The Micro-Determinants of Credit Spreads

ECO375: Empirical Project

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November 28, 2025

1   Introduction

The yield that investors require to purchase a firm's bond is the spread over the yield provided by a comparable government bond. Finding the micro-determinants of credit bonds is useful for finding what affects yields over time. Micro-determinants are variables that are related to the probability of default and the liquidity associated with a specific bond issue. This project seeks to assess the importance of firm specific factors in determining the spread for its bonds. The data used covered two points in time: 2022 and 2024. The model deals with a cross-sectional problem focusing on the changes in spread from 2022 to 2024. Fixed effects were not included as these do not vary across bonds.

Economic intuition suggests that Total Debt to Equity, which represents leverage; Price to Book Value, which measures how expensive a firm is relative to its accounting value; the Current Ratio, which indicates liquidity; and Return on Average Total Equity, which reflects firm efficiency, are micro-determinants of a bond's spread.

This paper is structured as follows: Section 2 is the literature review situating the research question, Section 3 contains the preliminary analyses, Section 4 contains the methodology, Section 5 has the hypothesis testing, and Section 6 contains the results.

1.1   Description of variables

There are 861 observations encompassing 34 categories. The variables are as follows

Variable	Description
Issuer	Name of the company that issued the bond
Spread	The difference between the bond's yield and the yield on a government bond of the same maturity. Measured in bps
Ticker Parent	Identifier for the parent company
Enterprise Value to Sales	Measures how expensive a company is relative to its revenue
Enterprise Value to PPE	Measures valuation relative to tangible assets
Price to Sales	How much investors pay for $1 of revenue

Variable	Description
Price to Book Value	Measures how expensive the firm is relative to accounting equity
Dividend Yield	Return shareholders receive from dividends
Return on Average Total Equity	How efficient the firm is with investments
Operating Margin	Core profitability measure
Total Capital Expenses to Total Assets	How much the firm invests in long-term assets
Book Value per Share	Accounting value per share
Asset Turnover	Measures how well a firm's assets generate revenue
Current Ratio	Measures short-term liquidity
Cash Dividend Coverage Ratio	Measures if firm can pay dividends purely from operations
Total Debt to Equity	Measures financial leverage
Total Debt to Total Capital	Shows how much of capital is from debt

1.2   Statement of hypothesis/research question

The research question this paper will seek to answer is what are the micro-determinants of credit spread. We propose that Total Debt to Equity, Price to Book Value, Return on Average Total Equity, and Current Ratio are the micro-determinants that affect the change in bond spreads over time.

2   Literature Review

In "Credit Default Swap Spreads", Fu et. al employed a multi-factor analysis from both a firm-specific and market-specific perspective to examine the determinants of credit spreads in the USA, the UK, and Japan between 2005 and 2012. Their results indicated that the degree of firm leverage has a significant influence on spreads. They mention re-testing the influence of leverage on spreads as done by Collin-Dufresn, Goldstein, and Martin (2001) and Aunon-Nerin et al. (2002). From the data used, leverage is seen in Total Debt to Equity.

In "Liquidity of Corporate Bonds and Credit Spread", Wang examined corporate bond liquidity's impact on credit spreads for listed companies in China. He found that the better the liquidity of listed corporate bonds, the smaller the credit spread. He found that "the higher
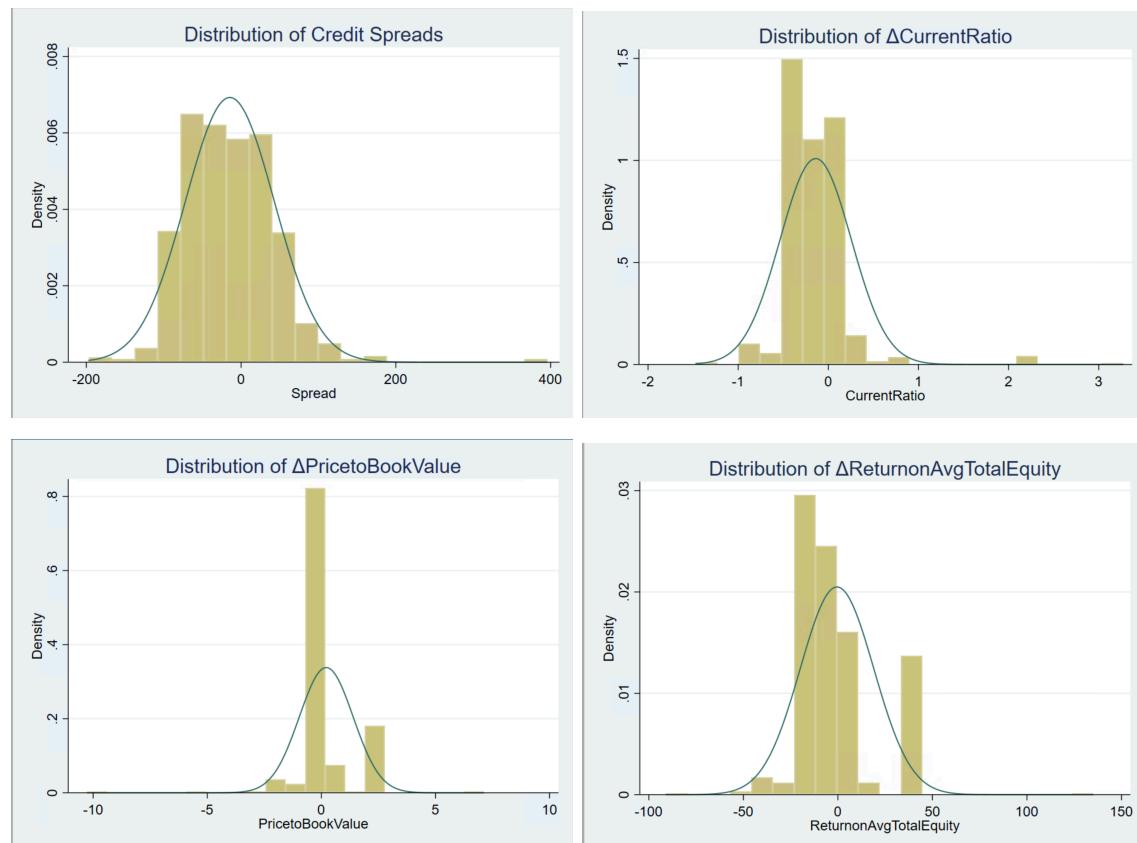
the ROE, the higher the current ratio, the better the ability to service debt…the smaller the credit spread" (Wang 2023). From the data used, return on net assets can be seen in Return on Average Total Equity, and Current ratio is used directly in the data.
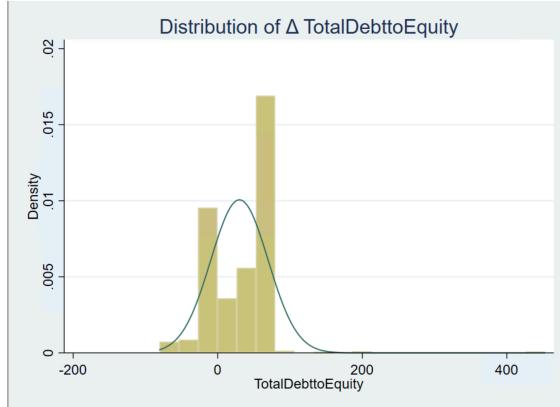
In "Loan Spreads and Credit Cycles", Carvalho et. al finds evidence that lender optimism can lead to excessive fluctuations in credit spreads. Carvalho mentions "Equity Volatility, Size, Firm Age, Profibility, Tangibility, M/B (market-to-book), Leverage…" as determinants for bond spreads (Carvalho, Gao, and Ma 2023). From the data used, Price to Book Value corresponds with Market-to-book.

3 Descriptive

3.1 Plots

The following shows the distributions of our key variables.

Distribution of Δ TotalDebttoEquity

3.2 Summary of key variables

Spread represents the yield investors require to purchase a firm's bond. The variable is numeric with a range from [-196.8, 395.8]. It had a mean of -14.6 and a standard deviation of 57.6. Additionally, it had skewness of 1.017 which indicated it was right-skewed.

Price to Book Value compares a firm's market value compared to its accounting value. It is numeric with a range from [-10.3, 7.1]. It had a mean of 0.214 and a standard deviation of 1.17. Additionally, it had skewness of 0.106 which indicated it was slightly right-skewed. We model the effect of Price to Book Value linearly as a lower ratio indicates higher expected default and higher spreads. Conversely, a higher ratio indicates lower expected default and thus lower spreads. We model this variable linearly because theory predicts a monotonic relationship without diminishing marginal effects.

Return on Average Total Equity is how efficient the firm is with investments. A higher Return on Average Total equity indicates the firm is more efficient which means lower spreads. The variable was numeric with a range [-90.96, 135.03]. It had a mean of -0.47 and a standard deviation of 19.466. It had a skewness of 1.236 which indicated it was right-skewed. We applied a log-transformation to capture diminishing marginal effects of profitability. We took the log of the squared value to accommodate negative values, as profitability can be below zero.

Current Ratio indicates how much liquidity a firm has. A low current ratio means liquidity risk which implies higher spreads. It is numeric with a range from [-1.47, 3.27]. It had a mean of -0.14 and a standard deviation of 0.395. It had a skewness of 2.86 which indicated it was right-skewed. We applied a cubic transformation to allow for asymmetric effects, where improvements in liquidity may reduce spreads more gradually at higher levels and where negative liquidity increases spreads.

Total Debt to Equity measures financial leverage. A high total debt to equity means the firm has a high reliance on debt which implies higher spreads. It is numeric with range from [-80.36, 452.69]. It had a mean of 30.07 and a standard deviation of 39.65. It had a skewness of 1.167925 which indicated it was right-skewed. We applied a log-transformation to capture diminishing marginal effects of leverage. We took the log of the squared value to accommodate negative values, as leverage can be negative.

4 Methodology

4.1 Clear statement of the model and its assumptions

Let our model be as follows:

$$\Delta y_i = \beta_0 + \beta_1 log(x_{i1}^2) + \beta_2 x_{i2} + \beta_3 log(x_{i3}^2) + \beta_4 x_{i4}^3$$

Where:

- Δy is the difference in the spread of bonds from 2022 to 2024.
- x_1 is the difference in Total Debt to Equity.
- x_2 is the difference in Price to Book Value.
- x_3 is the difference in Return on Average Total Equity.
- x_4 is the difference in Current Ratio.

Linearity in Parameters

From the model above, it is clear that the model is linear in parameters.

Random Sampling

This is an assumption about the data given. It is randomly sampled.

No Perfect Collinearity

We ran correlation between all the variables and got the following table. Since no correlation value is exactly 1, there is no perfect collinearity.

```
. pwcorr Spread llTotalDebttoEquity PricetoBookValue ///
>        llReturnonAvgTotalEquity CurrentRatio_cb

                 |   Spread llTota~y Pricet~e llRetu~y Curren~b
    -------------+---------------------------------------------
          Spread |   1.0000
    llTotalDeb~y |   0.0224   1.0000
    PricetoBoo~e |  -0.2129  -0.3022   1.0000
    llReturnon~y |  -0.2710   0.0525   0.4303   1.0000
    CurrentRat~b |   0.0147  -0.0201   0.0396  -0.0317   1.0000
```

Zero Conditional Mean
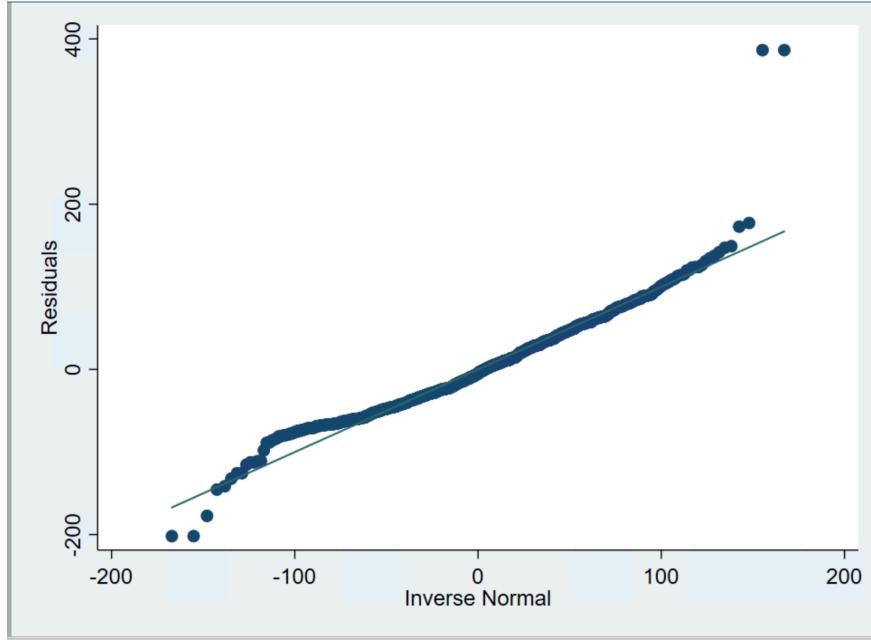
This is an assumption from the population that there is zero conditional mean.

Homoskedasticty

We performed robust on all our entries and did not assume homoskedasticity.

Normality of Error Terms

As seen below, using the Q-Q Test, we can see that the error terms are approximately normally distributed.

Thus, following all these assumptions, the model is consistent and unbiased. Further, because the errors are normally distributed, we can perform statistical inference tests.

4.2 Specification tests

Before adjusting for non-linearity, `estat ovtest, rhs` gave $F(12, 809) = 6.22$ with a p-value=0.0000. Thus, this indicates that a linear model is not correct for the data. Using the intuition described in Summary of Key Variables, we applied a log transformation on the square of Total Debt to Equity, a log transformation on the square of Return on Average Total Equity, and a cubic transformation on Current Ratio.

After adjusting for non-linearity, `estat ovtest, rhs` gave `F(12, 809)=0.96` with `p-value=0.4874`, indicating that our model fit all nonlinearities from the data.

We then ran `estat ovtest` for omitted variable bias and received `F(3,818)=0.33` with `p-value=0.8054`. Therefore, no endogeneity test was needed nor did we need an instrument variable.

4.3 Robustness considerations

For robustness considerations, we applied robust standard errors for all regressions. Thus, we never assumed homoskedasticity.

5 Hypothesis Testing

We chose to do a joint F-test to see whether any of the parameters should be 0. We also completed a t-test to see individual significance against the yield.

The joint F-test gives us a critical value `F(4, 821) = 20.52` with a `p value=0.0000`, which means not all of the coefficients of the variables in the regression are zero at the 95% confidence level. This means that at least one of the coefficients definitely affects *Spread* either positively or negatively at the 95% confidence level.

To see which variables affect difference of *Spread* only positively or only negatively at the 95% confidence level, we ran t-tests.

Spread	Critical Value	p-value
log(|TotalDebttoEquity|)	-0.06	0.952
PriceToBookValue	-3.41	0.001
log(|ReturnOnAvgTotalEquity|)	-4.63	0.000
CurrentRatio^3	0.51	0.609

The coefficient for $PricetoBookValue$ is negative and the p-value is less than 0.05, which means we can say with a 95% confidence that an increase in $PricetoBookValue$ leads to a decrease in $Spread$.

The coefficient for $log(ReturnonAvgEquity^2)$ is also negative and the p-value is less than 0.05, which means we can say with a 95% confidence that an increase in $log(ReturnonAvgEquity^2)$ leads to a decrease in the difference of $Spread$.

6 Results

A decrease in the difference of spreads is good as it means an investor requires less of a difference of yield from the firm as compared to the government bond yield over time.

Since our model estimates the differences in Spread over time,

```
. *REGRESS SPREAD ON NEW NON LINEAR VARIABLES
. reg Spread llTotalDebttoEquity PricetoBookValue ///
>        llReturnonAvgTotalEquity CurrentRatio_cb ///
>        ///
>        , robust

Linear regression                               Number of obs   =        826
                                                F(4, 821)       =      20.52
                                                Prob > F        =     0.0000
                                                R-squared       =     0.0850
                                                Root MSE        =     55.225

-----------------------------------------------------------------------------------
                         |               Robust
                Spread |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------------------+---------------------------------------------------------
    llTotalDebttoEquity |  -.0553214   .9105389   -0.06   0.952    -1.84258    1.731937
       PricetoBookValue |  -5.850426   1.716601   -3.41   0.001    -9.21987   -2.480982
llReturnonAvgTotalEquity |  -4.766823   1.029127   -4.63   0.000   -6.786854   -2.746793
        CurrentRatio_cb |   .4202304   .8219198    0.51   0.609    -1.193081    2.033542
                  _cons |    6.20318    5.70032    1.09   0.277    -4.985737     17.3921
-----------------------------------------------------------------------------------

.
. //test for multicollinearity
. vif

    Variable |       VIF       1/VIF
-------------+----------------------
PricetoBoo~e |      1.41    0.706877
llReturnon~y |      1.29    0.775993
llTotalDeb~y |      1.15    0.867816
CurrentRat~b |      1.00    0.995512
-------------+----------------------
    Mean VIF |      1.22
```
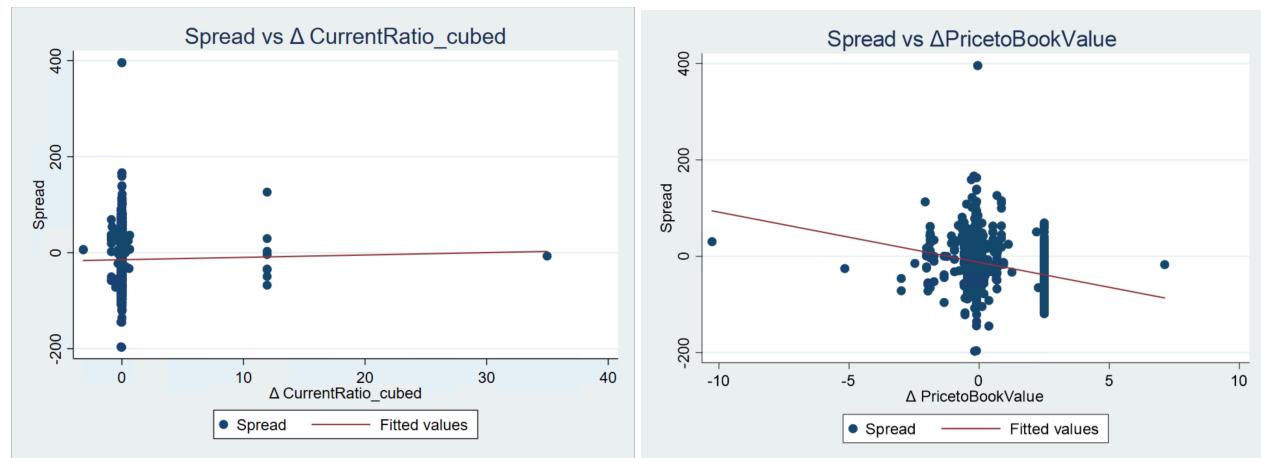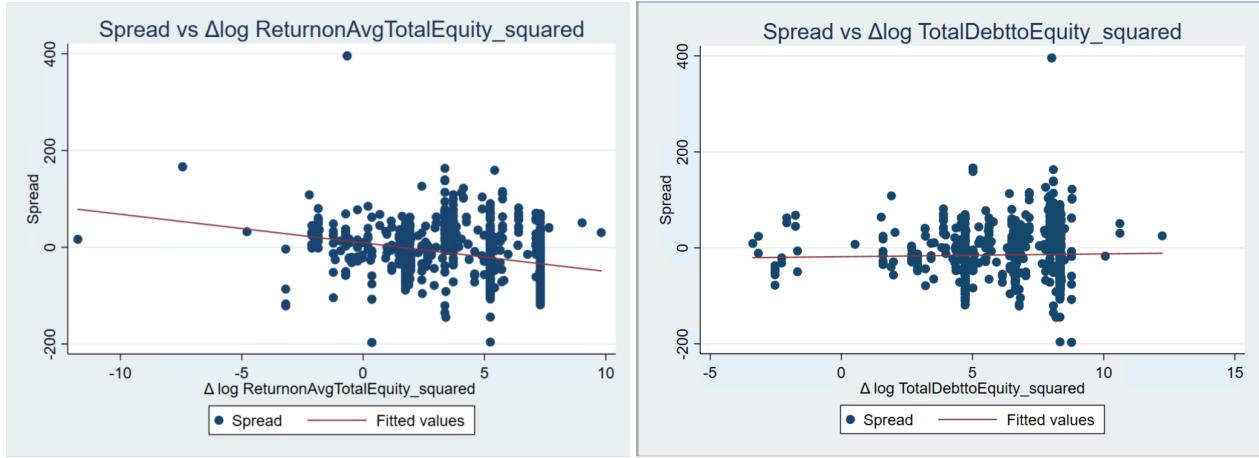
This means the model now is:

$$\Delta \text{Spread} = 6.2031 - 2 \cdot 0.0553 \log(|\text{TotalDebttoEquity}|)$$

$$- 5.8504 \,\text{PriceToBookValue}$$

$$- 2 \cdot 4.7668 \log(|\text{ReturnOnAvgTotalEquity}|) \tag{1}$$

$$+ 0.4202 \,\text{CurrentRatio}^3$$

Variable	Effect of a 1% increase on $Spread$
TotalDebttoEquity	$-2 \cdot 0.0553 \cdot 0.01$ bps
ReturnOnAvgTotalEquity	$-2 \cdot 4.7668 \cdot 0.01$ bps

Variable	Effect of a 1 unit increase on $Spread$
PriceToBookValue	-5.8504 bps
CurrentRatio^3	0.4202 bps

Thus, having a higher Return on Average Equity and higher Price to Book Value decreases difference in spreads.

Return on Average Equity: having a higher profit after taxes and lower average of shareholders' equity at the beginning and end of the accounting period leads to a decrease in the difference of Spread over time.

Price to Book Value: an increase in the change of Market price relative to Shareholder's Equity leads to a decrease in the difference of Spreads over time.

Overall, we notice that a decrease in Shareholder's Equity leads to a decrease in the difference of Spreads, and an increase in profits and market price also leads to a decrease in the difference of Spreads.

References

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