk premium spreads in interbank offered rate (Alfred Berg, 2019). The factors may explain why investors gains 250-300 extra basis points by investing in Nordic contra European high yield, yet to which extent. In the attempt to explain credit spread differences across two markets, I attempt to find approaches to where each factor is quantified to measure proportion of credit spread.

Pricing of bonds is vital to both issuers and investors within the market. Whereas bond pricing theory concentrates mainly on extensions and reductions of Merton’s structural model 1974. Merton’s model and its reduction/extension, respectfully constructed by Jarrow and Turnbull (1995) Leland and Toft (1996) and Eom et al (2004). Common denominator for structural models devised by Merton is the assumption that credit spread is compensated by credit risk. Due to results having varying degrees of accuracy, supplies the backdrop information that credit spread is not fully explained by only credit risk.

The approach and method in this thesis are obtained through Ytterdal and Knappskog (2015) and Eskerud (2017) thesis, where they trough inspiration of Eom et al (2004) successfully predicts spreads in the Nordic high yield bond market. This project assignment differs from Ytterdal and Knappskog, and Eskerud by including European high yield bonds to their methods, to explain spread differences to the Nordic high yield bond market.

The remainder of this project assignment is organized as follows. (2) Giving basis bond information, to create backdrop information for reader. (3) Breakdown of earlier literature, models, and results related to the problem statement. (4) Data collection, screening, and sample (5) Breakdown of methodology, through structural model and statistical approaches. (6) Results and analysis. (7) Conclusion.

2 Bond Theory

Within the bond theory section of assignment, I will present basic information within Bonds characteristics and nature. To set the backdrop for the coming analysis and information about the problem statement "Predicating the significant credit spread difference between Nordic and European HY".

2.1 What is a Bond?

A Bond is a debt security, issued in connection with borrowing arrangements. The borrower of set debt, issues (sells) a bond to the lender (investor/bond holder) for some amount of cash, for issuer to finance their operations: the bond is the "I owe you" (IOU) of the borrower. Repaid through issuer of bond makes periodical payments to the bond holder with respect to coupon or interest, there are two main types of repayment in bonds, coupon, and zero-coupon bonds, differentiated in whether the issuer makes coupon payments or not. Coupon paying principles through instalments, zero coupon through interest at maturity date. Due to fixed income stream or interest at maturity, bonds and debt securities are typically referred to as fixed income securities. The bonds owner can typically trade the bond in the secondary over the counter market (OTC). (Bodie, Kane, Marcus. Investments. 2021)

2.2 Bond relation to capital structure

A firms capital structure contains of balance between debt and equity to assets. For a firm to finance their projects, capital is needed. Firms thereby secure capital through equity or debt. Whereas undertaking debt financing often relates to issuing corporate bonds. Whereas debt is always repaid before equity in case of default. Different kind of debt have different priority during default liquidation, which affects the sum expected to recover at default. The higher the priority the higher the expected recovery. Thus, which type of bond is purchased by bond holder, impacts their risk in investment default and recovery. Ranking from senior secured, senior unsecured, subordinate, preferred stock, common stock, the two latter categorized as equity. (Bodie, Kane, Marcus. Investments. 2021)

2.3 Type of bonds

There are several diverse types off bonds, distinguished by characteristic of the bond: maturity convertibility and return type. As well as whom the bond issuer is. Bonds issued by government bodies goes under treasury bonds and notes, Firm issued bonds goes by corporate bonds and certificates. A corporate bond with maturity over one year is classified as a bond, while maturity of less than one year classifies it as a certificate. Treasury bonds with maturity in the interval 1-10 years is called a note, from 10-30 years they classify as treasury bonds. A bond with no/undefined maturity, hance perpetual maturity is known as perpetual bond. Bond or fixed income securities also classifies themselves after payment structure with respect to their floating or fixed rate. Fixed rate payment structure is self-explanatory. However floating rate bonds are linked to a benchmark rate example the interbank offered rate (IBOR) for the respected market, for instance the NIBOR in Norway and EURIBOR in EU markets. (Kloster and Syrstad, 2019) Nevertheless, floating rate bonds can additionally be associated to further economic indicators such as stock indices, inflation, and other measures of current market rates.

Floating rate bonds leans towards a more exotic type of fixed income securities. Referenced against the more vanilla bonds of set maturity, fixed rate, zero or coupon structure. However, the characteristics of exotic bonds are more unique. Such as, convertible, puttable, callable, catastrophic, inverse floaters, international and asset backed- bonds. These exotic bonds are unique with respect to their abilities. Such as conversion to equity rather than debt (convertible), which party (issuer/bondholder) have the right to extend or retire the bond at call date (callable/puttable). Catastrophic bonds, promising payout if catastrophe occurs. Inverse floaters character aims at coupon rates decline for bond when interest rate rises. There are several more unique characteristics to each type of exotic bond. Although, more plain vanilla bonds are relevant in explaining credit spread between two debt markets. (Bodie, Kane, Marcus. Investments. 2021)

2.4 Bond rating

Bond rating is an estimation of bond safety, officially issued by three major bond-rating-agencies: Moody's, Standard & Poor's, and Fitch's. The rating indicates bonds safety/quality according to risk of default, also called default/credit risk. Even though fixed income securities commonly ensure a fixed income flow, it is not guaranteed unless the bondholders can really that the issuer will not default on set obligation. Thus, the ratings consist of a relative measure of riskiness in borrower or issue.

The rating ranges from AAA/Aaa to D, the latter being the lowest rate possible/in default. Although as mentioned above an AAA rating is not guaranteed against default, however its probability of defaulting is lower than lower rated bonds. The alphabetical rating scale is used by all type of rating issuers, however they differentiate themselves through the finer grading of bonds, while Moody's utilizes each class with 1,2, or 3 suffix (e.g., Aaa1, Aaa2, Aaa3). Substitute for Moody's finer grading S&P /Fitch's utilizes + or – modifications. The bonds are divided into two main risk categories: investment grade (low risk) and speculative grade (high risk). The latter is referred as bonds ratings BB+/Ba1 and lower. Investment grade therefore covers the ratings from BBB-/Baa3. The higher the rating the lower they yield, with greater security, and vice versa. Table 2.1 visualize the bond ratings, risk category, and definition from issuers. (Bodie, Kane, Marcus. Investments. 2021)

Table 2.1 Credit Rating (Standard & Poor's, 2018)

Risk Class	*Moody's*	*S&P/ Fitch*	*Definition*
Investment Grade	Aaa	AAA	Extremely strong capacity to meet financial obligations.
	Aa1 Aa2 Aa3	AA+ AA AA-	Very strong capacity to meet financial obligations.
	A1 A2 A3	A+ A A-	Strong capacity to meet financial obligations, but somewhat susceptible to adverse economic conditions and changes in circumstances.
	Baa1 Baa2 Baa3	BBB+ BBB BBB-	Adequate capacity to meet financial commitments, but more subject to adverse economic conditions.
Speculative Grade / High-Yield	Ba1 Ba2 Ba3	BB+ BB BB-	Less vulnerable in the near-term but faces major ongoing uncertainties to adverse business, financial and economic conditions.
	B1 B2 B3	B+ B B-	More vulnerable to adverse business, financial and economic conditions but currently has the capacity to meet financial commitments.
	Caa1 Caa2 Caa3	CCC+ CCC CCC-	Currently vulnerable and dependent on favourable business, financial and economic conditions to meet financial commitments.
	Ca1 Ca2 Ca3	CC+ CC CC-	Highly vulnerable; default has not yet occurred but is expected to be a virtual certainty.
	C	C	Currently highly vulnerable to non-payment, and ultimate recovery is expected to be lower than that of higher rated obligations.
	D	D	Payment on a financial commitment or breach of an imputed promise; also used when a bankruptcy petition has been filed or similar action taken.

The Moody's, S&P and fitch base their rating on analysis of the level and trend of their issuer's financial ratios, five key ratios used to evaluate bond safety are: Coverage ratio, Debt/Equity ratio, liquidity ratios, profitability ratios, and Cash flow to debt ratio. Components of these ratios can be seen as components of credit risk. Hance, components of credit spread, giving them a significant role in explaining the credit spread between Nordic and European HY. (Bodie, Kane, Marcus. Investments. 2021)

2.4.1 Shadow Rating

Bond ratings issued by others than the major rating agencies, are commonly known as "shadow rating". Shadow ratings are unofficial rating made by brokerage houses, while credit analysis use similar methodologies as the official credit rating agencies. Due to the rating being unofficial they cannot be used for regulatory purposes. However, shadow ratings constitute an important part of the Nordic bond market, due to high numbers of unrated firms within the Nordic market. Official Credit Rating Agency (CRA) ratings are expensive and demands amounts of resources. Whereas ratings can cost towards millions NOK and have large annual costs. Hance making official ratings to expensive, making small-to-medium sized firms dependent on shadow ratings. As size of SME's does not make it cost efficient/ profitable to purchase official ratings.

Shadow ratings are based on public information of firms, as brokerage firms/ credit analysis does not have access to banks internal assessments on clients/issuer, suing the same similar method as CRA to construct the rating. Hance. There is information spread between shadow ratings and CRA's. The assignment problem statement will therefore use type of rating as a dummy factor to explain the credit spread. (Stensaker,2017)

2.5 Credit spread

Credit spread is defined as the difference in yield on two debt securities, with similar maternity and different credit risk. The spread is measured in basis points. For bonds issued at par, credit spread is calculated trough the spread between the coupon of the corporate bond and the corresponding government bond (benchmark / risk-free). Hance, the spread is a measure of market premium of the risky security. Furthermore, spreads on floating rate bonds are given trough only "coupon rate", as it is given above an already risk-free reference rate (IBOR).

Credit spread reflects whether a bond is secured by firms' assets or unsecured, the type of bond/ debt affects the repayment priority. Hance, the risk of investor, default, and recovery. Spread also incorporate the liquidity of the bond, reflecting how many buyers of the bond is available. Thus, liquidity and expected defaults works as components of credit spread, alongside credit risk due to investors' expectations to be compensated for the uncertainty/risk about probability of default. However, to explain the true nature of credit spread more confidently, more components need to be taken account for. Further research literature has investigated components of credit spreads, to fully explain its movements and spread. The following chapter will give a summary of their approaches, methods, findings, and assumptions.

3 Literature

The literature chapter of thesis will take reader through previous academic research and studies fit for the research question. giving in-depth knowledge of what other academics have written about similar and related research. Scoping out the research gap and how to apply set problem statement. looking through theories, data, methods, and mythology academics have previously used to generate a conclusion/result on “Predicating the credit spread difference between Nordic and European HY”. The findings in literature provide numerous studies in credit spread components and dynamics of bond markets, however predicating credit spread differences between two markets, remain unexplored.

3.1 Credit pricing

Credit modelling and pricing of credit risk follows two main approaches. Structural model developed by Merton (1974) and reduced form models pioneered by Jarrow and Turnbull (1995). Additionally, purely statistical models deriving from discrimination analysis and econometric techniques such as the SEBRA (2017) and Altman Z-score (2003). The Merton model represents the most widely known model in assessing credit pricing and risk, the model originates from the option pricing model developed by Black-Scholes (1973) and Merton (1974). All structural models are based on this contingent claim approach to valuate corporate debt using the option pricing theory proposed in Black-Scholes-Merton model. The structural models require market input parameters, thereby empirical testing mainly focusing on debt in publicly traded firms. Reduced form models focus on firm’s time to default as a stochastic process where price parameters are estimate by fitting the model to past price data of firm issued bonds. Reduced models therefore do not acquire estimates on asset value to predicate bond price and credit risk. Statistical models use various forms of econometric techniques and input parameters in identifying drivers of default and credit pricing.

I follow Ytterdal and Knappskog (2015) and Eskerud (2017) approach in modeling credit risk and credit spread. Therefore, implementing structural model derived from the basic Merton model (1974), the extended Merton model, by Eom et al (2004). The choice of the extended Merton model is due to absence in sufficient high yield bond data, restricts the implementation of reduced from models, and statistical model produce difficulties in implementation and understanding of econometric concept, additionally to generate further complications in separating credit risk from other factors. The following sections will supply in-depth review of the basic Merton model, and further focus on developments done to the Merton model. in addition to brief review of reduced from and statistical models.

3.2 Basic Merton Model

Description of basic Merton model is derived from Ytterdal and Knappskog's (2015) review of the basic Merton model. The cornerstone of Structural models is given in the basic Merton model developed by Robert C. Merton in 1974. By using the Black-Scholes option pricing model, Merton evaluates assets and debt of a firm, trough input parameters of market value of equity, equity volatility, and risk-free rate. By Building upon the fact that equity and debt value can be replicated using options pricing to value firms' debt under non-arbitrage arguments.

The model states that equity holders only have claim to the company when company assets are higher than the value of debt. Hance, describing the value as $E_T = Max[0, V_t - D]$, implying that if value of firm exceeds value of debt at maturity, the residual claim will be distributed to equity holders. Correspondently, if firm value is below debt at maturity, the equity is worthless. Meaning that equity position is utilized the same as a call option on firm assets, with exercise price equal to face value of debt (FV):

$$Equity = Call\ Option\ (FV) \quad (3.1)$$

Likewise, to utilizing equity as a call option on face value of debt. Debt value using options defined by using options on firm assets, due to put call parity must hold or else arbitrage opportunity would be precent $Call\ Option\ + PV(strike) = Underlying + Put\ Option(strike)$. Thereby, the payoff to debtholders at maturity is calculated through a portfolio of risk-free zero-coupon bonds with face value equal to face value of outstanding debt, and short put position on firm's assets with strike price equal to face value of outstanding debt at maturity:

$$Debt = Risk\ Free\ Bond\ - Put\ Option\ (FV) \quad (3.2)$$

The payoff to creditors is therefore given the principal payment in full when firm asset exceeds the required debt payment, whereas the put will be worthless. Is firm asset does not exceed required debt payment, hance default. The investor will exercise the put. Leaving creditors, the principle of risk-free bonds minus the difference in between asset value and principle, creditors with only the asset value of firm. hance $D = \mathrm{Min}(V_t, B)$.

Equation 3.2 can further be utilized as a proxy for firms' probability of default, through the put options probability of being exercised, in the scenario of firm asset value not exceeding required debt payment thereby representing the probability of default.

The basic Merton model claims that bond value depends on the return on risk-free debt. Whereas the difference between risk free bond and risky bond is simply a put option. The models assumes that the bond is issued as one zero coupon bond, and that default occurs when firm's asset value(V) falls below default point (B) at the time of maturity (T). If default does not occur, firm pay debt in full, and the remaining value of equity is $E = Max(V - D, 0)$

Merton's model is based on several assumptions, the list of assumptions below is extracted from Ytterdal and Knappskog (2015)

1. There are no transaction costs, taxes, or indivisibilities of assets
2. There are enough investors with comparable wealth levels such that each investor believes that they can sell as much of an asset as they want at the market price.
3. There exists an exchange market for borrowing and lending at the same rate of interest
4. Short sales of all assets, with full use of proceeds, are allowed
5. Trading in assets take place continuously in time
6. The Modigliani-miller theorem that value of firm is invariant to its capital structure obtains.
7. The term structure is flat and known with certainty; i.e. the price of a riskless discount bond that promises a payment of $1 at time T in the future is $P(t, T) = e^{-r}(T - t)$, where r is the (instantaneous) riskless rate of interest, the same for all time
8. The dynamics for the value of the firm, V, trough time can be described by a diffusion-type stochastic process.

(Ytterdal & Knappskog,2015)

Suresh Sundaresan (2013) reviews the Merton model applications, and notes that the first four assumptions can be significantly weakened. However, several of the assumptions are unrealistic. Such as assuming trading take place continuously in time, and the assumption of flat term structure.

The models assumes that asset value, V, follows a geometric Brownian motion,

$$dV = \mu_V \ x \ V \ x \ dt + \sigma_V \ x \ V \ x \ dW \quad (3.3)$$

Where μ_V is the expected continuously compounded return on V, σ_V is the volatility of asset returns, and dW is the standard wiener process, a continuous- time stochastic process, hance a random process. The Brownian motion assumes that there are two parts of this random movement. Constant drift μ_V and, random movement volatility in asset σ_V. The central limit theorem in statistic therefore gives the model that periodic return will be normally distributed. Thereby providing the foundation to the Black-Scholes-Merton model. Making Merton (1974) able to value equity as the value of a call on firm's assets V, with maturity T, exercise price equal to Debt B, giving the equation

$$E = V \ N(d1) - Be^{-rT}N(d2) \quad (3.4)$$

Where

$$d1 = \frac{\ln\left(\frac{V}{B}\right) + \left(r + \frac{1}{2}\sigma_v^2\right)T}{\sigma_v\sqrt{T}}$$

$$d2 = d1 - \sigma_v\sqrt{T}$$

The formulas above are the basic black-Scholes model, where N represents the cumulative normal distribution function. $d2$ represents the probability of option being exercised, $d1$ is known as the conditional probability.

Equation 3.4 shows what investors expect to receive minus the expected payment from buying the call option on equity.

Merton (1974) can then value debt of risk-free bond minus the put option on firm assets. trough utilization of Black- Scholes model. the value of put option/ risky debt is given in the following formula. $D = P = Be^{-rT}N(-d2) - VN(-d1)$.

3.3 Structural models derived from Merton.

From the Merton model assumptions and input estimates, literature points out the obvious shortcomings and critics the firm value process. These critics and limitations have generated later development of structural models, attempting to address these limitations and weakness of the basic Merton model.

First to address the limitations and unrealistic assumptions done by Merton were Black and Cox (1976), where they made two assumptions common in credit risk literature. i) company can default at any time $t \leq T$; ii) default happens at the *first passage*. i.e., happens instantly and is irreversible. When the path of assets V, hits the default barrier D. Hance, Assumption ii) making the Black and Cox model named *First Passage model.*

Additionally, to Black and Cox (1974) Leland and Toft (1996) addresses the shortcomings on the Merton model by incorporating four inputs: tax, payout ratio, Cost of financial distress, and average maturity of debt. The Leland and Toft model (1996) have been utilized in other literature in decomposing credit spreads by Churm and Pangirtzoglou (2015) where they address the credit spread movement in the UK and US.

The more successful extensions of The Merton model are Kealhofer, Mcquown and Vasicek (KMV) structural model utilized by Moody's analytics in credit pricing. The KMV relies on empirical testing. And is quite like the basic Merton model. The KMV addresses two of Merton's shortcomings, the Wiener process/Brownian motion, and default before maturity, trough incorporating a different type of default barrier, better reflecting the maturity on company's short- and long-term debt.

Most important for Thesis choice in structural model, influenced by Ytterdal and Knappskog (2015) and Eskerud (2017) is Eom et Al (2004) study on structural models. Where they analyze and test performance of five structural models for credit pricing, Merton (1974), Geske(1977), Longstaff and Schwartz(1995) Leland and Toft (1996) and Collin-Dufresne and Goldstein(2001) where Eom et al (2004) develops their extended Merton model, where coupon bond is calculated as an portfolio of zero coupon bonds, whereas each zero coupon bonds is priced using the ytm bond version of Merton model. the model, furthermore, incorporates financial distress by including recovery rate in event of default, and payout ratio.

Eom et al. (2004) furthermore concludes that none of the structural models is able to accurately predict spreads, Extended Merton model and Geske model underestimate spreads on average, while the remaining three overpredicts them.

3.4 Reduced forms.

Reduced from models differentiate themselves from structural models, by estimating jump rate to default empirically, instead of assuming default solely based on firm's value. the reduced form models originate from the work of Jarrow and Turnbull (1995) in their article *pricing derivates on financial securities subject to credit risk.* The advantage of reduced from models is that they allow for other sources of risk premia, than creditors only being compensated for credit risk.

Jarrow and Protter (2004) compare the structural and reduce form models for credit risk in their literature *Structural versus Reduced Form models: a new information based perspective.* Where they conclude that the model difference is essentially in the information assumed known by modeler. Structural models, requiring modeler to have all knowledge of firm's capital structure. Whereas reduced form models assume modeler have only market information, Hance incomplete knowledge of firm financial position. Jarrow and Protter (2004) argues that structural models thus, require more information than available. Hance, preferring reduced from models to structural models in pricing and hedging corporate securities.

3.5 Sources of Risk Compensation

Eom et al. (2004), Ytterdal and Knappskog (2015) and Sæbø (2015) shows in their results that their structural model is unable to generate sufficiently high yield spreads, relative to what is observed in the market. hance, making the assumption that structural models predict credit spreads as if creditor is only compensated for credit risk. Thereby intensify the presence of the credit spread puzzle, defined as credit spread unexplained by default for corporate bonds.

Substantial amounts of literature have studied this phenomenon of credit spread puzzle, utilizing different input parameters, credit pricing models, and factor variables to explain the gap between observed and estimated credit spread. Sæbø (2015) argues that the credit spread puzzle arise in the Nordic sector due to investor being in fact risk-averse rather than risk-neutral. Churm and Pangirtzglou (2005) decomposes the credit spread models, including taxes, regulations, and liquidity to best explain the credit spread puzzle. However, taxation cannot be a factor in credit spread in the Nordic sector due to Norway having the same tax policies on government and corporate bonds (Sæbø,2015).

Lastly the credit spread puzzle have been tried solved through including larger time series of investment and high yield bonds and including great amount of defaulted bonds to the structural models by Feldhütter and Schaefer (2016). They conclude their analysis *ex post* default rates are vital to obtain *ex ante* default probabilities with sufficient level of precision.

3.6 Studies on Nordic Credit spreads.

I have analyzed, interpreted, and utilized earlier studies on Nordic markets. To better understand and conclude on capable methods and models in estimating credit spread from the Nordic and European HY market. Ytterdal and Knappskog(2015) study credit spreads on Nordic HY market in their master thesis. Utilizing the extended Merton model, by Eom et al. (2004) and attempts to name the underlying explanatory factors through OLS regression model from tehri data set of 323 issued bonds. takeaway from Ytterdal and Knappskog's analysis is that data is hard and time consuming to come by and collect, and that on average 65% of spreads can be explained by credit risk. Eskerud (2017) also utilizes the extended Merton model by Eom et al. (2004) but on the complete Nordic bond market. using a data set covering the time period 2000-2015 with 62 bond issues. Eskerud analysis overpredicts credit spreads in the Nordic market, hance overestimates the probability of default in pricing corporate bonds. His results where unexpected, due to results by Eom et Al (2004), Ytterdal and Knappskog (2015) and Sæbø (2015) underestimate spreads through the same structural model. Sæbø (2015) have constructed a report analyzing the credit spread in Norwegian credit. Where he concludes that investors are risk-averse instead of neutral. And that credit risk attributes for 28% of credit spreads through results in structural model.

4 Data

The dataset utilized in this thesis is obtained from Bloomberg, Yahoo! Finance and published annual reports from the issuers. The chapter presents data on bonds, firm characteristics, financial market data and recovery rates. The Nordic sample data includes corporate bonds issued in Sweden, Denmark and Norway, the corresponding European sample includes issues in United Kingdom, Germany, and France. I will first discuss the assumptions and methods utilized to construct the final sample. Then present descriptive statistics on the final bond sample. Before presenting the process of identifying default and recovery data.

4.2.1 Bond Sample

The bond data are retrieved from Bloomberg terminal (Bloomberg L.P, 2022) Bloomberg is the leading financial data vendor, bringing together real-time data across all markets. Founded in 1981, employing 20,000 employees spread across 176 locations globally. Bloomberg offers a range of services for its consumers, such as charting tools, trading solutions, research sources, news, and financial market data. Bloomberg provides data across all markets and assets classes including fixed income, equities, foreign exchange etc. making Bloomberg one of the most widely used financial data providers worldwide, thus making the bond data subtracted from their database a trustworthy source to Nordic and European fixed income securities data from 2017-2021. The Bloomberg bond data includes, Issuer, rating, Tenor, Issue date, Maturity date, Coupon, Bid/Ask Price, coupon type, next coupon, and average 30-day and 6-month volume.

I created several Bloomberg searches with help from a Partner at Fernley Securities AS to subtract the bond data capable of investigating the credit spread difference of European and Nordic markets. The search included Bonds from Sweden, Norway and Denmark being the Nordic market, and United Kingdom, Germany and France representing the European market. limiting the search to bonds with tenor of 1 to 10 years, the HY sample includes only corporate bonds with ratings from bb+/Ba1 to D (default) and NR (non-rated). The benchmark (risk-free bonds) includes government bonds, with rating AAA. All bonds are issued in the 5-year time interval 3/1/2017-31/12/2021.

To tackle the issue of prices only quoted on days the bond undergoes transaction, where no date of last transaction is present in dataset. I have followed assumptions made by Ytterdal and Knappskog (2015) where they assume bond is issued at par, hance the credit spread is derived from calculations of YTM from issue to maturity.

4.2.2 Bond Sample Construction

From Bloomberg I obtained information of bonds characteristics such as, coupon, maturity, rating, and price for the two markets regarding the thesis. I obtained a total of 5001 securities in Nordic HY, and 731 in the European HY. In the following section I will present and overview initial samples characteristics, with respect to rating and coupon type trough four tables 4.1-4.4.

Table 4.1 represents the rating type for the initial Euro sample. Whereas across all CRA's there were no observed HY bonds without rating. the ratings range from BB+/Ba1 to D.

Table 4.1 INITIAL EURO SAMPLE RATING

Euro Sample

Rating	N	% of sample
Rated	731	100%
Non-Rated	0	0%

Table 4.2 represents the rating type for the initial Nordic sample. Where readers can see the majority of Nordic sample being non-rated by CRA. Indicating the Shadow rating variable utilized in this thesis.

Table 4.2 INITIAL NORDIC SAMPLE RATING

Nordic Sample

Rating	N	% of sample
Rated	1768	35,3%
Non-Rated	3233	64,7%

Table 4.3 and 4.4 provides overview of Euro and Nordic initial sample coupon type. From the tables readers can observe the difference in floating rates proportion of sample from Euro to Nordic. Where the Euro sample consist of 7% floating rate bonds, the Nordic sample consist of 54% floating rate bonds. Hance, giving fixed rates bonds the largest part of euro sample and floating rate bonds the largest part of Nordic sample. "Others" refers to Zero-coupon, Pay-in-Kind, Variable, Step-up, Exchangeable and Flat-Trading bonds

Table 4.3 INITIAL EURO SAMPLE COUPON

Euro Sample

Coupon type	N	% of Sample
Fixed	610	83%
Floating	51	7%
Other	70	10%

Table 4.4 INITIAL NORDIC SAMPLE COUPON

Nordic Sample

Coupon type	N	% of Sample
Fixed	1743	35%
Floating	2721	54%
Other	537	11%

4.3 Screening of Bonds

The screening of the initial samples covering Nordic and European HY is important to avoid potentially biased results. Constructing a homogeneous sample with respect to number of criteria. This is due to the different bond types yielding unlike spreads. I have only included callable and at maturity type bonds, with the assumption that callable bonds are held to maturity. The assumption is made to better reflect the whole bond market, the assumption can possibly yield non-significant results, due to callable bonds on average yield lower spreads with respect to credit risk, due to its embedded call option. As one model cannot be valid to analyze and compare credit spreads for the different type of bonds, hance the assumption that callable bonds is held to maturity. The various steps in the sample construction as s follow.

First step in screening the initial sample from Nordic and European bond is to exclude bonds with CRA rating above BB+/Ba1 to truly hold a corporate HY sample, as the sample derived from Bloomberg includes rating from all CRA's some bonds have different ratings by the different CRA's. Next is to exclude bonds with maturity less than 1 year. Furthermore, excluding all bonds with other maturity types than: at maturity and callable. Next only including fixed, and floating coupon types.

Described in the methodology section of thesis. The Merton model, utilized as proxy for credit risk proportion of spreads, requires financial market data, and firm characteristics. Hance requiring further screening of bond sample. Thus, omitting all bonds issued by non-public firms and firm not traded in the stock market. The requirement excludes most savings banks and smaller firms. The sample after screening includes 124 bond issues in the European sample and 141 bonds in the Nordic sample as seen in table 4.5, both in the time 1. January 2017 to 31. December 2021.

4.4 Final Bond sample Overview

The final bond sample overview section of thesis, provide overview of the final screened bond sample. The full list of bonds included in the sample is present in Appendix B. Table 4.5 provides overview of initial and Hy sample utilized in the analysis of credit spread differences between the two markets. From the table reader can see that 97% of the Nordic sample is omitted due to the criteria listed in the screening of bonds. The corresponding percentage of omitted issues is 83% in the European sample.

Table 4.5 HY SAMPLE, ISSUED BONDS

HY Sample

	Initial N	Sample N
Nordic	5001	141
Euro	731	124
Total	5732	265

Table 4.5 gives overview of amount of Bonds rated by CRA's. The table represents one of the larger differences between Nordic and European Hy market. Whereas all European bonds hold bond ratings from official CRA's, whereas only 30% of the Nordic sector hold such. The difference in official ratings is probably due to the high cost of CRA ratings, as mentioned by Stensaker (2017), hance accounting for the information spread between the two Hy Markets.

Table 4.6 RATED/NON-RATED SAMPLE

HY Sample

	Initial N	% of Sample
Nordic Rated	42	30%
Nordic Non-Rated	99	70%
Euro Rated	124	100%
Euro Non-Rated	0	0%

Table 4.7 describes the distribution of coupon rates, and types for Nordic and European Market. The sample provides no floating rate bonds in the European market making further differences between the two markets in the sample. The coupon given for floating rate bonds provides a direct credit spread for the issued bond, due to being a direct spread above a reference rate. Whereas spreads for fixed coupon bonds need to be calculated. The floating coupon rate is set as given coupon plus the average 3Month IBOR rate of the bonds lifetime for the corresponding bond issue country. The distribution of coupon is further visualized in figure 4.1 and 4.2

Table 4.7 HY SAMPLE FLOATING AND FIXED

HY Sample

	N	% of sample	Mean	Standard Deviation	Max	Min
Nordic Fixed	90	64%	4.73%	6.42%	13.50%	2.10%
Nordic Floating	51	36%	4.28%	1.82%	10.25%	2.37%
Euro Fixed	124	100%	4.05%	2.22%	10.25%	1.25%
Euro Floating	0	0%	0%	0%	0%	0%

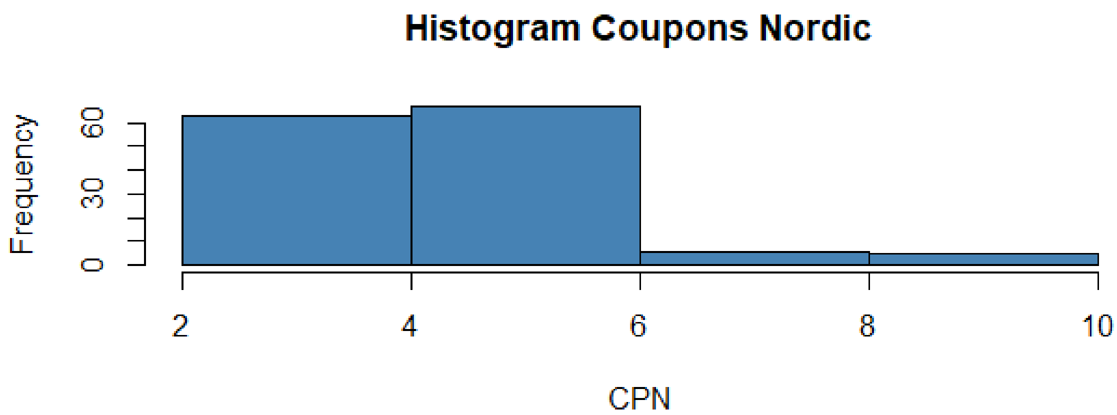


Figure 4.1 HISTOGRAM NORDIC COUPONS

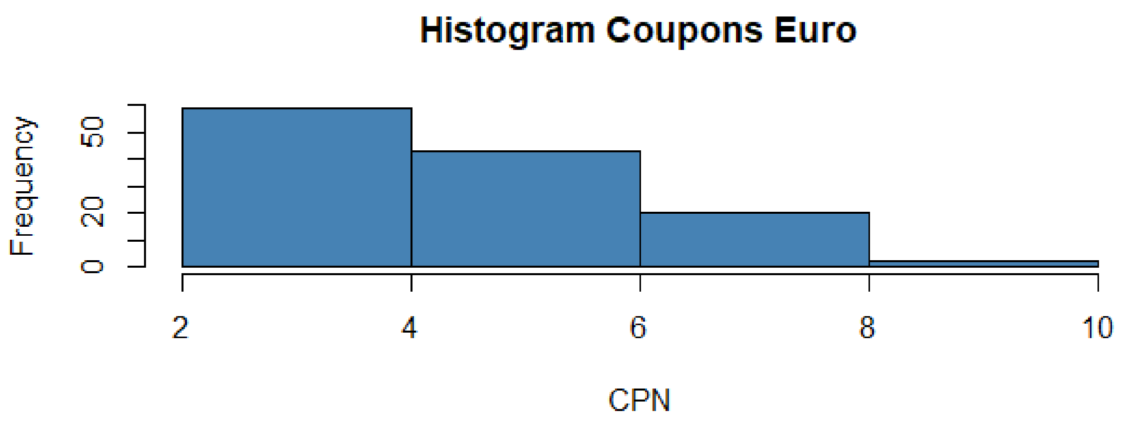


Figure 4.2 HISTOGRAM EURO COUPON

Descriptive statistics for the maturities in sample are illustrated and presented through table 4.8 and figure 4.3 and 4.4. The average maturity in both initial and sample is around 5 in the Nordic market and 6 in the European market.

Table 4.8 HY SAMPLE MATURITY

	HY Sample				
	N	Mean	Standard Deviation	Max	Min
Initial Nordic	5001	5.53	28.39	999.9	0.91
Sample Nordic	141	5.52	2.19	20	2
Initial Euro	731	6.43	1.65	10.09	1.99
Sample Euro	124	6.08	1.53	10.00	1.99

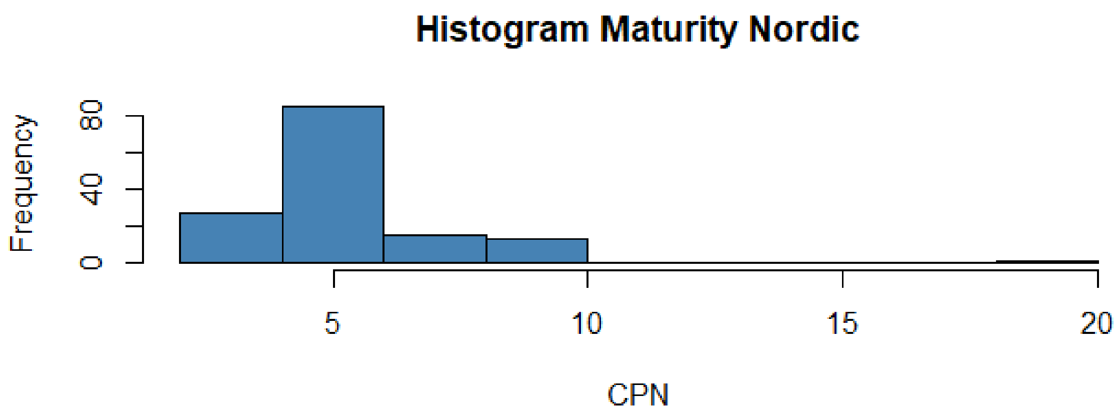


Figure 4.3 HISTOGRAM NORDIC MATURITY

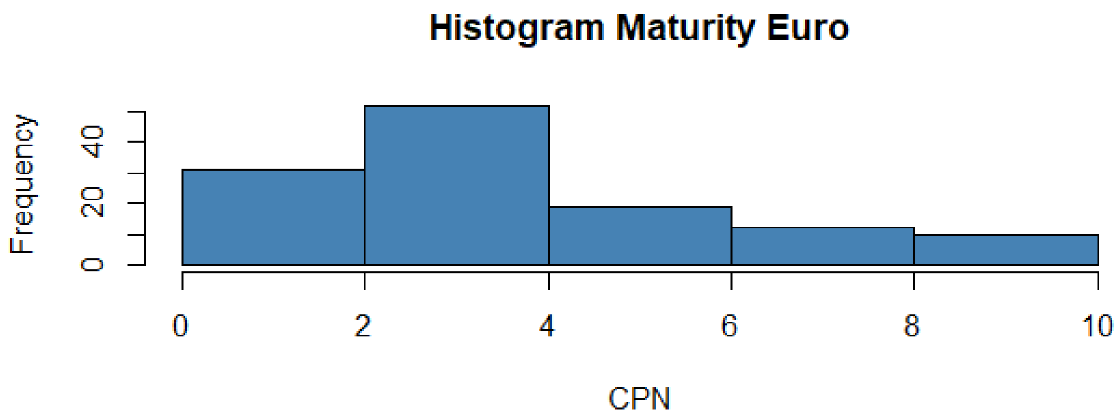


Figure 4.4 HISTOGRAM EURO MATURITY

4.5 Financials and Market Data

The financials data for bond issuers is obtained through firm's annual reports for the year of issue, resulting in collecting input data such as: current/non-current debt, interest payout, dividends, share repurchase, total number of shares outstanding, total assets, total equity from extreme amounts of annual reports. Market data such as stock price, and benchmark index is collected from yahoo! finance (Finance.yahoo, 2022).

4.6 Default and Recovery Data

One of the most important inputs of the Merton style credit risk models is the recovery rate parameter. Covering the amount recovered in the outcome of default, hance recovery being 1-expected loss given default. Earlier academics such as Ytterdal and Knappskog (2015) and Eskerud (2015) have estimated this parameter for the Nordic market through Stamdata Default and Recovery database on default events from 2006-2017. The corresponding database in the European market is provided by Moody's default and recovery analytics. Unfortunately, I where not able to access these Databases to construct recovery rate. The solution to the missing data where to utilize other academics recovery rate for this thesis analytics. Hance, utilizing an recovery rate for the Nordic market HY of 0.31, obtained from Rundhaug,Eilif de Lange and Per Egil Aamo report *"Modeling Bond Spreads and Credit Default Risk in the Norwegian Financial Market Using Structural Credit Default Models"* (2020) where they obtain an recovery rating from Sparebank 1 Midt-Norge of 31% in the high yield sector. The corresponding recovery rate for the European market is obtained from DWS Research Institute report *"High Yield Bonds: Reading the Spread"*(2020) where they inform that over the last 25 years, the recovery rate for HY index have averaged around 40%.

5 Methodology

The methodology section of thesis I will present the utilized credit pricing model, following Ytterdal and Knappskog (2015), and Eskerud (2017) methods and processes used in predicating credit spreads within Nordic bond markets. I will first guide reader trough presentation and implementation of the extended Merton model constructed by Eom et al (2004) utilized as proxy for bond pricing with respect to credit risk. further in the methodology section I will take reader trough presentation and estimation of the model parameters, and construction of regression model.

5.1 Bond Pricing Model

Utilizing the extended model, I follow the same procedures as Eom et al(2004), Ytterdal and Knappskog (2015) and Eskerud (2017). They use the Merton model and models a coupon paying bond as a portfolio of zero-coupon bonds. Further on they imply modifications to the basic Merton model by implementing payout ratio, reducing the drift of assets, and increases the chance of default.

The Merton model extended by Eom et al (2004) consider a defaultable bond with maturity T and unit face value that pays semiannual coupons at an annual rate C. To ease the compute of zero-coupon portfolio for each bond in sample, Eom et al (2004) assume that 2T is an integer, the assumption implies that if a bond has maturity of e.g., 5.6 years the maturity is rounded to 6 years. I assume that the default barrier K is constant, and that default is triggered if asset value falls below K. I may then price the coupon bond as the present value of expected payoffs from coupons and Principe, through equation 5.1.

$$P(0,T) = \overbrace{\sum_{i=1}^{2t-1} D(0,T_i)E^Q\left[\left(\frac{c}{2}\right)I_{(V_T,\geq K)} + Min\left(\frac{wc}{2}, V_{T_I}\right)I_{\left(V_{T_i}<K\right)}\right]}^{\text{I}} \quad (5.1)$$

$$\underbrace{+ D(0,T_i)E^Q\left[\left(1+\frac{c}{2}\right)I_{(V_T,\geq K)} + Min\left(w\left(1+\frac{c}{2}\right), V_{T_I}\right)I_{\left(V_{T_i}<K\right)}\right]}_{\text{II}}$$

$D(0,T_i)$ represents the time 0 value of a risk-free zero-coupon bond maturing at time T_i, E^Q is the expected value under the risk natural measure. $I_{(.)}$ is the indicator function and *w* is the recovery rate. The upper part of equation (I) represents the risk-natural expected present value of all future coupons payments made before principal. In the case of no default on coupon date *i*, bond holder will receive cash flow equal to the expected value of coupon payment $E^Q I_{V_{T_i} \geq K \frac{c}{2}}$ this cashflow is discounted by $D(0,T_i)$. If default does occur on coupon date *i*, the bond holder will receive cash flow equal to expected recovery value of the coupon payment, $E^Q I_{V_{T_i} < K min\left(\frac{wc}{2}, V_T\right)}$. The bottom part of equation (II) is the risk-natural expected present value including principal and last coupon paid at maturity.

Completing the model, it can be shown that

$$E^Q I_{\left(V_{T_i}<K\right)} = N(d_2(k,t)) \quad (5.2)$$

Equation 5.2 represents the risk natural probability of nor default on coupon date. Further given by Eom et al (2004) its shown that.

$$E^Q\left[I_{V_t<K} Min(\psi, V_t)\right] = V_o D(0,t)^{-1} e^{-\delta t} N\left(-d_1(\psi,t)\right) + \psi\left[N\left(d_2(\psi,t)\right) - N(d_2(Kt)\right] \quad (5.3)$$

Where ψ represents expected recovery value of cash flows. And *N(.)* is the cumulative normal function and

$$d1 = \frac{\ln\left(\frac{V}{B}\right) + \left(r + \frac{1}{2}\sigma_v^2\right)T}{\sigma_v\sqrt{T}}$$

(5.4)

$$d2 = d1 - \sigma_v\sqrt{T}$$

By combining the four equations 5.1, 5.2, 5.3 and 5.4 the price of the bond can be calculated under Merton assumptions, utilizing the extended Merton model.

5.2 Credit Spread

Credit spread as mentioned in section 2.5 of thesis, refers to the difference in yield to maturity between two bonds with similar maturity and different risk rating. hance in this study I match corporate HY bonds against risk-free government bonds. Thus, the spread is calculated buy yield to maturity of corporate bond less the yield to maturity of risk-free bond

$$Spread = YTM_{Corporate} - YTM_{Risk-free} \quad (5.5)$$

5.3 Implementation

The calculation of credit spreads for both Nordic and European market is done through excel RATE function to obtain the observed spread. Credit risk proportion of spread is done through utilizing the extended Merton model executed through Microsoft excel, where I modified an already existing Merton model template created by edbodmer.com (edbodmer.com, 2022). Modifications include changing the excel functions for d1 numerator and denominator to include the payout ratio and variance in asset value, further match the risk-free rate to sample yield on government bonds to construct a template for the extended Merton Model. The bond is further constructed as a zero-coupon portfolio. Earlier results shown by literature on structural models and shown in the results of Ytterdal and Knappskog (2015) and Sæbø (2015) that the extended Merton model produce the spreads that are too low on average, equivalent to model over pricing bonds. The proportion of model spread in respect to actual spread, is therefore used as proxy for credit risk proportion of credit spread. The spread explained buy the model is referred to as credit risk proportion of credit spread. observed credit spread is further predicated trough regression model implementing parameters proven to have explanatory significance to credit spreads from earlier literature.

5.4 Model Parameters

Table 5.1Model Parameters

Parameter Group	Description	Estimated as
Bond Features	Coupon C	Given
	Default Barrier K	Short-term debt + half Long-term debt
	Maturity T	Given
	Recovery Rate w	Given
Firm Characteristics	Asset Value V_0	Book value of debt + market value of equity
	Asset Volatility σ_V^2	Section 5.4.2
	Payout Ratio δ	Section 5.4.2
Interest rate	Risk-free rate rf	Yield on sovereigns' bond

5.4.1 Bond features

Default barrier

Following Eskerud's (2017) approach to the extended Merton model where Eskerud(2017) opt for using book value of total liabilities for his default barrier parameter. However, Eskerud describe an approach to the default barrier parameter utilized buy Crosbie and Bohn (2013) which is used as my parameter for default barrier. The default barrier K represents the level asset value must reach for default to occur. Different approaches to default barrier have been utilized in much of the literature. A widely used choice for default barrier is to use one that is less than the total of liabilities due to all debt is not likely to be due within the same assessment period. An approach tackling the difference in debt due, is a simplification of the one utilized in the KMV model (Crosbie and Bohn,2003), were

$$K = D_{Short-Term} + kD_{Long-Term} \quad (5.6)$$

With k = 0.5, hance, the sum of short-term debt + half of long-term debt.

5.4.2 Firm Characteristics

Asset value and Asset Volatility

Asset value and asset volatility are unobservable values in need of estimation. As mentioned by Eskerud (2017) the key input parameters is a general drawback of structural models, due to key inputs being weighted upon estimations. Ytterdal and Knappskog (2015) imply these values buy solving two functions derived from the Black-Scholes-Merton framework simultaneously. From the theory section 3.2 basic Merton model, I describe how the option pricing to model a call option on issuer assets through equations, utilizing the endogenous variables asset value V_t, asset volatilityσ_V, and input variables Maturity *T*, debt *B*, and risk-free rate *rf*. The relationship is expressed in equation 5.7

$$E_t = V_t N(d_1) - Be^{-rT} N(d_2) \quad (5.7)$$

Where

$$d_1(x,t) = \frac{\ln\left(\frac{V_0}{xD(0,t)}\right) + \left(-\delta + \frac{1}{2}\sigma_v^2\right)T}{\sigma_v\sqrt{T}}$$

(5.8)

$$d_2(x,t) = d_1(x,t) - \sigma_v\sqrt{T}$$

Additionally, it can also be shown that

$$\sigma_t E = \frac{V_t}{E_t} N(d_1)\sigma_t V \qquad (5.9)$$

Where E_t represents equity value estimated as the observed market capitalization on the bond issue date, and σ_E is the volatility of equity returns. there are numerous styles to estimate and predict volatility of equity returns, whereas the simple methods include *moving average and exponential weighted moving average.* More technical methods include ARCH and GARCH modeling. Eom et al (2004) utilize GARCH modelling on different estimation periods ranging from 30 to 150 trading days prior to issue. Ytterdal and Knappskog (2015) estimates their equity volatility through standard deviation on 5-year monthly data. Eskerud (2017) utilize the 150-day moving average prior to bond issue for his equity volatility input. Furthermore, Eskerud (2017) computes his asset value and asset volatility through utilization of Excel’s iterative equation solver function, as the equations need to be solved numerically. I have chosen to utilize the same approach and implementation. to asset volatility and value as Eskerud (2017) simulating 100 iterations.

Payout ratio

The extended Merton model constructed by Eom et al(2004) includes payout ratio to the basic Merton model, to reduce drift of asset value. Eom et al (2004) estimates firm payout ratio as the weighted average of coupon payments and the share repurchase-adjusted yield. Ytterdal and Knappskog (2015) and Eskerud (2017) however estimates their payout ratio from dividends paid to equity holders, share repurchased, interest paid to debt and equity holders and total assets. Expressed Trough equation 5.10

$$\delta = \frac{Dividendts + Share\ Repurchase + Interest\ paid\ to\ equity\ and\ debt\ holders}{Total\ Assets} \quad (5.10)$$

The time observation for the inputs is set to the year prior of issue date, due to dividends are normally paid out the following year. Total assets are the book value of total assets for the firm.

I follow Eskerud (2015) implementation where payout ratio is assumed to remain constant over the bond's lifetime.

5.5.1 Interest rate

Ytterdal and Knappskog (2015), Eskerud (2017) and Eom et al. (2004) utilize the Nelson-Seigel (1987) and/or the Vasicek (1977) models to estimate yields for missing dates. I have opted to match each corporate bond to the most similar sovereign bond with respect to issue and maturity. The deviation is implemented due to analysing a wider section of countries, and due to limited amount on time for thesis. The sovereign bond data includes AAA rated bonds issued by government with the maturities of 1 year, 3 year, 5 year, 10 year. from 2017 to 2021 issued by Sweden, Denmark, Norway, France, Germany, and United Kingdom. additionally, to price floating bonds, I have included NIBOR and STIBOR.

5.6 Regression analysis.

Posterior to computing credit risk proportion of credit spread in Nordic and European HY market through the extended Merton model. The relationship between the credit spread difference in European and Nordic HY is predicated trough regression analysis. Implementing the difference in actual observed credit spread between the markets in respect to the bond sample, as its dependable variable. Using the difference in extended Merton model input parameters in addition to leverage ratio, equity correlation to market, credit risk spread explained by Merton model, and price bid-ask spread as a proxy for market liquidity, as explanatory variables in the regression. Earlier literature by Delianedis and Geske (1999), and Ji and Qian (2013) observe tax to be a significant variable in explaining credit spread. However, I have omitted tax as a variable, due to Nordic corporate bonds having the same tax policy as government bonds, and complicated tax policies for the European countries. Table 5.2 provides an overview over variables included in the regression analysis.

I first execute simple regression on all explanatory variables against the dependent variable, to assess its significance, coefficient, standard error, and R squared. Omitting variables proven not significant and constructing a multiple regression model from the proven significant variables. In hope of predicating the credit spread difference between the Nordic and European HY market.

Bid/ask spread, default-barrier and market capitalization is adjusted to currency, redirecting all currencies to EURO to best match the two markets. Even though I attempt to make the variables from the different markets comparable to its best extend. The regression model will produce errors in predicating the difference, due to bonds from different markets being match up against one another with respect to time of issue instead of similar bond features. To cope with the issue I have converted the data from daily to monthly average, to produce more valid results for the regression. The dependable variable “credit spread difference” is calculated from monthly average observed credit spread in Nordic minus the monthly average observed credit spread in Europe.

Table 5.2 Regression Variables

Variable Class	*Description*	*Estimated as*
Dependable Variable	Credit Spread Difference, Nordic and European HY	Nordic credit spread – European Credit spread
Explanatory Variables	Rating / non-rating	Dummy variable
	Coupon	Nordic coupons – European Coupons
	Maturity	Nordic maturity -European maturity
	Bid/Ask Spread	Spread of Nordic bond – Spread of European bond
	Equity Volatility	EQT Vol Nordic – Vol European
	Asset Volatility	AST vol Nordic- Vol European
	Market Correlation	Nordic correlation to market – European correlation to market
	Payout Ratio	Nordic payout ratio – Euopean payout ratio
	Default-Barrier	Nordic default barrier – European default barrier
	Market capitalization	Nordic market capitalization – European market capitalization
	Leverage	Difference in leverage given by book value of debt divided by market capitalization + book value of debt.
	Proportion of credit risk	Difference in proportion of credit spread compensated by credit risk.(Extended Merton model)

6 Results and Analysis

The Results and analysis for thesis have Three objectives. First, to estimate credit risk proportion of credit spread for Nordic and European HY markets utilizing the Extended Merton Model by Eom et al. (2004), Second, analyse the difference in credit risk parameters and market factors between the Nordic and European HY markets Trough simple regression analysis. Last, construct Multiple regression model from statistically significant variables to best predicate the credit spread difference between the two HY markets.

Issue with the analysis is that bond price data is only given at date last traded, I have decided to cope with the issue by following Ytterdal and Knappskog (2015) by assuming that bond is issued at par. Furthermore, the comparison of the two markets from sample data arise issues due to bonds features, as bonds with high coupon rate and short maturity can be matched up against a low coupon rate bond in the other market. To cope with this issue, I have decided to construct the analysis on monthly basis, examining the monthly average differences between the two markets.

6.1 Extended Merton model

6.1.1 Nordic High Yield Market

Table 6.1 presents the credit spreads predicted by the model vs the observed credit spread of sample in the Nordic market. The model underpredicts credit spreads on average by 40%, implying that 60% is compensated by credit spread. The underprediction of credit spread through the extended Merton model where as expected based on the findings of Eom et al. (2004) where they discuss how low CRA rated bonds tend to generate underpredicted credit spread from the Merton model. The results are also in the lines of Ytterdal and Knappskog (2015) who finds that 35.5% of credit spread is explained by compensation for credit risk in the Nordic bond market. The Extended Merton model in the Nordic sector however provides a rather low multiple R squared of 0.1707, implying that the model / credit risk explained 17.07% of the variance in observed credit spread from the sample. Leaving 82.93% of the variance in credit spread unexplained in the Nordic sector. (appendix A)

Table 6.1 Nordic Observed vs Model Credit Spread (BPS)

NORDIC				
Credit Spreads	Mean	St.Dev	Max	Min
Observed	376.2897	126.3821	873.6402	190.9084
Model	229.2582	135.1493	633.4887	36.5871

Measuring the model accuracy, I follow Eskerud (2017) by measuring mispricing of model. hance, subtracting model BPS from observed BPS. The advantage of mispricing metric on credit spread is the indication of observations being over or under predicted. The over or under prediction of credit spreads of model reflecting credit risk is important, as compensation for credit risk can never be above the observed market spread. Figure 6.1 illustrates the model mispricing in the Nordic HY market. The figure shows that the mispricing leans towards underpredicting the spreads.

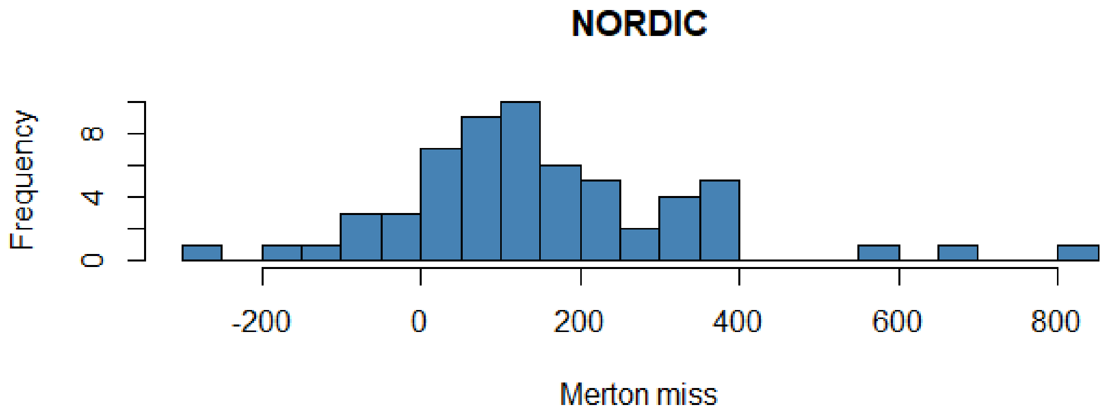


Figure 6.1 Distribution of model mispricing, Nordic (BPS)

The model further on illustrates that compensation for credit risk is lower than the observed market as seen in table 6.2

Table 6.2 Model mispricing, Nordic (BPS)

NORDIC				
	Mean	St.Dev	Max	Min
Mispricing	154.7306	187.1751	818.9746	-257.642

6.1.2 European High Yield Market

Table 6.3 presents the credit spreads predicted by the model vs the observed credit spread of sample in the European market. Like the Nordic market, the European market also underpredicts credit spreads through the extended Merton model by 30%, indicating credit risk compensation of credit spread to be 70%. The model yields a high multiple r squared of 0.6121, implying that 61.21% of the variance in observed credit spreads is explained by credit risk. Leaving 38.79% of the variance unexplained. (appendix A)

Table 6.3Euro Observed vs Model Credit Spread (BPS)

	EURO			
Credit Spreads	Mean	St.Dev	Max	Min
Observed	245.4988	101.0361	593.1986	85.85315
Model	173.2949	80.5247	441.329	70.36774

Figure 6.2 illustrates the model mispricing in the European HY market. The figure indicates a strong lean towards underpredicting spreads. meaning that most bonds within the sample generates lower spreads through the model.

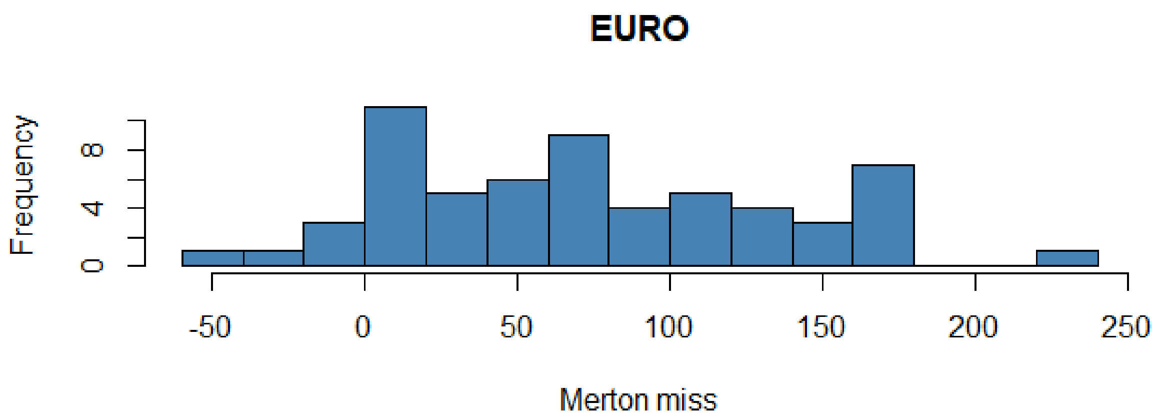


Figure 6.2 Distribution of model mispricing, European (BPS)

Same as Nordic sector the model further illustrates the compensation for credit risk is lower than observed in the European market as seen in table 6.4

Table 6.4 Model mispricing, Euro (BPS)

	EURO			
	Mean	St.Dev	Max	Min
Mispricing	72.20391	62.84146	233.1186	-49.194

6.2 Analysis of Credit spread differences.

The extended Merton model shows evidence of underpredicting credit spread in both HY markets, the model mispricing is utilized as a proxy for proportion of credit spread compensated by credit risk. In the following sections of thesis, I will interpret the difference in credit spread between Nordic and European HY markets, through difference in: Proportion explained by credit risk, Merton model Input parameters, Bid/ ask spread, Leverage, Equity market correlation, Market Capitalization, and difference in rating of bonds, as the Nordic sector is overpopulated with non-rated bonds. First, I perform simple regression analysis on the different Inputs. To assess the relationship between the difference in variables on the observed credit spread difference. Furthermore, I construct multiple regression analysis on all significant explanatory variables to measure how much of the credit spread difference is explained by the different variables.

6.2.1 Simple regression analysis.

Assessing the relationship between the different variables to credit spread differences, I perform sets of simple regression analysis. Utilizing the credit spread difference between Euro and Nordic market on monthly average basis, in the time 2017-2021 from sample data, providing 60 observations in the inputs. Mean, standard error, maximum and minimum values for Nordic, Euro and Spread difference, can be seen in table 6.5. Results of regressions are presented in table 6.6, scatter plots and histograms of residuals and fitted values to examine homoscedasticity and normality is presented in appendix A.

Table 6.5 Credit Spread Difference, Monthly average, (BPS)

	EURO			
	Mean	St.Dev	Max	Min
Nordic	393.2512	136.0553	815.6494	213.2134
Euro	241.1248	101.2038	571.4409	54.12625
Spread Difference	152.1263	179.5582	634.9636	-264.1424

Table 6.6 Simple Regression Results

	Dependent Variable:					
	Nordic/Euro-Credit Spread Difference					
Rating/Non-Rating	28.544** (9.757)					
Coupon		61.543*** (1.628)				
Maturity			27.094*** (1.785)			
Bid/Ask-Spread				70.201*** (5.946)		
Equity Volatility					397.191* (153.766)	
Asset Volatility						-1.212e-03*** (2.665e-04)
Intercept	110.364*** (5.518)	156.223*** (3.551)	42.188*** (6.664)	142.581*** (4.812)	122.279* (4.679)	1.218e+02*** (4.564e+00)
Observations	60	60	60	60	60	60
R^2	0.00467	0.4392	0.1122	0.071	0.003645	0.1121
Adjusted R^2	0.004124	0.4389	0.1117	0.07049	0.003098	0.1067
Residual Std.Error (df=58)	194.5	146	183.7	187.9	194.6	193.8
F Statistic (df= 1:58)	8.558	27.45	7.121	0.9994	0.004531	0.9012
P-Value	0.003482	2.2-e16	2.2-e16	2.2e-16	0.009869	5.767e-06
Note: Std.Error in Brackets ()			.P<0.05	*P<0.01	**P<0.001	***P<0

	Dependent Variable:					
	Nordic/Euro-Credit Spread Difference					
Market Correlation	50.809*** (10.653)					
Default-Barrier		-2.053e-10* (1.391e-10)				
Market Capitalization			8.956e-11*** (2.012e-11)			
Payout-Ratio				191.734*** (44.076)		
Leverage					-82.405*** (16.876)	
Credit Risk Proportion						48.564*** (0.185)
Intercept	110.220*** (4.933)	1.168e+2*** (4.904e+00)	1.218e+02*** (4.566e+00	116.418*** (4.593)	101.383*** (5.856)	96.04919*** (3.993)
Observations	60	60	60	60	60	60
R^2	0.01232	0.001193	0.01075	0.01027	0.0129	0.2724
Adjusted R^2	0.1178	0.0006455	0.0102	0.009725	0.01236	0.262
Residual Std.Error (df=58)	193.7	194.8	193.9	193.9	193.7	166.3
F Statistic (df= 1:58)	0.06387	0.5027	0.03669	3.3	0.3327	12.37
P-Value	1.996e-06	0.001401	9.051e-06	1.4363-05	1.136e-06	1.53e-08
Note: Std.Error in Brackets ()			.P<0.05	*P<0.01	**P<0.001	***P<0

Rating/Non-Rating

Probably the greatest difference between the market is the existence of non-rated bonds in the Nordic market. The rating variable identifies as a dummy variable, measuring 0 if the euro bond is measured against a nonrated bond, and 1 otherwise. From the regression output in table 6.6 reader can observe that rated variables will on average be produce credit spreads of 28.544 BPS higher than the non-rated. The coefficient result is unexpected as investor tends to expect higher premium for investing in bonds with less information regarding default. Furthermore, reader can observe from the intercept that if all bonds where non-rated, the average credit spread will be 110.364 bps. The multiple r square gives an explanatory to variance in credit spread difference of 0.467% which is extremely low, meaning 99.643% of the variance in credit spread difference is explained by other factors.

Coupon

The difference in average monthly coupon between the two markets provides the most vital variable in predicating the credit spread differences. Significant to $P<0$, and multiple r squared of 0.4392, leaves only 56% of the variance in credit spread difference unexplained. From the coefficient value, reader can see that by 1 increase in coupon difference yields 61.543 bps increase in credit spread difference. The high explanatory significance and impact on spread difference is not unexpected as coupons acts as the interest paid annually to investor, hance having great impact on yield to maturity.

Maturity

Monthly maturity difference yields significant to explaining the future value of credit spread difference with respect to its P-value being less than zero. Furthermore, reader can see from table 6.5 that with increase in maturity the spread difference will yield 27.904 bps in spread difference. Maturity provides an R squared of 0.1122 leaving 88.78% of the variance unexplained in predicating credit spread difference between Nordic and European HY market.

Bid / Ask – Spread

The bid ask spread derive from the last reported transactions on sample bonds. The B/A can be utilized as a proxy for liquidity of bond, the less the spread the more liquid the asset. The input variable in this regression analysis measures the difference in B/A spread between the markets. The coefficient of 70.201 indicates that increase in B/A spread difference, hance less liquidity in the Nordic market yields high impact on credit spread difference the results are in line with theory were investor demand premium from illiquid assets. The variable is significant with respect to its p-value, furthermore B/A spread generates an r squared of 0.071 leaving 92.9% of the variance unexplained.

Equity Volatility

Equity volatility is derived from 150 day moving average of bond issuer stock price prior to bond issue. The variable acts as an important parameter in estimating asset volatility. From the regression analysis, equity volatility yields significant to the 99% significant level. Estimate coefficient shows that increase in Nordic volatility compared to European have high impact on credit spread difference. The estimate makes sense, as investors would want premium as compensation for holding more volatile assets. Furthermore, high equity volatility means less information about firm's future financial state as its more inaccurately forecasted. However, equity volatility yields a low r squared of 0.003645, leaving 99.64% of the variance in spread differences unexplained.

Asset Volatility

Asset volatility variable is one of the more controversial variables in the regression output, due to the variable being an estimation. The negative estimate explains that the greater the difference in asset volatility of the two markets, shrinks the credit spread difference by 0.001212 bps, hance leaving minimal impact on credit spread difference. However, the variable yields R squared of 0.1121 leaving 88.8% of the spread difference variance unexplained.

Market Correlation

Market correlation derives from the equity stock correlation to its set stock market. making the variable difference in correlation to market. Coefficient estimate measures that by one unit change in correlation difference equals increase of 50.809 bps in credit spread difference. The variable is significant to an 99.99% level and yields r squared of 0.01232 leaving 98.8% of the spread variance unexplained.

Default Barrier

The default barrier is calculated by adding the total short-term liabilities to half of long-term liabilities. And represents the barrier asset value must breach to trigger default of firm. The variable is proven significant to an 99% level. Estimates show that by increasing the default barrier in the Nordic contra Euro, will decrease the credit spread difference minimally. The r squared for default barrier gives results of 0.01193 leaving 98.8% of variance in credit spread difference unexplained.

Market Capitalization

Market capitalization variable, measure the monthly difference in firm's equity value at bond issue date. Same as the default barrier, estimates for market capitalization gives minimal impact on credit spread difference. The variable is significant to an 99.999% level. And provides an r squared of 0.01075, leaving 99% of the variance in dependable variable unexplained.

Payout Ratio

The payout ratio, derived from dividends, share repurchase, and interest paid to debt and equity holders over total assets. is one of the extensions made by Eom et al (2004) to the Merton model. The estimates shows that average monthly payout ratio difference between the firms in Nordic and European HY market. yields 191.435 bps by one unit increase in difference. However, payout ratio yields a low r squared of 0.01027, leaving 99% of the variance in credit spread unexplained by the variable.

Leverage

The leverage variable can be utilized as a proxy for firms' distance to default in the regression the leverage variable measures the difference in leverage between the two debt markets monthly. An increase in leverage in the Nordic market, hance increasing its distance to default. will result in credit spreads differences to fall by 82.405 bps. The result is as expected as investors tend to demand premium for increased risk of default. The r squared results to 99% of the variance in credit spread difference being unexplained by leverage.

Credit Risk

As mentioned in section 6.1 the Merton model is utilized as a proxy for credit risk proportion of credit spread. Mentioned in section 6.1.1 and 6.1.2 Credit risk stands for 60% in the Nordic market and 40% in Europe. The credit risk variable measures the difference in credit spread with respect to difference in mispricing by Merton model in the two markets, on monthly basis. The variable is proven significant to 99.99% level, an indicates that if one unit of credit risk proportion of credit spread increases in the Nordic market. The credit spread difference will increase by 48 bps. The results are somewhat expected, due to if credit risk were known in a market where ratings is gaping investor will gain information on bond and can further set barriers for premium, creditor will accept to undertake such risk. the r squared provides high values leaving only 72.76 % of the variance in credit spread difference unexplained.

6.3 Drivers of Credit Spread Difference in Nordic and European High Yield

Trough the analysis of variables and credit risk proportion of credit spreads in the debt markets. author and reader can interpret which variables and differences have the largest impact in credit spread difference. From the simple regressions reader can first see that, one of the largest differences in the markets is in respect to lack in Official ratings in the Nordic market gives and reverse impact than expected, whereas when European bonds are compared towards rated Nordic bonds, the spread will increase by 28.5 bps. Furthermore, as expected reader is informed about the great difference in coupon rate between the markets, this may result in the probability of non-rated bonds having premium embedded in the coupon rate of bond. Third, I observe how increase in maturity difference yields 27 bps, the increase due to maturity is expected, due to investor expecting to be compensated for holding investment one additional year, as I assume all bonds to be hold and paid principle at maturity.

Additionally, to bond features differences, the regressions analyze firm and market differences, whereas bid/ask spread utilized as a proxy for market liquidity difference between the market yields the most interesting results. Where an increase in illiquidity difference is compensated by 70 bps. The difference volatility of firm’s equity structure high compensation in credit spread differences. This is prompt due to an increase in fluctuations of equity increase the chance of generating distressed firm structures, hance increasing credit risk. the equity volatility is directly linked to the estimate of asset volatility and value, utilized to conclude the extended Merton model. Other market factor differences erupt from the market correlation. Where increase in correlation to the equity market is compensated by 50 bps. The compensation is probably due to debt investors wanting to diversify their portfolio by including debt.

The firm’s payout ratio, indicating how much of firm’s total assets is paid out to its equity and debt holders, the results from the payout ratio difference is somewhat reversed, due to payout ratio for equity is decided by firms, and should never surpass their total assets, as this would generate solvency issues for firm. Furthermore, leverage utilized as proxy for distance to default yields expected results, as if the distance to default difference increases the credit spread difference corresponds by -82 bps.

The last driver of credit spread difference is the proportion of credit risk in the markets, derived from the extended Merton model. where the takeaway from simple regression between credit risk proportion of credit spread difference, yields result of increase 48 bps due to increase of credit risk proportion in credit spread.

To assess how much of the variance is explained through the variables, I have constructed a multiple regression analysis of variables proven significant in explaining credit spread difference. As expected, due to components of model, and significant to spread, the coupon and Credit risk (Merton model) variables yield moderate high in respect to multicollinearity: visualized in the VIF test in table 6.7. Output from the multiple regression analysis given in table 6.8.

Table 6.7 Multicollinearity

VIF TEST	
	Multicollinearity
Rating/Non-Rating	1.364805
Coupon	3.613192
Maturity	1.366576
Bid/Ask-Spread	1.126576
Equity Volatility	1.226761
Asset Volatility	1.106813
Market Correlation	1.171546
Default-Barrier	1.355230
Market Capitalization	1.194749
Payout-Ratio	1.330115
Leverage	1.281004
Merton Model	4.694763

Table 6.8 Multiple Regression

	Dependent Variable:	
	Nordic/Euro-Credit Spread Difference	
Rating/Non-Rating	1.521e+01*	
		(7.412e+00)
Coupon	12.411e+01***	
		(2.681e+00)
Maturity	1.354e+01***	
		(1.463e+00)
Bid/Ask-Spread	3.431e+01***	
		(4.247e+00)
Asset Volatility	-4.365e-05*	
		(1.829e-04)
Equity Volatility	-7.912e+01*	
		(1.107e+02)
Market Correlation	5.384e-05***	
		(7.527e+00)
Default-Barrier	-1.961e-10**	
		(1.051e-10)
Market Capitalization	2.157e-12*	
		(1.434e-11)
Payout-Ratio	1.277e+02***	
		(3.315e+01)
Leverage	-4.850e+01***	
		(1.247e+01)
Credit Risk Proportion	2.243e+02***	
		(1.901e+01)
Intercept	3.895e+01***	
		(7.269e+00)
Observations	60	
R^2	0.5524	
Adjusted R^2	0.5064	
Residual Std.Error (df=58)	150.7	
F Statistic (df= 1:58)	3.471	
P-Value	2.2e-16	

Note: Std.Error in Brackets		
	.P<0.05	*P<0.01
	***P<0	**P<0.001

The results from table 6.8 indicate that the included variables explain 50% of the credit spread difference between the two markets leaving 50% unexplained with respect to the adjusted r squared. The coefficient estimates for all models have nevertheless decreased. Making official rating difference account for 15bps, coupon 124.11 bps, maturity 13 bps, bid/ask spread 34 bps, equity volatility -79 bps, payout ratio 127 bps, leverage -49 bps, and credit risk 224.3 bps. Asset volatility, market correlation, market capitalization, and default barrier coefficient estimate results are equal to 0 bps.

From the multiple regression analysis we can see those differences in rating, coupon, maturity, equity volatility, leverage, credit risk, and bid ask spread provides the biggest drivers for the credit spread difference between the two HY markets. Furthermore, I have proven trough the extended Merton model that both markets have credit spreads unexplained by credit risk, hance the credit spread puzzle is present in both HY markets according to the sample dataset utilized in thesis. Additionally, I will point out that the credit spread difference unexplained by the model, may be due to market investors risk tolerance, not researched in this thesis.

The Model is evaluated for homoscedasticity trough Breusch-Pagan test and visualized in scatter plot of model found in appendix A. the results provide P-value above 0.05, rejecting the null hypothesis of homoscedasticity, hance data being heteroscedasticity. Meaning the variance in model varies widely. Additionally, the histogram examining normality in appendix A, shows that the data is fairly accepted as normal.

6.4 Criticism

In this section, I will present limitations of thesis, points of improvements, and suggestions to future research.

Time and resources have been the main limitation of this master thesis. Lack of available databases and collecting processes, have made a challenge in collecting and overcoming the pure existence of data needed to research the problem statement. The challenge has forced me to utilize only one database for bond data, and hundreds of annual reports for firm characteristics. Furthermore, a challenge in screening and sorting and aligning the different datasets. Additionally increasing the risk of measurement error. Furthermore, choosing and understanding the models have been a time-consuming, but exciting process, and can additionally be seen as a possibility of implementation error. The results of credit spread derived from the extended Merton model are similar to Ytterdal and Knappskog (2015), however results hugely derive from Eskerud (2017) results. This may be due to my calculations of portfolio of zero-coupon bonds as the total price of portfolio, where I assume Eskerud (2017) have added each zero-coupon bond derived from a coupon paying bond, to his bond sample as a new bond observation in time, increasing his bond data from 62 observations to 491 observations. Thesis result may also be opted for further errors, due to using the closest match risk free bond, instead of the nelson Siegel model utilized by Eom et al (2004), Ytterdal and Knappskog (2015) and Eskerud (2017)

I have only utilized bond observation at last traded date assumed bond issued at par, furthermore a static recovery rate for all bonds. the point estimates cause further risk of measurement error. Additionally, to measure the spread difference between the two markets, I have matched monthly average for all variables. due to matching on daily basis will generate un valid results because of large gaps in time series. To truly measure credit spread difference, the bond compared against one another should have the same bond characteristics with respect to coupon, maturity, and firm characteristics, sector and issue date. Leaving the only differences between the market to be market factors such as liquidity, rating, and investors risk tolerance. The matching using monthly data therefore further rise the cause of measurement error, as seen in table 6.5, where the minimum value of spread difference is negative, meaning that in some months, the European credit spread is over Nordic, a state that have never occurred according to the Norway Xover over Europe Xover given by Sparebank 1 markets (2021)

From literature there have derived many different variations of the original Merton model. where most of them focus on including different economic and market factors to further explain credit spread and effect of credit risk. given more time and resources I would have liked to include tax and regulation differences of bonds to the analysis. Tax between government and corporate bonds is equal in Norway, however in the European market, more sophisticated equations are used to calculate tax for bonds. furthermore, I would have created a dummy variable for sectors like Ytterdal and Knappskog (2015) to better measure the credit spread difference between the two HY markets. Additionally, to generate a greater level of precision, I would have attempted to include some already defaulted bonds in the data set, as they are absent in this thesis.

Lastly, the Merton model have its defects as some important inputs are reliant on estimates. Th structural model is therefore often criticized for these unobservable input variables. For future research I would recommend to explore pure statistical models and machine learning type of models, to predicate credit spread. such as the discrimination models SEBRA (2017) and Altman Z-score (2003). To explore if new methods in credit spread and credit risk yields more significant and higher results.

7 Conclusion

The purpose of this thesis was to predicate and examine the credit spread difference between the Nordic and European High Yield Bond markets. Earlier studies have researched components of credit spread, however credit spread differences between two markets, remains unexplored. I have utilized the extended Merton model by Eom et al (2004) on bond data in both markets in period 2017 to 2021, to assess how much of the credit spread is on average compensated by credit risk in both Nordic and European HY market. I have utilized standardized recovery rates of 31% in the Nordic and 40% in European market, whereas results underestimate credit spreads in both markets. leaving me with the assumption that on average 60% is compensation from credit risk in the Nordic market, and 70% in the European. The result of 40% mispricing in the Nordic market, trough the extended Merton model, is close compared to the prior studies of Ytterdal and Knappskog(2015), where they find 35% mispricing of Nordic HY bonds through Eom et al's (2004) model the results. However, the results show great deviations from Eskerud's (2017) and Sæbø (2015). Where Eskerud claims the model overprice bonds by 67%. Where Sæbø yields results of mispricing at 72%. The deviations may be due to Eskerud and Sæbø research the Norwegian credit market as whole, thus including investment grade rated bonds.

I then analyze differences in structural model input variables in addition to liquidity, leverage, and market correlation on monthly basis between the two HY markets, where official rating, monthly average coupon, monthly average maturity, liquidity, equity volatility, payout ratio, leverage, and credit risk, are explanatory factors in credit spread difference in Nordic and European High Yield market. Explaining 50% of the variance. The adjusted R squared could yield better explanatory power through inclusion of systematic risk factors such as Fama-French factors, where Sæbø (2015) finds the factors yields significant in predicting credit spreads.

Additional to deviations from prior study, the thesis results are affected by notable risk of error in analysis. Due to complications in understanding the implementation of structural model, insufficient data from screening and sorting. Leaving me to conclude that the analysis and results are invalid in predicating the problem statement. The invalid results are further complimented by the use of static recovery rate, differences based on market monthly average, use of closest match of corporate and risk-free bond instead of Nelson-Seigel model, and input estimations being calculated trough simplest implementations i.e., using 150 moving averages for equity volatility, instead of more sophisticated GARCH and ARCH modelling. Additionally, the non-rated Nordic bonds may produce sample error to posing as an exclusive HY sample, due to the probability of non-rated bonds being classified as an investment grade bond trough official rating method. This leaves an interesting statement for further studies, where Altman-z score or SEBRA model could be implemented to calculate the true rating nature of bonds, thus creating better sample data in researching the phenomenon.

Although the results yield several interesting findings in the high yield markets, the small sample size and risk of measurement errors, causes suspicion to validity and robustness of results. Literature prior to thesis by Schuermann and Hanson (2004) gives evidence that larger-time series prove significant in measuring credit spread. Additionally, Bruche and Gonzales-Aguado (2006) proves that systematic time-variations in recovery rates is vital to debt pricing models. Thus, to yield trustworthy results: larger data sets, systematic risk factors, tax input, regulation factors, and additional dummies for bond type, sector and seniority, must be implemented to truly satisfy the research of credit spread differences between Nordic and European High Yield.

8 References/Bibliography

Alfred Berg. (2019). *The Nordic High Yield market – H1 2019 review.*

Altman, E., Resti, A., & Sironi, A. (2003). Default Recovery Rates in Credit Risk Modeling: A Review of the Literature and Empirical Evidence.

Altman, E., Sironi, A., Resti, A., & Brooks, B. (2003). The Link between Default and Recovery Rates: Theory, Empirical Evidence and Implications.

Amato, J. D., & Remolona, E. M. (2003). *The credit spread puzzle.*

Apergis, N. (2019). Oil prices and corporate high-yield spreads: Evidence from panels of. *The Quarterly Review of Economics and Finance*.

Black, F., & Cox, J. C. (1976). Valuing Corporate Securities: Some Effects of Bond Indenture Provisions. *The Journal of Finance*.

Bloemarts, B. (2006). *Valuing equity in distressed firms as a.*

Bodie, Z., Kane, A., & Marcus, A. J. (2021). *Invetsments.* McGraw-Hill Education.

Bolton, P., Freixas, X., & Shapiro, J. (2012). The Credit Ratings Game. *The Jurnal of finance*.

Bruche, M., & González-Aguado, C. (2008). Recovery Rates, Default Probabilities and the Credit Cycle.

Churm, R., & Panigirtzoglou, N. (2005). Decomposing credit spreads .

Corporate Finance Institute. (2021). *corporatefinanceinstitute.com*. Retrieved from https://corporatefinanceinstitute.com/resources/knowledge/finance/credit-rating/

de Lange, P. E., Aamo, P. E., & Westgaard, S. (2018). The Norwegian financial bond market: A comprehensive market review with an empirical analysis of the main. *Universitetforlaget*.

de Lange, P. E., Stiberg, K. H., & Aamo, P. E. (2019). Estimating Contingent Convertible credit. *Universitetforlaget*.

Delianedis, G., & Geske, R. (2001). The Components of Corporate Credit Spreads: Default, Recovery, Tax, Jumps, Liquidity, and Market Factors.

DNB Markets. (2021). *WEEKLY CREDIT REPORT 10 NOVEMBER 2021.*

edbodmer.com. (2022). *Merton Model and Credit Analysis in Project vs Corporate Finance*. Retrieved from https://edbodmer.com/: https://edbodmer.com/credit-analysis/

Eom, Y. H., Helwege, J., & Huang, J.-Z. (2004). Structural Models of Corporate Bond Pricing: An Empirical Analysis.

Eskerud, H. (2017). Predicting credit spreads in the.

Feldhütter, P., & Schaefer, S. (2016). The Myth of the Credit Spread Puzzle.

Finansmarkedavdelingen I Norges Bank. (2007). Modellering av kredittrisiko i foretakssektoren – videreutvikling av SEBRA-modellen.

Fondsfinans Kapitalforvaltning. (2021). *Markedsrapport Oslo 12. mars 2021.*

Gemmil, G. (2002). Testing Merton's Model for Credit Spreads. *Financial Econometrics Research Centre*.

Hayes, A. (2021). *Black-Scholes Model*. Retrieved from Investopedia.com: https://www.investopedia.com/terms/b/blackscholes.asp

History of KMV. (n.d.). Retrieved from Moody' Analytics: https://www.moodysanalytics.com/about-us/history/kmv-history

Houweling, P., Mentink, A., & Vorst, T. (2004). Comparing possible proxies of corporate. *Journal of Banking & Finance*.

Jarrow, R. A., & Turnbull, S. M. (1995). Pricing Derivatives on Financial Securities Subject to Credit Risk. *The Journal of Finance*.

Jarrwo, R. A., & Protter, P. (2004). Structural Versus Reduced Form Models: A New Information Based Perspective. *The Journal Of Investment Management*.

Ji, K., & Qian, Z. (2013). Does tax policy affect credit spreads? Evidence from the US and UK.

Katz, Y. A., & Shokhirev, N. V. (2010). Default Risk Modeling Beyond the First-Passage Approximation:.

Kloster, A., & Syrstad, O. (2019). Nibor, Libor and Euribor – all IBORs, but .

Lee, K.-H. (2006). *LIQUIDITY RISK AND ASSET PRICING*.

Lie, C. M., & Nielsen, M. L. (2015). *Empirical Studies of Credit Spreads in the European High Yield Market.* Copenhagen.

LP, Bloomberg. (2022). *Bloomberg Terminal*. Retrieved from Bloomberg Professional.

NIBOR. (n.d.). Retrieved from https://www.referanserenter.no/

Rundhaug, M., de Lange, P. E., & Aamo, P. E. (2020). Modeling Bond Spreads and Credit Default. *Universitetforlaget*.

Sæbø, J. K. (2015). *Risikopremier i norsk kreditt.* Folketrygdfondet.

Schuermann, T., & Hanson, S. (2004). Federal Reserve Bank of New York Staff Reports Estimating Probabilities of Defaul.

Sparebank 1 Markets. (2021). *High Yield Weekly*.

Standard & Poor's . (2018). *S&P Global Ratings' credit rating definitions**. Retrieved from S&P: https://www.fsk-ees.ru/upload/docs/2018_Rating_FSK_EES_SP.pdf

Stensaker, T. (2017). How will a ban on shadow ratings.

STIBOR. (n.d.). Retrieved from https://swfbf.se/sfbf-benchmarks/rates/

Sundaresan, S. (2013). A Review of Merton's Model of the Firm's Capital Strucutre with Wide applications. *Annual Review of Financial Economics*.

Yahoo! finance. (n.d.). Retrieved from https://finance.yahoo.com/

Ytterdal, A. G., & Knappskog, B. H. (2015). Predicting spreads in the Nordic: A study of credit pricing in the years 2000-2012.

Additionally: Annual Reports for all firms on issue year (2017-2021) present in Appendix B is Used to extract Data on Firm Characteristics

9 Appendix A

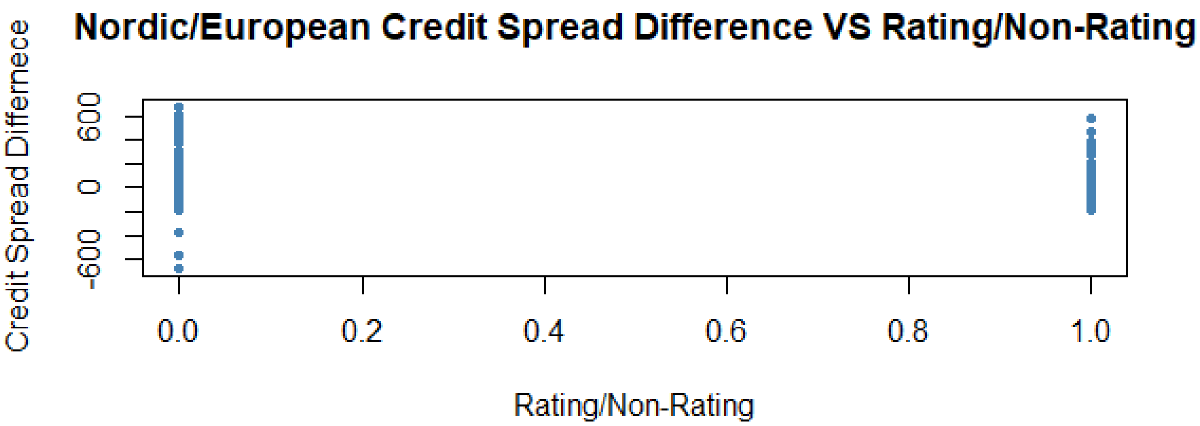
Appendix A- Regression analysis, scatter plots and Histogram

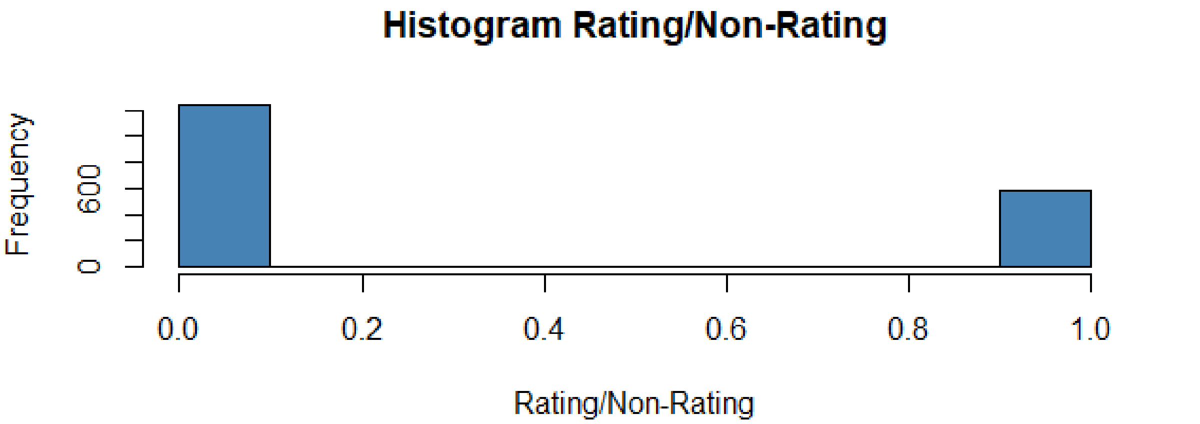
Nordic Merton

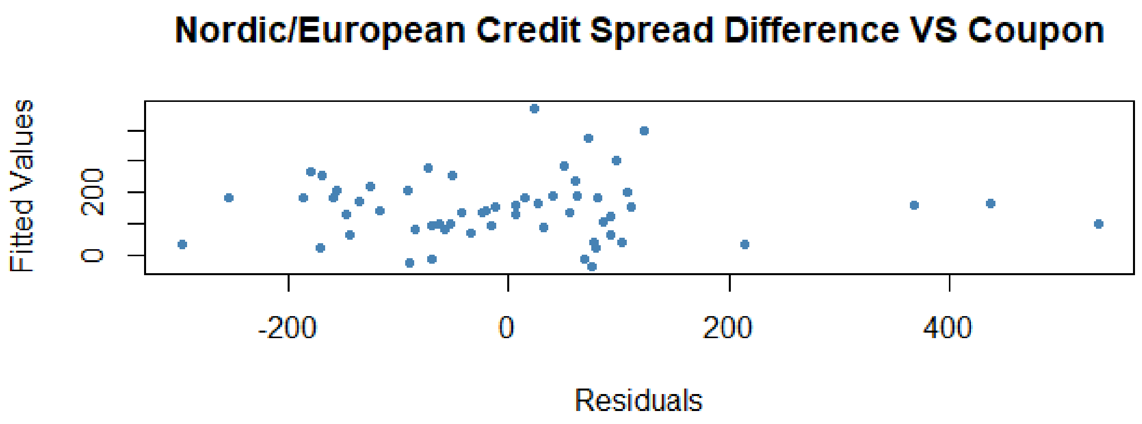
	Dependent Variable:	
	Nordic Credit Spread	
Merton Model	0.3586**	
		(0.1208)
Intercept	277.8835***	
		(1.46e-08)
Observations	60	
R^2	0.1707	
Adjusted R^2	0.132	
Residual Std.Error (df=58)	127.8	
F Statistic (df= 1:58)	8.82	
P-Value	0.0043	
	.P<0.05	*P<0.01
Note: Std.Error in Brackets	***P<0	**P<0.001

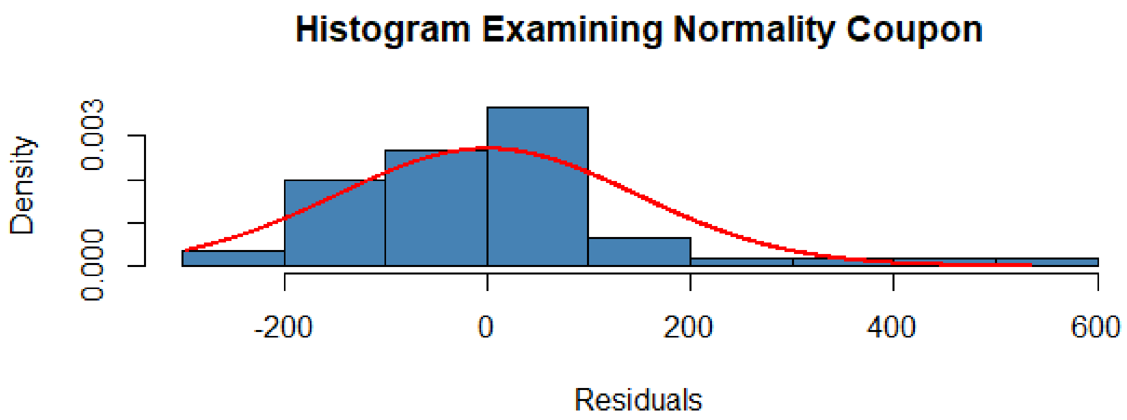
European Merton

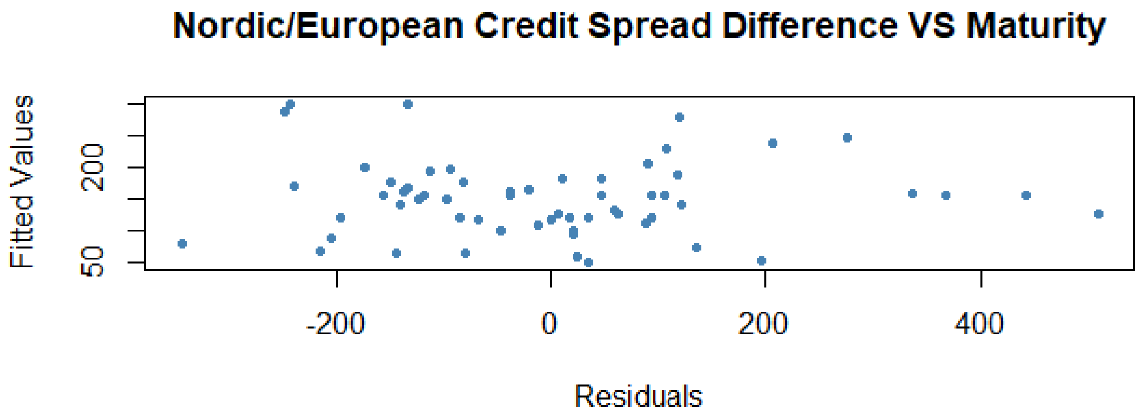
	Dependent Variable:	
	European Credit Spread	
Merton Model	0.9833***	
		(0.1028)
Intercept	27.5969***	
		(0.1689)
Observations	60	
R^2	0.6121	
Adjusted R^2	0.6054	
Residual Std.Error (df=58)	63.57	
F Statistic (df= 1:58)	91.51	
P-Value	1.563e-13	
	.P<0.05	*P<0.01
Note: Std.Error in Brackets	***P<0	**P<0.001

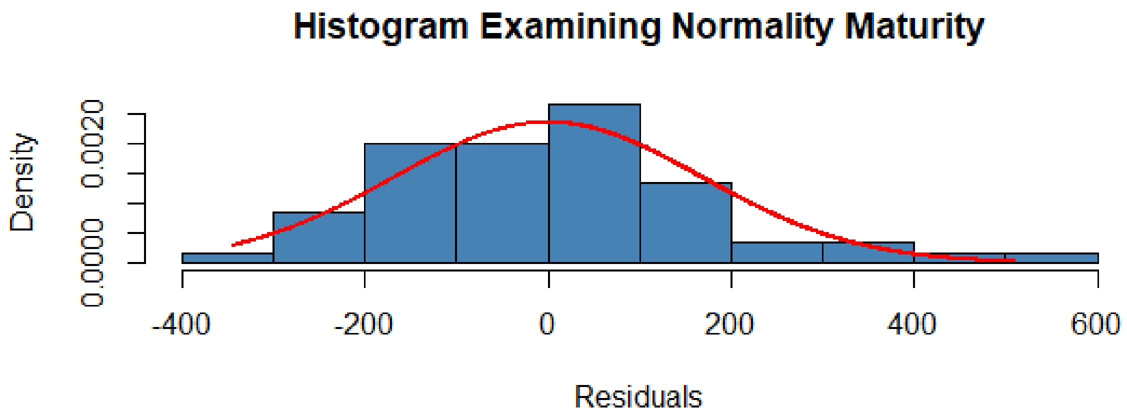

Nordic/European Credit Spread Difference VS Rating/Non-Rating
Credit Spread Differnece
-600
0
600
0.0
0.2
0.4
0.6
0.8
1.0
Rating/Non-Rating

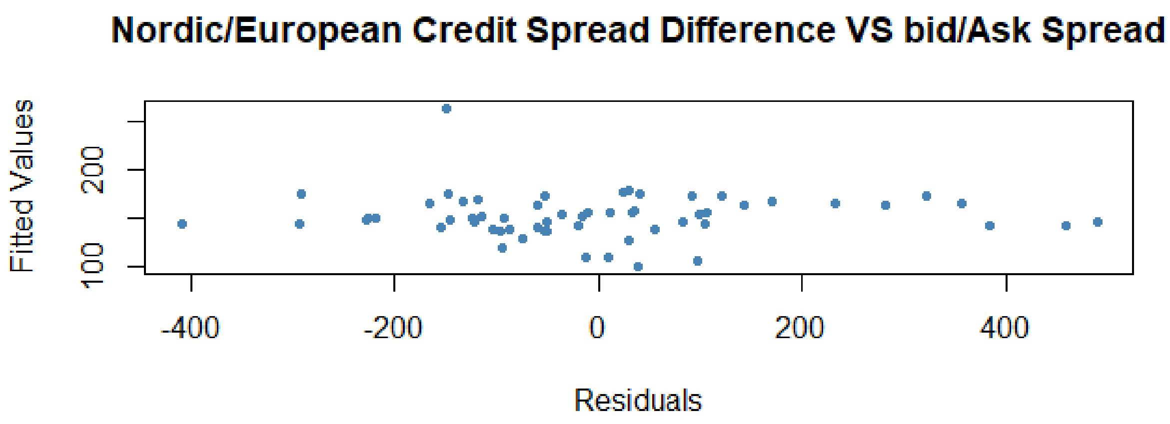

Histogram Rating/Non-Rating
Frequency
0
600
0.0
0.2
0.4
0.6
0.8
1.0
Rating/Non-Rating

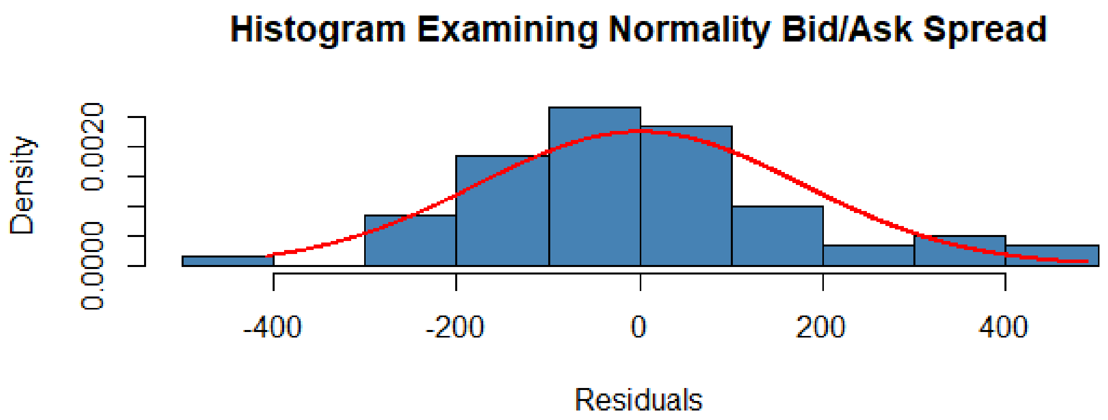

Nordic/European Credit Spread Difference VS Coupon
Fitted Values
0
200
-200
0
200
400
Residuals

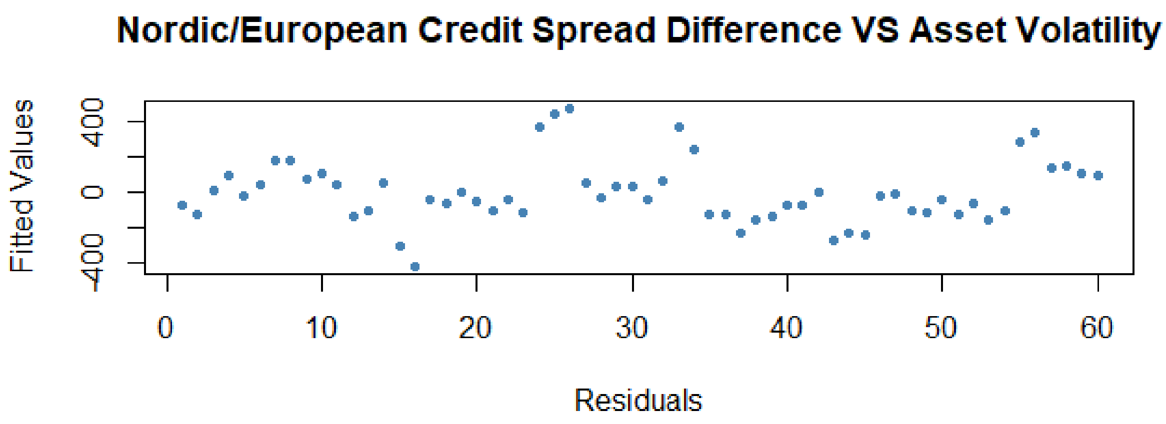

Histogram Examining Normality Coupon
Density
0.000
0.003
-200
0
200
400
600
Residuals

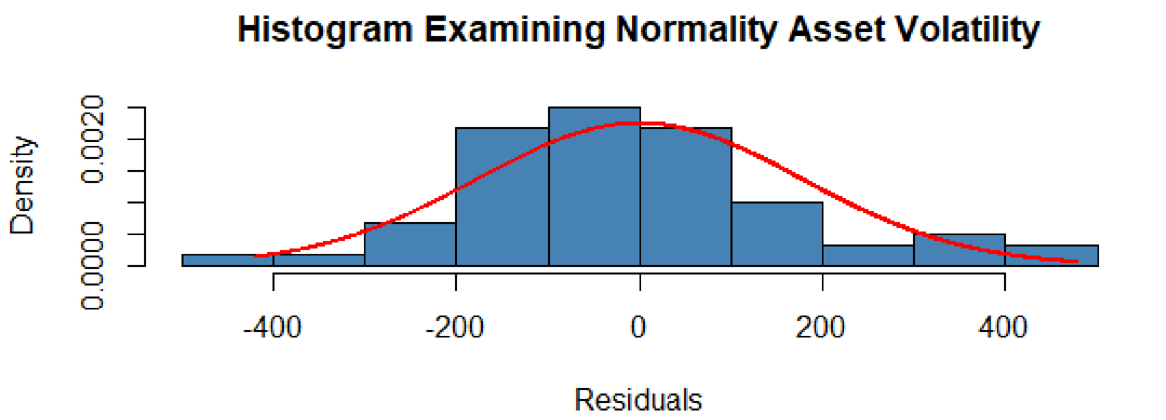

Nordic/European Credit Spread Difference VS Maturity
Fitted Values
50
200
-200
0
200
400
Residuals

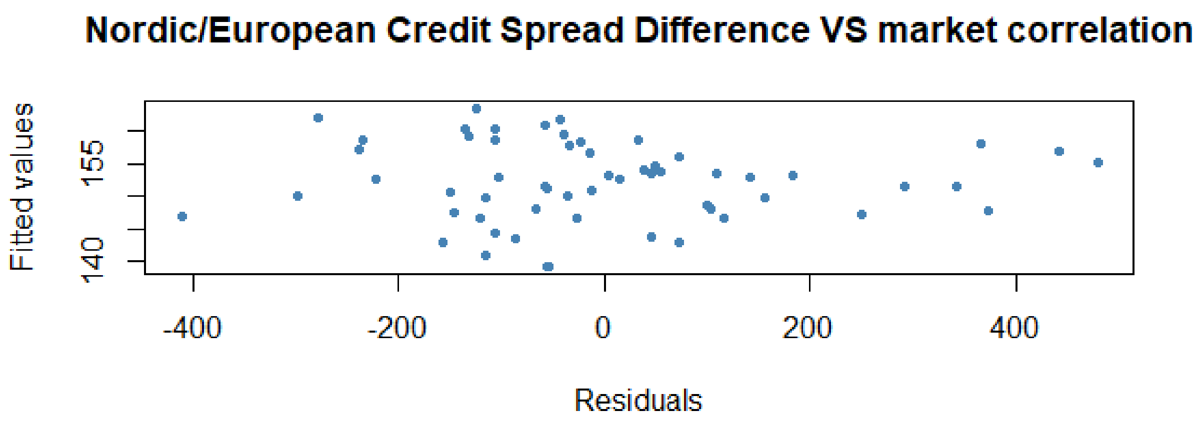

Histogram Examining Normality Maturity
Density
0.0000
0.0020
-400
-200
0
200
400
600
Residuals

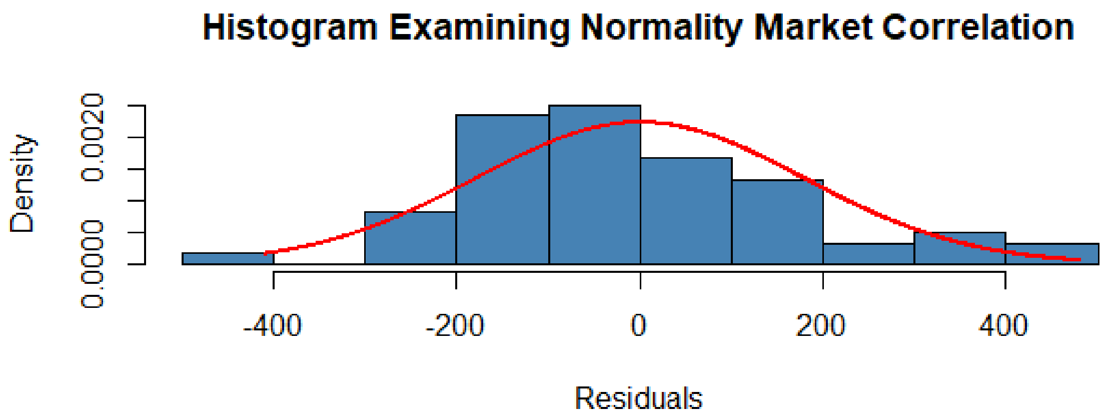

Nordic/European Credit Spread Difference VS bid/Ask Spread
Fitted Values
100
200
-400
-200
0
200
400
Residuals

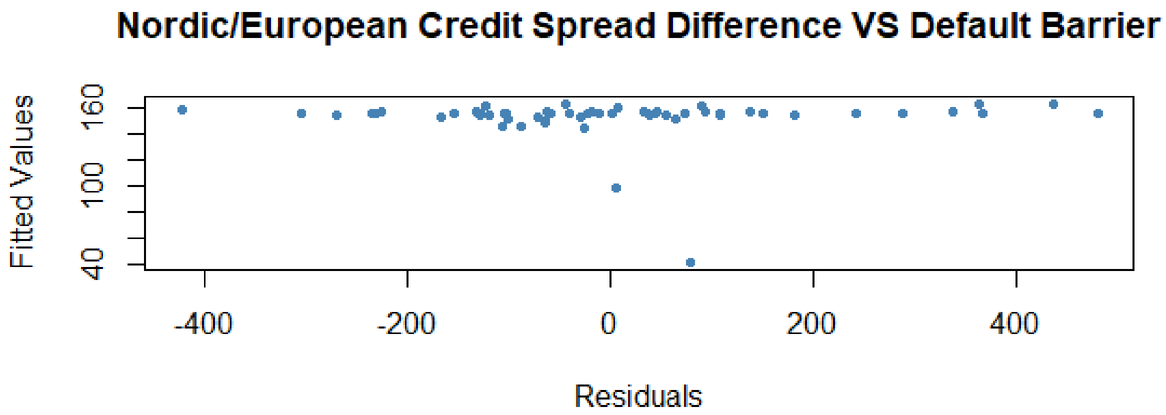

Histogram Examining Normality Bid/Ask Spread
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals

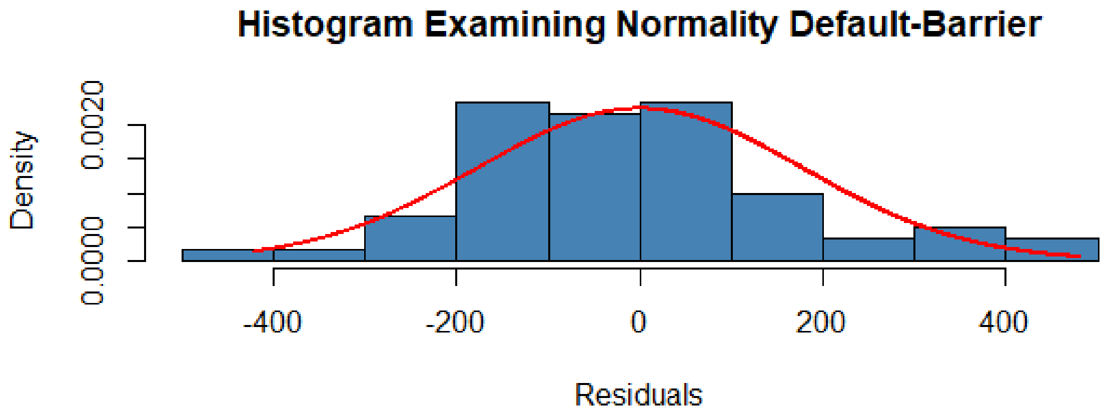

Nordic/European Credit Spread Difference VS Asset Volatility
Fitted Values
-400
0
400
0
10
20
30
40
50
60
Residuals

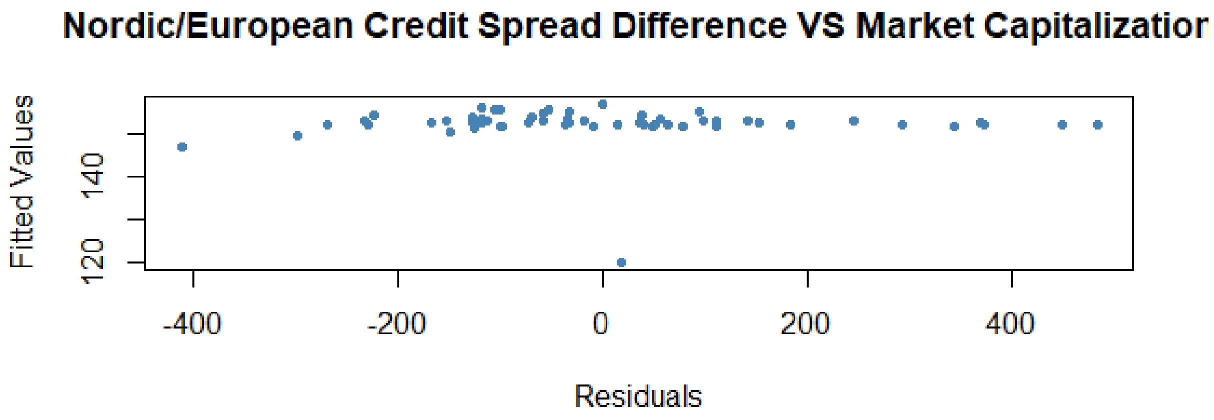

Histogram Examining Normality Asset Volatility
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals

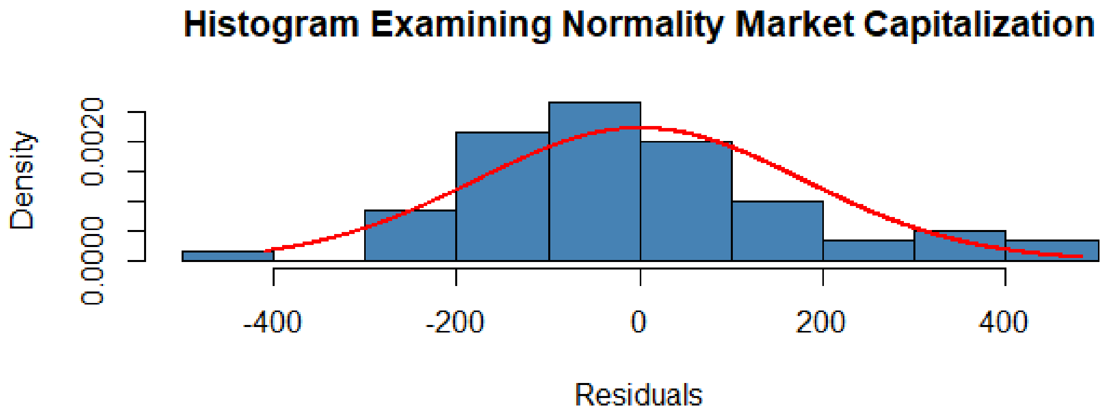

Nordic/European Credit Spread Difference VS market correlation
Fitted values
140
155
-400
-200
0
200
400
Residuals

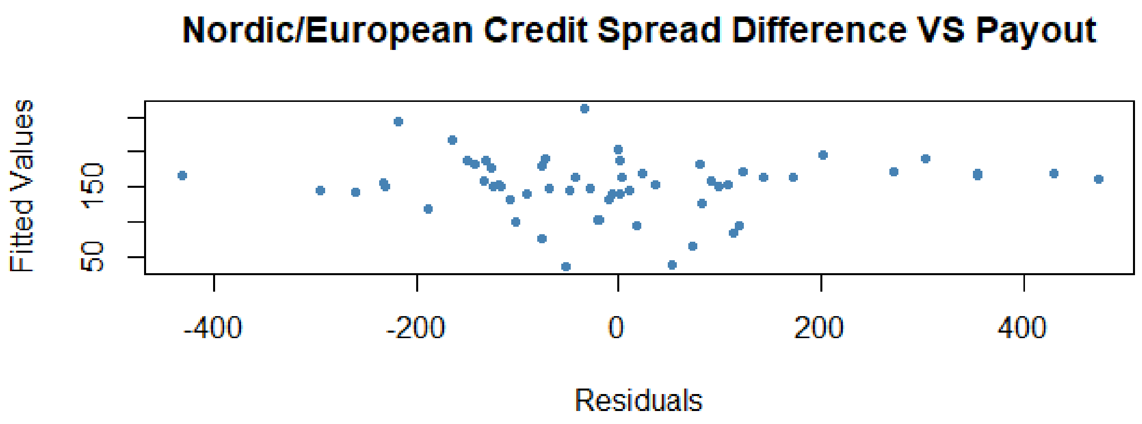

Histogram Examining Normality Market Correlation
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals

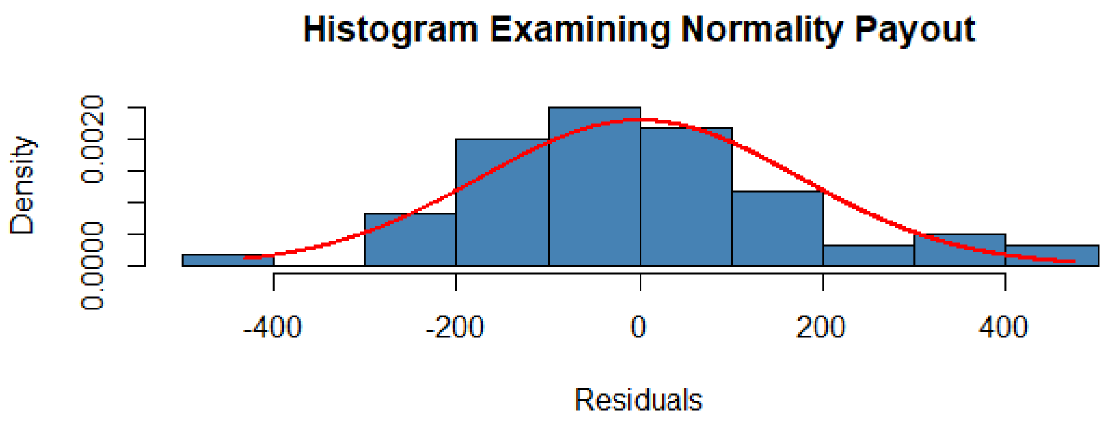

Nordic/European Credit Spread Difference VS Default Barrier
Fitted Values
40
100
160
-400
-200
0
200
400
Residuals

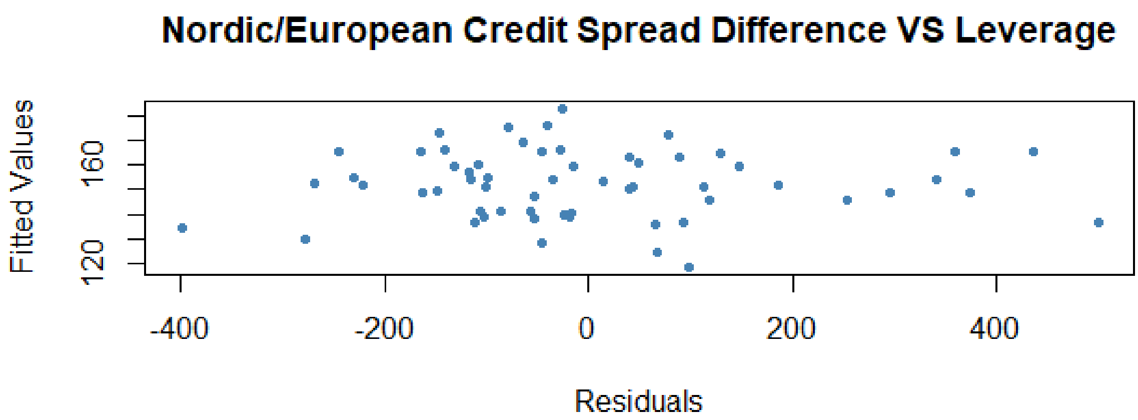

Histogram Examining Normality Default-Barrier
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals

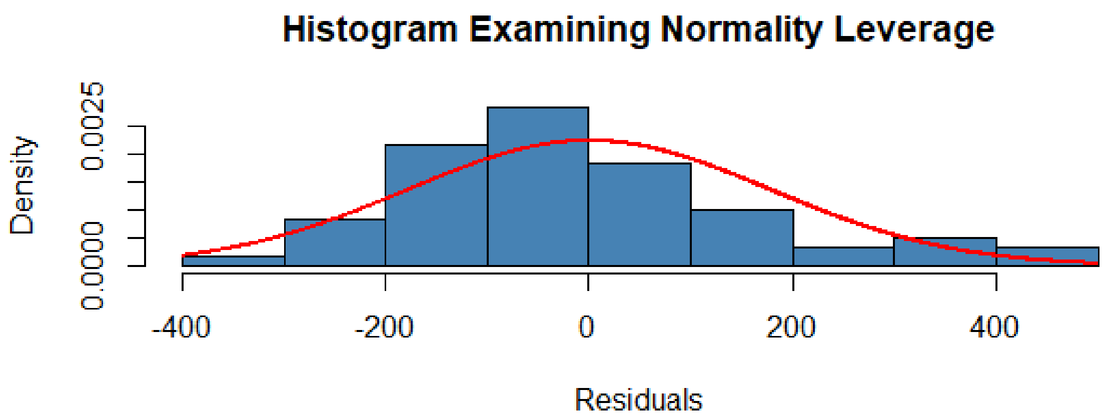

Nordic/European Credit Spread Difference VS Market Capitalizatior
Fitted Values
120
140
-400
-200
0
200
400
Residuals

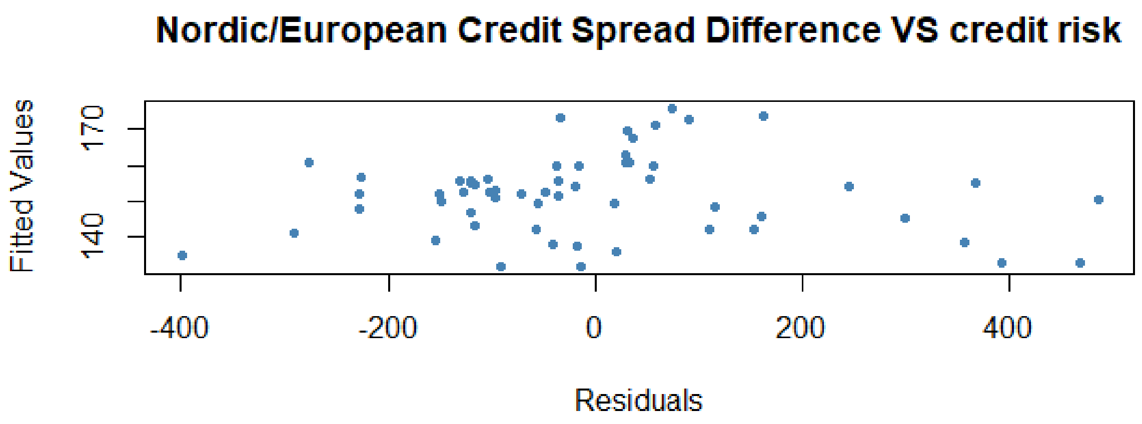

Histogram Examining Normality Market Capitalization
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals


Nordic/European Credit Spread Difference VS Payout
Fitted Values
50
150
-400
-200
0
200
400
Residuals

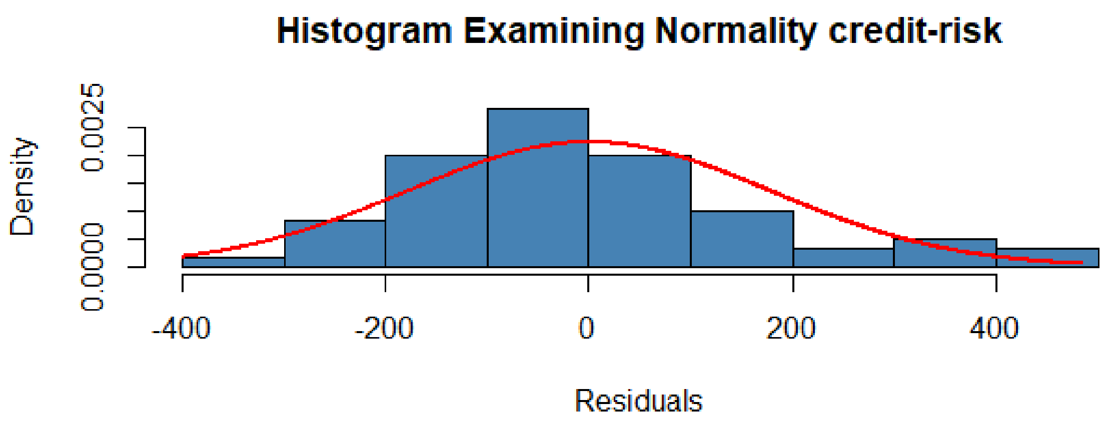

Histogram Examining Normality Payout
Density
0.0000
0.0020
-400
-200
0
200
400
Residuals


Nordic/European Credit Spread Difference VS Leverage
Fitted Values
120
160
-400
-200
0
200
400
Residuals

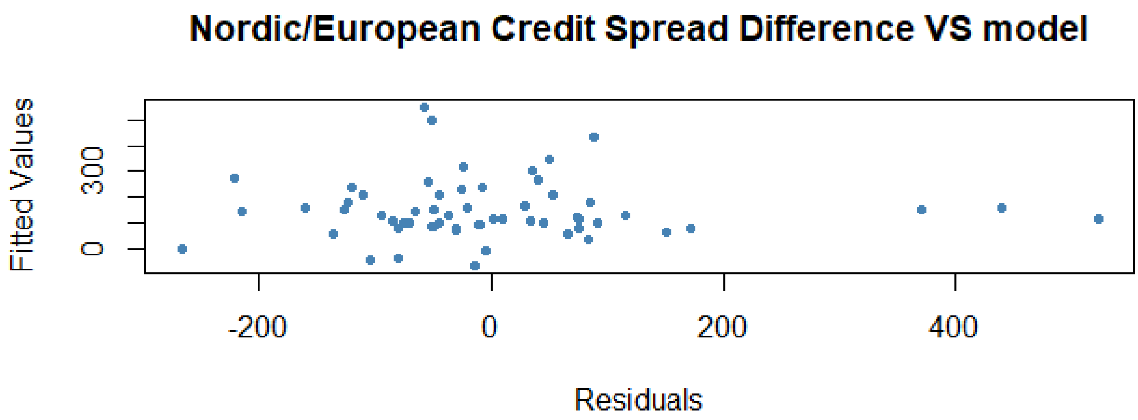

Histogram Examining Normality Leverage
Density
0.0000
0.0025
-400
-200
0
200
400
Residuals

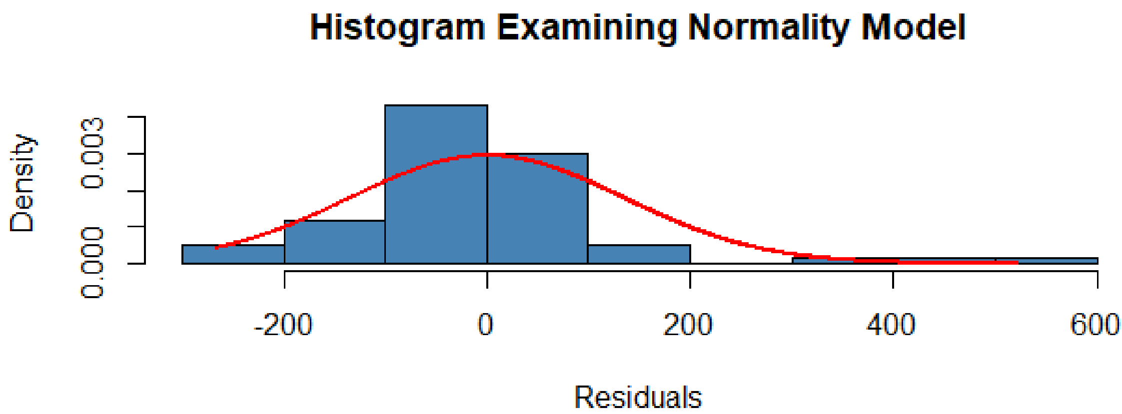


Nordic/European Credit Spread Difference VS credit risk
Fitted Values
140
170
-400
-200
0
200
400
Residuals



Histogram Examining Normality credit-risk
Density
0.0000
0.0025
-400
-200
0
200
400
Residuals





Breusch-Pagan		
BP	df	P-value
6.689	10	0.0754

9 Appendix B

Bonds

Nordic

Issuer Name	Issue Date
Securitas AB	2.20.2017
Tele2 AB	2.24.2017
Electrolux AB	3.2.2017
Castellum AB	3.8.2017
AFRY AB	4.5.2017
Swedish Match AB	5.30.2017
Swedish Match AB	6.2.2017
Castellum AB	6.8.2017
Odfjell SE	6.13.2017
Schibsted ASA	6.22.2017
Intrum AB	6.26.2017
Husqvarna AB	9.1.2017
Sagax AB	9.7.2017
Dfds A/S	9.28.2017
Saab AB	9.28.2017
Fabege AB	10.5.2017
B2Holding ASA	11.14.2017
Arise AB	12.1.2017
Aker Solutions ASA	1.25.2018
Aker ASA	1.31.2018
Husqvarna AB	2.14.2018
Husqvarna AB	2.14.2018
OXE Marine AB	2.15.2018
Indutrade AB	2.23.2018
Indutrade AB	2.23.2018
Swedish Match AB	2.27.2018
Fabege AB	2.28.2018
Wallenstam AB	3.9.2018
Hufvudstaden AB	3.15.2018
Hufvudstaden AB	3.28.2018
REC Silicon ASA	4.13.2018
Hufvudstaden AB	4.16.2018
SSAB AB	5.8.2018
Holmen AB	5.23.2018
Volati AB	6.12.2018
AFRY AB	6.20.2018
Fabege AB	8.30.2018
Sagax AB	9.17.2018

SKF AB	9.17.2018
Telia Co AB	9.18.2018
Odfjell SE	9.19.2018
Intrum AB	10.10.2018
Tele2 AB	11.15.2018
Tele2 AB	11.15.2018
Husqvarna AB	12.6.2018
Husqvarna AB	12.6.2018
Epiroc AB	3.5.2019
Epiroc AB	3.5.2019
Sagax AB	3.13.2019
AAK AB	3.22.2019
Intrum AB	4.3.2019
Elkem ASA	4.5.2019
Telia Co AB	4.11.2019
Schouw & Co A/S	4.16.2019
Orsted AS	5.16.2019
Entra ASA	5.22.2019
Entra ASA	5.22.2019
Holmen AB	5.24.2019
GN Store Nord AS	6.5.2019
Kongsberg Gruppen ASA	6.5.2019
Dfds A/S	6.7.2019
Boliden AB	6.19.2019
SSAB AB	6.26.2019
Intrum AB	7.31.2019
SSAB AB	9.3.2019
Hufvudstaden AB	9.5.2019
Intrum AB	9.19.2019
Holmen AB	10.29.2019
SKF AB	11.15.2019
AAK AB	11.20.2019
Aker ASA	11.22.2019
Intrum AB	12.13.2019
Sagax AB	12.16.2019
Aker BP ASA	1.15.2020
Aker BP ASA	1.15.2020
Aker BP ASA	1.15.2020
Aker BP ASA	1.15.2020
Sagax AB	1.30.2020
Mowi ASA	1.31.2020
Electrolux AB	2.3.2020
Fabege AB	2.4.2020
Entra ASA	2.12.2020
Entra ASA	2.12.2020
Kinnevik AB	2.19.2020

Swedish Match AB	2.26.2020
Elekta AB	3.13.2020
Elekta AB	3.13.2020
Investment AB Latour	3.16.2020
Electrolux AB	4.3.2020
SKF AB	6.10.2020
SKF AB	6.10.2020
AAK AB	6.12.2020
Entra ASA	6.29.2020
Fabege AB	8.21.2020
Holmen AB	8.28.2020
Holmen AB	8.28.2020
Wallenstam AB	9.16.2020
Fabege AB	9.22.2020
Aker BP ASA	9.30.2020
Aker BP ASA	9.30.2020
Entra ASA	10.21.2020
Epiroc AB	11.18.2020
Epiroc AB	11.18.2020
Telia Co AB	11.27.2020
SKF AB	2.15.2021
Scatec ASA	2.19.2021
Securitas AB	2.22.2021
Swedish Match AB	2.24.2021
Elkem ASA	2.26.2021
Elkem ASA	2.26.2021
Danske Bank A/S	3.10.2021
Mowi ASA	3.10.2021
Fabege AB	3.17.2021
Mekonomen AB	3.18.2021
Tele2 AB	3.23.2021
Holmen AB	4.8.2021
Salmar ASA	4.22.2021
Holmen AB	5.17.2021
Entra ASA	5.28.2021
Danske Bank A/S	6.11.2021
Investment AB Latour	6.16.2021
Essity AB	6.17.2021
D/S Norden A/S	6.28.2021
Entra ASA	6.30.2021
Humble Group AB	7.21.2021
Entra ASA	8.20.2021
Elkem ASA	8.25.2021
Elkem ASA	8.25.2021
Hufvudstaden AB	9.2.2021
Norsk Hydro ASA	9.2.2021

Indutrade AB	9.9.2021
Leroy Seafood Group ASA	9.17.2021
Leroy Seafood Group ASA	9.17.2021
Leroy Seafood Group ASA	9.17.2021
Hufvudstaden AB	10.14.2021
Fabege AB	10.15.2021
GN Store Nord AS	11.25.2021
Investment AB Latour	11.29.2021
OKEA ASA	12.6.2021
Elekta AB	12.14.2021
Elekta AB	12.14.2021

Euro

Issuer Name	Issue Date
Accor SA	1/25/2017
Deutsche Pfandbriefbank AG	2/22/2017
Renault SA	3/8/2017
Evraz PLC	3/20/2017
Evraz PLC	3/20/2017
Nexans SA	4/5/2017
K+S AG	4/6/2017
Saga PLC	5/12/2017
Deutsche Pfandbriefbank AG	5/24/2017
Casino Guichard Perrachon SA	6/13/2017
Constellium SE	11/9/2017
Constellium SE	11/9/2017
Constellium SE	11/9/2017
Constellium SE	11/9/2017
Iron Mountain UK PLC	11/13/2017
Iron Mountain UK PLC	11/13/2017
Renault SA	11/28/2017
ADLER Real Estate AG	12/6/2017
Nordex SE	2/2/2018
Nordex SE	2/2/2018
Elis SA	2/15/2018
Elis SA	2/15/2018
Faurecia SE	3/8/2018
Tullow Oil PLC	3/23/2018
Tullow Oil PLC	3/23/2018
Renault SA	4/18/2018
ADLER Real Estate AG	4/27/2018
ADLER Real Estate AG	4/27/2018
K+S AG	7/18/2018
Nexans SA	8/8/2018
Renault SA	9/28/2018
Accor SA	2/4/2019
thyssenkrupp AG	2/22/2019
Schaeffler AG	3/26/2019
Schaeffler AG	3/26/2019
Faurecia SE	3/27/2019
Evraz PLC	4/2/2019
Evraz PLC	4/2/2019
Elis SA	4/11/2019
ADLER Real Estate AG	4/17/2019
Fnac Darty SA	5/14/2019

Fnac Darty SA	5/14/2019
Bilfinger SE	6/14/2019
Renault SA	6/24/2019
Marks & Spencer PLC	7/10/2019
Deutsche Lufthansa AG	9/6/2019
thyssenkrupp AG	9/6/2019
Elis SA	10/3/2019
Elis SA	10/3/2019
Renault SA	10/4/2019
DEMIRE Deutsche Mittelstand Real Estate AG	10/15/2019
Hornbach Baumarkt AG	10/25/2019
Carnival PLC	10/28/2019
Peach Property Finance GmbH	11/15/2019
Peach Property Finance GmbH	11/15/2019
Faurecia SE	11/27/2019
Synthomer PLC	6/25/2020
Synthomer PLC	6/25/2020
Constellium SE	6/30/2020
Constellium SE	6/30/2020
Faurecia SE	7/31/2020
Solocal Group	8/13/2020
Schaeffler AG	10/12/2020
Schaeffler AG	10/12/2020
Peach Property Finance GmbH	10/26/2020
Peach Property Finance GmbH	10/26/2020
Getlink SE	10/30/2020
Travis Perkins PLC	11/17/2020
Marks & Spencer PLC	11/19/2020
Renault SA	11/25/2020
Deutsche Lufthansa AG	12/1/2020
Casino Guichard Perrachon SA	12/22/2020
TechnipFMC PLC	1/29/2021
TechnipFMC PLC	1/29/2021
Deutsche Lufthansa AG	2/11/2021
Deutsche Lufthansa AG	2/11/2021
Constellium SE	2/24/2021
Constellium SE	2/24/2021
Faurecia SE	3/22/2021
CGG SA	4/1/2021
CGG SA	4/1/2021
CGG SA	4/1/2021
CGG SA	4/1/2021
Renault SA	4/1/2021
Hapag-Lloyd AG	4/6/2021
Hapag-Lloyd AG	4/6/2021
Casino Guichard Perrachon SA	4/13/2021

Weir Group PLC/The	5/13/2021
Weir Group PLC/The	5/13/2021
Ferroglobe Finance Co PLC	5/17/2021
Ferroglobe Finance Co PLC	5/17/2021
Ferroglobe Finance Co PLC	5/17/2021
Tullow Oil PLC	5/17/2021
Tullow Oil PLC	5/17/2021
Atlantica Sustainable Infrastructure PLC	5/18/2021
Atlantica Sustainable Infrastructure PLC	5/18/2021
Constellium SE	6/2/2021
Constellium SE	6/2/2021
Derichebourg SA	6/24/2021
Derichebourg SA	6/24/2021
Vallourec SA	6/30/2021
Vallourec SA	6/30/2021
Vallourec SA	6/30/2021
Saga PLC	7/2/2021
Elior Group SA	7/8/2021
Deutsche Lufthansa AG	7/14/2021
Deutsche Lufthansa AG	7/14/2021
DIC Asset AG	9/22/2021
Ocado Group PLC	10/8/2021
Ocado Group PLC	10/8/2021
Endeavour Mining PLC	10/14/2021
Endeavour Mining PLC	10/14/2021
Harbour Energy PLC	10/18/2021
Harbour Energy PLC	10/18/2021
Seche Environnement SA	11/4/2021
Faurecia SE	11/10/2021
Deutsche Lufthansa AG	11/16/2021
Deutsche Lufthansa AG	11/16/2021
Energean PLC	11/18/2021
Energean PLC	11/18/2021
SIG PLC	11/18/2021
SIG PLC	11/18/2021
Accor SA	11/29/2021
Renault SA	12/2/2021