

What is the relationship between asset liquidity and capital structure in each business life cycle stages?

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Method and initial Results

Data

The sample data contains of all active U.S firms with financial statement, cash flow statement and income statement available from the Compustat Capital IQ- Fundamentals Annual Full Coverage during the period 1995 to 2017.5. The data has 813 variables including all information of financial statement, cash flow statement and income statement and there are 121,281 firm-year observations with 9,872 companies. I used to classify industry of every company using two-digit Standard Industrial Classification (SIC) into 13 categories. At this stage, I did not exclude any companies that belong to certain industry. I omit missing data in the variable Sale by 21,921 firm-year observation. The availability of sale growth rate estimate, life cycle index, liquidity index and other variables used in the analysis reduces the sample size by 12,420 firm-year observation. The final sample data contains 86,940 firm-year observations with 7,044 companies. Additionally, I exclude observed outliers using the variable Industry adjusted sale growth rate in the data. Descriptive statistics for the sample data are reported in Table1. The key variables in Table1 include the control variables that has proven to be related with the leverage such as profitability, sales growth and capital expenditures. The sample data and the key variables that used in Table1 includes a whole range of firm-year observation and is not separated by any characteristics and classifications of companies.

TABLE1
Summary Statistic

Table 1 reports data from Compustat Industrial Annual files (1995-2017). The key variable definitions used in this table will be in Appendix A.

Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/Total book assets	0.077	0.212	0.280	0.418	0.25
Total debt/Total book assets	0.000	0.038	1.334	0.198	39.33
Total assets	88	635	15296	3464	111798.02
R&D-to-sales	0.000	0.030	4.520	0.150	159.46
Capital expenditures/Total book assets	0.029	0.078	0.310	0.231	1.83
Market-to-book	1.3	2.7	34.2	5.7	2935.01
PPE/ Total book assets	0.937	0.937	3.376	2.939	16.92
EBIT/ Total book assets	-0.055	0.159	-1.112	0.360	35.84
Industry adjusted sale growth rate(%)	-11.018	-0.244	21.193	14.196	210.89
Liquidity Index	0.5087	0.5279	0.5626	0.5797	0.09

Details of Life cycle stage Index

Life cycle stage index is an important computation index in the research. The firm life cycle stages have important meanings for understanding firm's performance, researchers have developed many different methods to measure firm life cycle stages (Anthony and Ramesh (1992)). I choose the method introduced by Yan et al (2009) that considers the applicability of large sample of firms and specific development path of each firm. Following Yan et al (2009), I will divide the firm life cycle as five stages: Start-up, Growth, Mature, Revival and Decline.

In this paper, I mainly follow their methodology. At the same time, I modified their method considering the characteristic of our sample data set. According to their method, I employ firm age and sales growth as classification variables. Following are steps to get life cycle index.

Step1: Measure yearly industry adjusted sale growth rate.

Sale growth rate defines as below:

$$SG_t = (Sales_t - Sales_{t-1}) / Sales_{t-1}$$

where $Sales_t$ denotes sales in year t .

Industry adjusted sale growth rate defines as below:

$$\text{Industry adjusted sale growth rate} = \frac{\text{the firms' sales growth} - \text{industry median sales growth rate}}{\text{industry median sales growth rate}}$$

The industry medians are computed at the two-digit SIC level and yearly.

Step2: Aggregate all yearly industry adjusted sale growth rate by each company and compute mean Industry adjusted sale growth rate.

Step3: Employ two numeric criteria to count of firm-year observation and mean Industry adjusted sale growth rate.

As I do not have all IPO date for all companies in the sample data, I simply count firm-year observations of each companies. If the count is less than 4 years, it has classified as start-up stage. This count of firm-year observation is used as criterion only in start-up stage. A mean Industry adjusted sale growth rate criterion is used in classifying growth (>67%), maturity (33%~67%), revival (0%~33%), decline (<0%).

Based on these steps I calculated life cycle index using the sample data, consequently the firms classified into one of the five life cycle stages. Table2 shows that the lifecycle stage index observations and its percentile. The number of total companies are 7,044 and the number of companies in Revival stage is 2,744(39%) and the number of companies in Decline stage is 2,033(28.9%).

TABLE2				
Life cycle stage index observations				
Start-up	Growth	Maturity	Revival	Decline
1235	592	440	2744	2033
(17.5%)	(8.4%)	(6.2%)	(39%)	(28.9%)

In the result tables, the Industry adjusted sale growth rate quantiles are not consistent with criterion of life cycle index since the sample data is based on firm-year observations. Descriptive statistics for Start-up stage firms are reported in Table3.

TABLE3					
Summary Statistic of Start-up stage firms					
Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/Total book assets	0.1114	0.3386	0.4079	0.6897	0.32
Total debt/Total book assets	0.000	0.0617	5.1478	0.5434	43.12
Total assets	6	75.3	3744	578	62600.71
R&D-to-sales	0.006	0.143	27.444	1.329	264.92
Capital expenditures/Total book assets	0.0074	0.0462	0.6793	0.1849	7.74
Market-to-book	2.2	5.3	729.9	17.1	16954.74
PPE/ Total book assets	0.1028	0.4818	5.4040	2.0616	35.42
EBIT/ Total book assets	-2.0753	-0.3400	-11.2166	0.1595	83.38
Industry adjusted sale growth rate(%)	-19.908	3.772	96.101	45.103	480.11
Liquidity Index	0.5109	0.5377	0.6028	0.6465	0.13

Descriptive statistics for Growth stage firms are reported in Table4.

TABLE4					
Summary Statistic of Growth stage firms					
Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/ Total book assets	0.1842	0.4139	0.4537	0.7182	0.31
Total debt/ Total book assets	0.0000	0.0125	3.7497	0.2627	42.14
Total assets	7.23	49.01	1744.48	290.77	1744.48
R&D-to-sales	0.052	0.314	15.362	2.210	127.59
Capital expenditures/Total book assets	0.0080	0.0330	0.3491	0.1262	2.44
Market-to-book	1.2	61.5	79.6	258.9	14033.02
PPE/ Total book assets	0.1279	0.3677	3.0832	1.3552	22.13
EBIT/ Total book assets	-1.3863	-0.4230	-5.1715	-0.0053	44.51
Industry adjusted sale growth rate(%)	-27.072	9.528	280.187	94.058	1318.11
Liquidity Index	0.5250	0.5851	0.6313	0.7011	0.13

Descriptive statistics for Maturity stage firms are reported in Table5.

TABLE5					
Summary Statistic of Maturity stage firms					
Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/ Total book assets	0.1448	0.3373	0.3868	0.6040	0.28
Total debt/ Total book assets	0.0000	0.0152	1.0274	0.2199	8.76
Total assets	26	208.1	5330.8	1422.2	43243.13
R&D-to-sales	0.0145	0.1305	3.9377	0.3853	42.54
Capital expenditures/Total book assets	0.0152	0.0486	0.4075	0.1601	1.85
Market-to-book	11.7	71.4	127.4	271.4	9485.77
PPE/ Total book assets	0.1609	0.4301	4.0136	1.3549	30.66
EBIT/ Total book assets	-0.5653	-.0410	-1.6318	0.1914	45.50
Industry adjusted sale growth rate(%)	-9.864	12.737	46.330	55.507	134.06
Liquidity Index	0.5132	0.5559	0.5991	0.6479	0.11

Descriptive statistics for Decline stage firms are reported in Table6.

TABLE6					
Summary Statistic of Revival stage firms					
Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/ Total book assets	0.081	0.215	0.270	0.406	0.23
Total debt/ Total book assets	0.000	0.031	0.418	0.162	14.20
Total assets	155	776	16880	3644	119557.21
R&D-to-sales	0.000	0.025	0.513	0.120	16.56
Capital expenditures/Total book assets	0.035	0.087	0.313	0.251	0.94
Market-to-book	17	65	802	223	54557.82
PPE/ Total book assets	0.359	0.881	3.047	2.870	7.18
EBIT/ Total book assets	0.046	0.202	-0.054	0.394	12.76
Industry adjusted sale growth rate(%)	-7.697	2.726	8.894	17.009	41.27
Liquidity Index	0.5088	0.5275	0.5561	0.5744	0.07

Descriptive statistics for Decline stage firms are reported in Table7.

TABLE7					
Summary Statistic of Decline stage firms					
Statistics	Quartile1	Median	Mean	Quantile3	Std Dev.
Cash holdings/ Total book assets	0.055	0.157	0.222	0.324	0.21
Total debt/ Total book assets	0.003	0.057	1.711	0.228	59.52
Total assets	37.27	270.65	2332.95	1215.66	122219.24
R&D-to-sales	0.004	0.020	5.212	0.067	256.56
Capital expenditures/Total book assets	0.035	0.088	0.248	0.243	1.08
Market-to-book	5.3	31.7	474.2	158.5	9450.89
PPE/ Total book assets	0.579	1.315	3.619	3.893	19.23
EBIT/ Total book assets	0.040	0.185	-0.0611	0.392	44.87
Industry adjusted sale growth rate(%)	-13.394	-4.518	-7.449	3.493	160.60
Liquidity Index	0.5071	0.5208	0.5476	0.5579	0.07

Figures in the results tables seems somewhat anomaly especially regarding the variables total assets and market-to-book. Standard deviations of two variables are relatively large comparing to other variables. It suggests that I need to exclude unusual and outliers in the data set and recheck the definition of variables with more accurate criterion.

Details of Liquidity Index

Many models are used to measure and test the relationship between asset liquidity and the leverage, one of the difficulties is attaining a measure of asset liquidity. Existing theories has tested the relationship between asset liquidity and capital structure using their own liquidity indexes, but those liquidity indexes are made for their specific purpose includes special samples of firm-size and assets (Kim (1998) and Alderson and Betker (1995)) so those indexes are not appropriate for our research.

Considering the innate characteristics of asset liquidity, I will follow the liquidity index introduced the firm-level weighted asset illiquidity index introduced by Ortiz-Molina and Phillips (2013) to measure firm-level liquidity and use as liquidity index. In this stage, to get the initial results I will use and modify second weighted asset liquidity index in their method which considers cash and equivalents and other noncash current

asset as primary liquidity index. Liquidity Index defines as below.

$$\text{Weighted asset liquidity index} = \left(\frac{\text{Cash \& Equivalent}}{\text{Total Assets}} \right) - 0.5 \left(\frac{\text{Noncash CA}}{\text{Total Assets}} \right)$$

Table8 showed that average liquidity index by life cycle stage. The largest average liquidity index is Growth stage, 0.6317. However, the average liquidity indexes across the life cycle stages do not have large differences.

TABLE8				
Average Liquidity index by life cycle stage				
Start-up	Growth	Maturity	Revival	Decline
0.6028	0.6317	0.6000	0.556434	0.5479

Methodology

To examine the relationship of asset liquidity and capital structure in each business life cycle, I performed multivariate regression analysis of the level of leverage on the liquidity index and control variables that has proven to be related with the leverage such as firm-size, sales growth and capital expenditures. The control variable definitions in this methodology are in Appendix A. The multiple regression model is specified as follows:

$$\text{Leverage} = \alpha + \beta_1 \text{Liquidity} + \beta_2 \text{R\&D to Sale} + \beta_3 \text{Market to book} + \beta_4 \text{PPE} + \beta_5 \text{EBIT}$$

At this time, to get the initial results I will apply the multiple regression model at Revival stage. Since the sample data set is not processed perfectly, the results would not be statistically significant.

TABLE9	
Determinants of Leverage at Revival stage	
Statistics	Coefficient(p-value)
Liquidity Index	-1.886 (4.6e-05)
R&D-to-sales	0.1075 (<2e-16)
Market-to-book	-8.543e-06 (0.15)
PPE/ Total book assets	-9.637e-07 (0.80)
EBIT/ Total book assets	-1.116e-05 (0.63)
Intercept	1.37 (5.5e-07)
Adjusted R^2	0.0198 (<2e-16)

The results appear in Table9. As I predicted in earlier, the results showed that the coefficient of primary explanatory variable Liquidity index is -1.886 and the P-value is 4.6e-05, so Liquidity Index is statistically significant variable in the testing model. However, Liquidity Index is negatively related with the response Leverage. When I see Adjusted R^2 , it is 0.0198 so I can not say the testing model explains the response Leverage well.

I will do not apply the testing model further into other life cycle stage dataset since Revival stage sample data has the least standard deviation in majority of variables. From this initial result, I had learned that I need to check the outliers in data set, and execute the data sampling again. In addition, I need to refine the criterion to select right variables in the database when I define the variable definitions.

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Appendix A

Table 1: Variable Definitions

Variable	Definitions
Cash holdings/ Total book assets	Cash / Book Equity
Total debt/ Total book assets	Total Debt / Book Equity
Total assets	Total Asset
R&D-to-sales	Research and Development Expense / Total Assets
Capital expenditures/ Total book assets	Capital expenditures / Total Assets
Market-to-book	Market equity / Book Equity
PPE/ Total book assets	Total Property, Plant and Equipment / Book Equity
EBIT/ Total book assets	EBIT/ Book Equity