8-2017

Debt/Equity Ratio and Asset Pricing Analysis

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A thesis submitted in partial fulfillment
Of the requirements for the degree

of

MASTER OF SCIENCE

in

Financial Economics

Abstract

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Utah State University, 2017

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A firm's value can be manipulated by altering how much debt a firm takes on relative to its equity called the Debt/Equity ratio. The positive aspects of debt are tax shields and the perception that the firm is trying to expand their current operations while the negative effects are increased bankruptcy risk. The optimal ratio is where the negative aspects begin to outweigh the positive. Since bankruptcy risk is hard to value there are many opinions on what the optimal Debt/Equity ratio for a specific firm is.

This study looks to historic data to determine how the market perceives debt and where the optimal ratio may lie. Fama-French three and four factor models as well as the capital asset pricing model will be used to look for possible patterns in risk adjusted expected returns. Book to market ratio and market capitalization are variables used to determine what the market efficient debt/equity ratio may be.

The information in this study shows that too little or too much debt will result in diminished returns.

Introduction

The debt/equity ratio is a common measure of a firm's capital structure. Capital structure is how a firm finances their assets, with either debt, equity, or a combination of both. Many factors play into what the "optimal" debt/equity ratio would be for an individual firm. While prior studies attempt to measure the optimal d/e ratio while examining the market value of firms the purpose of this study is to use traditional asset pricing tests to examine how capital structure influences expected returns or various measures of portfolio alphas.

When talking about debt/equity ratios it is impossible not to mention the work of Modigliani and Miller (1958). They are the founders of the Modigliani-Miller Theorem. Their theorem of capital structure states that in a hypothetical world, that does not have taxes, agency costs, bankruptcy costs, and asymmetric information, there exists no evidence that companies that finance with debt, equity, or a mixture of the two will have diverse firm values. In reality, none of the underlying assumptions of the theory hold. Therefore, tests of how capital structure affects alphas, in an asset pricing sense are compelling. In this study, I will not narrow down a precise formula for what is optimal but rather look at how prices incorporate the information about the capital structure of the firm.

One of the main inspirations for this study was from Basu (1977) which examines Price/Earnings ratios. He found that there was an abnormally high return for companies that had low P/E ratios. This study will attempt to determine whether similar findings could be discovered with Debt/Equity ratios. While search and transaction costs may have kept investors from exploiting the abnormal returns associated with low P/E ratios, Basu still finds that the abnormality was present in the security prices. Likewise, this study will examine whether there is a persistent return premium associated with D/E ratios.

Research about how Debt/Equity ratios affect common stock returns is found in a paper by Bhandari (1988). He finds that stocks with higher debt equity ratios also have a higher return. However, as Debt/Equity ratios rise so does the risk of bankruptcy showing a diminished return for a higher ratio. This is something that will be addressed in this study.

A few asset pricing models will be implemented into this analysis. Specifically, the use of the Capital Asset Pricing Model (CAPM), the Fama-French 3 Factor (FF3F) and the Fama-French 4 Factor models to look for the presence of possible alphas across portfolios based on varying Debt/Equity ratios. FF3F was introduced in 1993 in response to the shortcomings of the CAPM. It builds on the CAPM's risk beta but introduces two more factors, style and size of the firm. Style accounts for the market favoring low book to market stocks over high book to market stocks and size, which favors small company over larger company returns. Carhart (1997), which added a momentum factor to the FF3F, introduced the FF4F. The momentum factor is investing in firms that have increased in value and selling those that have decreased in the recent time period.

Results from my tests revealed important information about the data that was collected and could offer some insight into how firms formulate what they believe is their optimum Debt/Equity ratio, how market efficiency has changed over the past four decades, and whether investors account for Debt/Equity ratios when pricing securities.

Data Description

A few sources of quarterly data are used for this analysis. Data from COMPUSTAT was used to obtain the following variables: assets, earning per share, liabilities, and net income about active company's financial statements that were full and complete for the years ranging from 1977 to 2016. It was assumed that using forty years of data would be sufficient enough to run these portfolio tests. Equity was then calculated by taking the difference of assets and liabilities. Data from the Center for Research in Security Prices (CRSP) was used to obtain the following variables: price returns, ask high, bid low, ask price, bid price, market cap, and turnover. The quarterly returns for the securities were calculated by adding the change in prices from each month of the quarter, due to the fact that only monthly data was given. The data was then sorted by stock identifier to ensure that, when merged together, the firms would match up with each other. CRSP and COMPUSTAT were then merged by gvkey using the CRSP-COMPUSTAT merge file.

From the final data, the Debt/Equity ratio was calculated for each of the quarters for each company. If there were any firms that had missing Debt/Equity ratios they were deleted. The resulting data was then sorted by PERMNO and quarter. The quarterly Debt/Equity ratio was then lagged and the overlapping observations were deleted because of the pooled (stock - quarter) nature of the data. The data was then sorted by Debt/Equity_{t-1}. This data was split into five portfolios and compiled in ascending order. The portfolios were rebalanced each quarter to account for variations in firms capital structure.

The objective is to conduct asset pricing tests such as those laid out in the capital asset pricing model (CAPM), Fama-French 3 factor (FF3F), and Fama-French 4 factor (FF4F) models. The factors for the Fama-French models were obtained from WRDS.

Empirical Findings

Table 1 introduces statistics that can summarize the data collected as a whole. D/E refers to the debt equity ratio for all the firms that have a security price higher than 5 USD and a Debt/Equity ratio greater than zero, but less than ten thousand. D/E ratios of less than 0 were deleted because this portrays a more accurate representation of healthy companies that are trying to maximize shareholder value. Most companies that have a negative D/E ratio are likely hoarding cash and not maximizing their shareholder value. D/E ratio of greater than 10,000 were excluded to control for outliers. The reason firms were deleted that have a security price of less than 5 was to reduce noise from less established companies.

In Table 2, the data is split into five different portfolios. Each portfolio was split evenly by Debt/Equity_{t-1} ratio, arranged in ascending order. Asset pricing test are then used to search for alphas to find possible differentiations in the returns of the portfolios. The portfolios have been rebalanced each quarter. Table 2 presents some descriptive statistics about each portfolio so that it is evident how the portfolios are split up. Table two reaffirms that D/E ratios are split into five ascending portfolios. Looking at the mean return for the data in table 1 and then again after they are split into ascending portfolios there is a higher mean return in portfolio one and two when compared to the return of the data as a whole. Speculating on the data ex-ante from an asset pricing test point of view portfolio one or two would be expected to produce a higher abnormal return than the rest of the portfolios.

Table 3 presents the summary statistics for the returns of each portfolio. Ex-ante, the expectation of the portfolio returns would get larger as we go up in portfolios and then decrease in later portfolios. Giving the portfolios somewhere in the middle the highest average return. Ex-post we do not see a particularly interesting pattern. Portfolio 2 had the highest mean return compared to the rest and portfolio 4 had the lowest quarterly return. There also appears to be a reduction in standard deviation across ascending portfolios. This is representative of volatility decreasing in higher D/E portfolios as opposed to lower D/E portfolios.

Table 4 presents the capital asset pricing model to look for the presence of possible interesting alphas. The CAPM was introduced as a way to price assets using beta or systematic risk as an exogenous variable and market return of the firm as the endogenous variable. This is a foundational model in the world of finance and is used by many firms to decide what their rate of return with an assumed level of risk will be. The underlying assumptions of this model do not hold well in the real world but it is still used as a way to value the premium return on various securities. This model is used in ex-post scenarios. The intercept or alpha refers to the risk adjusted expected return. The alphas in the portfolios from the CAPM regressions show an increase across increasing portfolios. In other words, we can expect a higher risk adjusted expected return associated with a higher Debt/Equity ratio when this type of model is used to price the excess return on the market. The sixth portfolio that is included in this regression is each value in the first portfolio subtracted by the fifth. This gives an idea of how the portfolio data has changed from the last to the first. The intercept being negative in the sixth portfolio asserts that the alphas are increasing in the ascending portfolios. However, the market premium is greater in the first as opposed to the fifth portfolio. The sixth portfolio's alpha is the only portfolio not statistically significant from zero holding all else constant.

Table 5 uses the Fama-French Three Factor regression which builds upon the capital asset pricing model. The FF3F model includes two new variables to help make the CAPM more accurate when identifying abnormal returns. It introduces the "small minus big" risk factor which is the return on small market cap stocks minus the return on large-cap stocks. This is known as the value premium. In the regressions the SMB coefficients are all positive and statistically different than zero suggesting each portfolio has a value premium that decreases over the ascending portfolios. This implies that firms that have a larger market capitalization are more likely to take on less debt relative to their equity while firms that have a smaller market cap use more debt to finance their business. Also introduced in this model is a style factor, HML or "high minus low". This variable takes into account the high book to market stocks minus the low book to market stocks. The market generally favors small book to market stocks or value stocks over large book to market stocks or growth stocks holding all else constant. This is known as the small firm effect. In the regressions portfolios 1, 2, and 6 have a negative HML coefficient and 3, 4, and 5 have a positive sign. This implies that firms that have a higher book to market value take on less debt relative to equity while firms with a smaller book to market value are more likely to finance their business with more debt relative to their equity holding all else constant. By using this model there is more information about the return premium to more accurately identify the abnormal return. All of these coefficients are statistically significant from zero. This model also helps return a more precise value of the alphas in a real world setting. We can see that there is in fact a parabolic effect in the intercept variable. From the regressions it is clear that a Debt/Equity ratio that is too high or too low is correlated with a lower risk adjusted expected return when using this model. All of the coefficients presented in this model are statistically significant at all confidence levels except for the sixth portfolio's intercept.

In Table 6 the Fama-French 4 Factor model is implemented. This model builds on the three factor model above. The FF4F model adds another variable to the regression, UMD or "up minus down". This factor is known as the momentum factor. This coefficient is calculated by selling securities that are decreasing in value and investing in securities that are increasing in value. There only appears to be a momentum factor present in portfolio five suggesting that firms with a higher debt/equity ratio are more likely to take advantage of the momentum factor. However, this coefficient is not statistically significant from 0. Using this additional factor increases the explanation of returns presenting a more accurate abnormal return. The same results for the SMB and HML coefficients from the FF3F model are found in the FF4F model. In these regressions, the intercept and the market return premium are decreasing as we increase the Debt/Equity ratios holding risk constant. All of the intercepts and market premium for the portfolios are statistically significant at a 95 percent confidence level except for the sixth portfolio.

Conclusion

The results from this study suggest that there does exist a relationship between Debt/Equity ratios and abnormal returns. From the asset pricing models presented there are varying returns between each of the ascending portfolios. This information would be beneficial for any firm that is speculating how debt in relation to their equity affects their returns.

By sorting the portfolios into ascending order it becomes apparent that a too low or too high of debt/equity ratio is associated with a smaller risk adjusted return. Suggesting that there is a parabolic relationship between debt/equity ratio and the corresponding alpha. While the risk adjusted return differences were small they were mostly statistically significant for both the Fama-French three-factor model and the Fama-French four factor model.

When looking at the Fama-French three factor and four factor model to identify the abnormal return associated with capital structure can give insight into how different types of firms structure their debt and equity and the payoff to investors. From the regressions there is also evidence that firms with a large market caps prefer to take on less debt as opposed to smaller cap firms taking on more debt holding all else constant. And, firms that have a higher book to market value also take on less debt relative to their equity while firms with a higher book to market ratio take on more debt holding all else constant.

Using this information could be the starting point to where a firm level return maximizing Debt/Equity ratio should be. It would be interesting to see how firms perform when they are compared to what the market says their D/E ratio should be when using a firm's market cap, book to market ratio, or other financial information.

Appendix

Table 1

Table 1 gives a description of the 543790 observations used in this study using the mean, standard deviation, minimum, and maximum of the data. D/E is the debt to equity ratio I calculated from the COMPUSTAT data for each quarter. Price is the closing price of the security, if the closing price is not given the price is calculated using the average of the bid ask spread by quarter. Return is the quarterly return on the market for the specific security. Finally, liabilities and equity are the quarterly debt and equity used to calculate the Debt/Equity ratios.

	Mean	Standard Deviation	Minimum	Maximum
D/E	3.1516	30.49	0	8938.88
Price	41.9146	1475.55	5	232273.67
Return	0.047802	0.2393	-1.8698	13.42123
Liabilities	43.175	354.379	-54244	26615
Equity	144.01	7527.67	0.001	286359

Table 2

Table 2 presents data about the Debt/Equity ratios from the five different portfolios. This table can give us a little more insight into what the data I use in this study represents. P1 is for portfolio one and so on through portfolio 5. The reason that the maximum in the previous portfolio is larger than the minimum of the leading portfolio is becuase I rebalance the portfolios each year leading to varying minimums and maximums. Doing this controls for companies that have significantly altered their capital structure during the course of this study.

Debt/Equity Summary Statistics by Portfolio				
Portfolio	Mean	Standard Deviation	Minimum	Maximum
P1	0.2422	0.1323	0	0.7237
P2	0.6436	0.1572	0.3039	1.08756
P3	1.1767	0.20496	0.7368	1.8989
P4	2.2269	0.7354	1.253	7.2131
P5	11.048	59.4502	1.8472	8938.88

Table 3

Table 3 represents the statistical descriptions of quarterly returns for each of the five portfolios sorted by their Debt/Equity ratio in ascending order.

Returns by Debt/Equity Portfolio P1 to P5				
Portfolio	Mean	Standard Deviation	Minimum	Maximum
P1	0.0480754	0.12137	-0.293809	0.459344
P2	0.0481934	0.10589	-0.232275	0.287448
P3	0.046434	0.095153	-0.255682	0.297598
P4	0.0454072	0.0910677	-0.239491	0.321491
P5	0.0462427	0.0928711	-0.263401	0.275824

Table 4

Table 4

The CAPM regression is represented in this table:

$$(Return\ -RF)_{i,t} = R_f + \beta_1(MKT\text{-}R_f) + \epsilon_i$$

The intercept is the alpha or the risk adjustedreturn one can expect from this regression. MKT-RF is the market return premium, it is calculated from the market return minus the risk free rate at that time. Below the coefficients in parentheses is the P-value that represents it. In this regression we use a sixth portfolio to observe the change in the first portfolio from the fifth portfolio.

CAPM Regression		
Portfolios	Intercept	MKT-RF
P1	0.01168 (0.01559)	1.31670 (0.0000)
P2	0.01584 (0.00004)	1.17070 (0.0000)
P3	0.01478 (0.00002)	1.0678 (0.0000)
P4	0.01531 (0.00001)	1.0113 (0.0000)
P5	0.01776 (0.00014)	0.9234 (0.0000)
P6 (P1 - P5)	-0.00608 (0.35938)	0.3934 (0.0000)

Table 5

Table 5 represents the Fama-French 3 factor regression given by:

$(\text{Return -RF})_{i,t} = \alpha + \square_1 \text{ MKT-RF} + \beta_2\text{SMB} + \beta_3\text{HML} + \epsilon_i$

Intercept is known as the alpha or the risk adjusted rate of return associated with each portfolio. MKT-RF is the market return from the portfolio minus the current risk free rate. SMB is the small market cap securities minus the large market cap securities. HML is the High book to market ratio minus the high book to market ratio.

Fama-French Three Factor Regression				
Portfolios	Intercept	MKT-RF	SMB	HML
P1	0.01427 (0.0000)	1.0140 (0.0000)	0.9910 (0.0000)	-0.3452 (0.0000)
P2	0.01433 (0.0000)	.95741 (0.0000)	0.9047 (0.0000)	-0.0137 0.6788
P3	0.01048 (0.0000)	0.9421 (0.0000)	0.7421 (0.0000)	0.2264 (0.0000)
P4	0.00992 (0.0000)	0.9299 (0.0000)	0.6411 (0.0000)	0.3262 (0.0000)
P5	0.00960 (0.00386)	0.8996 (0.0000)	0.5922 (0.0000)	0.5488 (0.0000)
P6 (P1 - P5)	0.00467 (0.36306)	0.1144 (0.0937)	0.3987 (0.0005)	-0.8940 (0.0000)

Table 6

Table 6 represents the Fama-French 4 Factor regression given by:

$(\text{Return -RF})_{i,t} = \alpha + \beta_1 \text{ MKT-RF} + \beta_2\text{SMB} + \beta_3\text{HML} + \beta_4\text{UMD} + \epsilon_i$

This model is the same as the Fama-French Three Factor model but ads in the coefficient to control for momentum of a firm being in an upswing or downturn, UMD stands for "Up minus Down".

Fama-French Four Factor Regression					
Portfolios	Intercept	MKT-RF	SMB	HML	UMD
P1	0.01713 (0.0000)	0.9926 (0.0000)	0.9690 (0.0000)	-0.3884 (0.0000)	-0.1083 (0.00952)
P2	0.01633 (0.0000)	0.9420 (0.0000)	0.8893 (0.0000)	-.0441 (.2014)	-.07071 (0.0076)
P3	0.01198 (0.0000)	0.9308 (0.0000)	0.7306 (0.0000)	0.2037 (0.0000)	-.05298 (0.04026)
P4	0.01202 (0.0000)	0.9141 (0.0000)	0.0625 (0.0000)	0.2945 (0.0000)	-0.07399 (0.00666)
P5	0.00865 (0.01492)	0.9068 (0.0000)	0.5995 (0.0000)	0.5633 (0.0000)	0.03361 (0.45193)
P6 (P1 - P5)	0.00848 (0.12111)	0.0858 (0.2145)	0.3695 (0.0013)	-0.9517 (0.0000)	-013444 (0.05348)

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