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

Alice Mee Seon Chung

Abstract

This paper tests the relationship between asset liquidity and capital structure in each firm life cycle stages. Using data from all active companies of U.S from 1995 to 2017, I find that asset liquidity is negatively related to capital structure. Examined analysis shows that firms in decline stage have stronger relationship than in start-up stage. In addition, important determinants of capital structure found to have weak or no relationship with leverage. The results are consistent with the view that high asset liquidity reduces the firm's opportunity to commit to external financing actions.

Alice Mee Seon Chung
The University of Chicago
Masters in Computational Social Science
Saieh Hall Research Pavilion
5757 S. University Ave.
Chicago, IL 60637
alicechung@uchicag

I. Introduction

What important factors affect on capital structure to maximize firm values is one of constitutional question in corporate finance field. Different forms and types of financial funds affect capital structure of a firm. The theory on what factors affect on capital structure has been controversial debates and researches on capital structure has not reached to the conclusive results.

The liquidation value and liquidity is found to be an important determinant of capital structure. Asset loses its value when it is liquidated so it is imprecise to conclude that whether the asset affect a firm's capital structure. It is commonly accepted that the higher asset liquidity, the higher the liquidation value. Harris and Raviv (2001) argues that firms that have more tangible assets tend to have higher liquidation value of a firm and the liquidation level affect on capital structure strategy. By using U.S public companies, Sibilkov (2009) found that the relationship between asset liquidity and leverage is positive and this results are consistent with the view that the cost of financial distress and constraint are important and they affect on capital structure adjustment. Ortiz-Molina and Phillips (2013) also argue that asset liquidity lowers the implied cost of capital and increases firm's operating flexibility and leverage.

Many studies have tested the impact of asset liquidity on leverage and identified there is positive relationship between asset liquidity and capital structure, however the results are opposite in some researches. When the theory tested empirically in different countries and industries, the results showed that there is negative, weak or curvilinear relationship which means that the effect of asset liquidity is different from the results of past researches.

Firms also change capital structure over the life cycle. The firms in introduction stage usually have large share of assets and tend to borrow external finances than the firms decline stage so leverage in introduction stage is higher than the decline stage. DeHan (2014) argued and empirically showed that firms in highly innovative industries tend to have high leverage than the firms in mature industries and it is consistent with trade-off theory.

Previous studies mainly focused on modeling and testing hypothesis within particular spatial, industry-sectional and firm-type constraints. The researchers widely researched

the scope from Croatia small and medium sized firms (Harc (2015), private firms in 9 EU countries (Koralun-Breznicka (2013)), private firms in U.S. ((Campello and Giambona (2013), Frank and Goyal (2003) and Ortiz-Molina and Phillips (2014)) and U.S public companies (Sibilkov (2009). Existing studies that examine the relationship between asset liquidity and capital structure tend to limit their perspective to certain industries and firms. To extent existing research, our work will research on the relationship between asset liquidity and capital structure in firm life cycle stages.

Many different models and indexes are used to measure the relationship between asset liquidity and capital structure. Attaining the asset liquidity index is especially hard because there is no standard liquidity index. There are variety of sources that effect on firm's asset, so constructing the liquidity index is difficult. Considering this situation, I use the firm-level liquidity index that can calculate from Compustat data base. This asset liquidity index that measures the proportion of cash on the firm's balance sheet introduced by Gopalan et al (2012).

The case of constructing life cycle index is also in similar situation. There is no fixed life cycle index to calculate life cycle stage of firms. This is common since every industry has its own characteristic, so determining fixed life cycle index is difficult. Hence, I select the method introduced by Anthony and Ramesh (1992) since this method empirically tested in many researches. Based on this method I modified to include industry characteristics for each firms.

Using all active U.S companies in the period 1995 to 2017, I applied multivariate regression analysis to seek the relationship between asset liquidity index and capital structure in each life cycle stages. The model applied in regression analysis contains the dependent variable as *Leverage* and the primary explanatory variable as *Liquidity Index*. In addition, I include the control variables that are known as important determinants of capital structure; *R&D expenditure rate, Market-to-book ratio, PPE rate* and *EBIT rate.*

This paper differs from existing literature in two major ways. First, it is the first research on the relationship between asset liquidity and capital structure in the aspect of firm life cycle stages. Many studies only extend the theory on firm-size, industry and country levels (Harc, (2015), Koralun-Breznicka (2013), Campello and Giambona (2013), Frank and Goyal (2003), Ortiz-Molina and Phillips (2014), Sibilkov (2009)). This research will add empirical results to the existing results in different view. Second, this

research steps forward to apply more discrete life cycle stages than existing research. Past studies regarding firm life cycle stages only divide into two or three stages. This research is also different from other research since not many of studies provide their life cycle index in details. Some studies only describe the life stage as IPO company and old company or just interpreted the time-series graph of one company.

Through examination of the relation between asset liquidity index and capital structure with applying liquidity index and firm life cycle stage index, I find that asset liquidity is negatively related to capital structure. Additionally, the control variables which I consider in the model, *R&D expenditure rate, Market-to-book ratio, PPE rate* and *EBIT rate,* are found to be not closely related to capital structure. These findings are exactly opposite side of the hypotheses offered by Sibilkov (2009) that asset liquidity index is positively related with capital structure and the costs of financial distress and inefficient liquidation are economically important. However, these findings are consistent with the hypotheses argued by Myers and Rajan (1998) that asset liquidity reduces the firm's discretion to use external financing options.

The remainder of the paper is organized as follows. Section II includes the main hypotheses. Section III describes the sample data section procedure and the details of life cycle index and life cycle index. Section IV presents descriptive statistics applying two indexes. Section V presents the main empirical results using multivariate regression analysis. Section VI concludes the paper.

II. Main Hypotheses

A. Positive relationship between asset liquidity and capital structure

The positive relation between asset liquidity and leverage is consistent with trade-off theory. When investors or creditors offer financing to a firm, they observed the firm's financial statement and cash flow to examine their ability to pay back the principal and interest cost. The investors trade off the cost of default and potential growth of a firm. So as asset liquidity increases, the cost of default decreases.

Sibilkov (2009) and Ortiz-Molina and Phillips (2013) argued that asset liquidity increases leverage and there is positive relationship between asset liquidity and capital

structure. When a firm resell the asset, the asset value is often discounted and the procedure also costs the capital of company. Asset liquidity is related with the cost of capital, so the higher asset liquidity, the lower the capital of company. Shleifer and Vishny (1992) argued that asset liquidity affects the cost of distress since in economy-wide recession or when industry buyers are not allowed to bid, the assets fetch high discounted process when sold. With higher asset liquidity, a firm can reduce the cost of distress and a firm can use the cost to increase leverage. Sibilkov (2009) also found that asset liquidity affects the costs of financial distress. The cost of financial distress and inefficient liquidation are economically important determinants and they affect on capital structure.

B. Negative or weak relationship between asset liquidity and capital structure

Even though there are many evidences argued positive relationship between asset liquidity and capital structure, there are studies argued exactly opposite results. Morellec (2001) found that asset liquidity affects on capital structure only when bond covenant restricts the disposition of assets. This is because higher asset liquidity makes easy to resell asset and causes low cost on selling. So this trend affects in negative way on the credit of a firm. The firm size and firm-value will decrease and it will make firm's credit ratings lower. Morellec (2001) also predicted that when there is no relationship between collateral value and asset value and the relationship between asset liquidity and leverage is negative. Myers and Rajan (1998) argued that the greater asset liquidity reduces the firm's ability to commit to financial action. This is because even though a firm has high asset liquidity, the managers will not sell at low price.

C. The relationship between firm age and capital structure

Firms change their capital structure corresponding to their environments. It is commonly accepted that firms adjust their capital structure over firm life cycle. Ahmad and Wan Aris (2015) found that firm age plays an important role in the firm's decision to seek for debt financing. DeHan (2014) argued that firms in innovative industries have high leverage compared to the firms in mature industries. However, Pfaffermayr et al (2013) argued that firms' debt ratio is negatively associated with firm age.

My conceptual framework compiled up on the above hypotheses which emphasizes the positive relationship between asset liquidity and capital structure. High asset liquidity indicates high liquidation value of firm so it will positively affect on creditor's decision. Hence, younger firms tend to have high asset liquidity than old firms, which means that younger firms have stronger positive relation than old firms. This leads to main hypothesis: Firms in start-up stage have high correlation between asset structure and capital structure than firms in decline stage.

III. Data, Life Cycle Index and Asset Liquidity Index

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. The data has 813 variables including all information of financial statement, cash flow statement and income statement and there are 136,495 firm-year observations with 9,872 unique companies. I used to classify industry of every company using two-digit Standard Industrial Classification (SIC) into 13 categories. I omitted the missing values in the variables *sale growth rate* and *dividends*. This procedure reduces the sample size to 87,525 firm-year observation with 7,340 unique companies. Additionally, I exclude observed outliers using the variables *industry adjusted sale growth rate, total asset* and *liquidity* in the sample data with within 3 standard deviations. The final sample data contains 81,869 firm-year observations with 6,808 unique companies.

Descriptive statistics for the sample data are reported in Table 1. The key variables in Table 1 include the control variables that has proven to be related with leverage such as profitability, sales growth and capital expenditures rate. The sample data and the key variables that used in Table 1 includes a whole range of firm-year observation and is not separated by any characteristics and classifications of companies. The result seems anomaly especially regarding the variables *total assets* and *sales*. Standard deviations of two variables are relatively large comparing to other variables. First, it is because those variables use different unit compared to other variables. Second, it means the differences between the lowest and the highest variables are large.

TABLE 1
Summary Statistic

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.035	0.091	0.117	0.179	0.097
Total debt/Total book assets	0.003	0.137	0.208	0.301	0.271
Total assets	60	429	4,336	2,614	11,162
R&D-to-sales	0.001	0.001	0.609	0.100	5.480
Capital expenditures/Total book assets	0.014	0.030	0.045	0.056	0.056
Market-to-book	0.001	0.002	0.229	0.037	16.500
PPE/ Total book assets	0.203	0.411	0.487	0.702	0.693
EBIT/ Total book assets	0.003	0.104	-0.155	0.117	2.510
Sales	44	378	3,891	2,302	10,983
Liquidity Index	0.508	0.526	0.552	0.573	0.064

A. Details of Firm Life Cycle Index

Since the interest of this paper is the relationship between asset liquidity and capital structure in each firm life cycle stages, firm life cycle index is an important computation index in the research. I will divide the sample data using computed firm life cycle index into 5 groups (start-up, growth, mature, revival and decline), then continue testing the hypothesis on each sample data.

The firm life cycle stages have important meanings to understand firm's performance, researchers have developed many different methods to measure firm life cycle stages. I choose the criteria to divide and name the firm life cycle stages introduced by Yan et al (2009) which considers the 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.

To classify and compute firm life cycle index I followed the computation concept introduced by Anthony and Ramesh (1992). Based on this method I modified to include industry characteristics of each firm and the characteristic of the sample data set. Anthony and Ramesh (1992) used four classification variables: (1) annual dividend as a percentage of of income, (2) percent sales growth, (3) capital expenditure as a percentage of total

value of the firm and (4) age of the firm. I modified second variables to industry adjusted sales growth to consider industry level characteristic in the firm life cycle index. As original Method did not use five stages and classify start-up stage. I decide to apply four quartile scale (low, low-medium, high-medium and high) to give a score.

TABLE 2

Expectations for firm-specific descriptors of life cycle stages and a given score

DP, ISG and CEV refer to dividend payout rate, industry adjusted sales growth, capital expenditure divided by value of the firm, respectively.

	Life cycle descriptors and given score				
Life cycle stages	DP	ISG	CEV	Firm age	Given Score
Growth	Low	High	High	Young	1
Mature	Low-medium	High-medium	High-medium	Yong-Adult	2
Revival	High-medium	Low-medium	Low-medium	Adult-Old	3
Decline	High	Low	Low	Old	4

Followings are steps to compute life cycle index.

Step 1: Measure firm-yearly industry adjusted sales 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:

$$Industry\ adjusted\ sale\ growth\ rate(IASG)$$
$$= the\ firms' slaes\ growth - industry\ median\ sales\ growth\ rate$$

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

Step 2: Compute firm-specific financial variables using given variables in the dataset. Specific equations follow:

$$DP_t = DIV_t / IBED_t$$
$$CEV_t = CE_t / VALUE_t$$

where DIV_t = common dividends in year t,

$IBED_t$ = income before extraordinary items and discontinued operation in year t.

CE_t = capital expenditure in year t,

$VALUE_t$ = market value of equity plus value of long-term debt at the end of year t.

Step 3: Compute firm age.

If a firm-year observation has IPO data, firm age equals fiscal year minus year of IPO date. For observations that does not have IPO data, I assume that the simple count of the availability on firm-year observations of each companies. If fiscal year minus year of IPO data is is less than 3 years, it has classified into start-up stage. Rest of data divided into 4 groups with for every 4 years (growth, mature, revival and decline).

Step 4: Classify into four quartile scale by industry level.

All firm-year observations are divided by 13 industry levels. Within same industry the three financial variables grouped into four quartile scales. Once a firm-year is assigned to a quartile group by financial variables, it is given a score by the criteria in Table 2.

Step 5: Calculate a composite score and decide life cycle index.

All firm-year observations sum up with a composite score range 4 to 16. I create four life cycle stages based on a composite score obtained by summing corresponding scores of financial variables within previous steps. Firms are classified into a life cycle stage as follows:

Growth stage: a firm-year is classified as a growth stage
if the composite score is greater than 3 and less than or equal to 7.

Mature stage: a firm-year is classified as a mature stage
if the composite score is greater than 7 and less than or equal to 10.

Revival stage: a firm-year is classified as a revival stage
if the composite score is greater than 10 and less than or equal to 13.

Decline stage: a firm-year is classified as a decline stage
if the composite score is greater than 13 and less than or equal to 16.

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. The 81,869 firm-year observations are classified:

Start-up stage: 15,294 firm/year observations (3,144 firms)

Growth stage: 5,871 firm/year observations (2,099 firms)

Mature stage: 27,868 firm/year observations (4,911 firms)

Revival stage: 29,691 firm/year observations (4,064 firms)

Decline stage: 3,145 firm/year observations (1,070 firms)

The start-up stage counts on 18.6% and growth stage counts on 7%. Mature stage counts on 34%, revival stage counts on 36.2% and decline stage counts on 4%. The figure 1 is a bar plot of observations by life indexes and it shows that the observations in mature and revival stage are larger than the other three stages. This is because we consider all firm-year observations and we do not limit the number of the observations by industry. Some industry might have large observation than other industries. It is likely that mature and revival industries have more observations than in other early life cycle stage. We can interpret that most of U.S industries enters into mature and revival stages.

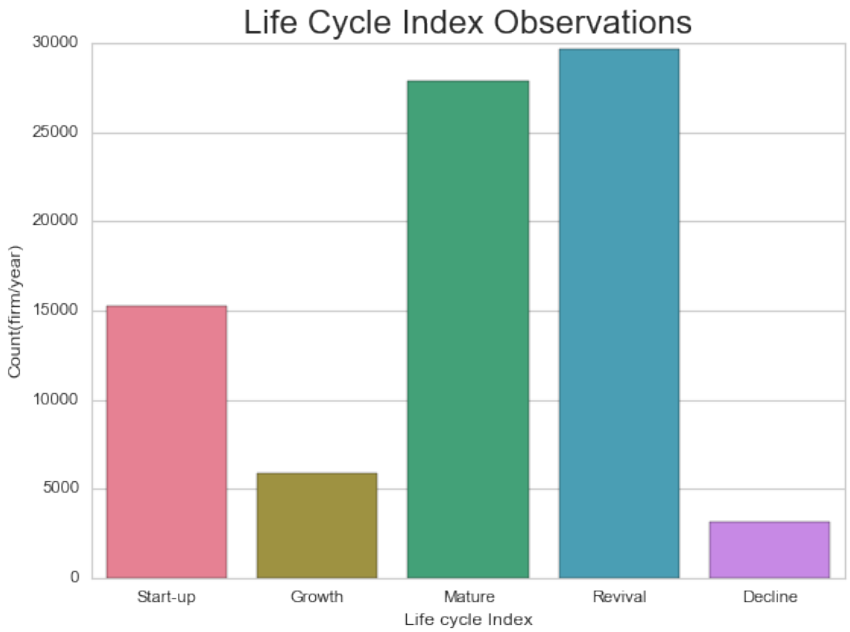

Fig1. Total observations distribution by life cycle index. Number of counts means the number of observations.

B. Details of Liquidity Index

Many models are used to measure and test the relationship between asset liquidity and 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.

Since liquidity index is the variable of interest, it has to be straight forward and accurate. Considering the innate characteristics of asset liquidity, I will follow the firm-level weighted asset illiquidity index introduced by Ortiz-Molina and Phillips (2013) to measure firm-level liquidity and use as liquidity index. I use their second weighted asset liquidity index in their method which considers cash and equivalents and other noncash current asset as primary liquidity index. To measure the liquidation value of firm, this method is straight forward to indicate the value. Liquidity Index defines as below.

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

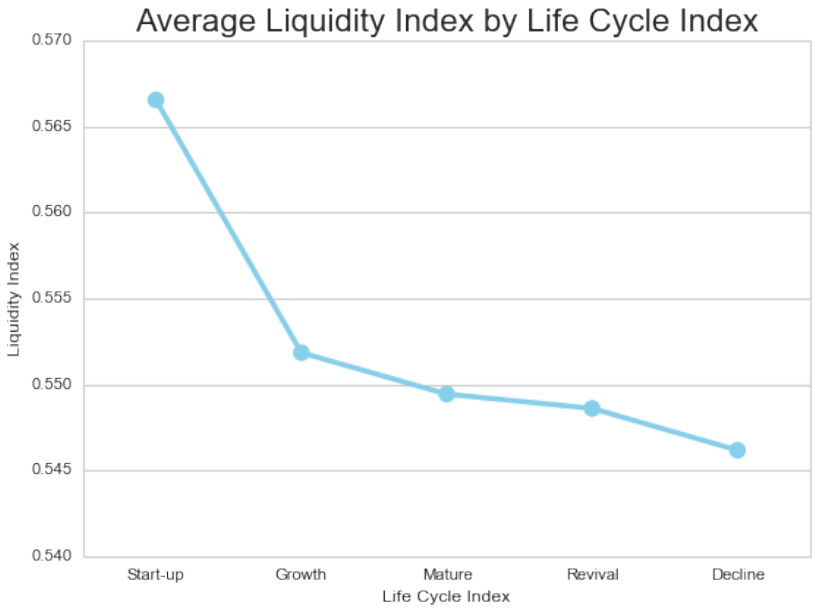

Fig 2. Average of liquidity index by life cycle index. The interval of Liquidity index on y-axis set from 0.540 to 0.570 to present the result more closely.

Figure 3 showed that average liquidity index by life cycle stage. The largest average liquidity index is start-up stage, 0.567 and the smallest liquidity index is decline stage, 0.546. This implicates that as firm moves start-up to decline stage, the ratio of liquidation

value of firm decreases. However, the differences between the average liquidity indexes across the life cycle stages are small, so the changes are not dramatic.

IV. Applying life cycle index and liquidity index

Using life cycle index, the data divided into 5 sub-sample data and within 5 sub-sample dataset, we can compute liquidity index. This procedure will give the overview of the sample dataset before executing multivariate regression analysis. Descriptive statistics for Start-up stage firms are reported in Table 3. In start-up stage, mean of *cash holdings ratio* is 0.134 and it is the highest mean comparing to other life cycle stages. It means that firms in start-up stage tend to have larger portion of *cash holdings* and this trend can be seen in *liquidity index*. Here, we can see that *cash holdings ratio* and *liquidity index* has positive relationship which is straight forward because the composition of *liquidity index* is related with cash holdings. Also the mean of *R&D-to-sales* is 1.060 and it is the highest among five life cycle stages. It means that the firms in start-up stage invest more into R&D than firms in other life cycle stages to boost up their growth opportunity.

TABLE 3
Summary Statistic of Start-up stage firms

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.040	0.111	0.134	0.214	0.106
Total debt/Total book assets	0.001	0.094	0.205	0.319	0.287
Total assets	58	216	1,661	858	5,504
R&D-to-sales	0.001	0.101	1.060	0.203	7.280
Capital expenditures/Total book assets	0.014	0.034	0.058	0.071	0.077
Market-to-book	0.005	0.006	0.041	0.061	15.400
PPE/ Total book assets	0.111	0.25	0.376	0.542	0.364
EBIT/ Total book assets	-0.050	0.055	-0.237	0.111	1.910
Sales	28	144	1,272	653	6,020
Liquidity Index	0.511	0.535	0.567	0.600	0.075

Descriptive statistics for growth stage firms are reported in Table 4. The standard deviation of *R&D-to-sales* is 0.958 and this is the lowest among five life cycle stages. It means that the differences in ratio of investment into R&D of firms at growth stage is similar to each other.

TABLE 4
Summary Statistic of Growth stage firms

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.033	0.086	0.112	0.169	0.094
Total debt/Total book assets	0.007	0.163	0.209	0.314	0.238
Total assets	319	826	2,299	1,844	6,321
R&D-to-sales	0.000	0.001	0.116	0.112	0.958
Capital expenditures/Total book assets	0.017	0.030	0.042	0.052	0.042
Market-to-book	0.003	0.001	0.142	0.015	2.290
PPE/ Total book assets	0.190	0.340	0.447	0.503	0.437
EBIT/ Total book assets	0.031	0.091	0.081	0.144	0.166
Sales	268	758	1,804	1,730	4,451
Liquidity Index	0.508	0.527	0.552	0.575	0.061

Descriptive statistics for mature stage firms are reported in Table 5. The standard deviation of *R&D-to-sales* is 4.570 and compared to growth stage firms, this means there is huge differences between firms. It implies that the differences in ratio of investment into R&D of firms at growth stage is dissimilar to each other. As firms enter into maturity stage, firms change their strategies to invest into R&D more or less corresponding to their target goal.

Descriptive statistics for Decline stage firms are reported in Table 6. The standard deviation of *market-to-book ratio* is 24 and it is the largest figures among the five life cycle stages. It implies that as firms enter into revival stage, some company success to boost their own firm value and some companies failed to maximize or revive their firm value. Consequently, that ratio changes to have large difference between companies.

TABLE 5
Summary Statistic of Mature stage firms

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.036	0.091	0.116	0.176	0.095
Total debt/Total book assets	0.003	0.138	0.203	0.292	0.262
Total assets	97	574	4,430	2,716	11,223
R&D-to-sales	0.001	0.002	0.480	0.680	4.570
Capital expenditures/Total book assets	0.015	0.029	0.044	0.056	0.051
Market-to-book	0.001	0.002	0.255	0.034	8.870
PPE/ Total book assets	0.203	0.380	0.498	0.681	0.473
EBIT/ Total book assets	0.001	0.067	0.130	0.119	2.580
Sales	71	539	4,088	2,378	11,464
Liquidity Index	0.508	0.526	0.549	0.568	0.060

TABLE 6
Summary Statistic of Mature stage firms

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.034	0.085	0.111	0.167	0.094
Total debt/Total book assets	0.006	0.146	0.212	0.300	0.281
Total assets	31	342	6,042	4,526	13,631
R&D-to-sales	0.003	0.029	0.655	0.112	6.050
Capital expenditures/Total book assets	0.013	0.028	0.041	0.051	0.055
Market-to-book	0.001	0.006	0.036	0.034	24
PPE/ Total book assets	0.201	0.380	0.542	0.677	1.032
EBIT/ Total book assets	0.001	0.067	-0.206	0.112	3.050
Sales	26	325	5,461	4,296	13,070
Liquidity Index	0.508	0.524	0.549	0.566	0.061

Descriptive statistics for Decline stage firms are reported in Table 7. As compared to earlier life stages, firms in decline stage show decreasing in the mean of *R&D-to-sales* and *sales*. This is straight forward since firms enter into decline stage, firms decide to minimize expenditure and experience decrease in sales.

TABLE 7
Summary Statistic of Decline stage firms

Table 1 reports data from Compustat Industrial Annual files (1995-2017). I include all companies of industries. All observations are calculated for each firm-year. The liquidity index equals the sum of the ratio of cash-to-total asset and 0.5 times on the ratio of the differences in total minus cash-to-total asset. Industry adjusted sale growth rate are sales growth rate minus median of sales growth rate in each industry (defined at the two-digit SIC level). Total asset and sales measured in 1994 dollars. Cash holding, total debt, capital expenditures, PPE and EBIT are deflated by total book asset. The key variable definitions used in this table is in Appendix A.

Statistics	Quartile 1	Median	Mean	Quartile 3	Std Dev.
Cash holdings/Total book assets	0.034	0.091	0.120	0.186	0.101
Total debt/Total book assets	0.001	0.145	0.214	0.311	0.266
Total assets	27	743	4694	4786	9893
R&D-to-sales	0.010	0.027	0.340	0.029	2.700
Capital expenditures/Total book assets	0.011	0.028	0.043	0.055	0.054
Market-to-book	0.001	0.003	0.133	0.029	1.360
PPE/ Total book assets	0.180	0.39	0.487	0.691	0.418
EBIT/ Total book assets	0.010	0.061	-0.040	0.122	0.750
Sales	26	475	4303	4398	10,217
Liquidity Index	0.507	0.522	0.546	0.563	0.059

V. Main Empirical Results

To examine the relationship of asset liquidity and capital structure in each firm life cycle, I performed multivariate regression analysis of the level of leverage on the liquidity index. The literature has proved leverage are *R&D expenditure rate, Market-to-book ratio, PPE rate* and *EBIT rate* are important factors to capital structure decision. To control for those important determinant, I set those to control variables in model. Thus, the multiple regression model is specified as follows:

$$Leverage = \alpha + \beta_1 Liquidity + \beta_2 R\&DtoSale + \beta_3 Markettobook + \beta_4 PPE + \beta_5 EBIT$$

The left-hand side variable of the model I estimate is book leverage. *Leverage* is the ratio of total debt to book value of total asset. *Liquidity Index* is the primary explanatory variable and it computes from measure of liquidity index introduced by Ortiz-Molina and Phillips (2013). *R&D-to-sales* is the ratio of R&D expenditure to sales. *Market-to-book* is the ratio of market value of equity to book value of equity. *PPE* is the ratio of PPE (Property, Plant and Equipment) ratio to total book assets. *EBIT* is the ratio

of earning before income taxes to total book assets. Our focus is on asset liquidity index and leverage. Every analysis executed based on each firm-year observation and its component.

TABLE 8

	Dependent Variable				
	Leverage				
	(1) Start-up	(2) Growth	(3) Mature	(4) Revival	(5) Decline
Liquidity Index	-1.320*** (0.069)	-1.380*** (0.086)	-1.160*** (0.047)	-1.190*** (0.050)	-1.380*** (0.173)
R&D-to-sales	-0.0001 (0.0005)	0.003 (0.004)	0.0001 (0.0005)	-0.001 (0.0004)	0.001 (0.003)
Market-to-book	-0.0002 (0.0002)	0.005** (0.002)	-0.00005 (0.0003)	-0.0002** (0.0001)	-0.009 (0.006)
PPE/ Total book assets	-0.00000 (0.00000)	-0.00000** (0.00000)	0.00000** (0.00000)	0.00000*** (0.00000)	0.00001*** (0.00000)
EBIT/ Total book assets	0.00001 (0.00001)	0.00004*** (0.00001)	-0.00000* (0.00000)	-0.00000 (0.00000)	-0.00001 (0.00001)
Intercept	0.946*** (0.039)	0.959*** (0.048)	0.835*** (0.027)	0.852*** (0.028)	0.973*** (0.097)
R^2	0.074	0.119	0.062	0.065	0.107
Adjusted R^2	0.074	0.117	0.062	0.064	0.101

*p<0.1; **p<0.05; ***p<0.01

The results appear in Table 8. The results showed that the coefficient of primary explanatory variable *Liquidity index* is in the range from -1.380 to -1.160 and the P-values are all significant at 0.01 level, so *Liquidity Index* is statistically significant variable in the multivariate regression model. Interestingly, the coefficient of control variables *R&D expenditure rate, Market-to-book ratio, PPE rate* and *EBIT rate* are all are close to 0. It means that those variables are nearly have no effect on dependent variable, *Leverage*. From the results, we can conclude that *Liquidity Index* is negatively related with the response *Leverage*. R^2 of multivariate regression analysis on 5 different life cycle stages is around 0.06 to 0.11. From the Table 8, we can conclude that the relationship between *Leverage* and *Liquidity Index* is negative.

In Fig3, from the results in Table 8 we can visualize to see the coefficient plots of the testing relationship on all 5 life cycle stages. As we observed earlier, we can clearly

see that the coefficient of *Liquidity Index* is negative. In addition, when we compared to start-up stage and decline stage, start-up stage shows weaker relationship than decline stage. From our results, we can not conclude that there is linear relationship between asset liquidity index and capital structure over life cycle stages.

Fig3. Aggregating all coefficient of dependent variables in the testing multivariate models

VI. Conclusion

I examine whether asset liquidity is positively associated with capital structure in each firm life cycle stages and the association is stronger in the start-up stage than decline stage. The findings are not consistent with the hypothesis offered by Sibilkov (2009); that is asset liquidity index is positively related with capital structure and the costs of financial distress and inefficient liquidation are economically important.

Using two important index to get the sample data set and the primary explanatory variable *Liquidity Index*, I examined the relation between asset liquidity index and capital structure. I find that asset liquidity index is actually negatively related to capital structure and the control variables that regard as the important determinant of capital structure such

as *R&D-to-sales, PPE rate* and *EBIT rate* have weak or no relationship with *Leverage*. These findings are consistent with the hypotheses argued by Myers and Rajan (1998), that asset liquidity reduces the firm's discretion to use external financing options.

These findings are limited to all active companies in U.S. from 1995 to 2017 and in the testing model since it contains limited control variables of capital structure determinants. Another variable may have more important effects on capital structure. Credit ratings of company and M&A transaction data that are not in the financial statement and cash flow statement might be considered in the further research. In addition, in the sampling procedure I did not consider to set the condition that in every life cycle, there should be even number of observations. This might make my finding biased.

Taken together, the result suggest that asset liquidity index can be one of the primary explanatory determinants of a firm's capital structure and it has an economically significant impact on a firm's financial decision.

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Appendix A

Table 1: Variable Definitions

Variable	Definitions
Book Equity	Total asset – Liabilities + Balance Sheet Deferred Taxes and Investment tax credit – Preferred stock
Dividend Payout Rate	Cash Dividens / Income
Values	Market Equity + Long Debt
Capital Expenditure rate	Capital Expenditure / Values
Market Equity	Stock Price * Shares Outstanding
Values	Market Equity + Long Debt
Cash holdings / Total book assets	Cash / Book Equity
Total debt / Total book assets (Leverage)	Total Debt / Total Assets
Total assets	Total Assets
R&D-to-sales	Research and Development Expense / Sales
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 / Total Assets
EBIT/ Total book assets	EBIT/ Total Assets