Cointegration Analysis of Leverage

Stoyu I. Ivanov
Nancie Fimbel Investment Fellow
Associate Professor
San José State University
Accounting and Finance Department
Lucas College and Graduate School of Business
One Washington Square
San José, CA 95192-0066
Phone: (408) 924-3465
Email: stoyu.ivanov@sjsu.edu

Abstract

In this study we attempt to identify aggregate and industry optimal capital structure. We study total aggregate assets and liabilities empirically because of the popular leverage metric, total debt ratio, which is total liabilities divided by total assets, by using the tools of cointegration analysis. We document that a long-run relation exists between total assets and total liabilities, which implies that optimal capital structure exists at the aggregate level. Industry level, annual and size analyses provide additional evidence for the existence of leverage optimality. Optimality of capital structure has been a widely discussed topic in the finance literature. If indeed, optimal capital structure exists, in the real non-perfect world, that would imply that a certain relation exists between the elements of capital structure over the long-run. That is, optimality suggests stability, predictability and thus some form of a relation between the components of capital structure. If such a relation does not exist then that would imply randomness and thus lack of stability, predictability and optimality.

Keywords: assets, debt, leverage, cointegration, VECM
JEL Classification: G30, G35

I. Introduction

Optimal cpaital structure has been extensively studied in the finance literature ever since Modegliani and Miller (1958) made their famous discovery. Modigliani and Miller (1958) concluded that financial leverage does not affect the firm's market value. Naturally, this conclusion was based on very restrictive assumptions that in the real world do not necessarily hold. The fact that capital markets are not perfect, that investors do not have homogenous expectations, that there are taxes, transaction costs, bankruptcy costs and preferential tax treatment of interest suggest that in the real world there might be such thing as an optimal capital structure, i.e. there is an optimal level of leverage, which maximizes firm value.

Francis and Leachman (1994) expand the discussion in the area of optimal capital structure by examining it at the aggregate long-run eaquilibrium level. At the end of their study Francis and Leachman (1994) conclude: “Clearly, further research is needed on the determinants of these common trends.“ In this study, we attempt to fill this void in the literature by extending their ideas and providing an alternative way of studying the long-run relation equilibrium and optimal capital structure by examining the relation between aggregate assets and liabilities by using cointegration methods.

If indeed, optimal capital structure does exist in the real non-perfect world that would imply that a certain relation exists between the elements of capital structure over the long-run. That is, optimality suggests stability, predictability and thus some form of a relation. If such a relation does not exist then that would imply randomness and thus lack of stability, predictability and optimality. A popular measure of leverage is the total debt ratio, i.e. the ratio of total liabilities to total assets, therefore we study the relation of total aggregate assets and total debt empirically.

We document that the long-term relation between total assets and total liabilities results in a leverage ratio of about 86%. This seems to be a higher numberrelative to the historic total debt ratio average of 69%. Industry level analysis suggests that the leverage ratio for Basic Materials is 63.16%, for Capital Goods is 92.99%, for Communication Services is 85.42%, for Consumer Cyclicals is 49.89%, for Consumer Staples is -93.4% (which is surprising), for Energy is 80.04%, for Heatlh Care is 91.59%, for Technology is 78.52%, for Transportation is 54.33% and for Utilities is 46.01%. The indsutry level analysis suggests that only Financials have no optimal leverage ratio. Annual analysis suggests that optimal leverage ratios in the later sample are different from the leverage ratios in the early years of the sample. Size analysis provides evidence that only large companies have optimal leverage ratios.

II. Literature Review

García Padrón, María Cáceres Apolinario, Maroto Santana, Concepción Verona Martel & Jordán Sales (2005), Abor (2005), Ebel Ezeoha (2008), El-Sayed Ebaid (2009), Lee and Moon (2011), Shyu (2013), Dawar (2014) and Nguyen (2017) discuss the role that capital structure and leverage play in the value of the corporation.

Francis and Leachman (1994) expand the leverage discussion in the area of optimal capital structure by examining it at the aggregate long-run eaquilibrium level. They use the tools of cointegration analysis to address the issue of factors causing optimal capital structure. They test four hypotheses related to the four categories of factors influencing capital structure. Something else which is important for the motivation of this study is the argument that they make in that most capital structure studies are cross-sectional and very few use the tools of time-series analysis and are at the aggregate level.

Francis and Leachman (1994) use ideas developed by Fischer, Heinkel and Zechner (1989) in that Fischer, Heinkel and Zechner (1989) suggest that firms do not have a single level of optimal capital structure but rather a range of levels, which bounds the capital structure. The fluctuation happens over time and as such requires time-series analysis, which cross-section studies naturally ignore. In this study, we attempt to fill this void in the literature by extending their ideas and providing an alternative way of studying the long-run equilibrium capital structure by examining the relation between aggregate assets and debt across time directly.

Several studies have utilized the tools of dynamic modeling, but not cointegration, to incorporate time-series into cross-section data such as Zwiebel (1996), Goldstein, Ju and Leland(2001), Guha-Khasnobis and Bhaduri (2002) who study a panel data of capital structure choice. To the best of our knowledge this is the first study to examine directly the relation of aggregate level assets and debt across time with cointegration tools.

III. Methodology

As customary in the study of cointegration, we use standard Augmented Dickey Fuller and Phillips-Perron Unit Root tests to check for stationarity in the assets and debt first. Both tests use a null hypothesis of unit roots. Stationarity is necessary in statistical analysis to be able to conduct simple ANOVA, correlation and regression analysis. If the series are stationary cointegration methodology cannot be used. However, most likely the assets and debt series are integrated and therefore we rely on the Granger representation theorem (Engle and Granger, 1987) to study the relation between the two series since with integrated series ANOVA is meaningless. The Granger representation theorem states that when two series are integrated a cointegration of order 'k' can be estimated for their relation. Thus, we use the Johansen Cointegration Test to establish the rank of cointegration and a vector error correction model VECM(p) to estimate the best and most parsimonious fitting model for this relation. A VECM(p) with the cointegration rank r<=k can be expressed as:

$$\Delta y_t = \delta + \Pi y_{t-1} + \sum_{i=1}^{p-1} \Phi_i^* \Delta y_{t-i} + \varepsilon_t , \tag{1}$$

where Δ is the difference operator, $\Pi = \alpha\beta'$, where α and β are k*r matrices and α is the adjustment coefficient and β is the long-run parameter.

To choose the best and most parsimonious fitting model we use the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC). This model is then used to represent the relation between assets and liabilities. AIC measures the relative quality of a statistical model by controlling for the number of variables used. It is therefore used to establish the quality of each model, relative to other competing models. SBC also controls for number of parameters used and both AIC and SBC introduce a penalty term for the number of parameters in each model-candidate. The penalty is larger in SBC than in AIC, thus making SBC a more conservative criterion. The lower the value of AIC or SBC the more parsimonious the model. The long-run relation between assets and debt estimated using the cointegration tools, if statistically significant, can then be used to find the ratio of assets and debt and as such leverage and capital structure as defined by the total debt ratio.

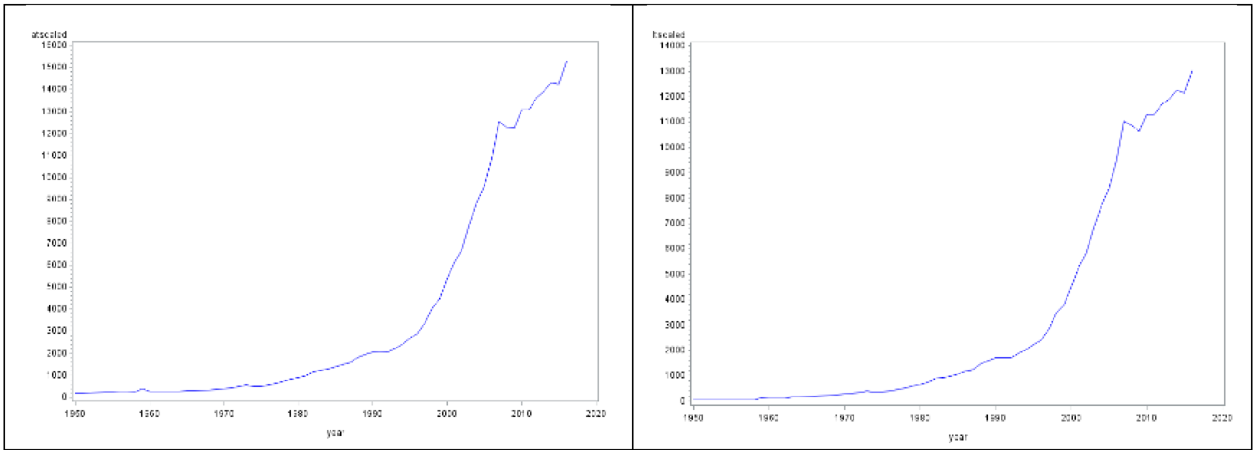
IV. Data and Analysis

The data in this study are from Compustat and cover the period 1950 to 2016. We use total company assets and total liabilities on annual basis for the period 1950 to 2016. Naturally, the aggregation needs to used carefully since when adding across time accounts also for the increased number of firms across time. For example, in 1950 there were 607 Compustat reporting firms, in 1983 there were 8364 firms and in 2016 there were 11,732 Compustat reporting firms. Therefore, in the rest of the analysis we scale assets and liabilities by the number of firms in the year. Summary statistics on the data used in the analysis are provided in Table 1. The average historic total debt ratio is 69% and the median is 77%.

Table 1. Summary Statistics.

Variable	N	Mean	Median	Minimum	Maximum	Std Dev	Skewness	Kurtosis
atscaled	67	3,625.24	1,214.95	150.42	15,270.39	4,791.70	1.34	0.26
ltscaled	67	3,061.44	936.67	45.85	13,035.98	4,175.71	1.33	0.20
tdr	67	0.69	0.77	0.24	0.88	0.21	-1.25	0.12

Note: atscaled is total annual assets scaled by number of firms that year, dlttscaled is total annual long term debt scaled by number of firms that year, ltscaled is total annual liabilities scaled by number of firms that year, tdr is total debt ratio (total liabilities divided by total assets).



Total Assets Scaled By Number Of Firms In The Year	Total Liabilities Scaled By Number Of Firms In The Year

Figure 1. Total Assets and Total Liabilities, Scaled.

Figure 1 displays visually the intertemporal behavior of the scaled by number of firms annual total assets and liabilities. Clearly, there are trends in both series. Nevertheless, as standard in the cointegration analysis methodology, we also formally test for the presence of nonstationarty. We use the standard Augmented Dickey Fuller and Phillips-Perron Unit Root tests. Both tests have a null hypothesis of unit roots. Table 2 reports results of those tests and shows that both tests fail to reject the null hypothesis of unit roots in assets and debt in each of the three model specifications.

Since the series are non-stationary we cannot use simple ANOVA analyis to draw conclusions with regards to their relation. Non-stationarity of each series can be better studied with the methods of cointegration as defined by the Granger representation theorem (Engle and Granger, 1987).

Table 2. Unit Root Tests.

		Dickey-Fuller Unit Root Tests				**Phillips-Perron Unit Root Test**			
Variable	**Type**	**Rho**	**Pr < Rho**	**Tau**	**Pr < Tau**	**Rho**	**Pr < Rho**	**Tau**	**Pr < Tau**
atscaled	**Zero Mean**	3.37	0.9991	3.58	0.9999	3.3266	0.9991	6.1229	1
	Single Mean	2.72	0.9992	2.76	0.9999	2.7306	0.9992	4.1034	1
	Trend	0.11	0.996	0.08	0.9965	0.3505	0.997	0.3038	0.9983
ltscaled	**Zero Mean**	3.28	0.999	3.25	0.9996	3.2362	0.9989	5.5415	1
	Single Mean	2.56	0.9989	2.44	0.9999	2.5911	0.999	3.6763	1
	Trend	-0.21	0.9942	-0.14	0.9931	0.0853	0.9959	0.0669	0.9964

Note: atscaled is total annual assets scaled by number of firms that year, ltscaled is total annual liabilities scaled by number of firms that year.

Thus, we next proceed with formally testing for cointegration between each of the two series. Table 3 reports the Johansen Cointegration Test results on scaled total assets and total liabilities. Panel A displays the unrestricted test and Panel B the restricted test. Both test results suggest rejection of no-cointegration, which suggests that optimality on the aggregate level might exist, since there is a predictable long-run relation between aggregate liabilities and assets.

Table 3. Johansen Trace Cointegration Test Results, Total Assets to Total Liabilities, Scaled.

Panel A. Cointegration Rank Test Using Trace.

Cointegration Rank Test Using Trace						
H0: Rank=r	**H1: Rank>r**	**Eigenvalue**	**Trace**	**Pr > Trace**	**Drift in ECM**	**Drift in Process**
0	**0**	0.347	26.545***	0.0006	Constant	Linear
1	**1**	0.002	0.1255	0.7229		

Panel B. Cointegration Rank Test Using Trace Under Restriction.

Cointegration Rank Test Using Trace Under Restriction						
H0: Rank=r	**H1: Rank>r**	**Eigenvalue**	**Trace**	**Pr > Trace**	**Drift in ECM**	**Drift in Process**
0	**0**	0.3472	27.9525***	0.0036	Constant	Constant
1	**1**	0.024	1.5071	0.8718		

Panel C. Long-Run Parameter Beta Estimates, When RANK=1

Variable	1
ltscaled	1.00000
atscaled	-0.85679

Note: atscaled is total annual assets scaled by number of firms that year, ltscaled is total annual liabilities scaled by number of firms that year. ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

Panel C of the same table reports that the equilibrium long-term relation between liabilities and debt based on the long-run parameter beta estimates is liabilities=0.85679*assets, which implies that the long-term leverage ratio is about 86% (as computed based on the total debt ratio, total liabilities divided by total assets). This seems to be a higher when compared to the historic total debt ratio average of 69% from Table 1. This might be due to the aggregate nature of the analysis and the fact that this is a forecasting model. At least, with establishing that a statistically significant relation exists, based on the cointegration methodology, we can argue that in the real world some form of optimal capital structure does exist. This is a direct proof of optimality and contrary to the theoretical models developed by Modigliani and Miller (1958).

Table 4 reports the VECM parameter estimates of the most parsimonious fitting model of the relation between total assets and total liabilities. The AIC and SBC values are 18.06 and 18.63, respectively.

Table 4. VECM Model Parameter Estimates.

Equation	Parameter	Estimate	Pr > |t|	Variable
D_ltscaled	**CONST1**	-195.0513***	0.0045	1
	AR1_1_1	-2.2605		ltscaled(t-1)
	AR1_1_2	1.9368		atscaled(t-1)
	AR2_1_1	-1.1133	0.2208	D_ltscaled(t-1)
	AR2_1_2	1.3978*	0.0940	D_atscaled(t-1)
	AR3_1_1	1.9089**	0.0349	D_ltscaled(t-2)
	AR3_1_2	-1.5920*	0.0514	D_atscaled(t-2)
	AR4_1_1	-3.5276***	0.0001	D_ltscaled(t-3)
	AR4_1_2	3.5851***	0.0001	D_atscaled(t-3)
	AR5_1_1	1.4258*	0.0740	D_ltscaled(t-4)
	AR5_1_2	-0.8643	0.2351	D_atscaled(t-4)
D_atscaled	**CONST2**	-182.9067**	0.0170	1
	AR1_2_1	-2.2100		ltscaled(t-1)
	AR1_2_2	1.8936		atscaled(t-1)
	AR2_2_1	-1.4328	0.1645	D_ltscaled(t-1)
	AR2_2_2	1.6353*	0.0835	D_atscaled(t-1)
	AR3_2_1	2.0144**	0.0484	D_ltscaled(t-2)
	AR3_2_2	-1.6366*	0.0756	D_atscaled(t-2)
	AR4_2_1	-3.9008***	0.0001	D_ltscaled(t-3)
	AR4_2_2	3.9767***	0.0001	D_atscaled(t-3)
	AR5_2_1	1.3516	0.1325	D_ltscaled(t-4)
	AR5_2_2	-0.7726	0.3467	D_atscaled(t-4)

Note: atscaled is total annual assets scaled by number of firms that year, ltscaled is total annual liabilities scaled by number of firms that year. ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

V. Industry Analysis

Starting with DeAngelo and Masulis (1980) the argument that different industries exhibit different levels of leverage cannot be ignored. Therefore, it is natural that one might argue that each industry might have its own optimal leverage ratio. Therefore, next we address the issue that leverage ratios vary across industries by using the S&P – spcseccd Code for Economic Sectors, which include 970 Basic Materials, 925 Capital Goods, 974 Communication Services, 976 Consumer Cyclicals, 978 Consumer Staples, 935 Energy, 800 Financials, 905 Health Care, 940 Technology, 600 Transportation, 700 Utilities.

Table 5. Industry Analysis Results.

	Cointegration Rank Test Using Trace					**Cointegration Rank Test Using Trace Under Restriction**						
	Drift in ECM Constant, Drift in Process Linear					**Drift in ECM Constant, Drift in Process Constant**						
Code	**H0: Rank =r**	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**H0: Rank =r**	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**Long-Run Parameter Beta Estimates When RANK=1**	
970	**0**	**0**	0.5635	77.2489 ***	<.0001	**0**	**0**	0.5641	82.882 ***	<.0001	**ltscaled**	1
	1	**1**	0.3277	25.0188 ***	<.0001	**1**	**1**	0.3845	30.576 ***	<.0001	**atscaled**	-0.6316
925	**0**	**0**	0.3382	26.5267 ***	0.0006	**0**	**0**	0.3403	27.8996 ***	0.0036	**ltscaled**	1
	1	**1**	0.015	0.9359	0.3334	**1**	**1**	0.0335	2.1105	0.7554	**atscaled**	-0.9299
974	**0**	**0**	0.7414	92.4507 ***	<.0001	**0**	**0**	0.7971	109.374 ***	<.0001	**ltscaled**	1
	1	**1**	0.0472	3.1938 *	0.074	**1**	**1**	0.0603	4.1035	0.3973	**atscaled**	-0.8542
976	**0**	**0**	0.3692	33.3527 ***	0.0001	**0**	**0**	0.3701	33.9405 ***	0.0002	**ltscaled**	1
	1	**1**	0.0742	4.7806*	0.0287	**1**	**1**	0.0817	5.283	0.2536	**atscaled**	-0.4989
978	**0**	**0**	0.408	38.268 ***	<.0001	**0**	**0**	0.4082	39.0612 ***	0.0001	**ltscaled**	1
	1	**1**	0.071	4.7127 *	0.0299	**1**	**1**	0.0822	5.4882	0.2339	**atscaled**	0.9340
935	**0**	**0**	0.2931	26.3368 ***	0.0006	**0**	**0**	0.3012	30.0664 ***	0.0013	**ltscaled**	1
	1	**1**	0.0688	4.4886 *	0.034	**1**	**1**	0.1121	7.4916	0.1028	**atscaled**	-0.8004
800	**N.A.**											
905	**0**	**0**	0.5992	58.5145 ***	<.0001	**0**	**0**	0.5995	59.571 ***	<.0001	**ltscaled**	1

	1	**1**	0.0001	0.007	0.9337	**1**	**1**	0.0157	1.0128	0.9491	**atscaled**	-0.9159
940	**0**	**0**	0.502	47.8668 ***	<.0001	**0**	**0**	0.5024	48.6824 ***	<.0001	**ltscaled**	1
	1	**1**	0.0494	3.2436 *	0.0718	**1**	**1**	0.0607	4.0107	0.411	**atscaled**	-0.7852
600	**0**	**0**	0.6499	74.7934 ***	<.0001	**0**	**0**	0.6667	78.255 ***	<.0001	**ltscaled**	1
	1	**1**	0.0962	6.5739 *	0.0104	**1**	**1**	0.0998	6.8314	0.1353	**atscaled**	-0.5433
700	**0**	**0**	0.6015	61.6251 ***	<.0001	**0**	**0**	0.7455	90.5801 ***	<.0001	**ltscaled**	1
	1	**1**	0.0564	3.659	0.0558	**1**	**1**	0.0671	4.3764	0.3594	**atscaled**	-0.4601

Note: Codes - 970 Basic Materials, 925 Capital Goods, 974 Communication Services, 976 Consumer Cyclicals, 978 Consumer Staples, 935 Energy, 800 Financials, 905 Health Care, 940 Technology, 600 Transportation, 700 Utilities. ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

Based on the Long-Run Parameter Beta estimate from Table 5 the statistically significant leverage ratios based on the total debt ratio are as follows – for Basic Materials 63.16%, Capital Goods 92.99%, Communication Services 85.42%, Consumer Cyclicals 49.89%, Consumer Staples -93.4% (which is surprising), Energy 80.04%, Financials (none), Heatlh Care 91.59%, Technology 78.52%, Transportation 54.33% and Utilities 46.01%. The results suggest that only Financials have no optimal leverage ratio.

VI. Year Analysis

Some might argue that the temporal behavior of aggregate assets and liabilities might have changed across time therefore we split the sample into two groups, 1950-1983 and 1984-2016, across the years of the study. The statistically significant relation between assets and liabilities exists even when the sample is divided. Results are presented in Table 6, they suggest that in the later part of the sample, 1984-2016, the leverage ratio is 85.24%, whereas in the earlier part of the sample, 1950-1983, the leverage ratio is -164.9%, which is surprising.

Table 6. Year Analysis Results.

	Cointegration Rank Test Using Trace					**Cointegration Rank Test Using Trace Under Restriction**						
	Drift in ECM, Constant, Drift in Process Linear					Drift in ECM Constant, Drift in Process Constant						
	H0: Rank =r	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**H0: Rank= r**	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**Long-Run Parameter Beta Estimates When RANK=1**	
1984-2016	**0**	**0**	0.4645	19.3859 *	0.0118	**0**	**0**	0.6211	32.7962 ***	0.0003	**ltscaled**	1
N=33	**1**	**1**	0.0008	0.0251	0.8744	**1**	**1**	0.0839	2.7151	0.6349	**atscaled**	-0.85
1950-1983	**0**	**0**	0.3955	19.4467 *	0.0115	**0**	**0**	0.6064	33.6092 ***	0.0002	**ltscaled**	1
N=34	**1**	**1**	0.0824	2.8368*	0.0922	**1**	**1**	0.0825	2.8407	0.6107	**atscaled**	1.649

Note: ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

VII. Size Analysis

Next, we proceed with size analysis considering the possibility that optimal leverage might exist only for large firms. The sample break downs into quartiles are based on total asset size. The maximum asset size (in millions) is 3,771,199.852, the 75% (Q3) quartile is at a maximum asset value of 849.234, the median 50% (Q2) quartile is at a maximum asset value of 122.257, the 25% (Q1) quartile is at a maximum asset value of 18.469.

We document that only large firms have a statistically significant rejection of no cointegration as presented in Table 7, and thus as statistically significant relation between assets and liabilities. The optimal leverage ratio for large firms is 85.91%, which is similar in magnitude to the total sample result of 85.679%, which suggests that large firms are driving the results. This also suggests that optimal capital structure might not exists for small firms.

Table 7. Size Analysis Results.

	Cointegration Rank Test Using Trace					**Cointegration Rank Test Using Trace Under Restriction**						
	Drift in ECM, Constant, Drift in Process Linear					Drift in ECM Constant, Drift in Process Constant						
	H0: Rank =r	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**H0: Rank =r**	**H1: Rank >r**	**Eigen value**	**Trace**	**Pr > Trace**	**Long-Run Parameter Beta Estimates When RANK=1**	
Q4	**0**	**0**	0.3229	25.4632 ***	0.0008	**0**	**0**	0.3819	34.2238 ***	0.0002	**ltscaled**	1
	1	**1**	0.0018	0.1157	0.7337	**1**	**1**	0.0444	2.9517	0.5897	**atscaled**	-0.8591
Q3	**0**	**0**	0.0394	2.9283	0.9700	**0**	**0**	0.0825	7.0277	0.8953	**ltscaled**	1
	1	**1**	0.0042	0.2770	0.5985	**1**	**1**	0.0202	1.3448	0.8999	**atscaled**	-0.5509
Q2	**0**	**0**	0.1309	15.1377	0.0564	**0**	**0**	0.1520	16.7685	0.1408	**ltscaled**	1
	1	**1**	0.0884	6.0148*	0.0141	**1**	**1**	0.0889	6.0522	0.1865	**atscaled**	5.7402
Q1	**0**	**0**	0.0573	5.6434	0.7369	**0**	**0**	0.0590	7.4565	0.8661	**ltscaled**	1
	1	**1**	0.0274	1.8050	0.1788	**1**	**1**	0.0525	3.5065	0.4909	**atscaled**	-0.1697

Note: Q4 – Largest Firms, Q1 – Smallest Firms. ***, **, * represent statistical significance at the 1, 5 and 10% confidence level.

VIII. Conclusion

We study total aggregate assets and liabilities empirically because a popular measure of leverage is the total debt ratio. We document that a long-run relation exists between total assets and total liabilities, which implies that optimal capital structure exists at the aggregate level. Industry level analysis suggests that the leverage ratio for Basic Materials is 63.16%, for Capital Goods is 92.99%, for Communication Services is 85.42%, for Consumer Cyclicals is 49.89%, for Consumer Staples is -93.4% (which is surprising), for Energy is 80.04%, for Heatlh Care is 91.59%, for Technology is 78.52%, for Transportation is 54.33% and for Utilities is 46.01%. The indsutry level analysis suggests that only Financials have no optimal leverage ratio. Annual analysis suggests that optimal leverage ratios in the later sample are different from the leverage ratios in the early years of the sample. Size analysis provides evidence that only large companies have optimal leverage ratios and thus optimal capital structure.

References

Abor, J. (2005). The effect of capital structure on profitability: an empirical analysis of listed firms in Ghana. *The Journal of Risk Finance,* 6(5), 438-445.

Dawar, V. (2014). Agency theory, capital structure and firm performance: some Indian evidence. *Managerial Finance*, 40(12), 1190-1206.

DeAngelo, H., & Masulis, R. W. (1980). Optimal capital structure under corporate and personal taxation. *Journal of Financial Economics*, 8(1), 3-29.

Ebel Ezeoha, A. (2008). Firm size and corporate financial-leverage choice in a developing economy: Evidence from Nigeria. *The Journal of Risk Finance*, 9(4), 351-364.

El-Sayed Ebaid, I. (2009). The impact of capital-structure choice on firm performance: empirical evidence from Egypt. *The Journal of Risk Finance*, 10(5), 477-487.

Engle, Robert, and C. W. J. Granger. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica,* Vol. 55, No. 2, pp. 251-276.

Fischer, E. O., Heinkel, R., & Zechner, J. (1989). Dynamic capital structure choice: Theory and tests. *The Journal of Finance*, 44(1), 19-40.

Francis, B. B., & Leachman, L. L. (1994). A time-series approach to exploring aggregate optimal capital structure: cointegration analysis. *Applied Financial Economics*, *4*(1), 41-54.

García Padrón, Y., María Cáceres Apolinario, R., Maroto Santana, O., Concepción Verona Martel, M., & Jordán Sales, L. (2005). Determinant factors of leverage: An empirical analysis of Spanish corporations. *The Journal of Risk Finance*, 6(1), 60-68.

Goldstein, R., Ju, N., & Leland, H. (2001). An EBIT-based model of dynamic capital structure. *The Journal of Business*, 74(4), 483-512.

Guha-Khasnobis, B., & Bhaduri, S. N. (2002). Determinants of capital structure in India (1990-1998): a dynamic panel data approach. *Journal of Economic Integration*, 761-776.

Lee, H., & Moon, G. (2011). The long-run equity performance of zero-leverage firms. *Managerial Finance*, 37(10), 872-889.

Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review*, 48(3), 261-297.

Nguyen, P. (2017). Asset risk and leverage under information asymmetry. *The Journal of Risk Finance*, 18(3), 303-310.

Shyu, J. (2013). Ownership structure, capital structure, and performance of group affiliation: Evidence from Taiwanese group-affiliated firms. *Managerial Finance,* 39(4), 404-420.

Zwiebel, J. (1996). Dynamic capital structure under managerial entrenchment. *The American Economic Review*, 1197-1215.