Assignment 2 Report

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1 Executive Summary

This document outlines a ∼15 year backtest of a trading strategy that separates firms with high debt constraints those with low debt constraints. Debt constraints are observed when a firm changes its project and financial decision making based capital structure. Specifically, when a firm achieves a high Debt to Equity Ratio (D/E), it may be that the best interest of existing equity holders is served by risky behavior (i.e. investing in projects that would normally have sub-optimal expected value, or pose too great a risk). It is the goal of the following backtest to to quantify the debt constraints of a firm using public data relevant to the firm's capital structure and test the significance of a 'Debt Constraints' effect on returns. The backtest is evaluated based on the resulting alpha values generated in a regression against market returns, as done in the Capital Assets Pricing Model and Fama French 3 Factor Model. The resulting alphas of several zero-cost portfolios were determined in order to characterize the strength of effect. Some of these alphas were found to be statistically significant and suggested that the market may be undervaluing firms with high debt in good market conditions.

2 Background & Hypothesis

Companies that have accrued high leverage can face additional challenges in times of economic uncertainty compared to lower leverage counterparts. A 2017 study into the effects of leverage on firms during the 2008 European financial crisis found that "high ex-ante debt levels depress investment during crisis times, consistent with debt overhang, where both high leverage and high debt service affect investment negatively" [1]. As such, we might expect that firms undertaking high levels of debt incur financial risks that are not fully appreciated by the market. This would induce an alpha in a trading strategy that weights lower leverage firms more significantly over selected time periods.

In order to compute a threshold for determining when a firm has a 'relatively high' D/E ratio, we might want to standardize by industry. Many papers analyzing the choice to issue debt or equity have noted a significant industry effect that relates the D/E of a firm to the D/E of the industry. A 2009 paper notes how "managers perhaps use industry median leverage as a benchmark as they contemplate their own firm's leverage. Thus, industry median leverage is often used as a proxy for target capital structure" [2]. This builds off of a 2001 analysis by Titman et al that found that "in the debt/equity issue choice regression, the deviation of actual leverage from the industry mean is highly significant" [3]. As such, we use industry D/E as a benchmark for determining financial constraint due to debt.

The papers cited above indicate that a, perhaps under appreciated, debt constraints effect exists for firms that take on substantially more debt than is common in that firm's industry. This effect may be amplified in times of economic or firm crisis, as investors start to become concerned with the possibility of bankruptcy and the debt costs that come with it. We hypothesize that when a firm begins to have several consecutive months of poor performance, investors start to price the debt constraint costs into the company's stock price. If we can construct a portfolio that attempts to price in the D/E effect before other investors, then we may be able to extract a significant α value.

The explicit hypothesis is as stated below, with terms that will be fully defined in the subsequent Methodology section:

Hypothesis: A portfolio that is long firms falling into the low D/E+ quintile bucket and short firms falling into the high D/E+ quntile bucket will have positive alpha over the test time period. This alpha will be higher for L/S portfolios that only invest in stocks that have had 3 prior consecutive months of negative return.

3 Methodology

Filters

Annual fundamentals data was collected from the WRDS Compustat data base between 2000-01-01 and 2015-12-31 and filtered according to the following constraints:

- Currency is USD
- FIC is USA
- Exclude SIC 6000-6999 (financials)
- Exclude SIC 2834 (pharmaceuticals)
- Stock exchange is 11-19

Sorting into Quintiles

The following sorting variable was created from the TDQ (total debt), GIND (Global Industry Classification Standard code, industries level) and ME (market cap) variables:

$$\left(\frac{D}{E}\right)_{i,t} += \frac{(TDQ_i/ME_i)_t}{(TDQ/ME)_{avg(GIND)}}$$

That is, a firms D/E divided by the average D/E of its industry, determined by GICS. This sorting variable was then used to form quintiles, Q5 being the highest D/E+ and Q1 being the lowest. Q0 was designated for firms that has no out standing debt, which tended to only include very small firms (market cap $<$ \$5 million).

Markov Chains

An additional sorting variable was created using length three Markov Chains, intended to capture the past three months of a firms' returns. A Markov Chain is formed by concatenating the

signs of the previous three months of returns. For instance, if a firms has had three months of positive returns its Markov Chain would be: HHH. If a firm had most recently had a positive month return, but has two months of negative return prior, its Markov Chain would be HTT. The 8 different length-three Markov Chains provide an additional sorting method for returns

Sorting

A single sort backtest was first performed, using just the D/E+ sorting variable. Long/Short portfolios were formed using Q1 minus Q5 returns. Regression statistics were computed for each portfolio. A double sort was performed in a similar manner, computing alpha values for each Long/Short portfolio in the Markov Chain buckets.

4 Findings & Revised Thesis

The following is a summary for the equal weighted Long/Short portfolio regression in the overall time period of 2000-01-01 to 2015-12-31:

	Long/Short Portfolio Summary		
	Alpha	FF3 Alpha	Sharpe
	-0.58%	-0.36%	-0.658
T-Stat	-2.525	-1.950	

Figure 1: Regression Statistics for the equal weighted Low minus High L/S portfolio

Similarly, the regression statistics for the value weighted Long/Short portfolio over the same time period were:

	Long/Short Portfolio Summary		
	Alpha	FF3 Alpha	Sharpe
	0.64%	0.88%	0.364
T-Stat	2.146	3.196	

Figure 2: Regression Statistics for the value weighted Low minus High L/S portfolio

The above preliminary statistics seem to indicate that a Debt Constraints effect exists for firms with larger market cap (as the value weighted portfolio indicates) but that this effect is reversed for the smaller cap stocks (as the equal weighted portfolio indicates). This could imply that large cap stocks receive high amounts of market attention on capital structure figures and that the market is overly pessimistic about the returns of those firms that do not take on as much debt. If the market pays less attention to the capital structure of smaller firms, then it could create an overly positive outlook for firms that choose to take on less debt. The results of the zero cost portfolios are strengthened by the (near) monotonicity of returns across the quintiles seen in the different time periods of figures 4 and 5.

Double Sort Results:

Markov Chain	HHH	HHT	HTH	HTT
CAPM Alpha	**-1.05%**	**-0.97%**	**-1.03%**	-0.53%
T-stat	-2.782	-2.472	-2.081	-1.265

Markov Chain	THH	THT	TTH	TTT
CAPM Alpha	-0.30%	-0.03%	0.50%	-0.05%
T-stat	-0.747	-0.054	1.100	-0.075

Figure 3: Alpha and T-stat values for the Long/Short Portfolios in each Markov Chain bucket

The results of the double sort provide an interesting insight: a debt constraints effect is not observed for firms with that are performing poorly in recent months, but a reverse debt constraints effect is observed for firms would are performing well in recent months. This could indicate that when a firm is performing well, the market tends to over look the impact that capital structure could have on future performance. With this is mind, we might seek to revise our initial hypothesis in the following way:

> **Ex-Post Thesis:** A portfolio that is short firms falling into the low D/E+ quintile bucket and long firms falling into the high D/E+ quntile bucket will have positive alpha. This alpha will be higher for L/S portfolios that only invest in stocks that have had 3 prior consecutive months of positive return.

Note that this statement of the thesis is the logical converse of original thesis, perhaps supporting the underlying idea that the market misprices the debt constraints of firms. The findings do not, however, support the original hypothesis as L/S portfolios investing only in firms with poor prior 3 month performance did not have statistically significant alphas.

Additional Figures

Portfolio Returns (Equal-Weighted)

L	2	3	4	H	No Debt
Overall: 2000-01 to 2015-12					
0.66%	0.93%	1.07%	1.03%	1.27%	0.89%
t1: 2000-01 to 2007-12					
0.72%	1.07%	1.27%	1.23%	1.47%	1.03%
t2: 2008-1 to 2015-12					
0.60%	0.80%	0.87%	0.84%	1.06%	0.75%
Modern: 2016-01 to 2022-12					
0.53%	0.72%	1.03%	1.12%	1.40%	0.25%

Figure 4: Returns for the equal weight portfolios across quintiles and time periods

Portfolio Returns (Value-Weighted)

L	2	3	4	H	No Debt
Overall: 2000-01 to 2015-12					
1.17%	1.10%	1.16%	0.95%	0.68%	1.34%
t1: 2000-01 to 2007-12					
0.99%	1.12%	1.13%	1.02%	0.55%	1.11%
t2: 2008-1 to 2015-12					
1.34%	1.08%	1.19%	0.89%	0.81%	1.57%
Modern: 2016-01 to 2022-12					
1.79%	1.45%	1.50%	1.43%	0.90%	1.98%

Figure 5: Returns for the value weight portfolios across quintiles and time periods

Citations

[1] **Kalemli-Ozcan**, Sebnem., Luc. Laeven, and David, Moreno. "Debt Overhang, Rollover Risk, and Corporate Investment: Evidence from the European Crisis" *Cambridge, Mass: National Bureau of Economic Research*, 2018. Print.

[2] **Frank**, Murray Z., and Vidhan K. Goyal. "Capital Structure Decisions: Which Factors Are Reliably Important?" *Financial Management (Wiley-Blackwell)* 38.1 (2009): 1–37. Web.

[3] **Hovakimian**, Armen, Tim Opler, and Sheridan Titman. "The Debt-Equity Choice." *Journal of financial and quantitative analysis* 36.1 (2001): 1–24. Web.