Analysis of the Dynamic Impact of Intangible Assets on Capital Structure of Listed Companies in the Construction Industry

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Abstract: Due to the leverage effect, appropriate liabilities can reduce the cost of capital, while intangible assets can cause changes in the asset-liability ratio. In order to further study the relationship between the two, this research selected the empirical data of listed construction companies that could potentially yield adequate findings, and used the distributed-lag model and WLS model for an empirical analysis. The research results show that there is a significant positive correlation between the asset-liability ratio and intangible asset ratio, the book value of intangible assets and internal structure of intangible assets, but the impact is slightly less than the asset profit rate. Despite this, the additive effect between the above-mentioned variables is still considerable. In the context of enhancing a company’s leveraged operations, a company’s management is suggested to adopt corresponding improvement measures and systems to deal with operational risks.

1. Introduction

Most of a company’s liabilities need to be repaid with stable cash flow. The key to selecting debt management is judging whether a company’s current or future expected cash flow can meet the debt repayment. Intangible assets can bring a relatively stable cash flow, which can be used as collateral for a new debt financing, which in turn affects a company’s capital structure. A company’s fundraising operations include equity financing and debt financing, which in turn will cause changes in equity capital and debt capital structure, and debt capital can play a financial leverage role for a company. With the advancement of science and technology through time, the percentage of intangible assets in a company’s total assets increases year by year, cases of setting intangible assets as collaterals have emerged, and certainly it will become a new factor affecting the capital structure.

From the early theory of capital structure [1], a view is derived: “modest increase in corporate debt capital will help a company increase its value”, the 1970s and 80s Jensen and Meckling (1976) proposed the agency cost theory that a company’s debt default risk is the increase function of financial leverage. Nevertheless, in their theory, these two scholars ignored the agency costs involved in company employees, consumers and society [1]. Vincent Delbecque (2015) analyzes the choice of intangible assets in specific industries and its impact on a company’s production and management. The research finds that the intangible assets are related to specific industries; the manufacturing industry tends to focus on (R&D) and engineering design technology, and service industry tends to

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1 Capital structure theory in the early stage argued that company value is only related to net income or net operating income.
focus on computer program software; they also argued that the higher the proportion of intangible
assets, the higher the output of labor and tangible assets will be \[2\]. Masayuki Morikawa (2015) used
Japanese company data to analyze the investment restrictions of intangible assets and the sensitivity of
a company’s intangible assets to internal capital, and discovered that compared with tangible assets,
the amount of intangible assets investment is more sensitive to a company’s internal capital; and this
type of financial constraint is more obvious for small and medium-sized companies \[3\].

Liu Hong, Zhang Xiaoyou, and Huang Bingbing (2018) used Tobin’s q value to measure enterprise
value, and explored the education level of a company’s senior executives and the impact of each
intangible asset on it. Meanwhile, setting a company’s size and proportion of independent directors as
control variables, they used descriptive statistical analysis, principal component analysis and
regression analysis for their empirical research, and found that (1) the enterprise value is significantly
positively correlated with the intangible assets per share and with the education level of the executives;
(2) the education level of the executives significantly increased the value-relevance of intangible
assets \[4\]. In consideration of the current financing situation of China’s capital market, Xia Xuehua,
Gong Yifei et al. (2017) used the full sample regression model to empirically analyze the impact of
intangible assets of China’s A-share listed companies on their debt level and capital structure \[5\].

Based on the empirical analysis and theoretical researches conducted by scholars both inside and
outside of China, it can be found that there is a connection between intangible assets and capital
structure, but there are few studies on the impact of debt capital. Nevertheless, with the change of
company life cycle and economic environment, new choices are bound to be available for a company’s
fundraising, that is, the use of intangible assets for debt management can in turn affects a company’s
capital structure. Based on previous researches in the existing literature, this research intends to
analyze the impact of the proportion, scale, and internal structure diversity of the intangible assets on a
company’s capital structure.

2. Research design

2.1. Selection of research variables

In order to study the relationship between intangible assets and capital structure in depth, this research
selected the following factors as the explanatory (independent) variables: the intangible asset ratio
(INT), the intangible asset book value (VAL) and the intangible asset sample size (N). The study
measured the proportion, size and internal structure of intangible assets from the relative and absolute
numbers. Then this research set the asset-liability ratio (LEV) as the explained (dependent) variable to
measure the changes in the capital structure. The quantifiable factor profitability (ROA), which was
shown to have an impact on capital structure on the basis of previous studies, was used as a control
variable. To ensure that the sample data conform to linear features, the absolute number was taken as
its natural logarithm.

2.2. Model design

| Variable type          | Variable name                  | Variable name symbol | Variable definitions                                      |
|------------------------|--------------------------------|----------------------|----------------------------------------------------------|
| Explained variable     | Assets and liabilities         | LEV                  | Total liabilities / total assets                          |
| Explained variables    | Book value of intangible assets| VAL                  | Natural logarithm of the book value of intangible assets  |
|                        | Intangible asset rate          | INT                  | Intangible assets / total assets of enterprises            |
|                        | Intangible asset sample        | N                    | The natural logarithm of the intangible asset sample owned by the company |
| Control variable       | Profitability                  | ROA                  | ROA = net profit / average balance of total assets        |
Based on the research of Xia Xuehua, Gong Yifei (2017), the following regression analysis model was established for this research.

\[ \text{LEV}_i = C + \beta_1 \cdot \text{INT}_i + \beta_2 \cdot \text{LNN} + \beta_3 \cdot \text{LNVAL} + \beta_4 \cdot \text{ROA}_i + \epsilon_i \]

Where \( C \) is a constant term, \( \beta_1, \beta_2, \beta_3, \beta_4 \) are the coefficients obtained by the regression equation, \( \epsilon_i \) is a random error term; To avoid excessive data gaps, it may lead to large errors in the analysis results. The natural logarithm was used for \( N, \text{VAL} \). Based on the above model, the following hypotheses were made:

H1: The value of intangible assets is positively associated with the asset-liability ratio.
H2: The intangible asset ratio is positively associated with the asset-liability ratio.
H3: The internal structure diversity of intangible assets is positively correlated with the asset-liability ratio.

3. Analysis of the impact of intangible assets on capital structure of listed companies in the construction industry

Thirty-one A-share listed companies in the construction industry were selected as the target company, and 465 samples based on their 2013-2017 financial data were obtained for an empirical analysis.

![Figure 1. Trend line diagram](image)

The trend line graph was made from the panel data. The abscissa (coordinate along the horizontal axis) represents the sample individual number, and the ordinate represents the observation value corresponding to the sample. It can be observed that in general, the change direction of \( \text{INT}, \text{LNN} \) and \( \text{LEV} \) is basically uniform at the single cross-section level; in terms of different cross-sections, the observed values are also similar; but both the LNVAL line graph, compared with the explained variable LEV line graph, exhibits large differences and volatility in a single section or different sections, and the stability of the sequence needs to be further analyzed.

3.1. Stationarity analysis

Based on the above analysis, it is necessary to perform ADF unit root test on the data sequence of the sample to determine whether the sequence is stable, so that false regression can be avoided, not producing erroneous analysis results. The EVIEW 8.0 program was used to automatically select the number of lag periods by the SIC criterion, and the sequence of the research variable and the sequence after adding the control variable were tested separately. Subsequently, the following hypotheses were made:

\( H_0: \) There is a valid unit root \( H_{00}: \) there is no valid unit root
Table 2. ADF test

| Method                              | Statistic | Prob.** |
|-------------------------------------|-----------|---------|
| ADF - Fisher Chi-square (A)         | 39.0775   | 0.0000  |
| ADF - Choi Z-stat (A)               | -4.78271  | 0.0000  |
| ADF - Fisher Chi-square (B)         | 83.7217   | 0.0000  |
| ADF - Choi Z-stat (B)               | -7.07393  | 0.0000  |

Note: (A) indicates that there is no control variable sequence, and (B) indicates that the control variable sequence is introduced.

Under the ADF unit root test, when the \( \alpha \) value is at the 1%, 5%, and 10% significance level, the P values of the two types of sequence combinations are close to zero, indicating that a small probability event occurs. Consequently \( H_0 \) should be rejected, proving that the sample data sequence does not contain a valid unit root. Given that the data sequence is stationary, it proves that the addition of control variable sequence combinations does not affect the stability of the study variable sequence.

3.2. Cointegration test

In order to check whether the sample data sequence had a long-term equilibrium relationship so as to avoid pseudo-regression, Johansen cointegration test was needed for multivariate sequences. Prior to that, it was necessary to use the VAR model to determine an optimal lag order. The target data in EVIEWS 8.0 was selected to build the VAR model. At the 5% significance level, the lag period criterion was selected. The results are as follows:

Table 3. Lag period selection table

| Lag | LogL  | LR  | FPE   | AIC    | SC    | HQ     |
|-----|-------|-----|-------|--------|-------|--------|
| 0   | 192.5880 | NA  | 5.36e-08 | -2.552218 | -2.450503 | -2.510890 |
| 1   | 532.5681 | 652.2066 | 7.38e-10* | -6.837661* | -6.227369* | -6.589693* |
| 2   | 545.4320 | 23.80254 | 8.72e-10 | -6.672544 | -5.553674 | -6.217935 |
| 3   | 558.9788 | 24.14478 | 1.02e-09 | -6.516719 | -4.889273 | -5.855470 |
| 4   | 567.7335 | 15.00797  | 1.28e-09 | -6.295694 | -4.159670 | -5.427804 |
| 5   | 579.6542 | 19.62450  | 1.54e-09 | -6.117744 | -3.473143 | -5.043214 |

* indicates lag order selected by the criterion

Generally, the AIC criterion was used as a reference standard, and the lag number corresponding to the minimum value was selected. As shown in the table above, no matter it was FPE, AIC, SC or HQ criterion, when the number of lag periods was 1, the corresponding value was the most up to standard.

In order to further study the long-term equilibrium between variable sequences, and to measure the impact of short-term fluctuations, a cointegration test is needed. Cointegration theory believes that only two or more variables with the same order can have a long-term equilibrium relationship. The previous unit root test has proved that the sample sequence is single-ordered involving multiple variables, so Johansen cointegration could be performed on LEV, INT, N, VAL, ROA sequences with an optimal lag period of 1. Test (see table). In order to avoid the situation that the regression overly affects the numerical difference, the natural logarithm was taken for N, VAL.

Table 4. Cointegration test

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---------------------------|------------|----------------|---------------------|--------|
| None *                    | 0.360688   | 143.2560       | 69.81889            | 0.0000 |
| At most 1 *               | 0.159350   | 74.80961       | 47.85613            | 0.0000 |
| At most 2 *               | 0.124258   | 48.25191       | 29.79707            | 0.0001 |
| At most 3 *               | 0.117625   | 27.95125       | 15.49471            | 0.0004 |
| At most 4 *               | 0.055925   | 8.805155       | 3.841466            | 0.0030 |

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
With the significance level of 5%, all trace test results $P$ values were close to zero (<0.05), indicating that this null hypothesis should be rejected: “the presence of 0 cointegration”; by comparing the trace statistics and the lower threshold value with the confidence level of 95%, we gained results showing that the former values are larger than the latter. That proves that there is a cointegration relationship between the LEV, INT, N, VAL, and ROA sequences; that is, there is a long-term equilibrium relationship.

3.3. impulse response image and variance decomposition analysis
In order to further explore the response of INT, LNN, LNVAL, ROA and LEV itself to LEV changes over time, the VAR model was used to construct the impulse response map.

Figure 2. Impulse response diagram
The horizontal axis represents the number of periods, and the vertical axis represents the magnitude of the impact, that is, the degree of response. The image tends to converge, indicating that the sample data is stationary. The figure shows that in the first period, the response of LEV itself to LEV was the maximum, followed by INT, with the response of LNN, LNVAL, ROA being 0. Over time, LEV and INT gradually weakened the response to the explained variables, eventually approaching 0, but always maintained a positive impact; LNVAL’s response to LEV gradually increased from 0, and reached the maximum (about 0.0051) in the third period, then stayed at that level; LNN also rose gradually from 0, and reached the maximum in the third period (about 0.0099), then began to show a slight downward trend, and finally approached the 0 axis; ROA always had a negative response to LEV, and the negative impact force reached the maximum in the second period (about 0.0092), and then the degree of response gradually weakened, eventually maintaining the level, approaching the 0 axis. It can be seen that LNVAL, LNN, and ROA had a certain lag in response to LEV.

In order to analyze the contribution of LEV itself, INT, LNN, LNVAL and ROA to LEV fluctuations, the variance decomposition analysis was carried out.

### Table 5. Variance Decomposition of LEV

| Period | SE   | INT | LEV | LNN | LNVAL | ROA |
|--------|------|-----|-----|-----|-------|-----|
| 1      | 0.064355 | 10.60978 | 89.39022 | 0.000000 | 0.000000 | 0.000000 |
| 2      | 0.083017 | 10.81387 | 87.14427 | 0.025069 | 0.290555 | 1.226230 |
| 3      | 0.092540 | 10.46585 | 85.57425 | 1.565242 | 0.543042 | 1.851621 |
| 4      | 0.097718 | 10.18549 | 84.85807 | 2.258992 | 0.772900 | 1.924543 |
| 5      | 0.100733 | 10.02378 | 84.40655 | 2.696667 | 0.994310 | 1.878698 |
| 6      | 0.102604 | 9.926269 | 84.00942 | 3.023948 | 1.206524 | 1.833838 |
| 7      | 0.103821 | 9.859879 | 83.64806 | 3.287995 | 1.402060 | 1.802005 |
| 8      | 0.104637 | 9.811813 | 83.33768 | 3.495830 | 1.575298 | 1.779377 |
| 9      | 0.105195 | 9.776730 | 83.08425 | 3.651970 | 1.724263 | 1.762787 |
| 10     | 0.105583 | 9.751127 | 82.88323 | 3.765545 | 1.849508 | 1.750585 |

In the table above, SE denotes the standard error. The results show that in the first period, LEV fluctuations that may be self-explained by LEV itself accounted for 89.39022%, the remaining part was all explained by INT fluctuations. Over time, the extent to which the fluctuations in LEV could be explained by LEV itself and INT fluctuations was gradually reduced, yet still holding a dominant position; the rate of decrease was gradually reduced, which is consistent with the pulse image; the degree of LNN and LNVAL fluctuations gradually increase the degree of LEV fluctuation, but the growth rate in the third period reached its maximum, and then gradually weakened to a stable level. The ROA’s explanation of LEV fluctuations remained at 1.75%-2%, showing a trend of increasing first and then decreasing, and the growth rate reached the maximum in the second period, consistent with the pulse image. It can be seen that the contribution of LNVAL, LNN, and ROA to the random error fluctuation of LEV had a certain time lag. In general, in the short term, the extent to which LEV itself and INT could explain LEV fluctuations ranked highest.

### 4. OLS model correction

Based on the previous analysis, OLS regression was performed on the sample data using EViews 8.0, and the following statistics (Table 6) were obtained:

### Table 6. OLS regression

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|----------|-------------|------------|-------------|-------|
| C        | 0.676635    | 0.028818   | 23.47939    | 0.0000 |
| INT      | 0.047370    | 0.131000   | 0.361601    | 0.7182 |
| LNN      | 0.003991    | 0.019549   | 0.204147    | 0.8385 |
| LNVAL    | 0.025608    | 0.004706   | 5.442000    | 0.0000 |
| ROA      | -0.148760   | 0.126706   | -1.174099   | 0.2422 |
It should be noted that the goodness of fit $R^2$ of this regression equation was 0.346560, and the fitting level was low. Generally speaking, the larger the goodness of fit $R^2$ is, the better the constructed model can explain the changing relationship between the explained (dependent) variables and the explanatory (independent) variables. The DW value is 0.580777<2, which indicates that there is a strong first-order forward autocorrelation in the random error term sequence. Generally, the closer to 2 it is, the better it is. The residual autocorrelation may make the regression coefficient invalid, or lead to a big difference between the fitting model and the real model. The $P$ value of the regression coefficients of INT and LNN was much larger than 0.05, indicating that the regression coefficient is very low. Since ROA is a control variable, this research pays little attention to the significance of its regression coefficient. Through the White heteroscedasticity test, $P=0.009<0.05$, it is proved that the regression equation obviously has heteroscedasticity, and its existence will also lead to the loss of validity of the parameter estimation. Therefore, the regression equation needs further correction.

In order to further eliminate the heteroscedasticity, this research adopted the WLS weighted least squares method to correct the original model.

The weighted least squares regression was performed using the sixth power of the residual Resid01 generated by the OLS regression model as the weight, and the following equation was obtained:

$$LEV = 0.6714 + 0.0154* INT + 0.0055* LNN + 0.0257* LNVAL - 0.1267* ROA$$

$$R^2 \approx 1 \text{ DW} = 2.0128 \text{ white test value} 0.4494$$

The modified model had a high degree of fit, and there was no autocorrelation and heteroscedasticity. The regression parameters were highly significant ($P<0.05$). The statistics show that the capital structure of listed companies in the construction industry was significantly affected by the intangible asset ratio, the book value of intangible assets and the internal structure diversity. Among them, the asset-liability ratio was significantly positively correlated with the intangible asset ratio, the book value of intangible assets and the intangible assets, and negatively correlated with profitability.

Specifically, within an appropriate range, for every 1% increase in the intangible asset ratio (INT), the asset-liability ratio will increase by approximately 0.0154%; for every increase of 2.7183 (e^1) pieces in the intangible asset sample (N), the debt-asset ratio will increase by about 0.0055%; for every increase of 2.7183 (e^1) billion yuan the intangible assets book value (VAL), the asset-liability ratio will increase by about 0.0257%. Judging from the absolute value of the regression parameters, the impact of the three variables was less than that of the enterprise. The effect of profitability, but the additive effect of the three parameters is still considerable. If the number of intangible assets increases, it may cause the intangible asset rate and the book value to increase at the same time, and the increase will, in turn, affect the positive change in the capital structure through the superposition effect of the three variables.

5. Conclusions

In summary, within moderate fluctuations\(^2\), a company’s asset-liability ratio is significantly positively correlated with the intangible asset ratio, the size of intangible assets and the internal structure diversity, which proves that intangible assets can indeed be used as new collateral assets for listed companies in the construction industry for borrowing from or debt repayment to financial institutions.

\(^2\) The fluctuation range delineated in this research is 70%~130% of the industry average of the asset-liability ratio.
including banks; meanwhile, a company’s asset-liability ratio was significantly negatively correlated with a company’s profitability, which may be due to the reason the increase in profitability will encourage the management to use more profits as operating capital, in order to obtain better economies of scale, or as liability repayment, resulting in a reverse relationship. The results of variance decomposition analysis show that the asset-liability ratio was largely affected by its own value and the rate of intangible assets in different periods; the book value of intangible assets, the internal structure diversity and the contribution rate of profitability were weak, with a significant lag in contribution.

In addition, the distribution lag model indicates that the current asset-liability ratio of listed companies in the construction industry was also significantly positively correlated with the asset-liability ratio of the previous period, and was significantly negatively correlated with the rate of intangible assets in the previous period. This may be because the leverage effect of the previous period played a key role, lifting the confidence of a company’s management in debt management. However, due to the special nature of intangible assets, management should pay attention to the lagging effect of intangible assets on the capital structure when making decisions; they should be cautious and take further measures to prevent operating risk.

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