Risk Adjusted Performance Analysis of Corporate High-Yield Bonds

Anton Wahlberg[1]

Dec 9, 2019

Abstract: This paper evaluates whether corporate high-yield bond returns can be explained by the Fama French Factors and other accepted factors as commonly used when analyzing equity excess returns. As high yield bonds exhibit a somewhat similar return profile as equities, the hypothesis is furthermore that their excess returns should to a significant extent be explained by the same risk-factors. The study is conducted on an aggregate index level for the European and US High-Yield corporate bond markets and regressed onto the Factors for respective market for comparison. Alpha can not with certainty be found but the thesis proves that High-Yield bond returns can significantly be explained by various equity factors.

Keywords: High-Yield Bonds, Fama French Factors, Factor Investing, Alpha

Stockholm School of Economics
MSc Thesis in Finance
Tutor: Michael Halling

[1] 22984@student.hhs.se

Acknowledgements:

I would like to thank my tutor Michael Halling, Associate Professor in Finance at Stockholm School of Economics, for advice and support throughout the writing process of the Thesis. All errors are naturally my own.

Table of Contents:

1. Introduction

The corporate high-yield bonds grew in popularity during the 1980's era as Drexel Burnham Lambert and Michael Milken propagated for their attractive risk-return profile. A high-yield bond had equity-like return profile but was still above equity in seniority in the capital structure. The inspiration came from early research in the area from Braddock W. Hickman and T R. Atkinson who showed that the low default rates did not justify the superior returns. There was alpha to be found. Drexel Burnham Lambert created and ruled this market and opened up for new opportunities of financial engineering. By setting up an ecosystem for issuing enormous amount of high-yield bonds, promising a solid return profile for investors, a new type of funding took place where small fishes could gobble up large sharks. This paved the way for Leveraged Buyouts and Corporate Activism that to a large extent define the corporate landscape today. The high-yield bond frenzy turned sour and ended abruptly in the 1990s but as of recently the high-yield bond markets have had a revival and now presents a reasonable way of funding, not as extreme as before. The notion that investors willing to take additional risk to receive higher returns and entrepreneurs that have a business idea, want to grow a business and are willing to take on risk should have the possibility to transact is at the foundation of capitalism and poses an equal, transparent and open capital market.

Recently, factor investing and smart beta investing has grown in popularity and enabled further analysis of risk-return characteristics. What started with simple and common well-established factors for equities have now proliferated and reached other asset classes and geographies, including the corporate bond market. Research on this area is still nascent and there is a lot to be explored cross-sectionally over asset classes, geographies and sectors but also on a time-varying level. The early research on corporate high-yield bonds was essentially a discussion around default rates in relation to returns and how to appropriately measure the default rates. By applying common equity factors, that discussion can be rather sidestepped and a risk-adjusted performance analysis can be performed on these other factors to determine whether the returns can be justified in relation to the amount of risk taken and ultimately reveal whether corporate high-yield bonds can be explained typical equity-like features.

2. Literature Review

The earliest studies of credit risk on high-yield bonds were conducted in the US by Braddock W. Hickman, summarized in his book released in 1958: “Corporate Bond Quality and Investor Experience”. Yields on corporate bonds in first half of the 20^{th} century and their corresponding loss rate were studied, resulting in a measurement of the investor experience and providing a benchmark against other investments. The main conclusion was that a diversified portfolio of high-yield corporate bonds generated greater returns than a portfolio of investment grade bonds even after the higher default losses were taken into consideration. In addition, shifts and variations of corporate bond default rates over time could be noted and bonds issued in periods of high business activity and generous funding environment were floated that, if lower confidence in the market, would not have been issued.

Hickman’s studies was complemented by T R. Atkinson in his book “Trends in Corporate Bond Quality” published in 1967 in which bond ratings and corresponding returns were examined. Together, Braddock W. Hickman and T R. Atkinson lay the foundation to quantify and put a number on the risk premiums generated on corporate bonds and concluded that the risk adjusted returns were higher than what could possibly be explained by the observed default rates.

In the US during the period when high yield credits were in the fashion and throughout the following market crash of high yield bonds, further studies were conducted. In the forefront was Edward Altman, writing several papers on the subject and constantly updating his own studies. In the summer of 1990, in the midst of the high-yield bond crash, Altman concluded that default rates had increased to 4,3%, twice the historical average of 2,2%, and yield spreads over treasuries were at a stunning 7%. Going forward, Altman predicted that the system must be “cleansed” from the excesses of the past years but still remarked that high-yield bonds will not entirely cease to exist but prevail at more conservative levels with more equity backing up the debt burden. He also noted that other risk factors than the traditional default risk may be in play such as interest rate risk and liquidity risk which his predecessors had not considered. Eventually 10 years later, in 2000, Altman revisited his old studies in the paper: “Revisiting the High-Yield Bond Market: Mature but never dull” to note that default rates during the beginning of the 1990's, in the midst of the crisis, had reached 10% and yield spreads were up at two-digit numbers. The recession was followed by a boom and High-yield bond investors in 1991 earned a stunning 43,2% on their investments. Overall, the total compounded annual returns on high yield bonds between 1978-1999 averaged 2,96% in excess of the 10-year US treasury rate which was quite in line with the promised yield at 4,55% less the average default rate of around 2%.

In 1989, Asquith, Mullins and Wolff presented their research in the paper "Original Issue High Yield Bonds: Aging Analyses of Defaults, Exchanges and Calls" stating that default estimates were too low. Including exchanges and calls in the analysis, which could be seen as similar to a default, and adding an aging effect, which for example Altman did not consider, the result was a default rate considerably higher. The aging effect captured the fact that the default rates increase with the bond age and a surge in new issuances will thus depress the true value downwards. This paper got widely spread and fueled the skepticism of high-yield bonds. The argument was that the early ways of measuring default rates still used by the rating agencies were outdated and the risk-adjusted outperformances were non-existent. The cumulative defaults were estimated to as high as 34% in Dec 1988 for bonds issued 10 years earlier, and slightly lower for more recent issues but still significantly higher than conventional numbers. Altman commented this later on and indeed in his paper from 1989 "Measuring Corporate Bond Mortality and Performance" he uses a similar kind of aging method called mortality, resulting in numbers not far off from traditional measures thus debunking the critics.

Around the same time Blume & Kein published their paper in 1987: "Lower-Grade Bonds: Their Risks and Returns" in which they evaluate the risk-return characteristics of high-yield bonds in more of a factor analysis method, taking into consideration beta to the SP500, standard deviation of monthly returns and alpha-factor and correlation to other portfolios. Two time periods were considered, a longer period spanning over 10 years between 1977-1986 that marks the starting point for when high-yield bonds took off, and one shorter period between 1982-1987 which is easier to construct and trust in terms of data availability. Their findings are interesting as high-yield bonds indeed generate superior returns compared to investment grade bonds over the period 1977-1986, although with a lower standard deviation. The following result is a positive alpha for high-yield bonds and even a negative alpha for the investment grade bonds. For the shorter period, the returns for high-yield bonds are slightly lower than other bonds but still maintains a significantly lower standard deviation. In terms of alpha, the order is reversed in the short term as the higher-graded bonds have a higher alpha even though not significantly different from zero. As a well-diversified portfolio, Blume & Kein find that high-yield bonds has no greater risk than investment grade bonds, have a low correlation to other bonds and risky assets, and as such works great as diversification to a portfolio of higher graded bonds or stocks.

In the same spirit, Eugene Fama and Kenneth French started to investigate whether it was possible to quantify asset returns with risk factors. In a paper released in 1992, “Common Risk Factors in the returns on Stocks and Bonds”, 5 risk factors are identified and tested for both equities and bonds. The specific bond factors were related to default risk and maturity risk. Even though the ambition was to create an integrated model that could explain all different asset classes, the 3 equity factors and later the additional 5 equity factors were the initial public takeaway from their reports.

Although the interest for factor investing in corporate bonds was initiated quite early, it is as of recently that the research has taken off and become extensive. A reason for this is AQR Capital Management, focusing on research based investing and Factor Investing including bonds for several markets. The factor data is to a large extent kept publicly available to stimulate others to advance the research. Example of researchers and employees at AQR to mention within the subject are Assness, Frazzini, Pedersen, Israel and Illmanen, all of which I will go through more in detail.

Frazzini & Pedersen released their paper in 2014, “Betting Against Beta” which was based on the notion that high beta assets were overpriced due to leverage constraints of many investors. The equivalent of buying low beta assets and lever up was not possible. An increased demand of high beta assets subsequently lead to overpricing and lower required risk-adjusted returns. A market neutral factor based on a long position in levered low beta assets and short position in high beta assets was created and turned out to generate excess returns although the net beta was zero. This can be seen as a flattening of the security market line compared to the traditional CAPM-line and rather resemble the Limited Borrowing CAPM, where the factor give rise to a premium due to limited borrowing opportunities. The study included several different asset classes and geographies but focus was mainly on equities.

Another paper evaluating factors within corporate bonds is “Common Factors in Corporate Bond Returns” by Ronen Israel et al. published in 2018. Factors proven to explain returns in other markets are extracted and applied on credit markets to test whether these factors can explain the variation of the excess returns in credits even after considering traditional market premia and macroeconomic factors. Following factors are considered: Carry, as the option adjusted spread (OAS) over treasuries if market conditions are constant; Defensive, based on the fact that safer low risk assets tend to deliver higher risk adjusted returns and is created out of multiple variables such as leverage ratio, gross profitability and low duration; Momentum, as is the fact that past winners tend to outperform past losers; Value, market value compared to a fundamental value. The excess returns of portfolios based on these characteristics are proven and subsequently benchmarked against traditional equity and debt factors, such as the Fama-French Factors, to test whether these can explain the excess returns. Eventually a combined portfolio is constructed out of all characteristics, superior to the individual ones in terms of alpha.

As of recently, in 2019, Ronen Israel in collaboration with AQR colleagues Illmanen, Wang & Thapar amongst others released an additional paper on the same topic: “Do Factor Premia Vary Over Time? A Century of Evidence”. The same factors as the previous paper from Israel are used; Carry, Defensive, Momentum and Value, across 6 different asset classes over a century in time. The choice of factors are based on their strong in-and-out of sample evidence and have proven to be useful across markets and time. Significant time variation is further proven for single factor returns and variances. In addition, a multifactor portfolio diversified across the factors is compiled and shown to generate a lower variation over time and risk can furthermore be diversified away. Ultimately, macroeconomic factors and the possibility of arbitrageurs affecting the premia is tested for but is concluded to not be of any significance for these factors.

In line with the report from Israel in 2016 and with a focus on Factors within Corporate Bonds is the paper from Demir Bektic et al. in 2017, “Extending Fama French Factors to Corporate

Bond Markets". Portfolios based on the characteristics of the Fama French Factors are examined and tested for whether to generate excess returns and to what extent the portfolios can be explained by the traditional five Fama French Factors and two Debt factors. Furthermore, the dynamics behind the equity and debt factors are assessed. This is done for the European and US Investment grade bond markets and the US High Yield Market, which is particularly interesting to analyse and compare to the Fama French factors as it is quite unique and unprecedented. For the purpose of comparison, a multifactor portfolio with equal weights of the 4 Factors is analyzed and shown that the US high-yield market enjoys significant average excess returns even after being controlled for the Fama French- and debt factors. In relation, both Investment Grade markets experience a low, non-significant excess returns after being controlled for systematic risk in the Fama French- and debt Factors. Interestingly, this paper touches upon the impact of company characteristics and the similarities of bond and equity return dynamics.

Patrick Houweling and Jeroen Van Zundert also investigate the factor premia in corporate bonds in a similar fashion as their peers in their paper: "Factor investing in Corporate Markets" published in 2016. Bond-specific factors are evaluated for the US Investment Grade and High-Yield Bond Market: size (small companies), low risk (short maturities), value (high credit spread compared to a modelled fair spread) and momentum (high past returns). They get to the a similar conclusion that these factor-portfolios can generate significant alphas, even when tested for the traditional Fama French equity factors and specific bond factors. To be noted is that due to low correlations in the single factor portfolios, diversification benefits can be extracted in a multi-factor portfolio.

Most of the research has been conducted on the US market by US based researchers but one exception is Amit Goyal, based on the University of Lausanne, who is on the forefront in the research on Quantitative Corporate Bond Portfolio Management. In 2017, he was part of a research team investigating factors relevant for equities and bonds in a paper named: " Are Capital Market Anomalies Common to Equity and Corporate Bond Markets? An Empirical Investigation". The conclusion was that some specific factors only affect equities such as accruals, earnings surprises and idiosyncratic volatility. Some factors affect equities and bond returns as well, in line with theory, such as profitability, asset growth and equity returns. The theory is based on the fact that companies with larger amount of real investment, high asset growth and profitability require lower returns and smaller companies with lower profitability require higher returns. The study also find evidence of that corporate events first can be observed as a reaction in the equity market, to eventually spill over to the credit market. When considering transaction costs, cross sectional bond return predictors do not generate outstanding Sharpe ratios at all.

3. Theory and Hypothesis

According to theory, there is a relationship between equities and debt as both have in common a claim on the company assets. That implies that there ought to be risk premiums and factors applied to the assets of the firm that correspond to both types of funding. This reasoning is in line with what Merton presented in one of the earliest credit risk models in 1974: "On the pricing of Corporate Debt: The risk structure of Interest Rates". If a company issues a zero-coupon bond (D) with face value (F) and maturity (T), the claim on the value of the assets can be summarized as:

$$D_t(V_t, T) = \min(V_t, F)$$

The creditors at best get the face value (F) at maturity or they have to settle for the value of the assets (V_t) if lower than face value.

To make the connection between equity and debt, the put-call parity according to the Black-Scholes formula has to be applied. The equity value (E) can then be seen as the value of a call option on the asset value (Vt), where the strike price is the Face value of the zero-coupon bond (F) with regards to time to maturity (T-t):

$$E(V_t, t) = Call_{BS}(V_t, F, T - t)$$

The put-call parity then makes the value of the Bond:

$$D(V_t, t) = PV(F) - Put_{BS}(V_t, F, T - t)$$

Debt value is then represented as the present value of a risk free bond with strike price (F) less a short put on the asset value (V_t) with strike price at Face Value (F) and with regards to maturity (T-t). According to theory follows, the spread between risky debt and risk free debt is the value of a put on the assets.

From the Merton paper, both the Equity and Debt value is concluded to be dependent on the company asset value (V_t), implying that some factors relevant for explaining asset and equity value should also be relevant to the debt value of the company. Which essentially makes the hypothesis of the thesis the following: Factors explaining the equity returns should further be applicable to the valuation of debt.

4. Data and Methodology

4.1 Data

In order to perform a risk adjusted return evaluation of the high yield corporate bond markets, return data from the markets selected need to be collected as it moreover becomes the dependent variable in the regressions of the study. Bond returns might be slightly burdensome to extract as bonds are often defined out of their yield to maturity, the internal rate of return if held to maturity, and the discount factor of all the future cash flows to justify the current price. Yield data is also highly relevant but in this study, total returns on a monthly basis are needed and more specifically, the change in total value excess the risk free rate from month to month.

This high-yield bond data is provided publicly by the Federal Reserve Bank of St Louis (FRED)[2] that has sourced the data from ICE Benchmark Administration and Bank of America Merrill Lynch in their indices. More specifically, the data series used for European High Yield corporate bond return data is the ICE BofAML Euro High Yield Index Total Return Index Value [BAMLHE00EHYITRIV], and for US high yield data the ICE BofAML US High Yield Master II Total Return Index Value [BAMLHYH0A0HYM2TRIV]. Both data series is edited to provide monthly

[2] https://fred.stlouisfed.org

returns based on the index level and starting date and end date can be chosen after preferences. The period this study is intended to examine is the period starting January 2000 and ending August 2019. This period is the most recent to date and spans over a period long enough to make the study relevant. Over period of time, an IT-crisis and a financial crisis have occurred followed by two bull-markets making the time-period certainly interesting and can be treated as sort of a stress testing to the asset pricing fundamentals.

The ICE BofAML Euro High Yield Index tracks the performance of Euro denominated below investment grade corporate debt, based on an average from the three major rating agencies: Moody's, Fitch and S&P, publicly issued in the Euro domestic or Eurobond markets. The securities included in the index must at least have one year remaining until maturity, a fixed coupon schedule, and a minimum of 100 million Euro outstanding. Defaulted securities are excluded from the index. The index is capitalization weighted based on the current amount outstanding and the accrued interest is calculated assuming a next day settlement. Cash flows received from the bond payments during the month are retained in the index throughout the month and then removed as part of the rebalancing which occurs at the end of each month. Inclusion in the index is based on business information up until 3 days before the end of the month. No reinvestment returns are assigned to the cash while held in the index. Securities qualifying for inclusion in the index will enter the following month and securities disqualified from the index will be removed the following month. The US High Yield Index follows the same criteria as the European Index but should be issued in the US domestic market and have a minimum of 100m USD outstanding. In line with the Fama French factors, both the European and the US Index returns have been deducted by the US 1-month T-bill rate to calculate excess returns. The reason for this will be explained later in the thesis.

Table 1. Summary statistics for US and European High Yield Bond Data

Summary Statistics Excess Monthly Returns	US High Yield	European High Yield
Mean	0,46	0,34
Volatility	2,51	3,13
Maximum Monthly Loss	-18,05	-20,40
Sharpe Ratio	0,18	0,11
Count	236	236

Figure 1. Graph over European Return Data

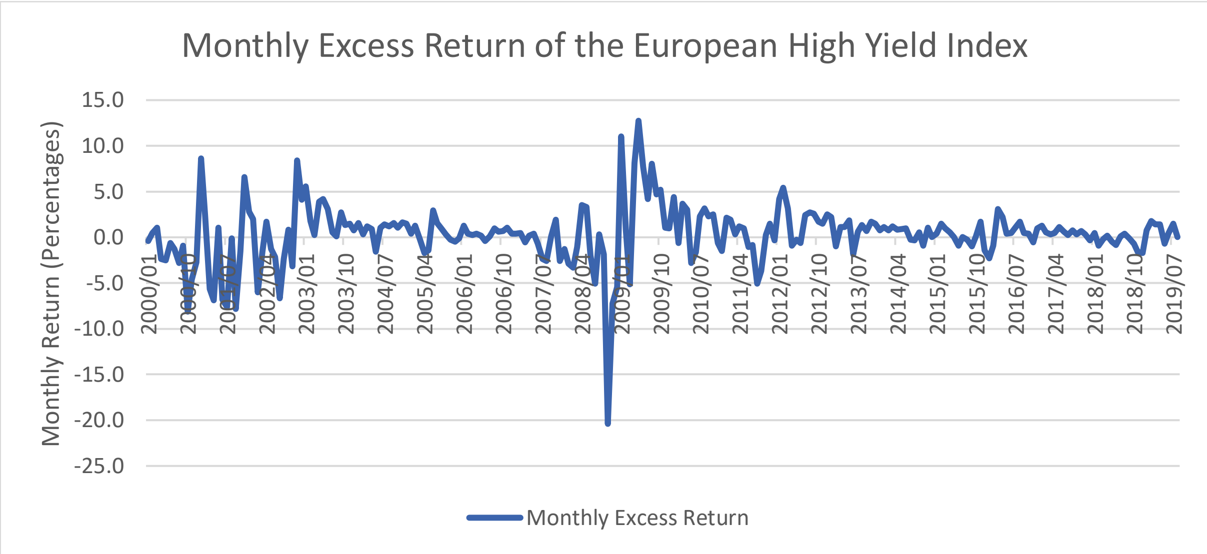


Figure 2. Graph over US Return Data

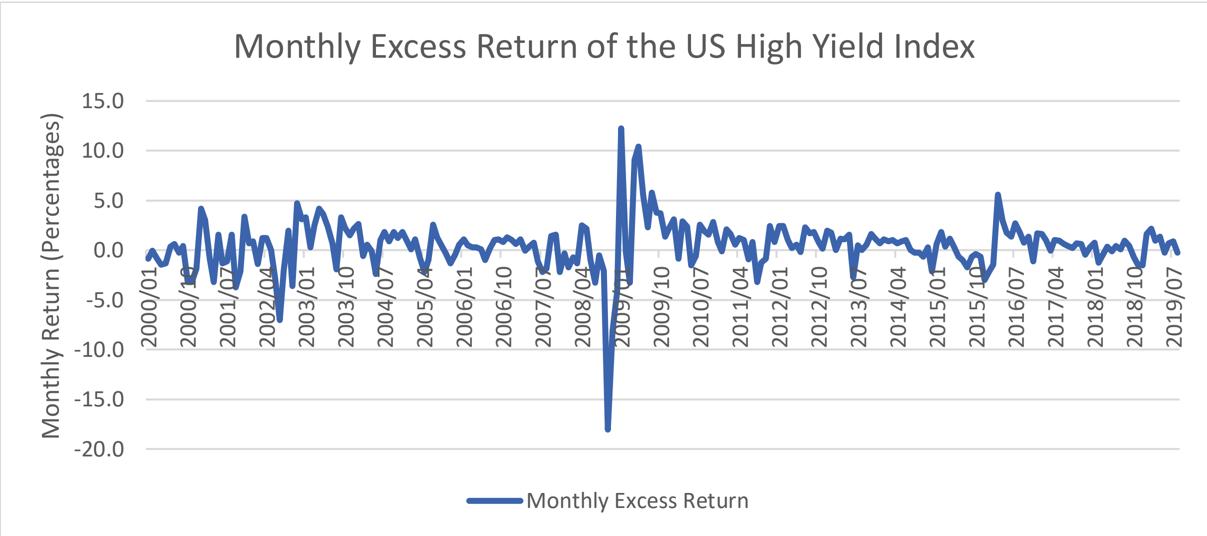
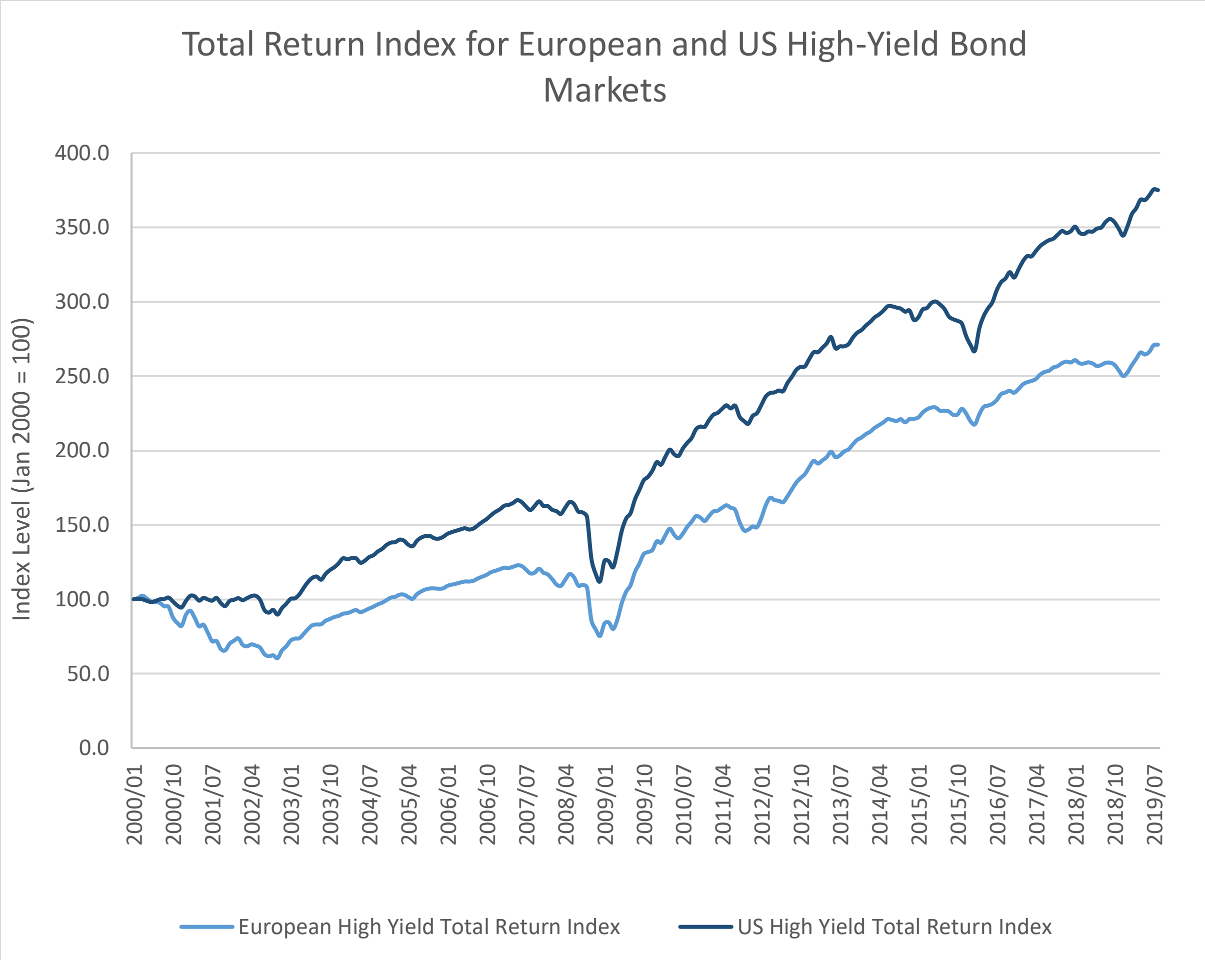


Figure 3. Cumulative Return Graph of European and US High-Yield Bond Markets



As the hypothesis of the thesis states, the high yield corporate bond market will possess similar asset pricing characteristics as equities and their returns should therefore be explained by the same risk factors, the Fama French Factors for example. These factors are to be found on the Kenneth French website[3] and are constantly updated and extended when new factor are disclosed. The background to the Fama French factors are that stocks possessing certain characteristics was found to generate higher returns. Fama and French created portfolios of stocks based on these characteristics and proved that on average these portfolios outperformed the ones not having these characteristics. The average outperformance by taking a long position in the portfolios with a high rank on the characteristic and taking a short position in the portfolios with low rank of the characteristic then make up the factors presented on a monthly basis. What started with the US market now include the European,

[3] https://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html

Emerging and Pacific-markets with different types of asset-characteristic factors and industry specific factors. The traditional factors are the 3 factor model including the Market risk premium excess risk free rate (Mkt-RF), Small-minus-Big factor (SMB) and the High-minus-Low (HML) Factor. This has been extended to the 5 Factor model including Conservative-minus-Aggressive (CMA) and Robust-minus-Weak (RMW).

The returns for the Fama French Factors are denominated in US Dollars across all factors and geographical regions. Dividends and capital gains are included and no continuous compounding exists. As the returns are denominated in US Dollars, the risk free rate subtracted from both the European and US specific value weighted returns when computing the market risk premium is the 1-month US T-Bill rate. Subsequently, the returns from the high-yield bonds will also be deducted with the US 1-month T-bill rate to calculate the excess return to make the equation comparable. The resulting factor loading will be the beta that reflects how the excess returns correlates to the overall equity market returns over the risk free rate.

The SMB and HML Factors are constructed in the same fashion as the market risk premium factor, creating portfolios based on a characteristic and then comparing the returns of being long the portfolio of the highest rank of the specific characteristics and short the portfolio ranking the lowest on the same characteristics. This will represent a premium that equals the factor return of the month. The SMB is based on the notion that stocks of small companies will over time generate greater returns so the stocks are ranked based on their market cap and sorted into two groups, the 10% with the smallest market cap and the 10% with the largest market cap. The same procedure is done for the HML, where the idea is that companies with a high book-to-market ratio (value stocks) will generate higher returns than low book-to-market (Growth stocks).

The SMB-Factor is constructed by equal weighted returns according to the following formula to calculate the excess return of small companies and furthermore neutralized for the value-effect by adding stocks from three different value ranks:

$$SMB = \frac{1}{3}(Small\ Value + Small\ Neutral + Small\ Growth) - \frac{1}{3}(Big\ Value + Big\ Neutral + Big\ Growth)$$

The HML-factor is created the opposite way, by equal weighting the returns of the two high B/M portfolios and shorting the two portfolios with low B/M, neutralized over size:

$$HML = \frac{1}{2}(Small\ Value + Big\ Value) - \frac{1}{2}(Small\ Growth + Big\ Growth)$$

The same method is utilized when adding the two other factors, Robust-minus-Weak and Conservative-minus-Aggressive. The universe of stocks is divided into groups based on their rank on the characteristics with high and low operational profitability and conservative and aggressive investment portfolios for each market respectively, and neutralized for size differences according to the following formulas:

$$RMW = \frac{1}{2}(Small\ Robust + Big\ Robust) - \frac{1}{2}(Small\ Weak + Big\ Weak)$$

$$CMA = \frac{1}{2}(Small\ Conservative + Big\ Conservative) - \frac{1}{2}(Small\ Agressive + Big\ Aggressive)$$

The SMB factor is slightly changed in the extended five-factor model and is neutralized by all 3 additional different factors instead, taking a long position in 9 small portfolios and a short position in 9 large portfolios.

This thesis further takes bond specific factors into consideration to figure out how much they can explain the excess returns of the high yield corporate bonds and possibly if a mix of factors prove to better explain the returns. The effect and dynamics of the factors can subsequently be compared and hopefully give an answer on how to classify high yield bonds and their returns. Typically two factors are at play when explaining the risk and return of credits: The interest rate changes also known as term premium, and the credit spread representing a default premium.

The term premium (TERM) is the change in interest rates over time with the background that longer term bonds are more exposed to changes in interest rates and should be rewarded a premium due to this risk. The factor is constructed by subtracting the monthly return of long term government bonds by the short term risk free rate. The residual will be the term premium. For the European market, the return of the long term government bonds is proxied by the returns from the iShares € Govt Bond 7-10yr UCITS ETF, managed by BlackRock and tracking the Bloomberg Barclays Euro Government Bond 10 Year Term index. The short term risk free rate is represented by the 1-month EURIBOR rate, to be found on the ECB website and provided by Reuters. Traditionally, the EURIBOR rate is presented on an annual basis, implying that a conversion to monthly rates has to be made to fit the format. The US Term premium factor is constructed using the ICE Fixed income index US Treasury 7-10 Years as the long term component subtracted by the 1-month T-bill rate, presented at the Kenneth French website as a component in the Fama French Factors.

For the purpose of investing in corporate bonds, most investors are mainly looking to be rewarded for the default premium, the second bond specific factor that might prove some explanation to the credit returns. The default premium (DEF) is represented by the option adjusted spread (OAS) from the corresponding ICE BofAML high yield index the total return was calculated from. The OAS is the yield premium, adjusted for the optionality to call the bond early, in addition to the corresponding treasury rate (risk free) in terms of maturity to make up the total yield of the bond or index. The spread is compiled by weighting the spread from each bond by market capitalization and will represent the annual premium on a monthly basis the investors are expected to receive from investing in high yield corporate bonds. The default premium is the main risk investors are rewarded for and can be viewed as a CAPM market risk premium for credits.

To extend the thesis further, two extra equity factors not as established as the previous ones are added. These are the momentum factor (MOM) and the Betting-against-Beta Factor (BAB), retrieved from the databases at the website of AQR Capital Management[4], a fund manager that are in the forefront of factor investing and research based investing. AQR Capital Management is managing and updating a wide range of factor data from internal research that have proven fruitful. Both factors are provided for equities on the European and US markets and spans over the time period for this study.

The Betting-against-Beta Factor presented in the paper "Betting against Beta" by Frazzini and Pedersen where for different markets and assets classes, market neutral, self-financing betting-against-beta factors were constructed taking a long position in a leveraged portfolio of low-beta assets and a short position in a portfolio of high-beta assets. Both portfolios are rescaled to have a beta of one at construction to when shorting the high beta portfolio become a zero beta self-financing portfolio. The formula for the factor return is the following:

$$r_{t+1}^{BAB} = \frac{1}{B_t^L}(r_{t+1}^L - r^f) - \frac{1}{B_{t+1}^H}(r_{t+1}^H - r^f)$$

The Momentum Factor is constructed based on papers from Asness and Frazzini (2013), Asness, Frazzini and Pedersen (2013) and Fama French (1996). The Factor is the average return of value weighted portfolios constructed based on prior 12 month returns (leaving out the recent month) taking a long position in the portfolio with the high return stocks and a short position in the portfolio of low-returns, neutralized for size according to the following formula:

$$MOM = \frac{1}{2}(\,Small\ High + Big\ High) - \frac{1}{2}(\,Small\ Low + Big\ Low)$$

Ideally, the independent factors used in a regression should for statistical robustness not be correlated to the other independent factors, which would be a multicollinearity problem. By analyzing the correlation tables for the both markets, it can be concluded that in general the correlations in between the factors are fairly low with some exceptions around 0,5. The results are quite similar for both markets, the HML-factor and CMA-factor has the highest correlation

[4] https://www.aqr.com/Insights/Datasets

overall with 0,616 in Europe and 0,609 in the US. The RMW-factor is also noted to have strong correlations to many of the factors across both markets. This is naturally disturbing, harming the credibility of the regressions but has to be accepted as it is inherited in the Fama French Factors.

Table 2. Correlation between European High-Yield Factors

	Mkt-RF	*SMB*	*HML*	*RMW*	*CMA*	*MOM*	*BAB*	*TERM*	*DEF Factor*
Mkt-RF	1,000								
SMB	-0,096	1,000							
HML	0,191	-0,038	1,000						
RMW	-0,395	0,044	-0,539	1,000					
CMA	-0,271	-0,122	0,616	-0,175	1,000				
MOM	-0,461	0,146	-0,233	0,490	0,168	1,000			
BAB	-0,102	0,393	0,147	0,193	0,233	0,433	1,000		
TERM	0,148	-0,123	0,149	-0,146	0,043	-0,206	-0,206	1,000	
DEF Factor	-0,132	-0,037	0,098	0,103	0,166	-0,083	-0,139	0,156	1,000

Table 3. Correlation between US High-Yield Factors

	Mkt-RF	*SMB*	*HML*	*RMW*	*CMA*	*MOM*	*BAB*	*TERM*	*DEF-Factor*
Mkt-RF	1,000								
SMB	0,262	1,000							
HML	-0,055	-0,056	1,000						
RMW	-0,479	-0,515	0,407	1,000					
CMA	-0,256	0,029	0,609	0,263	1,000				
MOM	-0,368	0,028	-0,177	0,134	0,088	1,000			
BAB	-0,368	-0,210	0,334	0,574	0,327	0,390	1,000		
TERM	0,135	0,080	-0,053	0,088	-0,073	-0,204	-0,223	1,000	
DEF-Factor	-0,160	0,055	-0,034	0,113	0,112	-0,184	-0,100	0,205	1,000

4.2 Methodology

To perform a comprehensive risk adjusted factor analysis, the monthly excess return of the high-yield bonds, the dependent variable, will be regressed onto the independent variables as is the various factors estimated to give an explanation of the dependent variable. The method used is a an ordinary least square regression (OLS) where the aim is to reduce the square of the residuals to a minimum. That will be the most fitted line to the data points. The outcome of the regression will give an answer to whether there might be any alpha found in the regressions, outperformances that can not be explained by the factors, but also how and if the actual factors significantly can explain the total returns.

CAPM

As a sanity check, a traditional CAPM analysis is executed on the bond returns to figure out how well the returns can be described by what is supposed to and traditionally explain the return, the default premium (DEF). That will give an estimate how much needed new factor explanations are to describe high yield bonds. If the default premium would perfectly describe the returns, other factor analysis would be pointless to make as the returns could already be explained. This is a good start to estimate the need and purpose of this thesis. The formula for CAPM is the following, adjusted for the default premium replacing the traditional Market risk premium:

(1) $$R_t = \alpha_t + \beta_t * DEF_t + \varepsilon_t$$

Where:

R_t = Monthly excess return of the index

α_t = Outperformance not explained by risk factor

β_t = Return correlation with the Default premium

DEF_t = Default premium

ε_t = Residual

3 Factors

The 3 Factor model is the traditional Fama French model that has been widely accepted over time to value equities. The model is an extension of the equity CAPM where market risk premium still is a fundamental part but two additional factors have been added to explain the excess return. The monthly returns will be regressed onto these straight off equity factors to test whether there are any significance and similarities between the two asset classes and if there is any alpha when adjusted for the factors. The formula looks like the following:

(2) $$R_t = \alpha_t + \beta_{1,t} * (Mkt - RF_t) + \beta_{2,t} * SMB_t + \beta_{3,t} * HML_t + \varepsilon_t$$

Where:

$Mkt\text{-}RF_t$ = Equity Market risk premium

SMB_t = Small minus Big premium Factor

HML_t = High minus Low premium Factor

5 Factors

Similarly the 3 Factor was an extension to the CAPM, the 5 factor model is an extension to the 3 factor model. Two additional factors are added in the quest to explain the excess return of the dependent variable. These are the Robust-minus-Weak factor (RMW) and the Conservative-minus-Aggressive (CMA).

(3) $$R_t = \alpha_t + \beta_{1,t} * (Mkt - RF_t) + \beta_{2,t} * SMB_t + \beta_{3,t} * HML_t + \beta_{4,t} * RMW_t + \beta_{5,t} * CMA_t + \varepsilon_t$$

Where:

RMW_t = Robust minus Weak premium Factor

CMA_t = Conservative minus Aggressive premium Factor

7 Mixed Factors

The 7 Factor model is equal to the 5 Factor model but extended with the credit specific factors TERM and DEF. The independent factors becomes a mix of traditional equity factors and traditional credit factors which makes it interesting to follow the dynamics the factors in between and distinguish which factors in the capital structure that has the highest explanatory power.

(4) $$R_t = \alpha_t + \beta_{1,t} * (Mkt - RF_t) + \beta_{2,t} * SMB_t + \beta_{3,t} * HML_t + \beta_{4,t} * RMW_t + \beta_{5,t} * CMA_t + \beta_{6,t} * DEF_t + \beta_{7,t} * TERM_t + \varepsilon_t$$

Where:

DEF_t = Default premium (Option Adjusted Credit Spread)

$TERM_t$ = Term Premium

7 Equity Factors

The two debt factors DEF and TERM are removed in this regression and are replaced by two additional equity factors that have proven to be useful and gained popularity recently, the Momentum factor (MOM) and Betting-against-Beta factor (BAB). This is an extensive equity based analysis in terms of factors and will show how well excess returns can be described if assumed high yield bonds were equities.

$$(5) \quad R_t = \alpha_t + \beta_{1,t} * (Mkt - RF_t) + \beta_{2,t} * SMB_t + \beta_{3,t} * HML_t + \beta_{4,t} * RMW_t + \beta_{5,t} * CMA_t + \beta_{6,t} * MOM_t + \beta_{7,t} * BAB_t + \varepsilon_t$$

Where:

MOM_t = Momentum Factor

BAB_t = Betting-against-Beta Factor

9 Factor Regression

Lastly, adding back the debt factors will result in a comprehensive factor analysis including a wide range of factors potentially affecting the excess returns of high yield bonds. The independent variables are mostly equity factors but the most important debt factors have also been included. Hopefully, the explanatory value will be improved and result in a solid factor model to be used for determining prices and returns of high yield bonds.

$$(6) \quad R_t = \alpha_t + \beta_{1,t} * (Mkt - RF_t) + \beta_{2,t} * SMB_t + \beta_{3,t} * HML_t + \beta_{4,t} * RMW_t + \beta_{5,t} * CMA_t + \beta_{6,t} * MOM_t + \beta_{7,t} * BAB_t + \beta_{8,t} * DEF_t + \beta_{9,t} * TERM_t + \varepsilon_t$$

5. Empirical Results

5.1 European High Yield Index

To start, the Adjusted R2 is a measurement of how well the data points fall in line with the linear regression model and thus how much can be explained by the model and how trustworthy it is. The proxied CAPM for fixed income using the Default-premium spread are just 0,006 for the European Market implying basically no explanatory value at all. When regressing the excess returns on the Fama-French equity factors, a clear improvement is noted resulting in a R2 of 0,34. As a first takeaway, high-yield bond return are by far better explained by equity factors than debt factors. When further adding equity and even debt factors, the R2 will increase slightly further but the largest bump in explanatory value happens when adding the original 3 Fama-French factors.

Analyzing the CAPM regression, the beta of the DEF factor is negative at -0,079 which makes sense as an increase in the default spread would naturally be reflected in a price drop of the underlying bonds and result in a negative return. Although the beta is not significant and the R2 value is low so no further conclusions should be made on this result even if the alpha is positive at a value of 0,830% monthly and significant to a 95% level.

In the 3 Factor Regression, the Mkt-Rf and SMB factors have highly significant loadings of 0,279 and 0,603 respectively. The return of high-yield bonds can clearly to some extent be explained by the market risk premium and the premium for smaller companies. The hypothesis can be somewhat confirmed. To the contrary, the HML factor beta is non-significant and even negatively loaded and has to be neglected. The HML factor has been questioned for not generating promised returns but it might be that the value concept does not apply to bonds. No significant alpha is found at this stage.

Adding the two additional factors to construct the 5 Factor model: the Mkt-Rf and SMB factor loadings remain significantly positive, the HML stay neutral and non-significant and the two new factor betas are both significantly negatively loaded where RMW is -0,250 and CMA -0,366. The fact that the RMW- and CMA-factors are negatively correlated to the return is in line with previous studies: “Are Capital Market Anomalies Common to Equity and Corporate Bond Markets? An Empirical Investigation” by T.Chordia et al. and “Extending Fama French Factors to Corporate Bond Markets, Journal of Portfolio Management” by D.Bektic et al. which showed that bonds of profitable and prudent firms tend to underperform while bonds of unprofitable firms outperform. The papers concludes that these factors are a proxy for default risk premium and that solid companies underperform in the bond market and riskier companies surge in value as investors are searching for yield. This could be seen after the

European Central Bank initiated their bond buying programme. On top of this, there is some significant alpha at 0,323% monthly when regressing the returns on the five factor model.

Adding the Debt factors in the 7 Factor Model, none are actually significant. The DEF Factor has changed to a positive loading since the CAPM regression and the TERM factor is slightly negative. It makes sense that the TERM factor is negatively loaded as an increase in the steepening of yield curve of long term government bonds will increase the spread and thus depress prices/returns. The Mkt-Rf and SMB are still significantly positive as before, the CMA has even an increased significant negative beta loading (-0,572). The RMW is not significant anymore which could be that the added debt factors might incorporate the same effect as the RMW. As the correlations between the independent factors are low, it could also be the fact that the number of observations are lower due to limitations of data in the TERM factor, biasing the regression and neutralizing the RMW. No alpha can with significance be found.

Replacing the two debt factors with two additional equity factors, the BAB factor and MOM factor, shows that the momentum factor beta turns out to be negatively loaded (-0,153) and the BAB factor beta positively loaded at 0,115, both significant. The explanation for a negative correlation to the momentum factor might be that solid performing companies are underperforming in the bond market as was the case with the RMW- and CMA-factors. In this regression, there is a significant alpha of 0,374% per month.

In the last 9 Factor regression, all factors are included, and not much has changed from the two versions of the 7 Factor regressions. Mkt-Rf and SMB are positive and significant, HML and RMW are still non-significant, CMA is strongly negative and significant, MOM is negative and BAB is positive. The Debt Factors are still non-significant, the DEF-factor is positive and the TERM factor is negative as before. The significance of the alpha has now disappeared which could be an effect of the debt factors added or the decreased number of observations.

Table 4. Regression Summary of European High-Yield Index Factor Analysis

** , ** and *** indicate significance at the 90%, 95% and 99% level respectively. T-stat values within brackets.*

	CAPM	3 Factor Regression	5 Factor Regression	7 Factor Regression	7 Equity Factor Regression	9 Factor Regression
Alpha	0,830**	0,167	0,323*	0,290	0,374**	0,211
	(2,177)	*(0,993)*	*(1,836)*	*(0,791)*	*(2,136)*	*(0,518)*
DEF	-0,079			0,052		0,065
	(-1,525)			*(1,006)*		*(1,179)*
Mkt-RF		0,279***	0,207***	0,212***	0,173***	0,163***
		(8,616)	*(5,366)*	*(4,327)*	*(4,406)*	*(3,292)*
SMB		0,603***	0,566***	0,525***	0,530***	0,360***
		(7,569)	*(7,009)*	*(4,477)*	*(5,962)*	*(2,898)*
HML		-0,026	0,040	0,206	-0,035	0,198
		(-0,402)	*(0,405)*	*(1,245)*	*(-0,346)*	*(1,146)*
RMW			-0,250**	-0,026	-0,188	0,059
			(-2,039)	*(-0,117)*	*(-1,433)*	*(0,277)*
CMA			-0,366***	-0,572***	-0,310**	-0,536***
			(-2,796)	*(-3,007)*	*(-2,307)*	*(-2,716)*
TERM				-0,147		-0,117
				-(0,996)		*(-0,812)*
MOM					-0,153***	-0,155**
					(-3,160)	*(-2,085)*
BAB					0,115*	0,264***
					(1,945)	*(3,061)*
Adjusted R2	0,006	0,340	0,369	0,391	0,392	0,428
No Observations	236	236	236	151	236	151

5.2 US High Yield Index

The structure of the Adjusted R2 is the following: It starts on a low level for CAPM at 0,001, increases sharply when using the 3 Fama French Factors to 0,163. A second increase materialize when adding the MOM and BAB factors to 0,381. When replacing the additional debt factors, a further increase to 0,483 arise.

The CAPM model has a low explanatory value to start with and should not be trusted upon at a larger extent. The DEF-factor loading is negative, although not significant. The Alpha is 0,851% per month and significant but no further conclusions can be made due to low R2.

Subsequently analyzing the 3 Fama French Factors, the Mkt-Rf is positive at 0,220 and significant to a 99% level. The SMB and HML are at low levels and not significant at all, posing an explanation to the fairly low R2. The Alpha is still positive at 0,333% monthly and significant. Although as the R2 prevails at low levels, the credibility of the outperformance has to be questioned.

The 5 Factor model resembles the 3 Factor model to a large extent, as no other factors than Mkt-Rf factor (0,201) and Alpha (0,366) are significant. No explanation are given by adding the two additional factors and the R2 remains low. The 7 Factor model, constructed by adding back the 2 debt factors follows the same pattern, only that the significance of the alpha in this regression has disappeared. Either the reduction in observations or the debt factors may explain this change. Both debt factors are insignificant pointing to the fact that the lack of observations is the culprit.

Moreover including the MOM factor and BAB, the R2 increases where the MOM is negatively correlated at (-0,181) and BAB positive at (0,385), both significant. Surprisingly, when adding these factors, the RMW becomes significant at 99% level at (-0,242) and SMB significant at 90% at 0,094. The answer might be found in the high correlation between the RMW and the BAB factor at 0,574, which could capture an effect that might have been assigned to the RMW factor previously. Alpha is positive but not significant at this stage.

Ultimately when testing for all 9 factors, the MOM-factor and BAB-factors are still significant and are amplified having larger magnitude of the beta loadings. The RMW and SMB factors are no longer significant which must be an effect of either the decreased amount of observations or the debt factors added. The R2 is up at 0,483, thus the model should have somewhat predictable power to explain the returns. Although, no alpha exists significantly in this comprehensive model.

Table 5. Regression Summary of US High-Yield Index Factor Analysis

** , ** and *** indicate significance at the 90%, 95% and 99% level respectively. T-stat values within brackets.*

	CAPM	3 Factor Regression	5 Factor Regression	7 Factor Regression	7 Equity Factor Regression	9 Factor Regression
Alpha	0,851**	0,333**	0,366**	0,171	0,204	0,091
	(2,239)	*(2,211)*	*(2,300)*	*(0,431)*	*(1,474)*	*(0,261)*
DEF	-0,068			0,032		0,013
	(-1,148)			*(0,509)*		*(0,234)*
Mkt-RF		0,220***	0,201***	0,268***	0,172***	0,194***
		(6,193)	*(4,805)*	*(5,177)*	*(4,626)*	*(4,550)*
SMB		0,073	0,080	-0,038	0,094*	0,066
		(1,496)	*(1,376)*	*(-0,441)*	*(1,859)*	*(0,960)*
HML		0,056	0,084	-0,043	-0,047	-0,016
		(1,128)	*(1,247)*	*(-0,490)*	*(-0,770)*	*(-0,197)*
RMW			-0,031	-0,169	-0,242***	-0,021
			(-0,413)	*(-1,233)*	*(-3,443)*	*(-0,188)*
CMA			-0,082	-0,117	-0,101	-0,141
			(-0,838)	*(-0,765)*	*(-1,194)*	*(-1,140)*
TERM				-0,001		0,063
				(-0,005)		*(0,716)*
MOM					*-0,181****	*-0,237****
					(-6,020)	*(-5,912)*
BAB					*0,385****	*0,552****
					(-8,711)	*(8,674)*
Adjusted R2	0,001	0,163	0,161	0,186	0,381	0,483
No Observations	236	236	236	175	236	175

5.3 Results Discussion

As commented, the Adjusted R2 is clearly improved when using common equity factors compared to the DEF-factor that normally represent the credit spread. The tested debt factors do not show any significance throughout the tests. This implies that the analysis of bond returns by equity market factors are highly relevant for analyzing bond returns. Striking is the structure of the Adjusted R2 when comparing between the markets, the European market has a sharp increase directly when testing for the 3 Fama French Factors and then gradually rise at a low pace when adding factors. The US market on the other hand has a lower explanatory value when testing for the initial 3 Fama French factors to further incrementally increase in greater steps when first adding the MOM and BAB factors and eventually reaching a higher level of explanatory value when debt factors are added to the comprehensive 9 factor model. The Adjusted R2 achieved in the comprehensive 9-factor model is around 0,4-0,5 for both markets which is fairly good. Not to be trusted upon as a definitive answer but clearly an indication of what factors that are affecting the high-yield bond markets and how they affect the returns.

Regarding the alpha, there are similarities across the European and US markets. Significant and positive alpha when the explanatory value is at a reasonable level is generated in most of the regressions using only equity factors. When combining the equity factors and the debt factors, as in the 9 Factor model, no significant alpha is seen. Furthermore, the explanation could either be that the number of observations are reduced when adding the debt factors and this affects the significance. Or it might actually be that the debt factors added explain some of the excess return and alpha is not significantly different from zero when including all independent variables. Theoretically, it would be great to prove that all the excess returns could be explained by a combination of equity and debt factors as high-yield bonds are in between in the capital structure but due to low significance of the debt factors and an alpha that shifts in significance across the regressions, any conclusions that either alpha persists or that all excess returns can be explained would be bold to make.

In the 3 Fama French factors which was the outset for this thesis, there are both similarities and differences across the markets and some strong explanatory power for high-yield bond returns can be found within the factors. Across all the regressions made for both markets, the market risk premium factor (Mkt-Rf) is significant to a 99% level and has a beta factor loading of about 0,2, suggesting that the high-yield bond returns moves with the equity markets excess return but only with a fifth of the magnitude. It is comforting to conclude that high-yield bonds can be explained by the equity market risk premium and moves in the same direction although not as volatile which is within the theory of the bond market. The SMB factor on the other hand differs across the markets drastically as it is significant to a 99% level and have a factor loading of around 0,5 in all the tests in the European market but only significant at 90% in one of the regressions in the US market where the factor loading is below 0,1. The fact that outperformance of smaller stocks versus bigger stocks will explain the returns of high-yield bonds was not obvious and the mixed signals from the tests are unexpected and entail segmentation between the markets. A reasonable explanation for the European market might be that high-yield bonds are to a larger extent issued by smaller companies and their outperformance might then drive the returns of the bonds. The HML factor is not significant for any of the markets which makes sense as the concept of companies with high fundamental value and book-to-market value is not the central bet taken in the high-yield bond market. It could also be an effect of that the book-to-market value is specifically based an equity metric and is too specific.

The RMW and CMA factors are interesting to analyse both in between markets but also on an individual level across the different regressions. The most obvious point is that the CMA factor beta is highly significant and negatively loaded between -0,3 and -0,5 in all regressions in the European market and not significant at all in the US market. The RMW beta is only significant on a negative level in the 5 Factor Analysis in the European market. In relation, the US market RMW factor is significant and negative in the 7 equity factors but not in any other tests. As previously mentioned, this might be because other factors are added that capture the same effect and are highly correlated. It might also be that the number of observations shift and is then a timing difference. The negative factor loading on both these factors are surprising and have been touched upon earlier that profitable and prudent firms tend to underperform in the high-yield bond market and the effect is not fully surprising. The low interest environment in Europe might also explain the higher significance on the CMA factor in Europe.

Lastly, the Momentum and the Betting-against-Beta factors added to construct the full-scale comprehensive model show the same pattern for all regressions across both markets at high significance which gives credibility that these factors provide an explanation to the high-yield bond returns. It's compelling that these equity factors, not as widely accepted, provide a better explanation than other more conventional factors. The MOM factor is negatively loaded which is surprising as a positive company characteristic should according to theory increase the value of the bonds. With the same background for the CMA and RMW, the same argument might be valid. The BAB factor is positively loaded on the other hand and could be seen as a proxy for liquidity, implying that illiquidity in the equity markets will increase the returns in the high-yield bond markets as higher demand for credits will drive up prices.

To summarize, some factors are strongly significant across all regressions and across both markets which implies that these are credible explanations for high-yield bonds in general. These are the Market risk premium factor, Momentum Factor and Betting-against-Beta Factor, where the Momentum factor has a negative factor loading and the others are positively correlated to the returns.

Some differences could also be noted as the European High-Yield bond market initially can be better explained in terms of adjusted R2 by the traditional Fama-French Factors, where both the Market risk premium factor and SMB is significant across all regressions for the European market but only the market risk premium is significant for the US market. It's also interesting from a comparison point of view that the CMA factor is highly significant for the European market but not at all for the US market which could possibly be explained by the extremely low interest environment created by the European Central Bank.

By testing for different factors and different markets, many conclusions can either be reinforced or questioned which ultimately gives the thesis reliability. It can be concluded that there are common factors affecting returns, interlinkage between the factors and between the markets but also segmentation between the different markets to an extent that was not expected.

6. Robustness Test

To verify the results and the regression method, an evaluation of robustness needs to be conducted. In this thesis, a vast amount of factors have been added and replaced throughout the regressions made in an attempt to pinpoint the effect and dynamics in between. Naturally, some of these factors can be questioned whether they provide any explanation and bring value to the thesis or even worse, the factors might distort the result and limit the thesis. In general, many factors was perceived solid and credible but the TERM factor was not significant in any of the tests and limited the number of observations included due to data limitations. Ever since the Global Financial Crisis, the long term government bond yield curve has been held down and recent inversions to the yield curve have been observed, increasing the risk for not proving any explanation or distorting the results as the traditional pattern is not followed. To test for this, the TERM factor was removed completely during the Robustness Checks.

As a first test, a the new 8 Factor regression, the old 9 Factor regression without the TERM factor is performed. This open up for including more datapoints as the TERM factor had a limited number of observations compared to the other factors and thus limited the usage of the other factor data points. Thus the regression gives a sense whether the TERM factor limit or distort the explanation or if it can be removed without any major changes in the results.

Futhermore, to control for variations over time in the data, the observed period from January 2000 to August 2019 will be divided into two parts separated by the Global Financial Crisis which naturally is the major event possibly affecting the return dynamics over this time. A pre-crisis and a post-crisis period is constructed from Jan 2000 until Dec 2007 and from Jan 2010 to Aug 2019 respectively. By comparing the results between the periods, conclusions can be drawn about the homogeneity of the period and possibly explain variations over time not shown in the original tests. This is tested for the CAPM, 3 Factor, 7 Equity Factors and the previous 8 Factor Regressions. The TERM factor is removed at this stage as the limited observations made it burdensome to construct two time periods. Only the original 9 Factor regression is altered as the other regressions did not contain the TERM factor.

6.1 European High Yield Index

Comparing the original 9 Factor regression to the 8 Factor test, nothing has drastically changed. The Adjusted R2 is almost the same. Regarding the significant factors, none have lost its significance or changed sign on the beta loading. The CMA and BAB factors have lost some strength in significance but are still significant to a 95% and 90% level. Most of the significant factor loadings have been amplified and slightly increased in magnitude. The HML factor and the DEF factor have turned negative on their loadings but are neither significant in the 9 factor model, suggesting no conclusions would be drawn. The TERM factor was limited in its observations in the early part of the time period, resulting in that the 9 Factor regression was slightly biased toward the late part of the time period probably explains most of the changes. Comforting is that no drastic changes has occurred when making this shift to the entire period with 236 observations.

Comparing the modified CAPM formula using the DEF-Factor instead, a large difference is noted as the Pre-crisis CAPM is significant both on the DEF-Factor and the Alpha compared to none post crisis. The Pre-crisis DEF-Factor is negatively loaded to a 95% significance level which makes sense according to theory. Remarkably there is an alpha of 1,15% monthly which is significant to a 95% level. The results pre-crisis are fairly similar to the overall CAPM for the entire period and the R2 is at about the same low level (0,005 pre-crisis) questioning the credibility of the test.

The 3 Factor regression has in line with earlier tests a higher explanatory value with R2 around 0,3 both pre- and post-crisis. Similar for both periods is the (Mkt-Rf) and SMB factors, positively loaded and highly significant. Although the difference is that the HML factor is positively loaded at a significant level in the post-crisis period and alpha is 0,519% per month at 99% significance level. Clearly a positive outperformance to be extracted that was not found either pre-crisis or in the general model.

Analysing the 7 equity and 8-factor regression pre- and post-crisis, it can be seen that the corresponding pre-and post crisis regressions for both 7 and 8 Factors are almost identical, implying that the DEF-Factor does not have a large effect. The only difference between the 7 and 8-factors regression is that the 7 factor post crisis has a highly significant alpha (99% level) of 0,568 % per month. The only valid explanation is that the DEF-factor makes up for this in the 8-Factor model, which can be seen shifting from negative to positive between the pre-and post crisis regressions. Further comparing in between the pre-and post crisis, the pre-crisis has a higher R2 to start with. This makes somehow sense as the return structure was probably more normal and predictable before the crisis. Otherwise, the main difference is that the HML significantly provide excess returns post crisis. The RMW factor was negatively significant pre crisis and is post crisis slightly positive with low significance. Regarding the last two Factors, the momentum is slightly negative pre crisis to later reverse to zero post-crisis, and the opposite happens for BAB which is zero pre crisis to turn negative post-crisis.

Table 6. Robustness Test Summary of European High-Yield Index Factor Analysis

** , ** and *** indicate significance at the 90%, 95% and 99% level respectively. T-stat values within brackets.*

	8 Factor Test	CAPM Pre-Crisis	CAPM Post-Crisis	3 Factor Pre-Crisis	3 Factor Post Crisis	7 Equity Factor Pre-Crisis	7 Equity Factor Post-Crisis	8 Factor Pre-Crisis	8 Factor Post-Crisis
Alpha	0,400	1,15**	0,263	-0,279	0,519***	0,017	0,568***	0,391	0,060
	(1,240)	*(2,009)*	*(0,600)*	*(-0,947)*	*(4,167)*	*(0,055)*	*(3,944)*	*(0,760)*	*(0,159)*
DEF	-0,004	-0,194**	0,067					-0,062	0,103
	(-0,097)	*(-2,480)*	*(0,084)*					*(-0,902)*	*(1,459)*
Mkt-RF	0,173***			0,249***	0,155***	0,113*	0,146***	0,105	0,145***
	(4,380)			*(4,135)*	*(5,296)*	*(1,665)*	*(4,638)*	*(1,532)*	*(4,638)*
SMB	0,531***			0,58***	0,170**	0,635***	0,219***	0,634***	0,219***
	(5,936)			*(5,423)*	*(2,258)*	*(5,389)*	*(2,706)*	*(5,376)*	*(2,740)*
HML	-0,034			-0,026	0,104*	-0,125	0,218*	-0,103	0,222**
	(-0,033)			*(-0,257)*	*(1,681)*	*(-0,739)*	*(1,969)*	*(-0,602)*	*(2,019)*
RMW	-0,184					-0,444**	0,123	-0,420**	0,107
	(-1,363)					*(-2,345)*	*(0,876)*	*(-2,191)*	*(0,759)*
CMA	-0,308**					-0,115	-0,145	-0,105	-0,165
	(-2,268)					*(-0,596)*	*(-1,058)*	*(-0,545)*	*(-1,165)*
MOM	-0,154***					-0,115*	0,004	-0,114*	0,004
	(-3,133)					*(-1,774)*	*(0,077)*	*(-1,750)*	*(0,067)*
BAB	*0,114**					0,047	-0,108*	0,035	-0,095
	1,887					*(0,565)*	*(-1,686)*	*(0,412)*	*(-1,475)*
Adjusted R2	0,389	0,051	-0,003	0,312	0,299	0,386	0,315	0,385	0,322
No Observations	236	96	116	96	116	96	116	96	116

6.2 US High Yield Index

When comparing the original 9 Factor model to the newly constructed the 8 factor test, where the number of observations are extended from 175 to 236, the Adjusted R2 decreases by around 0,1 units. That is a substantial amount implying that the TERM factor has a larger explanatory value in the US. The fact that the US has not experimented with negative interest rates post-crisis might be the answer. Overall, there are large similarities except for the RMW factor beta that has become largely significant at 99% level and negative at -0,241 compared to a slightly negative non-significant value for the 9 Factor regression. This value is strikingly similar to the RMW value of the original 7 Equity Factor Regression where both the DEF-Factor and TERM factor was removed. This might be evidence of the larger impact than expected of the TERM-factor or that further additional observations are added early in the time period examined.

Regarding the CAPM with the DEF-Factor, the same pattern as in the European market prevails with a stronger negative beta loading at -0,108 and a high positive alpha at 0,851 % monthly pre-crisis, and then weak positive non-significant results post-crisis. As follows, this is in line with the initial result for the entire period.

In the 3 Fama French Factor test, the pre-crisis results are highly significant at 99% level for all 3 factor betas and clearly positive (around 0,2). Although alpha is non-existent suggesting that all excess returns are exhaustively explained by the factors. The post-crisis results are almost reversed where alpha is at 0,409 % monthly to a 99% significance level and only the Mkt-Rf is significant at 0,166. As more factors explain the returns, the Adjusted R2 is also higher for the pre-crisis period.

Lastly, the 7-and 8-Factor regressions are almost identical pre-and post-crisis, similar to the European Market. To be noted is the highly positive and significant alpha in the post-crisis 7 factor regression at 0,379% per month which is neutralized when adding the DEF-Factor in the 8 Factor model. As mentioned in the earlier regressions, the pre-crisis tests have a higher Adjusted R2 at around 0,30 compared to 0,2 for post-crisis. This effect can be noted in the factor betas where almost all factors are significant in the pre-crisis tests, compared to only the market risk premium factor and momentum factor post-crisis.

Table 7. Robustness Test Summary of US High-Yield Index Factor Analysis

** , ** and *** indicate significance at the 90%, 95% and 99% level respectively. T-stat values within brackets.*

	8 Factor Test	CAPM Pre-Crisis	CAPM Post-Crisis	3 Factor Pre-Crisis	3 Factor Post-Crisis	7 Equity Factor Pre-Crisis	7 Equity Factor Post-Crisis	8 Factor Pre-Crisis	8 Factor Post-Crisis
Alpha	0,221	0,851	0,491	-0,033	0,409***	0,060	0,379***	0,320	-0,059
	(0,667)	*(1,609)*	*(0,906)*	*(-0,180)*	*(3,378)*	*(0,330)*	*(2,740)*	*(0,680)*	*(-0,111)*
DEF	-0,003	-0,108	0,017					-0,049	0,086
	(-0,056)	*(-1,216)*	*(0,159)*					*(-0,599)*	*(0,858)*
Mkt-RF	0,172***			0,196***	0,166***	0,100*	0,158***	0,098*	0,160***
	(4,545)			*(4,218)*	*(5,044)*	*(1,729)*	*(4,605)*	*(1,682)*	*(4,644)*
SMB	0,095*			0,198***	-0,032	0,169***	-0,033	0,179***	-0,037
	(1,826)			*(4,150)*	*(-0,585)*	*(2,660)*	*(-0,557)*	*(2,714)*	*(-0,621)*
HML	-0,048			0,253***	0,034	0,324***	0,044	0,316***	0,052
	(-0,761)			*(4,077)*	*(0,650)*	*(3,260)*	*(0,614)*	*(3,125)*	*(0,726)*
RMW	-0,241***					-0,230**	-0,046	-0,213**	-0,053
	(-3,324)					*(-2,432)*	*(-0,520)*	*(-2,145)*	*(-0,594)*
CMA	-0,100					-0,205**	-0,085	-0,190*	-0,112
	(-1,157)					*(-2,199)*	*(-0,814)*	*(-1,973)*	*(-1,026)*
MOM	-0,182***					-0,073*	-0,079*	-0,076*	-0,078*
	(-5,788)					*(-1,933)*	*(-1,803)*	*(-1,981)*	*(-1,772)*
BAB	*0,385****					0,108	0,108	0,101	0,115
	8,605					*(1,547)*	*(1,383)*	*(1,431)*	*(1,465)*
Adjusted R2	0,378	0,005	-0,009	0,256	0,184	0,320	0,190	0,315	0,188
No Observations	236	96	116	96	116	96	116	96	116

6.3 Robustness Discussion

There are signs of division between the results pre and post crisis and effects amplified during the crisis period, which could be expected as the Global Financial Crisis was a big event that naturally shift the conditions in the markets. Factors are significant in either of the two periods to not be significant in the overall test. Still, some time variances has to be endured to end up with a model functioning across all kind of market environments and market cyclicality.

Comparing the Adjusted R2 value, the pre-crisis tests have a higher explanatory value for both markets. Particularly the US market where the difference are about 10% in R2 value for the more comprehensive tests with many factors included and there are some factors are only significant pre-crisis. In the European market, the CAPM regression pre-crisis has increased in R2 value and is significant for alpha and DEF-Factor but still at a low level though. It's also seen that alpha overall is highly significant post-crisis for both markets which could be due to the lower significance of the other factors not managing to explain the excess return showing up as excess return. Or it could have an economic explanation that market fundamentals where distorted during the financial crisis and excess returns beyond the factors were generated.

For the 3 original Fama French Factors in the European market, the SMB factor remains significant across all regressions but shifts in beta loading from around 0,6 to 0,2 when moving from pre-crisis to post-crisis. The market factor remains quite constant over the regressions but the HML-Factor shifts from being negatively loaded pre-crisis to be positively loaded and significant to 90% at least post-crisis. The US market has even larger fluctuations where the market factor is quite constant, the SMB-factor is positive and highly significant pre-crisis to be negatively loaded and non-significant post-crisis. The HML factor has the same pattern, with a highly significant positive values pre-crisis and lower non-significant loadings post-crisis. A key takeaway is that all 3 original Fama French Factors are significant and positive pre-crisis throughout all regressions but only the market factor shows up as significant in the original tests. This can be interpreted in two ways, either the robustness of the Market factor throughout all type of periods but also that there was some correlation between SMB and HML factors to the excess return that was vanished during the crisis. Thus it would be interesting to extend the time period further or make an updated test in maybe 10 years to figure out whether the factors are back to significantly affect the return.

Analysing the other 4 equity factors added throughout the tests, some interesting patterns can be found. In the European market the RMW-factor is only significant pre-crisis and negatively loaded which does not show up in the original regression. The CMA on the other hand is highly significant and negatively loaded in the original tests which does not show in any periods in the robustness test. The same goes for the BAB factor but on a positive basis. The explanation must be that the period omitted in the robustness test, the crisis period between 2008-2010 must contain values of high magnitude affecting the outcome in the original tests. This makes sense, particularly for the BAB factor which is a proxy for liquidity that was the culprit during the crisis. The US show similar signs where RMW and CMA is significantly negative pre-crisis, the MOM-factor effect is magnified in the original tests compared to the robustness periods and the BAB has the same feature as the European market where the crisis period must have a large effect to the outcome of the original test.

To summarize, time period differences appear naturally during the crisis that put the model into question but still, the ambition is to create a model and draw conclusions based on a model that can navigate through all kinds of scenarios and environments, even the largest financial crisis in modern time and clear patterns have been extracted and proven explanatory value over this time period.

7. Conclusion

In general, throughout the analysis for both markets, the value for alpha has been positive but shifted in significance. There is an opportunity to receive risk-adjusted outperformance but I would not dare to say with certainty that alpha persists in any of the markets. The initial hypothesis that the Equity Factors prove to be a better explanation for High Yield bonds than typical bond factors has been confirmed and can subsequently be a proxy for the Default premium that investors want to be rewarded for. It has to be said that everything naturally is interlinked and not binary. Some factors have positive loadings in line with traditional research on equities but some on the other hand are negatively loaded in line with previous research on bonds implying that high yield bonds are somewhere in between the two funding sources when it comes to explaining the return characteristics. A final conclusion is that the European and US markets comfortingly had some significant similarities but also differed quite a bit, not to the extent that the loadings were completely opposite but the factors still had quite different effect and significance. That shows prevalence for market segmentations that the markets behave differently and investors in the markets can not be pooled to one unit.

Whether the returns of high-yield bonds can be justified due to the default risk taken, has been a hot topic over the years. By proving that high-yield bond returns can be explained by typical factors used for equity valuation, this paper extend the research on corporate high-yield bonds Further, high-yield bonds could indeed be viewed as something in between equities and debt where equity factors are at play but simultaneously, negative loadings on some factors can be explained by debt market characteristics. This new framework for evaluating bonds and potentially the return of corporate bond investors is highly contemporary and will only grow in popularity and usage. Not just with in credits but across all asset classes.

There have been previous similar studies as mentioned, using different factors, classifying the factors differently and taking different perspectives and methods in the research. Some researchers evaluate individual bonds against indexes, constructing portfolios based on different factors and investigate the returns to prove they can outperform indexes and other investors. Due to limited access in terms of data and resources, this thesis has been kept on an aggregate index level using quite traditional, easy accessible data. The idea of demystifying research and constructing something meaningful and interesting out of simple ingredients is highly appealing. But naturally the lack of data limits the study where data on individual bonds could be used to create portfolios to further distinguish the effect and also tweak certain factors to test if they can make a better explanation. As an example, the HML-factor can be constructed out of a different measurement for fundamental value if individual bond data would be accessed.

As following, where this thesis distinguishes from the rest is not in a technical, statistical or data sense but more of general content. The research for high-yield bonds is not particularly established in general as focus tend to end up on investment grade bonds. This due to the fact that the market is way bigger as Limited Partners, Pension Funds and Mutual Funds have restrictions on their mandates and can only invest in the investment grade market. Specifically this thesis zooms in on the European High-Yield market using European Factors which is fairly unprecedented. Thus, the research that has been previously made is performed on either Investment Grade corporate bonds or US High-Yield bonds. To involve European High-Yield market and benchmarking the results to the US High-Yield market, the thesis connects to previous research but also brings it forward in regional market terms. Naturally, the thesis examines a contemporary time perspective where recent data is used up to August 2019, in an interesting period including a Global Financial Crisis and following a low interest rate environment, which brings the research forward.

Further research can be made on the subject digging deeper into the data and methods, this paper should be seen as a trailblaze on an aggregate level to lead the way for further detailed investigations. For example, each factor can be evaluated for the European market constructing portfolios out of assets possessing the characteristics in focus and benchmarking against other factor portfolios or indexes. Multi-factor portfolios can be constructed, either long only or long-short to continue the quest for alpha and reaching a high Sharpe ratio. Aside from the technical aspect, it would be interesting to further narrow down the geographical scope and zoom in on the Swedish high-yield market, evaluate whether the returns can be explained by certain factors and eventually uncover the performance of asset managers and mutual funds.

8. References

Andrea Frazzini and Lasse H Pedersen, 2014, Betting Against Beta, Journal of Financial Economics Vol 111 Issue 1, 1-25

Antti Illmanen, Ronen Israel, Tobias J. Moskowitz, Ashwin Thapar and Franklin Wang, 2019, Do Factor Premia Vary Over Time? A Century of Evidence

Braddock W Hickman, 1958, Corporate Bond Quality and Investor Experience, Princeton University Press, 3-27

Demir Bektic, Josef-Stefan Wenzler, Michael Wegener, Dirk Schierek, Timo Spielmann, 2017, Extending Fama French Factors to Corporate Bond Markets, Journal of Portfolio Management 45 (3), 141-158

Edward I. Altman, 2000, Revisiting the High Yield Bond Market: Mature but never Dull, Journal of Applied Corporate Finance 13.1, 64-74

Eugene F. Fama and Kenneth R. French, 1992, Common Risk Factors in the Returns on Stocks and Bonds, Journal of Financial Economics 33 (1993), 3-56

Marshall E. Blume and Donald B. Keim, 1987, Lower-Grade Bonds: Their Risks and Returns, Financial Analysts Journal Vol 43 No. 4, 26-33 + 66

Patrick Houweling and Jeroen Van Zundert, 2016, Factor Investing in the Corporate Bond Market, Financial Analysts Journal Vol 73 No. 2

Paul Asquith, David Mullins and Eric D. Wolff, 1989, Original Issue High Yield Bonds: Aging Analyses of Defaults, Exchanges and Calls, The Journal of Finance Vol 44, 923-952

Robert C. Merton, 1974, On the pricing of Corporate Debt: The risk structure of Interest Rates, The Journal of Finance Vol 29 Issue 2, 449-470

Ronen Israel, Diogo Palhares and Scott Richardson, 2018, Common Factors in Corporate Bond Returns, Journal of Investment Management Vol 16 No. 2, 17-46

Tarun Chordia, Amit Goyal, Yoshio Nozawa, Avanidhar Subrahmanyam, Qing Tong, 2017, Are Capital Market Anomalies Common to Equity and Corporate Bond Markets? An Empirical Investigation, Journal of Financial and Quantitative Analysis Vol 52 No 4, 1301-1342

Thomas R. Atkinson, 1967, Trends in Corporate Bond Quality, NBER, 1-20