How is firm leverage related to other firm-level variables?

- An empirical research based on three capital structure theories

Seminar Empirical Research in Finance - 2019

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Abstract

This report analyses how firm leverage is related to other firm-level variables based on the Modigliani-Miller-Theorem, the static trade-off theory of capital structure as well as the pecking order theory. By analysing the real-life panel-data of 1710 firms over several years, we find out that the leverage ratio is statistically significant correlated with profitability, tangibility, the logarithm of sales and profitability of the firm. Apart from this, we conclude that the trade-off theory may be in the most keeping with the financing method of firms. We utilise the OLS regression model to estimate our hypothesis.

Introduction

Financial leverage is essential to the survival of a company. It is the debt-to-asset ratio, which measures how much capital comes in the form of debt and indicates the use of company financial resources. As market expansion capital of companies is always limited, they can use debt to finance assets acquisitions. Therefore, leverage can help companies determine how much they can borrow to increase their profitability. There is, however, no fixed answer to the question of how leverage is related to other firm-level variables, and we used the following three theories as assistance mediums to determine just that.

The first one is the Modigliani-Miller(MM) theorem stating that in well-functioning markets without taxes, bankruptcy costs, agency costs, and asymmetric information, the market value of the firm is unaffected by how the firm is financed. Then comes the static trade-off theory, which suggests that firms are supposed to substitute debt for equity or vice versa until the value of the firm is maximised, which means there has to be one optimal point of a debt-equity ratio The last pecking order theory

points out that firms financing sources follow an order, they prioritise the internal financing, then debt and lastly equity. Since managers know more about the company than shareholders do, issuing debt indicates an under-valuation of a stock signalling their confidence in the company, while the issuance of equity would signal an over-valuation.

The paper form S. C. Myers has given us a good starting point of testing the best capital structure, and it makes us predict that the trade-off theory may be the best fit of strategic choices for a firm. Given the importance of debt financing and taxes, Myers points out that static trade-off theory makes sense to some extent. However, as its R^2 value is too low in the empirical observations, and the actual debt ratios vary widely across similar firms, the trade-off theory should find a middle point between itself and the pecking order theory, namely by introducing adjustment costs, possibly including those stemming from asymmetric information and agency problems to make it more applicable.

Based on the theories above, we have drawn the following hypothesis: Debt is essential to the firm financing policy. So leverage, as a standard measurement of the debt load degree, should be strongly related to other firm-level variables.

To prove our hypothesis, we use the real-life panel-data of 1710 firms amounting to 5358 observations over several years, to see the extent of relations between leverage and the market-to-book ratio, tangibility and sales revenue as the logarithm of net sales. We run regressions under several different conditions as well as observing the variables individually to see the mean, minimum and maximum. Market-to-book serves as a proxy for growth opportunities and net sales as a proxy for size and profitability.

Our finding shows that the leverage is statistically significant correlated with profitability, tangibility, the logarithm of sales and profitability on the 1% level and that the optimal debt-equity ratio is greater than 0. The effect of leverage on our four specified variables is independent of the industry sector, so the importance of debt financing in firms is proven regardless of the industry type.

To be exact, we find a positive correlation between the debt amount of the company and the number of tangible assets the company holds, as well as the number of log-sales it has. Market-to-book ratio

and profitability have a relatively weak to very weak negative correlation with leverage. Moreover, in our sample, the leverage has a mean of 0.269 and 603 observations have 0 leverage. As expected, the group with 0 leverage has a lower tangibility and log-sale value than the observations with leverage over 0. The average market-to-book ratio is also higher than the market-to-book ratio in the 0-leverage sample. However, interestingly, the value of profitability is negative, which indicates that the trade-off theory may hold the truth.

Data & Methodology

Upon gaining access to our data sample consisting of 7705 observations, we need to clean up the non-relevant data firstly to ensure our result correctness. As we focus only on the US dollar, we start with unifying our data by dropping all observations whose currencies are not USD, which helps us to limit our sample size to 7514. Then, we exclude the observations which are missing value in total assets. After the basic configuration, we were left with 7513 observations.

The next step we take is generating our variables. We start with the leverage (lev), which is the sum of long term debt and debt in current liabilities all divided by the book value of total assets ((long term debt + debt in current liabilities) / total assets). Then comes the tangibility (tan), namely the ratio of net property, plant and equipment to the book value of total assets. The third variable that we generate is the logarithm for net sales (log_sale) that stands for the sales revenue and the company size. The last two variables we considered in relations to leverage are market-to-book ratio(mb) and the profitability measurement ROA(roa). The mb represents the growth opportunities and profitability of a company, (total assets – common/ordinary equity + price per share * shares outstanding) / total assets is its expression.

Only doing basic univariate tests on these variables with ranges from min to max would not make sense due to the outliers. For example, a maximum of leverage ratio 881 and the minimum of

profitability -474 are incredibly unrealistic because the mean values of both are only 0.503 and -0.230, respectively. Considering the fact that only the mb under the two-digit level is considered to be reasonable, a ratio of 1673 would signal an unreal overvaluation.

Also, a tan ratio of 0.992 means that the firm has almost 0 intangible assets, which is unreasonable, too. Unlike other variables, log_sale does not appear to have a huge outlier, but it still skews the expected results. More data details can be found in the appendix below (Table A).

To prevent errors that may be generated by outliers, we winsorize our data on the 1% level by replacing the bottom 1% with the variable at the 1% level and equally on the 99% level. We will only talk about the winsorized data from now on, which will also be acknowledged by the W standing before the variable name. Our last step in the data-slicing process is eliminating observations that have one missing value in one of our five variables. After this step, we have filtered our sample to 5358 observations of 1710 firms over a total maximum of 12 years from 2005 to 2017.

Having cleaned our data, we want to take a look at each specific variable and examine them. Instead of doing a simple correlation test, we used the significance command to see not only the correlations but also the p-values to determine the usefulness of each variable in drawing any conclusions.

To refute our null hypothesis stating that leverage does not affect firm-specific variables, we looked for all the observations in our sample without leverage data by generating a dummy variable equal to 0 and replacing Wlev = 0 by Wlev=1. The total amount of observations in our sample with Wlev = 0 is 603. The mean is the fraction of total observations meaning that 11.2542% of our observations have the Wlev ratio of 0. (Table D)

We also want to figure out the fraction of firms with Wlev=0. We have managed to collect this data by collapsing the minimum and maximum value of our Wlev data by generating a new variable called alwayszero if the minimum and the maximum is equal to 0. The results show us that 9.59% of firms have 0 in Wlev every year.

Since our main objective is to see if there exist differences in the specific firm variables with Wlev > 0 and Wlev == 0, we have done four univariate T-tests on Wtan, Wmb, Wsale and Wroa between our

original sample and the dummy null sample. Having done that, we finally get to the regressions. We used the OLS – Regression based on the following equation:

$$Wlev = \beta_0 + \beta_1 Wtan + \beta_2 Wmb + \beta_3 Wsale + \beta_4 Wroa + \epsilon$$ Equation 1

We then included year and sector dummies in our previous regression because we have not only different years in our panel data but also SIC-sectors of firms, Equation 2

$$\mathbf{Wlev} = \beta 0 + \beta 1\,\mathbf{Wtan} + \beta 2\,\mathbf{Wmb} + \beta 3\,\mathbf{Wsale} + \beta 4\,\mathbf{Wroa} + \sum_{d=5}^{17} \beta d \sum_{e=5}^{17} fyear\,f + \sum_{f=18}^{92} \beta f \sum_{g=18}^{92} sic2 + \varepsilon$$

we need to determine if an industry sector has a specific effect on leverage.

In the next step instead of including sector dummies, we used the fixed effects model on the variable gvkey in our model with year dummies to see if there were any differences. We have to use the fixed effects model to try and refute our hypothesis that the optimal leverage ratio is equal for every firm and every year.

Results

The information we gather from our basic univariate test is that our extremes for Wlev are realistic, and have a wider variation in the upper percentile. Wmb also has a higher variation in the upper percentiles where the maximum far deviates from the minimum of the mean. We interpret a low Wmb as a stock being undervalued and a high Wmb as an overvaluation.

Wtan is distributed almost equally in our sample and shows a good variety of different kind of firms, although the maximum is still an outlier; Wsale which we use as a proxy for size is normally distributed, and the only variable that does not show uniformity is Wroa, our proxy for profitability.

The values are deformed negatively, but we have decided that even though the variation is quite substantial, we would not want to influence the data sample any more.

The Stata results in Table C show that the correlation of Wroa is statistically significant on the $p<0.05$ level, while the other four variables on the $p<0.01$ level. The tangibility ratio has a positive but relatively weaker correlation with regard to the leverage. So we conclude that there is a significant positive relationship between the debt and the number of tangible assets the firm owns. In addition, the weak negative correlation between Wmb and Wlev may stem from the fact that as overvaluation rises, issuance of equity gets more profitable for shareholders than the acquisition of debt. (Table C) Since debt is easier to acquire than equity, it makes sense that the bigger the company is, the higher the leverage ratio it has. And as the correlation of Wroa is too weak, it is hard to make a conclusive argument out of this matrix.

We then come to find the fraction with 0 leverage. Having a sample of observations with no leverage gives us the ability to do a reverse causality test, where we test that if there is no leverage at all the optimal leverage ratio does not exist. Before we do that, we look at the number of firms that have 0 leverage every year in our sample, which amounts to 9.59% of firms (Table E).

The following t-test is made to compare the positive leverage sample with the zero leverage sample. We used it to examine the trade-off theory using empirical research. We expect to find evidence of an optimal leverage ratio (Table F below and in appendix).

```
. ttest Wtan, by (Dummynull)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	4,755	.3401695	.0032607	.2248469	.333777	.346562
1	603	.1629306	.0075206	.1846763	.1481607	.1777004
combined	5,358	.3202227	.0031104	.2276754	.314125	.3263203
diff		.1772389	.0095403		.158536	.1959419

```
    diff = mean(0) - mean(1)                                  t =  18.5778
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

The earlier found positive correlation can also be observed here and is statistically significant because a t-value of 18.5 is equal to a p-value < 0.01. The mean that the sample with a Wlev > 0 shows a significantly higher mean than the sample with Wlev = 0. This confirms that as Wlev increases, Wtan increases.

Below is our second t-test result (Table G); it examines the mean between the two leverage samples and finds, that the sample with zero Wlev has a higher mean Wmb than the positive Wlev sample. This is also in line with what we found in our correlation that stated, if the Wmb increases, Wlev decreases. The t-test is statistically significant on the p <0.01 level.

```
. ttest Wmb, by (Dummynull)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |   4,755     2.23449    .0312008    2.151497    2.173322    2.295658
       1 |     603    3.351932    .1283295    3.151267    3.099904     3.60396
---------+--------------------------------------------------------------------
combined |   5,358    2.360249     .031595      2.3127    2.29831    2.422188
---------+--------------------------------------------------------------------
    diff |           -1.117442    .0988105               -1.31115   -.9237329
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                  t = -11.3089
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

The Pecking-order theory states exactly this occurrence, where an overvalued company is more likely to issue equity than taking on additional debt because equity is more accessible and cheaper to them. The logarithm of net sales, Wsale has a weak positive correlation and shows the same premise in our t-test here.

```
. ttest Wsale, by (Dummynull)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |   4,755    3.819528     .032807    2.262259    3.755211    3.883845
       1 |     603    2.243992    .0945386    2.321495    2.058326    2.429657
---------+--------------------------------------------------------------------
combined |   5,358    3.642214    .0317328    2.322788    3.580005    3.704423
---------+--------------------------------------------------------------------
    diff |            1.575536    .0980846                1.383251    1.767822
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =  16.0630
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

Moreover, we find that the sample with positive leverage has a higher mean of Wsale than the sample with zero leverage. The test is also significant on the $p < 0.01$ level. It presents a clear correlation between firm size and leverage ratio, which shows the easier acquisition of debt over equity again. (Table H).

```
. ttest Wroa, by (Dummynull)

Two-sample t test with equal variances
------------------------------------------------------------------------------
   Group |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       0 |   4,755    .0175374    .0053108    .3662164    .0071257    .0279491
       1 |     603   -.0804727    .0209891    .5154105   -.1216936   -.0392519
---------+--------------------------------------------------------------------
combined |   5,358    .0065072    .0052881    .3870792   -.0038596     .016874
---------+--------------------------------------------------------------------
    diff |            .0980102    .0166806                .0653093     .130711
------------------------------------------------------------------------------
    diff = mean(0) - mean(1)                                      t =   5.8757
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

We have a statistically significant t-test on the p <0.01 level and can see that the average profitability is higher for firms with leverage. We also see mean negative profitability for the sample with leverage = 0 standing in contradiction to the correlation matrix. What this shows us, is that the Trade-off Theory holds true, there is an optimal leverage ratio, and it is neither 0 nor our mean in this sample. Otherwise, the Wroa would be positive for our sample with Wlev = 0 (Table I)

```
. reg Wlev Wtan Wmb Wsale Wroa
```

Source	SS	df	MS	Number of obs	=	5,358
				F(4, 5353)	=	152.89
Model	38.4728732	4	9.61821829	Prob > F	=	0.0000
Residual	336.748244	5,353	.062908321	R-squared	=	0.1025
				Adj R-squared	=	0.1019
Total	375.221118	5,357	.070043143	Root MSE	=	.25082

Wlev	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Wtan	.287026	.015522	18.49	0.000	.2565966	.3174553
Wmb	-.0173426	.0017083	-10.15	0.000	-.0206915	-.0139936
Wsale	.010923	.0018087	6.04	0.000	.0073773	.0144687
Wroa	-.1312428	.0112315	-11.69	0.000	-.1532612	-.1092245
_cons	.178646	.0095931	18.62	0.000	.1598396	.1974524

This is our equation 1 regression. Every one of our variables as well as the constant, is statistically significant on the p < 0.01 level. Our R^2 is 0.1025, telling us that the explanatory variables explanations account for 10.25% of the movements that leverage has in our model. Wtan, as well as Wsale hold a positive relationship with leverage, with almost the same values as in the correlation matrix. Wsale being a logarithmic operator shows the stated percent point increase in leverage for every unit that it raises while the linear explanatory variables show their value as a unit decrease or increase on leverage. The stark contrast is seen in Wroa and Wmb. Wroa increases in negative value from - 0.039 to - 0.13 and decreases from - 0.1258 to -0,173. Important is that Wroa contradicts our t-test here because we saw a positive correlation between Wroa and Wlev there. This has to do with

the before mentioned the trade-off theory. Our constant, which is the value of leverage if every here stated explanatory variable was 0 is 0.179.

Source	SS	df	MS	Number of obs	=	5,358
Model	82.2788389	80	1.02848549	F(80, 5277)	=	18.53
Residual	292.942279	5,277	.055513034	Prob > F	=	0.0000
Total	375.221118	5,357	.070043143	R-squared	=	0.2193
				Adj R-squared	=	0.2074
				Root MSE	=	.23561

Wlev	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Wmb	-.0098605	.0016846	-5.85	0.000	-.013163	-.006558
Wtan	.2942219	.0192194	15.31	0.000	.256544	.3318998
Wsale	.017246	.0018728	9.21	0.000	.0135745	.0209175
Wroa	-.1376772	.0109257	-12.60	0.000	-.1590962	-.1162583
fyear						
2006	.0311943	.0249364	1.25	0.211	-.0176914	.08008
2007	.0454069	.0231398	1.96	0.050	.0000432	.0907705
2008	.0565928	.0229032	2.47	0.014	.011693	.1014926
2009	.0491495	.0228141	2.15	0.031	.0044243	.0938746
2010	.0390284	.0227479	1.72	0.086	-.0055669	.0836236
2011	.0146061	.0223051	0.65	0.513	-.029121	.0583333
2012	-.0029582	.0220229	-0.13	0.893	-.0461323	.0402159
2013	-.031514	.0217594	-1.45	0.148	-.0741715	.0111434
2014	-.0362165	.0232471	-1.56	0.119	-.0817903	.0093573
2015	-.0013488	.0245909	-0.05	0.956	-.0495571	.0468595
2016	.0513899	.0338203	1.52	0.129	-.0149119	.1176917
2017	.0662206	.0815855	0.81	0.417	-.0937207	.226162
sic 2						
7	.2175188	.2385955	0.91	0.362	-.2502272	.6852647
10	.2659827	.1713678	1.55	0.121	-.0699691	.6019344
13	-.0885891	.0506785	-1.75	0.081	-.1879399	.0107616
14	.0293451	.0959663	0.31	0.760	-.1587887	.2174788
15	.3003676	.0692595	4.34	0.000	.1645903	.436145
16	-.0405335	.055396	-0.73	0.464	-.1491326	.0680656
17	-.074259	.0625667	-1.19	0.235	-.1969156	.0483975
20	.0488172	.0398584	1.22	0.221	-.0293217	.1269562
21	-.517362	.2404866	-2.15	0.031	-.9888152	-.0459089
22	.0908832	.0453673	2.00	0.045	.0019444	.179822
23	-.0420035	.0662979	-0.63	0.526	-.1719748	.0879677
24	.1181108	.0564708	2.09	0.037	.0074046	.228817
25	.1035779	.0549136	1.89	0.059	-.0040754	.2112312
26	-.0054583	.0466819	-0.12	0.907	-.0969741	.0860575
27	-.000117	.0440227	-0.00	0.998	-.0864196	.0861856
28	-.030554	.0376318	-0.81	0.417	-.1043279	.04322
29	-.1484657	.0863971	-1.72	0.086	-.3178398	.0209083
30	.035054	.0435461	0.80	0.421	-.0503145	.1204224
31	.2250002	.111384	2.02	0.043	.0066413	.443359
32	.1139836	.0591481	1.93	0.054	-.001971	.2299383
33	-.0019585	.041862	-0.05	0.963	-.0840252	.0801083
34	.0514006	.0465868	1.10	0.270	-.0399287	.1427299
35	.0006732	.0384853	0.02	0.986	-.0747739	.0761203
36	.0149424	.0374267	0.40	0.690	-.0584293	.0883142
37	.0844975	.0423333	2.00	0.046	.0015068	.1674883
38	.0238792	.0379559	0.63	0.529	-.0505301	.0982885
39	.0254105	.048736	0.52	0.602	-.0701322	.1209533

41	.3523123	.2385813	1.48	0.140	-.1154057	.8200303
42	.1053798	.047813	2.20	0.028	.0116465	.199113
44	.001688	.0498988	0.03	0.973	-.0961343	.0995103
45	.1057701	.0584213	1.81	0.070	-.0087598	.2203
47	-.0421847	.0826641	-0.51	0.610	-.2042404	.1198711
48	.1610784	.0405352	3.97	0.000	.0816125	.2405442
49	.0191388	.0434346	0.44	0.659	-.066011	.1042886
50	.0594738	.0433597	1.37	0.170	-.0255292	.1444768
51	.182505	.0448705	4.07	0.000	.0945402	.2704698
52	.0449518	.0661634	0.68	0.497	-.0847558	.1746595
53	-.0054044	.0460343	-0.12	0.907	-.0956507	.0848419
54	.0227915	.0442311	0.52	0.606	-.0639197	.1095028
55	.1407021	.0548051	2.57	0.010	.0332614	.2481427
56	-.136471	.0473036	-2.89	0.004	-.2292056	-.0437363
57	-.0476708	.0492134	-0.97	0.333	-.1441494	.0488079
58	-.0586766	.0398467	-1.47	0.141	-.1367926	.0194394
59	-.0173762	.0440417	-0.39	0.693	-.1037162	.0689638
60	.1294259	.1233027	1.05	0.294	-.1122984	.3711502
61	.4459795	.0524818	8.50	0.000	.3430935	.5488656
62	-.0210865	.0664612	-0.32	0.751	-.1513779	.1092049
63	-.0372952	.0455479	-0.82	0.413	-.126588	.0519976
64	-.124564	.0572175	-2.18	0.030	-.236734	-.012394
65	.0276146	.0500157	0.55	0.581	-.0704368	.1256661
67	.1965563	.0391675	5.02	0.000	.1197718	.2733408
70	.3781535	.0560938	6.74	0.000	.2681864	.4881205
72	-.0211536	.0627348	-0.34	0.736	-.1441398	.1018325
73	-.0131549	.0372404	-0.35	0.724	-.0861614	.0598516
75	.3038109	.0689839	4.40	0.000	.168574	.4390478
76	-.1332462	.0959535	-1.39	0.165	-.3213547	.0548622
78	.0907121	.0451134	2.01	0.044	.0022712	.1791529
79	.1118421	.0471311	2.37	0.018	.0194456	.2042386
80	.1050313	.038815	2.71	0.007	.0289379	.1811247
81	-.0966486	.2387524	-0.40	0.686	-.5647021	.3714049
82	-.0045672	.0583664	-0.08	0.938	-.1189895	.1098551
83	.1349853	.0674938	2.00	0.046	.0026695	.267301
87	-.0080113	.0419465	-0.19	0.849	-.0902438	.0742212
99	.0509305	.044158	1.15	0.249	-.0356375	.1374985
_cons	.086995	.0422668	2.06	0.040	.0041345	.1698555

In our regression (TABLE J) we included year and sector dummy variables to see if there was a specific year that affected the leverage ratio and if the industry sector a firm resides in has an impact as well. We find a bigger R^2 by using the extra dummy variables, which doubled to now 21.93%. It is important to note that the year 2005 and SIC-sector 1 have been omitted because of a collinearity problem. Taking a look at the statistical significances, we can see the years 2007, 2008, 2009, having a real significant impact on the leverage ratio. The financial crisis, where firms took on additional debt is probably the cause of that. The higher R^2 is deceived, though because generating this, and many dummy variables create so much noise that it numbs out the gains from the additional data.

Our real differences in the regression model are, Wmb has become a little less negative, Wtan has risen marginally, Wsale has risen from 0.109 to 0.172, and the Wroa is almost precisely the same.

```
. asdoc xtreg Wlev Wtan Wmb Wroa Wsale i.fyear,fe
(File Myfile.doc already exists, option append was assumed)

Fixed-effects (within) regression               Number of obs      =       5,358
Group variable: Dgvkey                          Number of groups   =       1,710

R-sq:                                           Obs per group:
     within  = 0.0747                                         min =           1
     between = 0.0964                                         avg =         3.1
     overall = 0.0686                                         max =          12

                                                F(16,3632)         =       18.34
corr(u_i, Xb)  = -0.0646                        Prob > F           =      0.0000

------------------------------------------------------------------------------
        Wlev |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Wtan |   .2284233   .0308214     7.41   0.000     .1679944    .2888522
         Wmb |    .002298   .0018735     1.23   0.220    -.0013752    .0059712
        Wroa |   -.107285   .0123244    -8.71   0.000    -.1314484   -.0831216
       Wsale |   .0283575    .004717     6.01   0.000     .0191092    .0376059
             |
       fyear |
       2006  |   .0215959    .017154     1.26   0.208    -.0120365    .0552283
       2007  |   .0440497   .0166882     2.64   0.008     .0113305    .0767689
       2008  |   .0713185   .0167029     4.27   0.000     .0385705    .1040665
       2009  |   .0736379   .0167996     4.38   0.000     .0407004    .1065754
       2010  |   .0800852   .0169996     4.71   0.000     .0467556    .1134148
```

```
       2011  |   .0680091   .0168615     4.03   0.000     .0349502     .101068
       2012  |   .0626584   .0169621     3.69   0.000     .0294021    .0959146
       2013  |   .0481614   .0172518     2.79   0.005     .0143372    .0819855
       2014  |   .0597768   .0188699     3.17   0.002     .0227802    .0967734
       2015  |   .1064072    .021896     4.86   0.000     .0634775    .1493368
       2016  |   .1565615   .0338673     4.62   0.000     .0901606    .2229624
       2017  |   .0426292   .0686421     0.62   0.535    -.0919517    .1772101
             |
       _cons |   .0244226   .0231646     1.05   0.292    -.0209944    .0698395
-------------+----------------------------------------------------------------
     sigma_u |  .22952773
     sigma_e |  .15187368
         rho |  .69549777   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

By having fixed effects within the group, we see a definite change in regards to our equation 1. Here we have every variable but Wmb and our constant statistically significant on the $p < 0.01$ level and have every year besides 2006 and 2017 on the $p < 0.01$ level as well.

Since the constant is not statistically significant, we can not refute the null hypothesis that the optimal leverage ratio is the same for every firm.

Conclusion

In conclusion, we can see from the low R^2 in every regression model, that we did not gather all the necessary control variables to explain the influence of leverage on a firm. We gathered that leverage and tangibility have a positive correlation, leverage and the logarithm of net sales, as a proxy for firm size in our research, are positively correlated as well and show that in the regression. Market-to-book ratio is negatively correlated with leverage meaning an increase in Wmb equals a decrease in Wlev. We explained that correlation because of the profitability that issuance of equity has when a firm is overvalued. Our most significant finding, however, was the confirmation of the Trade-Off Theory and the Pecking Order Theory. We saw that a firm has an optimal leverage ratio, because while it was negatively correlated with leverage when we had a mean of 0.269 and was negatively correlated in our regressions, we found that if we set Wlev to 0 the profitability is lower for the firms with 0 Wlev than with a definite amount of leverage. This proves that there is an optimal debt-equity ratio the negative correlation between Wmb and Wlev also show us that overvalued firm issue equity more than debt. In conclusion, we also want to add that we would have liked the variable of liquidity to play a role in our statistical analysis. Its relation to leverage is interesting because it determines the ability to repay the debt without raising additional external capital and should, in theory, work like the Wtan ratio.

References

S. C. Myers (July. 1984), *The Capital Structure Puzzle*,
https://onlinelibrary.wiley.com/doi/full/10.1111/j.1540-6261.1984.tb03646.x

Appendix

```
. sum lev tan mb roa log_sale

    Variable |        Obs        Mean    Std. Dev.       Min        Max
-------------+---------------------------------------------------------
         lev |      7,492      .50269    10.30578         0        881
         tan |      7,496    .3164887     .233008         0     .9919075
          mb |      5,559    3.088316    25.51958  .1993789    1673.361
         roa |      7,454   -.2302782    6.563043      -474    13.52381
    log_sale |      7,223     3.51806    2.494934  -6.907755    11.27902
```

(Table A)

```
  variable |      mean        sd       min       p10       p50       p90
-----------+--------------------------------------------------------------
      Wlev |   .2685552  .2646567         0         0  .2138729  .6032981
       Wmb |  2.360249    2.3127  .5806862  .9445137  1.580133  4.474691
      Wtan |   .3202227  .2276754         0  .0356824  .2928405  .6508325
     Wsale |  3.642214  2.322788 -3.057608  .6108519  3.825048  6.445059
      Wroa |   .0065072  .3870792 -3.370349 -.3139867  .1081953  .2400126
-------------------------------------------------------------------------

  variable |       max         N
-----------+--------------------
      Wlev |   1.94633      5358
       Wmb |  17.14726      5358
      Wtan |  .9063205      5358
     Wsale |  8.967759      5358
      Wroa |  .4677013      5358
--------------------------------
```

(Table B)

```
. pwcorr Wlev Wmb Wtan Wsale Wroa, sig

             |     Wlev      Wmb     Wtan    Wsale     Wroa
-------------+---------------------------------------------
        Wlev |   1.0000
             |
             |
         Wmb |  -0.1258   1.0000
             |   0.0000
             |
        Wtan |   0.2658  -0.1221   1.0000
             |   0.0000   0.0000
             |
       Wsale |   0.1083  -0.3716   0.2403   1.0000
             |   0.0000   0.0000   0.0000
             |
        Wroa |  -0.0389  -0.4770   0.1182   0.5376   1.0000
             |   0.0044   0.0000   0.0000   0.0000
             |
```

Variable	Obs	Mean	Std. Dev.	Min	Max
Dummynull	5,358	.112542	.3160616	0	1

(Table D)

Variable	Obs	Mean	Std. Dev.	Min	Max
alwayszero	1,710	.0959064	.294549	0	1

(Table E)

```
. ttest Wtan, by (Dummynull)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	4,755	.3401695	.0032607	.2248469	.333777	.346562
1	603	.1629306	.0075206	.1846763	.1481607	.1777004
combined	5,358	.3202227	.0031104	.2276754	.314125	.3263203
diff		.1772389	.0095403		.158536	.1959419

```
    diff = mean(0) - mean(1)                                  t =  18.5778
Ho: diff = 0                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

(Table F)

```
. ttest Wmb, by (Dummynull)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	4,755	2.23449	.0312008	2.151497	2.173322	2.295658
1	603	3.351932	.1283295	3.151267	3.099904	3.60396
combined	5,358	2.360249	.031595	2.3127	2.29831	2.422188
diff		-1.117442	.0988105		-1.31115	-.9237329

```
    diff = mean(0) - mean(1)                                  t = -11.3089
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 1.0000
```

(Table G)

```
. ttest Wsale, by (Dummynull)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	4,755	3.819528	.032807	2.262259	3.755211	3.883845
1	603	2.243992	.0945386	2.321495	2.058326	2.429657
combined	5,358	3.642214	.0317328	2.322788	3.580005	3.704423
diff		1.575536	.0980846		1.383251	1.767822

```
    diff = mean(0) - mean(1)                                  t =  16.0630
Ho: diff = 0                                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

(Table H)

```
. ttest Wroa, by (Dummynull)

Two-sample t test with equal variances
```

Group	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
0	4,755	.0175374	.0053108	.3662164	.0071257	.0279491
1	603	-.0804727	.0209891	.5154105	-.1216936	-.0392519
combined	5,358	.0065072	.0052881	.3870792	-.0038596	.016874
diff		.0980102	.0166806		.0653093	.130711

```
    diff = mean(0) - mean(1)                                  t =   5.8757
Ho: diff = 0                     degrees of freedom =     5356

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 1.0000         Pr(|T| > |t|) = 0.0000          Pr(T > t) = 0.0000
```

(Table I)

```
. reg Wlev Wtan Wmb Wsale Wroa

      Source |       SS       df       MS      Number of obs   =     5,358
-------------+------------------------------   F(4, 5353)      =    152.89
       Model |  38.4728732     4  9.61821829   Prob > F        =    0.0000
    Residual |  336.748244 5,353  .062908321   R-squared       =    0.1025
-------------+------------------------------   Adj R-squared   =    0.1019
       Total |  375.221118 5,357  .070043143   Root MSE        =    .25082

------------------------------------------------------------------------------
        Wlev |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Wtan |    .287026   .015522    18.49   0.000     .2565966    .3174553
         Wmb |  -.0173426   .0017083  -10.15   0.000    -.0206915   -.0139936
       Wsale |    .010923   .0018087    6.04   0.000     .0073773    .0144687
        Wroa |  -.1312428   .0112315  -11.69   0.000    -.1532612   -.1092245
       _cons |    .178646   .0095931   18.62   0.000     .1598396    .1974524
------------------------------------------------------------------------------
```

(Table J)

Source	SS	df	MS	Number of obs	=	5,358
				F(80, 5277)	=	18.53
Model	82.2788389	80	1.02848549	Prob > F	=	0.0000
Residual	292.942279	5,277	.055513034	R-squared	=	0.2193
				Adj R-squared	=	0.2074
Total	375.221118	5,357	.070043143	Root MSE	=	.23561

Wlev	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
Wmb	-.0098605	.0016846	-5.85	0.000	-.013163	-.006558
Wtan	.2942219	.0192194	15.31	0.000	.256544	.3318998
Wsale	.017246	.0018728	9.21	0.000	.0135745	.0209175
Wroa	-.1376772	.0109257	-12.60	0.000	-.1590962	-.1162583
fyear						
2006	.0311943	.0249364	1.25	0.211	-.0176914	.08008
2007	.0454069	.0231398	1.96	0.050	.0000432	.0907705
2008	.0565928	.0229032	2.47	0.014	.011693	.1014926
2009	.0491495	.0228141	2.15	0.031	.0044243	.0938746
2010	.0390284	.0227479	1.72	0.086	-.0055669	.0836236
2011	.0146061	.0223051	0.65	0.513	-.029121	.0583333
2012	-.0029582	.0220229	-0.13	0.893	-.0461323	.0402159
2013	-.031514	.0217594	-1.45	0.148	-.0741715	.0111434
2014	-.0362165	.0232471	-1.56	0.119	-.0817903	.0093573
2015	-.0013488	.0245909	-0.05	0.956	-.0495571	.0468595
2016	.0513899	.0338203	1.52	0.129	-.0149119	.1176917
2017	.0662206	.0815855	0.81	0.417	-.0937207	.226162
sic 2						
7	.2175188	.2385955	0.91	0.362	-.2502272	.6852647
10	.2659827	.1713678	1.55	0.121	-.0699691	.6019344
13	-.0885891	.0506785	-1.75	0.081	-.1879399	.0107616
14	.0293451	.0959663	0.31	0.760	-.1587887	.2174788
15	.3003676	.0692595	4.34	0.000	.1645903	.436145
16	-.0405335	.055396	-0.73	0.464	-.1491326	.0680656
17	-.074259	.0625667	-1.19	0.235	-.1969156	.0483975
20	.0488172	.0398584	1.22	0.221	-.0293217	.1269562
21	-.517362	.2404866	-2.15	0.031	-.9888152	-.0459089
22	.0908832	.0453673	2.00	0.045	.0019444	.179822
23	-.0420035	.0662979	-0.63	0.526	-.1719748	.0879677
24	.1181108	.0564708	2.09	0.037	.0074046	.228817
25	.1035779	.0549136	1.89	0.059	-.0040754	.2112312
26	-.0054583	.0466819	-0.12	0.907	-.0969741	.0860575
27	-.000117	.0440227	-0.00	0.998	-.0864196	.0861856
28	-.030554	.0376318	-0.81	0.417	-.1043279	.04322
29	-.1484657	.0863971	-1.72	0.086	-.3178398	.0209083
30	.035054	.0435461	0.80	0.421	-.0503145	.1204224
31	.2250002	.111384	2.02	0.043	.0066413	.443359
32	.1139836	.0591481	1.93	0.054	-.001971	.2299383
33	-.0019585	.041862	-0.05	0.963	-.0840252	.0801083
34	.0514006	.0465868	1.10	0.270	-.0399287	.1427299
35	.0006732	.0384853	0.02	0.986	-.0747739	.0761203
36	.0149424	.0374267	0.40	0.690	-.0584293	.0883142
37	.0844975	.0423333	2.00	0.046	.0015068	.1674883
38	.0238792	.0379559	0.63	0.529	-.0505301	.0982885
39	.0254105	.048736	0.52	0.602	-.0701322	.1209533

41	.3523123	.2385813	1.48	0.140	-.1154057	.8200303
42	.1053798	.047813	2.20	0.028	.0116465	.199113
44	.001688	.0498988	0.03	0.973	-.0961343	.0995103
45	.1057701	.0584213	1.81	0.070	-.0087598	.2203
47	-.0421847	.0826641	-0.51	0.610	-.2042404	.1198711
48	.1610784	.0405352	3.97	0.000	.0816125	.2405442
49	.0191388	.0434346	0.44	0.659	-.066011	.1042886
50	.0594738	.0433597	1.37	0.170	-.0255292	.1444768
51	.182505	.0448705	4.07	0.000	.0945402	.2704698
52	.0449518	.0661634	0.68	0.497	-.0847558	.1746595
53	-.0054044	.0460343	-0.12	0.907	-.0956507	.0848419
54	.0227915	.0442311	0.52	0.606	-.0639197	.1095028
55	.1407021	.0548051	2.57	0.010	.0332614	.2481427
56	-.136471	.0473036	-2.89	0.004	-.2292056	-.0437363
57	-.0476708	.0492134	-0.97	0.333	-.1441494	.0488079
58	-.0586766	.0398467	-1.47	0.141	-.1367926	.0194394
59	-.0173762	.0440417	-0.39	0.693	-.1037162	.0689638
60	.1294259	.1233027	1.05	0.294	-.1122984	.3711502
61	.4459795	.0524818	8.50	0.000	.3430935	.5488656
62	-.0210865	.0664612	-0.32	0.751	-.1513779	.1092049
63	-.0372952	.0455479	-0.82	0.413	-.126588	.0519976
64	-.124564	.0572175	-2.18	0.030	-.236734	-.012394
65	.0276146	.0500157	0.55	0.581	-.0704368	.1256661
67	.1965563	.0391675	5.02	0.000	.1197718	.2733408
70	.3781535	.0560938	6.74	0.000	.2681864	.4881205
72	-.0211536	.0627348	-0.34	0.736	-.1441398	.1018325
73	-.0131549	.0372404	-0.35	0.724	-.0861614	.0598516
75	.3038109	.0689839	4.40	0.000	.168574	.4390478
76	-.1332462	.0959535	-1.39	0.165	-.3213547	.0548622
78	.0907121	.0451134	2.01	0.044	.0022712	.1791529
79	.1118421	.0471311	2.37	0.018	.0194456	.2042386
80	.1050313	.038815	2.71	0.007	.0289379	.1811247
81	-.0966486	.2387524	-0.40	0.686	-.5647021	.3714049
82	-.0045672	.0583664	-0.08	0.938	-.1189895	.1098551
83	.1349853	.0674938	2.00	0.046	.0026695	.267301
87	-.0080113	.0419465	-0.19	0.849	-.0902438	.0742212
99	.0509305	.044158	1.15	0.249	-.0356375	.1374985
_cons	.086995	.0422668	2.06	0.040	.0041345	.1698555

(Table K)

```
. asdoc xtreg Wlev Wtan Wmb Wroa Wsale i.fyear,fe
(File Myfile.doc already exists, option append was assumed)

Fixed-effects (within) regression               Number of obs      =       5,358
Group variable: Dgvkey                          Number of groups   =       1,710

R-sq:                                           Obs per group:
     within  = 0.0747                                         min =           1
     between = 0.0964                                         avg =         3.1
     overall = 0.0686                                         max =          12

                                                F(16,3632)         =       18.34
corr(u_i, Xb)  = -0.0646                        Prob > F           =      0.0000

------------------------------------------------------------------------------
        Wlev |      Coef.   Std. Err.      t    P>|t|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        Wtan |   .2284233   .0308214     7.41   0.000     .1679944    .2888522
         Wmb |    .002298   .0018735     1.23   0.220    -.0013752    .0059712
        Wroa |   -.107285   .0123244    -8.71   0.000    -.1314484   -.0831216
       Wsale |   .0283575    .004717     6.01   0.000     .0191092    .0376059
             |
       fyear |
       2006  |   .0215959    .017154     1.26   0.208    -.0120365    .0552283
       2007  |   .0440497   .0166882     2.64   0.008     .0113305    .0767689
       2008  |   .0713185   .0167029     4.27   0.000     .0385705    .1040665
       2009  |   .0736379   .0167996     4.38   0.000     .0407004    .1065754
       2010  |   .0800852   .0169996     4.71   0.000     .0467556    .1134148
```

```
       2011  |   .0680091   .0168615     4.03   0.000     .0349502     .101068
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       2016  |   .1565615   .0338673     4.62   0.000     .0901606    .2229624
       2017  |   .0426292   .0686421     0.62   0.535    -.0919517    .1772101
             |
       _cons |   .0244226   .0231646     1.05   0.292    -.0209944    .0698395
-------------+----------------------------------------------------------------
     sigma_u |  .22952773
     sigma_e |  .15187368
         rho |  .69549777   (fraction of variance due to u_i)
------------------------------------------------------------------------------
```

(Table L)