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Impact of Readability on Corporate Bond Market

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Abstract: This paper investigates the impact of annual report readability on the corporate bond market. My findings indicate that in the US corporate bond market, firms with less readable annual reports tend to have higher credit spreads, higher credit spread volatilities, higher transaction costs, higher transaction costs volatility, smaller trade size, higher number of trades and higher number of trades volatility. This paper also provides the first answers to the question as to whether annual report readability matters to international market participants in the corporate bond market. My findings provide evidence that in the EUR corporate bond market, firms with more readable annual reports are associated with lower credit spreads.

Keywords: readability; annual report; textual analysis; credit spread; spread volatility; transactions costs

JEL Classification: G12; G14; G28; M41

1. Introduction

Annual reports are very important information sources concerning publicly traded companies. Investors and analysts expend a lot of effort in the analysis of annual reports in order to obtain a true and complete view of the firms. Therefore, the readability of annual reports is crucial for market participants. However, in 1969, the Wheat Report of the Securities and Exchange Commission (SEC) complained about the complex language used in mandatory filing, and requested firms improve the readability of their filings. Based on Arthur Levitt's remarks to the Securities Regulation Institute in 1998, the SEC adopted the plain English regulation to improve the readability of financial reports. Despite the efforts of the regulator, the size of annual reports has greatly increased over the past 20 years.[1] Furthermore, annual reports from different firms show very different levels of readability, which might be explained by the respective characteristics of the firms.

There is a growing amount of academic literature examining the relationship between annual report readability and equity market variables, e.g., the impact of readability on future performance and earnings' persistence (Li 2008), firm investment efficiency (Biddle et al. 2009), analyst coverage and dispersion (Lehavy et al. 2011), the trading behavior of equity investors (Miller 2010; Lawrence 2013), and return volatility and earnings forecast errors (Loughran and McDonald 2014). For debt markets, there is only a very limited amount of academic study available concerning the readability of annual reports. Most of the papers analyze the association between readability and pricing of debt securities (corporate bonds, bank loans and Credit Default Swap (CDS)).

This paper contributes to the existing literature in the following ways:

First, I not only analyze the relationship between readability and credit spread of corporate bonds, but also provide the first evidence for the impact of annual report readability on spread volatility,

[1] Li (2008) shows the steady increase in the total number of words from 1994 and 2004.

transaction costs, transaction costs' volatility, trading volume and trading volume volatility in corporate bond markets. I find that bonds issued by firms with less readable 10-K filings (i.e., larger Total Number of Words) are significantly associated with higher subsequent spreads, higher spread volatilities, higher transactions costs, higher transactions costs' volatility, smaller trade size, higher number of trades and higher number of trades' volatility.

Secondly, in the corporate bond market, firms can issue corporate bonds in different currencies, which means that a group of firms that submit mandatory filings to the SEC also have corporate bonds in other currencies than USD. This allows me to conduct the first international examination regarding the impact of readability. The questions of interest are whether annual report readability matters to international market participants, and how it affects their evaluation of a firm's credit risk. I find that investors in EUR corporate bonds also consider annual report readability in their pricing logic. Firms with less readable annual reports tend to have higher spreads.

Finally, I provide further evidence that the Fog Index is not an appropriate proxy for readability of financial filings with corporate bond data. I find that one element of the Fog Index (percentage of complex words) shows a significant negative impact on corporate bond spreads. This result is not unexpected and is in line with the findings of Loughran and McDonald (2014), who provide similar evidence for equity market data.

The paper proceeds as follows. In Section 2, I summarize the relevant literature. Section 3 defines readability measures and describes the data used. Section 4 develops hypotheses and reports the empirical findings. Section 5 concludes the paper.

2. Related Literature

2.1. Readability Literature in the Equity Market

There are a large number of empirical papers that analyze the impact of annual report readability on equity markets. Li (2008) provides the first large-sample evidence on determinants of the readability of 10-K filings, and the relationship between 10-K readability and future performance and earnings persistence. Li (2008) uses two readability measures, Fog Index and Total Number of Words. His findings are in line with the motivation behind the plain English disclosure regulation of the SEC. Companies may be opportunistically choosing the readability of the annual report to hide adverse information from investors. Li (2008) finds that companies with lower earnings tend to publicize more complicated annual reports, and companies with more complicated annual reports show a lower persistence of earnings when they are profitable.

Biddle et al. (2009) examine the impact of readability on a firm's investment efficiency by using the Fog Index. They find evidence that the quality of financial reporting positively influences the capital investment efficiency.

Lehavy et al. (2011) investigate the relationship between readability, analyst coverage and dispersion by using the Fog Index. They find that firms with less readable annual reports tend to have higher analyst coverage, greater analyst dispersion, lower accuracy, and greater overall uncertainty in analyst earnings forecasts.

Miller (2010) and Lawrence (2013) focus on the relationship between readability and trading behavior of equity investors. Miller (2010) finds that firms with less readable annual reports tend to be less traded by equity investors. This is caused by a decrease in trading activity by small investors (trades less than or equal to $5000 volume). Lawrence (2013) uses discount brokerage data of individual small investors, and finds that individual investors invest more money in firms with more readable annual reports.

Loughran and McDonald (2014) show that the traditional readability measure (Fog Index) is not a suitable readability measure for annual financial reports, and they suggest applying the "10-K file size" as a measure of readability. They argue that the element "complex words" of the Fog Index is the main issue of this measure, since there are a large number of multi-syllable words in business contexts which

are easy for investors and analysts to understand. Therefore, the usage of multi-syllable words does not necessarily increase the complexity of financial documents. Loughran and McDonald (2014) find that the Fog Index does not show a significant impact on unexpected earnings and analyst dispersion. The suggested measure "10-K file size" has a significant positive impact on return volatility, earnings forecast errors and earnings forecast dispersion.

2.2. Readability Literature in the Debt Market

There is also some literature on the impact of annual report readability on debt markets (bank loans, corporate bonds and CDS).

Ertugrul et al. (2017) analyze bank loans for the time period between 1995 and 2013, and find that firms with less annual report readability and a higher percentage of uncertain words in their annual reports tend to have higher loan spreads.

Bonsall and Miller (2017) examine 3659 initial bond ratings and bond offering credit spreads between 1994 and 2014. Their evidence suggests that issuers with poorer readability tend to issue bonds with worse initial ratings, and with larger bond rating disparities amongst different rating agencies. Furthermore, the bond offering credit spreads are higher for issuers with less annual report readability.

Hu et al. (2018) investigate the CDS market for the time period 2005–2011. They show that firms with less readable annual reports are associated with higher CDS spreads. The impact of readability is more pronounced for firms with high information asymmetry (e.g., firms with high growth or with high Research and Development (R&D) expenditures) and with investment grade ratings.

2.3. Other Literature Regarding Annual Reports (10-K Filings)

A strand of literature examines the sentiment of annual reports. Loughran and McDonald (2011) examine the impact of the tone of annual report on 10-K filing returns, trading volume and return volatility. Li (2006) investigates the impact of risk sentiment in annual reports on future earnings and stock returns. Li (2006) finds a negative relationship between risk sentiment and future earnings/future returns.

There are some papers that focus on individual sections of annual reports. Li (2008) analyses the determinants of the readability of the MD&A (Management's Discussion and Analysis of Financial Condition and Results of Operations) sections and the notes to the financial statements. He finds that larger firms, younger firms, firms with higher return and firms with higher earnings volatility tend to have longer MD&A sections. Campbell et al. (2014) examine the determinants of the risk factor sections. They find that firms facing a greater risk disclose more risk factors. Kravet and Muslu (2013) find that filings with more risk disclosures in 10-K tend to have a higher stock return volatility, trading volume and earnings forecast dispersion. Campbell et al. (2014) find that the information content of risk factor sections is positively related with the firm risk after the publication of 10-K filings. Beatty et al. (2018) find similar results of Campbell et al. (2014) for the time period prior to financial crisis. However, Beatty et al. (2018) show that, after the financial crisis of 2007/2008, the risk factors sections become less informative for the subsequent firm risk. Feldman et al. (2010) investigate the MD&A section and find that the tone change of the MD&A section is associated with the short-window market reactions around the SEC filing. Loughran and McDonald (2011) examine the impact of the tone of the MD&A section and find that the tone of the MD&A section does not show a strong impact on 10-K file date excess return. Chin et al. (2018) examine the position of credit risk disclosures in the risk factor section of annual reports. They find that firms that place the credit risk disclosure at the beginning of the risk factors section are associated with worse credit rating and higher bond spreads.

3. Readability Measures and Data

3.1. Readability Measures

In this paper I apply the two most common readability measures: Fog Index and Total Number of Words. The Fog Index is developed by Gunning (1952) and is very widely used in various academic

fields. The value of the Fog Index can be interpreted as the number of years of education needed to understand the text after the initial reading. The definition of Fog Index is as following:

$$\text{Fog Index} = 0.4 \times (\text{Number of words per sentence} + \text{Percent complex words})$$

The two elements of the Fog Index are average number of words per sentence in the entire text, and percentage of complex words (words more than two syllables) of all words. The idea behind the definition is that a text with longer sentences and more complex words is associated with less readability.

The second measure is Total Number of Words, which is defined as:

$$\text{LnWords} = \ln(\text{Total Number of Words})$$

Due to the skewness of the raw Total Number of Words, I apply the natural logarithm of Total Number of Words to measure the readability of the text. This measure is easy to calculate and also widely used.

3.2. Data

In this paper, I use a corporate bond universe based on the BofA Merrill Lynch Global Corporate Index, 1999 to 2017. In the following analyses, I include only senior, unsecured, bullet investment-grade corporate bonds. Different bond characteristics, e.g., option-adjusted spread (OAS), issue date, modified duration, are also provided by BofA Merrill Lynch. To get equity control variables and filing variables, I use the issuer's ultimate parent company to do the mapping.[2] Equity control variables, e.g., volatility of stock, market capitalization, debt to enterprise value, are collected from Datastream, Bloomberg, Thomsen Reuter Worldscope[3] and Thomsen Reuter MarketQA database. Trading volume and price data are sourced from FINRA Trace[4]. Trace data are cleaned by using Dick-Nielsen (2014)'s procedure. 10-K filings are downloaded from EDGAR (Electronic Data Gathering, Analysis, and Retrieval System). The Loughran and McDonald (2011) parsing procedure is used to prepare the text.

Table 1 shows the number of observations (bond and month), number of bonds, number of ultimate parent companies and number of issuers for USD universe and EUR universe for the time period 1999–2017.

Table 1. Sample Overview.

Jan. 1999–Dec. 2017	USD Universe	EUR Universe
No. of bond and month: all corporate bonds	1,366,934	417,640
No. of bond and month: investment grade, senior, unsecured, bullet USD corporate bonds	818,018	271,332
No. of bond and month: investment grade, senior, unsecured, bullet USD corporate bonds with mapping filing data/Number of Words ≥ 3000	415,890	27,946
No. of bonds	8259	640
No. of ultimate parent companies	748	100
No. of companies	1258	138

This table reports the sample overview. USD universe includes only US dollar-denominated bonds. EUR universe consists of corporate bonds denominated in EUR.

[2] The reason for using the ultimate parent company is that investors generally consider all companies under the ultimate parent company as sharing the same default risk.
[3] Based on Quoniam Asset Management GmbH's contracts with data providers I cannot publish the Worldscope data.
[4] Based on Quoniam Asset Management GmbH's contracts with data providers I cannot publish the FINRA Trace data.

In the USD universe there are 415,890 observations, which contain 8259 corporate bonds from 1258 issuers under 748 ultimate parent companies. The EUR universe[5] consists of 27,946 observations, which contain 640 corporate bonds from 138 issuers under 100 ultimate parent companies.

Table 2 reports the number of ultimate parent companies, average Total Number of Words, and average Fog Index in different years.

Table 2. Summary Statistics.

Year	Number of Ultimate Parent Companies	Total Number of Words	Fog Index
1999	399	22,789	23.26
2000	426	22,216	23.10
2001	452	25,214	23.17
2002	475	27,304	23.00
2003	492	37,036	23.39
2004	502	39,918	23.05
2005	508	43,703	23.00
2006	519	47,363	22.96
2007	551	49,305	22.98
2008	568	52,140	23.03
2009	581	56,707	23.06
2010	580	57,526	23.18
2011	587	58,406	23.29
2012	595	58,834	23.38
2013	594	58,956	23.32
2014	587	59,571	23.45
2015	575	59,260	23.45
2016	545	60,859	23.50
2017	512	61,488	24.45

I present summary statistics for readability proxies used in this paper. These include the number of ultimate parent companies, average total number of words of the filings and average Fog index for the research time period 1999–2017.

Consistent with the results of Li (2008) and Loughran and McDonald (2014), Total Number of Words shows a strong increasing trend. In the research period 1999 to 2017, Total Number of Words has tripled from 22,789 to 61,488. The Fog Index shows little variation over time. The correlation between Total Number of Words and Fog Index is just 0.14. The different trends and low correlation lead to the question of which measure is the appropriate proxy for readability.

4. Hypotheses and Empirical Results

4.1. Hypotheses

In this study, I analyze the impact of the readability of annual reports on the subsequent corporate bond spreads, corporate bond transaction costs and trading behavior of corporate bonds.

Li (2008) finds that firms attempt to hide adverse information from investors by increasing the complexity of their annual reports. More complex annual reports require more time and effort for investors to possess the information. It is also more difficult for investors to evaluate and interpret the information of annual reports (Bloomfield 2002), which leads to a higher information risk and higher uncertainty in the forecast of future cash flows and default risk of the firms. Therefore, corporate bond investors require higher compensation for the greater information risk and uncertainty. Huang and Yu (2010) and Korteweg and Polson (2010) add the information uncertainty in the structural

[5] The EUR universe makes up only 11% of the entire senior, unsecured, bullet investment grade EUR-denominated corporate bonds in the Merrill Lynch Global Corporate Index. The reason for this is that I only have 10-K filings for publicly traded firms in US. Annual reports for firms with EUR-denominated bonds and without 10-K filings are not available.

model framework. They show that information uncertainty impacts the bond pricing, and therefore the corporate bond spread. Accordingly, I hypothesize the following:

Hypothesis 1. *Firms with less readable annual reports are associated with higher corporate bond spreads. This relationship holds for USD investors as well as EUR investors.*

Guo et al. (2017) examine the relationship between uncertainty and liquidity of the corporate bond market. They find that information uncertainty influences the liquidity of the corporate bond market. Corporate bonds with greater information uncertainty are associated with lower trading volume, and higher bid/ask spreads. They argue that, in cases of high information uncertainty, corporate bond investors are not confident with their corporate bond valuation. This reduces willingness to trade, and therefore lowers the trading volume. Additionally, information uncertainty influences corporate bond dealers. Bond dealers are not willing to make a market for firms with high information uncertainty, due to the high probability of pricing errors. Therefore, I test the following hypothesis:

Hypothesis 2. *Firms with less readable annual reports tend to have lower liquidity, which means lower trading volume, higher transaction costs, and smaller trade size.*

Lehavy et al. (2011) analyze the relationship between the readability of annual reports and analyst earnings forecasts. They argue that complex annual reports lead to disagreement or ambiguity among analysts. Accordingly, they find that firms with less readable annual reports are associated with greater analyst dispersion, lower accuracy, and greater overall uncertainty in analyst earnings forecasts. For the corporate bond market, Bonsall and Miller (2017) find that firms with less readable annual reports are associated with a higher probability of split ratings (Moody's and S&P) on the same issuance and exhibit a greater difference between the ratings of the two rating agencies. This disagreement among equity analysts and bond rating analysts can cause—or intensify—the disagreement among investors and dealers concerning pricing. These arguments lead to the following hypothesis:

Hypothesis 3. *Firms with less readable annual reports are associated with higher credit spread volatility, higher volatility of transaction costs, and higher volatility of trading behavior (trading volume/number of trades).*

4.2. Multivariate Results for USD Universe

This section reports the empirical results of the impact of readability on Option Adjusted Spreads (OAS), transaction costs, trading volume, number of trades, and trade size and volatility of the above variables.

4.2.1. Impact of Readability on OAS

Table 3 shows the results of multivariate regressions for the impact of readability on spreads in the USD universe.

For this research question, the following equation is used:

$$\begin{aligned} OAS_{it} = {} & \beta_0 + \beta_1 \times Readability_{it} + \beta_2 \times Volatility30D_{it} + \beta_3 \times Log(MarketCap)_{it} \\ & + \beta_4 \times Debt/EnterpriseValue_{it} + \beta_5 \times Ebitda/TotalAssets_{it} \\ & + \beta_6 \times RatingScore_{it} + \beta_7 \times ModifiedDuration_{it} + e_{it} \end{aligned} \quad (1)$$

The dependent variable is the OAS of a corporate bond at the end of each month. Readability measures are the natural logarithm of Total Number of Words and the Fog Index. The readability measures of certain 10-K filings are matched to the 12 months following publication of the filings. The control variables are based on the prior literature regarding determinants of corporate bond spreads. Merton's (Merton 1974) structural model shows that asset volatility (historical volatility of the ultimate parent companies' stocks is used as proxy for asset volatility) and leverage ratio (Debt/Enterprise

Value) are very important spread determinants. I also include profitability (Ebitda/Total Assets) and size (natural logarithm of the market capitalization) of the ultimate parent companies. Two bond characteristics—rating score and modified duration—are included. Rating score varies between 1 and 10 and represents rating AAA to BBB-, respectively. The higher the rating score, the worse the rating category. AAA (BBB-) rating has a score of 1 (10). All regressions include an intercept, month fixed effect and industry sector fixed effect. Standard errors are adjusted for month and industry clusters. 10-K filings with less than 3000 words are excluded.

Table 3. Impact of readability on spreads (USD Universe).

OAS_{it}	1	2	3	4	5	6	7	8	9
Readability Measures:									
Log (Number of Words)		3.60 (5.81)				3.00 (4.78)			
Fog Index			0.39 (1.91)				0.31 (1.42)		
Average Sentence Length				0.21 (2.50)				0.21 (2.29)	
Percentage Complex Words					−0.64 (−1.90)				−0.83 (−2.59)
Control Variables									
Volatility30D	2.78 (15.54)	2.77 (15.44)	2.78 (15.54)	2.78 (15.53)	2.78 (15.51)	2.80 (15.39)	2.81 (15.53)	2.81 (15.52)	2.81 (15.48)
Log (MarketCap)	−16.98 (−16.75)	−17.39 (−17.20)	−16.99 (−16.76)	−16.98 (−16.74)	−16.92 (−16.40)	−17.76 (−16.27)	−17.42 (−15.87)	−17.42 (−15.87)	−17.37 (−15.67)
Debt/Enterprise Value	74.73 (18.76)	73.63 (18.53)	74.93 (18.86)	74.84 (18.82)	74.26 (18.51)	73.51 (17.88)	74.56 (18.14)	74.54 (18.12)	73.88 (17.83)
Ebidta/Total Assets	−72.11 (−7.24)	−68.24 (−6.93)	−71.63 (−7.24)	−71.88 (−7.24)	−73.37 (−7.24)	−62.49 (−6.03)	−65.04 (−6.25)	−65.17 (−6.24)	−66.91 (−6.28)
Rating Score	10.62 (33.42)	10.33 (32.44)	10.62 (33.39)	10.60 (33.15)	10.58 (33.90)	10.43 (32.22)	10.68 (32.95)	10.66 (32.70)	10.62 (33.28)
Modified Duration	5.77 (47.09)	5.75 (46.79)	5.77 (47.11)	5.77 (47.07)	5.77 (46.61)	5.66 (44.86)	5.67 (45.06)	5.67 (45.03)	5.68 (44.64)
Herfindahl Index						−14.23 (−5.51)	−14.67 (−5.70)	−14.78 (−5.77)	−15.17 (−6.11)
Fixed Effect: Month	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	62.79%	62.82%	62.79%	62.79%	62.79%	62.51%	62.48%	62.49%	62.49%
Observations	415,890	415,890	415,890	415,890	415,890	399,008	399,008	399,008	399,008

The dependent variable in each regression is the OAS (Option Adjusted Spread) in basis points. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Fog Index is calculated by using $0.4 \times$ (Number of words per sentence + Percent complex words). The readability measures of certain 10-K filing are matched to the 12 bond and month observations following publication. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

In the baseline regression (1) of Table 3, all control variables show the expected signs. Equity Volatility, Debt Ratio, Rating Score and Modified Duration have a positive impact on the corporate bond spread. Size and profitability are negatively associated with spread. In regression (2) the readability measure Log (Number of Words) has a significantly positive estimate, which means that firms with less readable annual reports (higher number of words) tend to have higher credit spreads. This finding is consistent with the findings of Bonsall and Miller (2017) for initial bond offering credit spreads, the findings of Ertugrul et al. (2017) for bank loan spreads, and the findings of Hu et al. (2018) for CDS spreads. Based on Li (2008)'s findings, firm managers may try to hide adverse information from investors by increasing the complexity of their written documents. Complex documents are more difficult for investors to analyze and interpret. Therefore, the readability of annual reports can be considered as a proxy for information risk and uncertainty about the future performance and cash flows. The more readable the annual reports, the less information asymmetry and less information risk. Investors require higher compensation (higher credit spread) for a higher information risk.

The Fog Index in regression (3) also shows a significantly positive effect on the credit spread, but it is less significant than Log (Number of Words). In regression (4) and (5), I regress OAS on two elements

of the Fog Index separately. The average sentence length shows a significantly positive impact on credit spread. However, the percentage of complex words has a significantly negative estimate, which means 10-K filings with a higher percentage of complex words tend to have lower credit spreads. This is not consistent with Hypothesis 1. This is in line with the findings by Loughran and McDonald (2014); namely, that the Fog Index is not an appropriate readability/complexity measure for business filings. The main reason is the component "percentage of complex words". Complex words are defined in the Fog Index context as words with more than two syllables. Loughran and McDonald (2014) argue that, in annual reports, there are many complex words which are easy to understand and do not make the text less readable, e.g., words like company, financial, agreement, management. Based on the definition of the Fog Index, usage of these words leads to a high Fog Index value, which indicates a less readable text. Therefore, the component "percent of complex words" might lead to a wrong assessment of business text readability. In the empirical analysis of Loughran and McDonald (2014) they find that the Fog Index has the expected significant and positive impact on subsequent volatility. However, the component "percent complex words" shows an insignificantly negative impact on stock price volatility.

Li (2008) finds that the complexity of a company's business is positively related to the readability measures. Therefore, I include the Herfindahl Index in terms of the sales in different business segments. The maximum of the Herfindahl Index is 1, which means the company has only one business segment. The smaller the Herfindahl Index, the more complex the company's business. The results in regression (6) show the same evidence for Total Number of Words, even after controlling for the complexity of the business. The worse readability (higher number of words) of the 10-K filings, the higher the credit spread. Investors require more compensation for greater information risks. The Herfindahl Index has a significant negative estimate, which means firms with more complex business structures are associated with higher credit spreads. The Fog Index in regression (7) does not show a significant impact after controlling for the complexity of the business (T-value = 1.42). Regression (9) shows again the problem with "percent complex words"; namely, that "percent complex words" has a significantly negative impact on spreads. Based on this finding, the Fog Index is not an appropriate proxy of readability for corporate bond characteristics. Therefore, I use only Total Number of Words as the proxy of readability in the following analyses.

4.2.2. Impact of Readability on OAS Volatility

Table 4 reports the evidence of the readability's impact on spread volatility[6].
The following equation is used:

$$\begin{aligned} &ExOASDailyVol_{i,(t;\,t+1)} \\ &\quad = \beta_0 + \beta_1 \times Readability_{it} + \beta_2 \times ExOASDailyVol_{i,(t-1;\,t)} \\ &\quad +\beta_3 \times Log(DaysSinceIssueDate)_{it} \; + \; \beta_4 \times Log(MarketValue)_{it} \\ &\quad +\beta_5 \times RatingScore_{it} + e_{it} \end{aligned} \tag{2}$$

In this analysis, I only include the observations of month t+1 following publication month. The dependent variable $ExOASDailyVol_{i,(t;\,t+1)}$ is daily spread volatility in excess of daily market spread volatility in the month t+1 following publication of the 10-K filings. It regresses on the latest readability measure as of publication month t, the excess daily spread volatility in the month t, the natural logarithm of days since issue date of the corporate bond at the end of month t, the natural logarithm of market value of the corporate bond at the end of month t and the rating score of the bond at the end of month t.

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[6] Due to availability of daily OASs I run this regression for the time period 2009–2017.

Table 4. Impact of readability on spread volatility (USD Universe).

ExOASdailyVol$_{(t,t+1)}$	**1**	**2**
Readability Measures:		
Log (Number of Words)		0.36
		(1.64)
Control Variables		
ExOASdailyVol$_{(t-1,t)}$	0.66	0.66
	(20.79)	(20.76)
Log (Days Since Issue Date)	0.10	0.10
	(1.28)	(1.28)
Log (Market Value)	0.26	0.21
	(1.11)	(0.93)
Rating Score	0.21	0.18
	(1.95)	(1.86)
Fixed Effect: Month	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes
R-squared	52.99%	53.01%
Observations	16,587	16,587

The dependent variable (ExOASdailyVol$_{(t,t+1)}$) in each regression is daily OAS volatility in excess of daily market spread volatility, in the month following publication of 10-K filings. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

Table 4 presents the results for the USD universe. The readability measure Total Number of Words shows a weak but positive impact on spread volatility (T-Value = 1.64). Lehavy et al. (2011) investigate the relationship between readability and analyst coverage and dispersion in the equity market. They find that firms with less readable annual reports are associated with greater analyst dispersion. Bonsall and Miller (2017) find that bonds with less readable annual reports tend to receive split ratings and exhibit a higher difference between Moody's and S&P ratings. This disagreement among equity analysts and bond rating analysts can cause or intensify disagreements among investors and dealers concerning pricing. This is in line with the findings of spread volatility; namely, that firms with less readable annual reports are associated with a higher information risk and higher dispersion, which leads to higher spread volatility in the time period following publication of the filings.

The OAS volatility in the previous month has a significant positive impact on spread volatility. Bonds with worse ratings have a higher spread volatility.

4.2.3. Impact of Readability on Trading Behavior: Transaction Costs (Average Price Spread), Transaction Cost Volatility, Trading Volume, Number of Trades, Trading Volume Volatility and Number of Trades Volatility

Table 5 reports the results of the impact of readability on trading costs of corporate bonds, based on the following equation:

$$\begin{aligned} &PriceSpread_{i,t+1} \\ &\quad = \beta_0 + \beta_1 \times Readability_{it} + \beta_2 \times PriceSpread_{i,t} \\ &\quad + \beta_3 \times Log(DaysSinceIssueDate)_{it} + \beta_4 \times Log(MarketValue)_{it} \\ &\quad + \beta_5 \times Volatility30D_{it} + \beta_6 \times RatingScore_{it} \\ &\quad + \beta_7 \times Modified\ Duration_{it} + e_{it} \end{aligned} \tag{3}$$

Table 5. Impact of readability on average price spread.

Price Spread$_{t+1}$	1	2
Readability Measures:		
Log (Number of Words)		0.03
		(2.72)
Control Variables		
Price Spread$_t$	0.01	0.01
	(1.11)	(1.12)
Log (Days Since Issue Date)	0.05	0.05
	(10.38)	(10.47)
Log (Market Value)	−0.09	−0.09
	(−7.27)	(−7.45)
Volatility30D	0.01	0.01
	(6.02)	(5.96)
Rating Score	−0.004	−0.01
	(−0.82)	(−1.61)
Modified Duration	0.03	0.03
	(19.03)	(19.03)
Fixed Effect: Month	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes
R-squared	27.88%	27.94%
Observations	13,008	13,008

The dependent variable (Price Spread$_{t+1}$) in each regression is the average price spread, in the month following publication of the 10-K filing. Price Spread is average daily bid/ask spread estimates for a certain month. Daily bid/ask spread is calculated as average buy price/average sell price −1 of a certain day. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

According to Hong and Warga (2000) and Chakravarty and Sarkar (2003), the price spread for a certain month is calculated as the average daily price spread in that month. The daily price spread is calculated as $100 \times \left(Mean\left(P_{d,j}^{buy}\right) / Mean\left(P_{d,i}^{sell}\right) - 1 \right)$. $Mean\left(P_{d,j}^{buy}\right)$ and $Mean\left(P_{d,j}^{sell}\right)$ are average reported buy and sell bond prices for bond j on day d. This price spread captures the average round-trip transaction costs of corporate bonds. The higher the price spread, the higher the transaction costs. $PriceSpread_{i,t+1}$ is the average daily price spread in month t+1 (the following month after the publication of 10-K filing). Other control variables are the price spread in the month t, the natural logarithm of days since the issue date of the corporate bond, the natural logarithm of market value of the corporate bond, volatility of the ultimate parent company stock, rating score and modified duration of the bond.

The regression (2) in Table 5 shows that the readability measure Total Number of Words has a significantly positive impact on the price spread of corporate bonds in the month following publication of 10-K filings, which means bonds with less readable 10-K filings have higher transaction costs. This is evidence that corporate bond dealers also consider readability of the annual reports in their decisions as to whether and/or how to make a market for the bonds of certain issuers. Corporate bond dealers prefer bonds with better readability of annual reports (firms with less information risk and less uncertainty about the future performance and cash flows), and therefore lower price spreads of their bonds.

Table 6 reports the results of the readability's impact on subsequent transaction costs volatility.

Table 6. Impact of readability on price spread volatility.

$Price\_Spread\_STD_{t+1}$	1	2
Readability Measures:		
Log (Number of Words)		0.02 (1.92)
Control Variables		
$Price\_Spread\_STD_t$	0.001 (1.37)	0.001 (1.42)
Log (Days Since Issue Date)	0.03 (5.44)	0.03 (5.46)
Log (Market Value)	−0.06 (−4.84)	−0.06 (−4.94)
Volatility30D	0.01 (6.83)	0.01 (6.77)
Rating Score	0.0005 (0.11)	−0.001 (−0.23)
Modified Duration	0.03 (17.40)	0.03 (17.26)
Fixed Effect: Month	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes
R-squared	20.45%	20.51%
Observations	8719	8719

The dependent variable ($Price\_Spread\_STD_{t+1}$) in each regression is the daily price spread volatility, in the month following publication of the 10-K filing. Daily bid/ask spread is calculated as average buy price/average sell price −1 of a certain day. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

I use the same regression as Equation (3) and replace the dependent variable $Price\_Spread_{i,t+1}$ with $Price\_Spread\_STD_{i,t+1}$, and replace the independent variable $Price\_Spread_{i,t}$ with $Price\_Spread\_STD_{i,t}$. $Price\_Spread\_STD_{i,t+1}$ and $Price\_Spread\_STD_{i,t}$ are the standard deviation of daily price spread in months t+1 and t, respectively. The readability measure Total Number of Words shows a significantly positive impact on the volatility of the transaction costs in the subsequent month after the publication of 10-K filings (T-Value = 1.92). This finding is consistent with the previous findings of readability impact on subsequent spread volatility. The readability of annual report shows a positive impact on subsequent spread volatility and transaction costs volatility. This is consistent with Hypothesis 3: namely, that firms with less readable annual reports are associated with higher volatility of transaction costs. This can be explained by Lehavy et al. (2011)'s finding that firms with less readable annual reports tend to have greater analyst dispersion, lower accuracy and greater overall uncertainty in analyst earnings forecasts. Bonsall and Miller (2017) find that firms with less readable annual reports are associated with a higher probability of split ratings and a greater difference between the ratings of the two rating agencies. The dispersion among equity analysts and bond analysts leads to the dispersion among investors and dealers, and, therefore, higher volatility of transaction costs in the time period following the publication of annual reports.

For the trading volume analysis I use the following equation:

$$\begin{aligned} &TradingVolume_{i,t+1} \,|\, NoTrades_{i,t+1} \,|AvgTradeSize_{i,t+1} \\ &\quad = \beta_0 + \beta_1 \times Readability_{it} \\ &\quad + \beta_2 \times TradingVolume_{i,t} \,|\, NoTrades_{i,t} \,|AvgTradeSize_{i,t} \\ &\quad + \beta_3 \times Log(DaysSinceIssueDate)_{it} + \beta_4 \times Log(MarketValue)_{it} \\ &\quad + \beta_5 \times Volatility30D_{it} + \beta_6 \times RatingScore_{it} \\ &\quad + \beta_7 \times Modified\ Duration_{it} + e_{it} \end{aligned} \tag{4}$$

Table 7 shows that the readability measure Total Number of Words has a significantly positive impact (T-Value = 1.68) on Number of Trades and significantly negative impact (T-Value = −1.68)

on the Average Trade Size of corporate bonds in the month following publication of the 10-K filings. Firms with poorer readability of annual reports are associated with a larger total number of trades and smaller trade size. Edwards et al. (2007) find that trade size is an important factor for bond liquidity and transaction costs. Smaller trade size is associated with less liquidity and higher transaction costs. This is consistent with Hypothesis 2: namely, that bonds from issuers with less readability of annual reports tend to be less liquid. The impact of readability on Trading Volume is not significant (*T*-Value = 0.45). This finding is in line with Miller (2010)'s findings that firms with less readable annual reports tend to have lower aggregate trading volume of stocks, and this is driven by a decreasing amount of small investors' (trades less than or equal to $50,000) trade volume. Miller (2010) does not find evidence for a reduction in large investors' (trades more than $50,000) trade volume and Table 5 of Miller (2010) shows a positive and not significant estimate of the readability measure Total Number of Words. In contrast to the equity market, the corporate bond market is populated almost entirely by institutional investors. The statistics of Trace data in Figure 1 show that from 2002 to 2018 the average percentage of trading volume caused by small trades (less than €100,000) was 2%. Therefore, the strong impact of small investors cannot be expected for the corporate bond market. In contrast to the equity market, there is no significant relationship between readability and aggregate trading volume in the corporate bond market, due to the different investor characteristics.

Table 7. Impact of readability on trading volume/number of trades/average trade size.

Dependent Variables:	**TradingVolume$_{t+1}$**	**NoTrades$_{t+1}$**	**AvgTradeSize$_{t+1}$**
Readability Measures:			
Log (Number of Words)	0.50 (0.45)	3.82 (1.68)	−0.02 (−1.68)
Control Variables			
TradingVolume$_t$	0.58 (7.89)		
NoTrades$_t$		0.84 (17.75)	
AvgTradeSize$_t$			0.03 (1.76)
Log (Days Since Issue Date)	−5.94 (−2.50)	−0.80 (−0.52)	−0.20 (−16.96)
Log (Market Value)	38.40 (7.43)	29.41 (5.43)	0.12 (7.82)
Volatility30D	0.13 (1.62)	0.19 (1.39)	−0.0001 (−0.19)
Rating Score	1.19 (2.27)	−1.86 (−1.05)	0.09 (11.12)
Modified Duration	−0.35 (−2.44)	−1.40 (−3.97)	0.03 (9.70)
Fixed Effect: Month	Yes	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes	Yes
R-squared	57.05%	71.46%	9.23%
Observations	27,428	27,428	26,148

The dependent variable in each regression is trading volume, number of trades and average size of each trade, in the month following publication of the 10-K filing. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

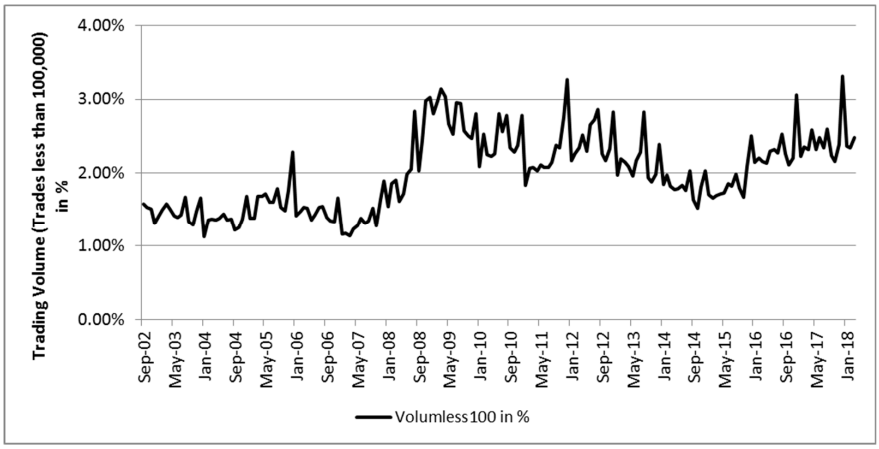

Figure 1. This figure shows the percentage of trading volume from small trades (trades with volume less than $100,000) to total trading volume in each month.

Table 8 reports the results of the impact of readability on trading volume volatility and number of trades volatility of corporate bonds, based on the following equation:

$$\begin{aligned} &VolumeDailyVol_{i,t+1} \big| \, NoTradesDailyVol_{i,t+1} \\ &\quad = \beta_0 + \beta_1 \times Readability_{it} \\ &\quad + \beta_2 \times VolumeDailyVol_{i,t} \big| \, NoTradesDailyVol_{i,t} \\ &\quad + \beta_3 \times Log(DaysSinceIssueDate)_{it} + \beta_4 \times Log(MarketValue)_{it} \\ &\quad + \beta_5 \times Volatility30D_{it} + \beta_6 \times RatingScore_{it} \\ &\quad + \beta_7 \times Modified\ Duration_{it} + e_{it} \end{aligned} \tag{5}$$

Table 8. Impact of readability on trading volume volatility/number of trades volatility.

Dependent Variable:	VolumeDailyVol$_{t+1}$	NoTradesDailyVol$_{t+1}$
Readability Measures:		
Log (Number of Words)	0.08 (0.82)	0.15 (1.76)
Control Variables		
VolumeDailyVol$_t$	0.08 (2.92)	
NoTradesDailyVol$_t$		0.46 (8.33)
Log (Days Since Issue Date)	−1.19 (−12.68)	0.004 (0.07)
Log (Market Value)	4.43 (21.67)	1.34 (7.61)
Volatility30D	0.02 (2.08)	0.01 (1.85)
Rating Score	0.18 (4.85)	−0.06 (−0.90)
Modified Duration	−0.03 (−2.34)	−0.07 (−4.42)
Fixed Effect: Month	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes
R-squared	17.32%	40.88%
Observations	27,233	27,233

The dependent variable in each regression is trading volume daily volatility and number of trades daily volatility, in the month following publication of the 10-K filing. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

The dependent variable $VolumeDailyVol_{i,t+1} \big| NoTradesDailyVol_{i,t+1}$ is the daily trading volume volatility/daily number of trades volatility in the month following publication of the 10-K filings (t+1). Control variables are the daily trading volume volatility/daily number of trades volatility in the month t, the natural logarithm of days since the issue date of the corporate bond, the natural logarithm of market value of the corporate bond, volatility of the ultimate parent company stock, rating score and modified duration of the bond. The readability measure Total Number of Words has significantly positive T-Value 1.76 in regression (2), which means bonds with less readable filings tend to have higher number of trades volatility in the month following publication of the 10-K filings. There is no evidence of a significant impact of readability on trading volume volatility. This observation is consistent with the previous finding: namely, that the readability of annual reports has no significant impact on subsequent trading volume.

4.3. Multivariate Results for EUR Universe

4.3.1. Impact of Readability on OAS

Some of the companies which submit 10-K filings to the SEC also issue non-USD denominated bonds. In the non-USD universe, there are bonds denominated in EUR, GBP, JPY, AUD and CAD, which are relevant for investors in the respective currency areas. EUR-denominated bonds are the second-largest universe in the BofA Merrill Lynch Global Corporate Index. By using this EUR universe, I can analyze whether EUR investors consider readability of the filings.[7]

Table 9 presents the regression results for the EUR universe regarding the impact of readability on corporate bond spreads. For this research question, the following equation is used:

$$\begin{aligned} OAS_{it} = {} & \beta_0 + \beta_1 \times Readability_{it} + \beta_2 \times Volatility30D_{it} + \beta_3 \times Log(MarketCap)_{it} \\ & + \beta_4 \times Debt/EnterpriseValue_{it} + \beta_5 \times Ebitda/TotalAssets_{it} \\ & + \beta_6 \times RatingScore_{it} + \beta_7 \times ModifiedDuration_{it} + e_{it} \end{aligned} \quad (6)$$

Table 9. Impact of readability on spreads (EUR Universe).

OAS_{it}	1	2	3	4	5
Readability Measures:					
Log (Number of Words)		4.80		4.85	
		(4.11)		(4.00)	
Fog Index			0.38		0.37
			(0.58)		(0.54)
Control Variables					
Volatility30D	2.68	2.64	2.68	2.63	2.67
	(13.38)	(13.04)	(13.39)	(12.83)	(13.20)
Log (MarketCap)	−16.83	−18.33	−16.87	−19.79	−18.23
	(−6.10)	(−6.29)	(−6.08)	(−5.88)	(−5.70)
Debt/Enterprise Value	40.71	39.08	41.21	40.61	42.93
	(4.91)	(4.74)	(5.01)	(4.72)	(5.02)
Ebidta/Total Assets	−242.65	−236.78	−243.01	−248.07	−253.38
	(−6.07)	(−5.96)	(−6.06)	(−5.71)	(−5.77)
Rating Score	8.40	7.76	8.40	7.70	8.36
	(10.19)	(8.89)	(10.22)	(8.37)	(9.68)
Modified Duration	5.36	5.35	5.36	5.25	5.26
	(20.27)	(20.27)	(20.26)	(19.28)	(19.30)
Herfindahl Index				−10.93	−11.63
				(−1.78)	(−1.88)
Fixed Effect: Month	Yes	Yes	Yes	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes	Yes	Yes	Yes
R-squared	63.74%	63.79%	63.74%	63.89%	63.83%
Observations	27,946	27,946	27,946	27,350	27,350

The dependent variable in each regression is the OAS (Option Adjusted Spread) in basis points. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Fog Index is calculated by using 0.4 × (Number of words per sentence + Percent complex words). The readability measures of certain 10-K filing are matched to the 12 bond and month observations following publication. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect, industry sector fixed effect and currency fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

[7] Other currencies have very small number of observations. Therefore, an analysis with other currencies is not possible here.

Regressions (2) and (4) of Table 9 show that Total Number of Words has a statistically highly significant positive impact on spread, with or without control of the complexity of business (Herfindahl Index). This is the first evidence for international investors. Based on this result, EUR investors take into account the readability of the annual report in the pricing of the firms' credit risk. Firms with less readable annual reports tend to have higher credit spreads. This result is consistent with the result for USD investors; namely, that investors consider the readability of annual reports as a proxy for information risk of the firms. Firms with less readable annual reports tend to have higher information risk and, therefore, higher corporate bond spreads. The Fog Index in regressions (3) and (5) are not statistically significant. This is consistent with the previous finding for the USD universe and the finding of Loughran and McDonald (2014); namely, that Fog Index is not an appropriate readability measure for financial filings.

4.3.2. Impact of Readability on OAS Volatility

Table 10 reports the results for the EUR universe in terms of the impact on spread volatility[8]. The following equation is used:

$$\begin{aligned} &ExOASDailyVol_{i,(t;\,t+1)} \\ &\quad = \beta_0 + \beta_1 \times Readability_{it} + \beta_2 \times ExOASDailyVol_{i,(t-1;\,t)} \\ &\quad + \beta_3 \times Log(DaysSinceIssueDate)_{it} \; + \; \beta_4 \times Log(MarketValue)_{it} \\ &\quad + \beta_5 \times RatingScore_{it} + e_{it} \end{aligned} \tag{7}$$

Table 10. Impact of readability on spread volatility (EUR Universe).

ExOASdailyVol$_{(t,t+1)}$	**1**	**2**
Readability Measures:	EUR	EUR
Log (Number of Words)		0.79
		(1.19)
Control Variables		
ExOASdailyVol$_{(t-1,\,t)}$	1.42	1.41
	(19.04)	(19.20)
Log (Days Since Issue Date)	0.60	0.56
	(3.00)	(2.95)
Log (Market Value)	−1.31	−1.46
	(−1.09)	(−1.17)
Rating Score	−0.29	0.23
	(−0.86)	(0.68)
Fixed Effect: Month	Yes	Yes
Fixed Effect: Industry Sector	Yes	Yes
R-squared	60.96%	60.99%
Observations	1182	1182

The dependent variable (ExOASdailyVol$_{(t,t+1)}$) in each regression is daily OAS volatility in excess of daily market spread volatility, in the month following publication of 10-K filings. Log (Number of Words) is the natural logarithm of the total number of words in each filing. Definitions of control variables can be found in Appendix A. All regressions include an intercept, month fixed effect and industry sector fixed effect. T-statistics are in parentheses, with standard errors clustered by month and industry.

In the EUR universe the readability of annual reports has a positive but not significant (T-Value = 1.19) impact on excess spread volatility in the subsequent month. One reason could be that there are only a small number of observations. There are only 1182 observations for the EUR universe.

[8] Due to availability of daily OASs, I run this regression for the time period 2009–2017.

5. Conclusions

In this paper, I show that, on the US corporate bond market, firms with less readable annual reports tend to have higher credit spreads, higher credit spread volatilities, higher transaction costs, higher transaction costs volatility, higher number of trades, smaller trade size and higher number of trades volatilities in the month following publication of the 10-K filings. This paper also provides the first answers to the question as to whether international market participants take readability of the annual report into account when pricing a firm's credit risk. Firms with less readable annual reports tend to have higher credit spreads. This result is consistent with the result for USD investors.

In this paper, I focus on the readability of the whole annual reports. As mentioned in the literature review, there is a strand of literature that investigates the individual sections of annual reports. These papers focus especially on MD&A sections and risk factor sections. A further interesting research question could be which parts of the annual reports have an impact on credit spread, credit spread volatility and the trading behavior of the corporate bond market. A systematic comparison of all sections of annual reports could also provide important contributions to the existing literature.

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Conflicts of Interest: I wish to draw the attention of the Editor to the following facts which may be considered as potential conflicts of interest and to significant financial contributions to this work: Jieyan Fang-Klingler is an employee of Quoniam Asset Management GmbH.

Appendix A

Table A1. Definitions of Variables.

Control Variables	Definitions
Volatility30D	Volatility of stock return, based on 30 daily returns
Log (Market Cap)	Natural logarithm of market capitalisation of stocks
Debt/Enterprise Value	Debt to enterprise value ratio
Ebidta/Total Assets	Ebitda to total assets ratio
Rating Score	Rating scores of corporate bonds
Modified Duration	Modified duration of corporate bonds
Herfindahl Index	Herfindahl index based on revenues in different industry business segments Herfindahl index = sum of squares of percentage of revenue of individual industry segment in total revenue
$ExOASdailyVol_{(t-1,t)}$	OAS volatility in excess of market OAS volatility based on daily OASs in time period $t-1$ to t
Log (Days Since Issue Date)	Natural logarithm of number of days since issue date of corporate bonds
Log (Market Value)	Natural logarithm of market value of corporate bonds
$Price\ Spread_t$	Average daily price spread of corporate bonds in month t Daily price spread is defined as $100 \times (mean(BuyPrice)/mean(SellPrice) - 1)$
$Price\_Spread\_STD_t$	Standard deviation of daily price spreads of corporate bonds in month t
$TradingVolume_t$	Total trading volume of corporate bonds in month t
$NoTrades_t$	Total number of trades of corporate bonds in month t
$AvgTradeSize_t$	Total trading volume/total number of trades of corporate bonds in month t
$VolumeDailyVol_t$	Standard deviation of daily trading volume of corporate bonds in month t
$NoTradesDailyVol_t$	Standard deviation of daily number of trades of corporate bonds in month t

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