Research on Systematic Risk of Chinese Listed Banks Based on Correlation Analysis Between Beta Coefficient and Accounting Variables

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Abstract. Through empirical analysis and focused on listed banks in Chinese stock market, this paper is to explore the correlation between Beta (β) coefficient and accounting variables. The authors adopted Single Index Model and estimated statistical characteristics of β coefficient of listed banks. After running correlation analysis and regression analysis, the specific correlation and multivariate linear regression equations are obtained. From the results of regression analysis, as a whole, listed banks in China share a lower value of β coefficient and a weak correlation between their β coefficient and accounting variables. The multivariate linear regression equation indicates that there is obvious correlation between β coefficient and net asset return rate, circulation market value, non-performing loan rate and core tier one capital adequacy ratio.

1. Introduction
Systematic risk coefficients could reflect the sensitivity degree of one bond or portfolio to market portfolio. β coefficient measures systematic risk of portfolios and bears concise meaning. It has been widely used in investment portfolio, risk management and corporate finance.

β coefficient, as the key parameter of evaluating equity’s systematic risk, is not needed to be estimated its specific value. Rather, its influential factors or influential degree are more important to be analyzed. Study results of 40 years indicate that listed companies share bad stability. It means that their future value cannot be simply estimated from existed data. Therefore, except searching alteration reasons from estimating models and selecting samples, we could also explore accountant factors that influencing this coefficient from the aspect of systematic risk.

This coefficient is of high applicable value. In the long run, it is released regularly in Standard & Poor’s and Moody within western countries such as United Kingdom, U.S.A and Germany. It could help investors make rational investment decisions.

2. Literature Review
In nearly 50 years, many scholars do a great deal of research on the correlation between β coefficient and accounting variables, as well as its influence on banks’ systematic risk.

Beaver, Kettler and Scholes (1970) systematically study the relationship between systematic risk and accounting variables for the first time. The authors analyze β coefficients of individual stock and stock portfolios of 307 listed companies within New York Stock Exchange. They find that there is significant correlativity between β coefficient and dividend payout ratio, financial leverage, accounting β coefficient and profit liquidity relatively. And β coefficient is significant independent with growth property, scale and liquidity ratio [1]. Hamada (1972) explores the influence of financial
structure to systematic risk of 304 stocks in New York Stock Exchange. The results indicate that positive correlation is showed between the two [2]. Mandelker and Rhee (1984) select 255 companies within the period of 1957-1976 and study the relativity between β coefficient and operation leverage coefficient. Empirical results show that there is positive correlation between the above two coefficients [3]. Griffin and Dugan (2003) testify that there is significant correlation between fluctuations of corporation income and systematic risk [4].

Since the late 20th century, domestic scholars explore the relationship between β coefficient and accounting variables. Wu (1999)’s study is one of the most representative works that focus on influencing factors of β coefficient. The author selects 200 listed companies in the period of 1997-1998 from Shanghai Stock Exchange. Results show that there is significant influence on individual stock β coefficient from total asset growth rate, financial leverage and dividend payout ratio. And the circulation scale has same influence on portfolio β coefficient, but operation leverage has no significant influence neither individual stock nor portfolio β coefficient [5].

Zhong (2006) selects 293 stocks from Shanghai Stock Exchange and Shenzhen Stock Exchange and concludes that there is negative correlation between net asset yield rate, main business profit margin, capital accumulation rate, operation leverage, profit variability, dividend payout ratio and β coefficient relatively. And negative correlation is fond between financial leverage, company scale and β coefficient. The relationship between main business income growth rate and β coefficient is not stable. That is to say, positive correlation can be found in some years and negative correlation in another ones [6].

Zhang (2008) does regression analysis between 32 accounting variables and β coefficient and finds that significant correlation only exists between β coefficient and 9 of them. Among which, positive correlation is discovered between earning ration, profit variability, sales growth rate, main business cost rate, activity rate and β coefficient; negative correlation between turnover of current asset, circulation ratio, total share capital coefficient, cash sales ratio and β coefficient [7].

Via reviewing the literature, two key points about influencing factors of β coefficient are worth noticing: firstly, studies aiming at financial listed companies are few. These companies share the accounting principles and capital structure that are different from normal listed ones. Furthermore, they use specific accounting variables. Therefore, financial corporations are eliminated when researching accounting factors that influencing β coefficient. Secondly, final conclusions have not been arrived at. Many aspects such as selected research models and data period may affect the potential accounting variables.

Based on above researches, this study innovates in two ways: one is that it selects banking industry as the study object. Fewer works before explore influencing factors of β coefficient from financial listed companies. The other innovation is specific accounting variables are included. Financial corporations share accounting principles that are different from ordinary listed companies, and capital structure and operating modes of the former are also different from the latter. Here, non-performing loan ratio and core capital adequacy rate is adopted to reflect industry features of banking.

3. Empirical Analysis and Test

3.1. Sample Selection

This study selects 14 commercial banks that listed on Shanghai Stock Exchange. They include Shanghai Pudong Development Bank, Huaxia Bank, China Minsheng Bank, China Merchants Bank, Bank of Nanjing, Industrial Bank Co., Ltd., Bank of Beijing, Agricultural Bank of China, Bank of Communication, Industrial and Commercial Bank of China, China Everbright Bank, China Construction Bank, Bank of China and China Citic Bank. From January 2017 to January 2018, Simple Index Model is adopted to estimate β coefficient of listed commercial banks in China. This study employs logarithmic rate of return to estimate individual stock β coefficient and Shanghai securities composite index as market portfolio rate of return. On a weekly basis, estimating return rate of listed bank stock and return rate of market portfolio.
From the aspect of selecting accounting variables, this study adopts net asset rate of return ($X_1$) to measure their profitability, net profit growth rate ($X_2$) to measure their growth ability, shareholder’s equity turnover rate ($X_3$) to measure their operating ability, adopts dividend cover ($X_4$) to measure their dividend ability, adopts circulation market value ($X_5$) to measure their company scale, adopts net asset per share ($X_6$) to measure their intrinsic value, and two particular indicators in banking industry: non-performing loan rate ratio ($X_7$) and core tier one capital adequacy ratio ($X_8$).

### 3.2. Accounting Variables Selection

Multicollinearity may exist between the accounting variables. Here, Pearson Correlation Coefficient is employed to test and screen them. Correlation coefficient matrix can be got through software SPSS (Table 1):

|       | $X_1$ | $X_2$ | $X_3$ | $X_4$ | $X_5$ | $X_6$ | $X_7$ | $X_8$ |
|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| $X_1$ | 1.00  |       |       |       |       |       |       |       |
| $X_2$ | -0.16 | 1.00  |       |       |       |       |       |       |
| $X_3$ | 0.45  | 0.23  | 1.00  |       |       |       |       |       |
| $X_4$ | 0.21  | 0.33  | 0.42  | 1.00  |       |       |       |       |
| $X_5$ | -0.04 | -0.28 | -0.14 | -0.49 | 1.00  |       |       |       |
| $X_6$ | 0.542*| 0.06  | 0.669**| 0.23  | -0.42 | 1.00  |       |       |
| $X_7$ | -0.29 | 0.53  | 0.19  | -0.11 | -0.19 | -0.31 | 1.00  |       |
| $X_8$ | -0.08 | -0.22 | -0.39 | -0.618*| 0.26  | -0.37 | -0.21 | 1.00  |

Correlation is significant when confidence level is 0.05.

Correlation is significant when confidence level is 0.01.

From Table 1, correlation coefficient $|r|$ of 8 accounting variables is less than 0.8 and correlation degree between variables is small. There is no multicollinearity from preliminary judgement. Therefore, 8 accounting variables all can be retained.

### 3.3. Correlation Hypotheses of Accounting Variables and $\beta$ Coefficient

According to the analytic results of above related financial theories, correlation direction hypotheses of accounting variables and $\beta$ coefficient are as followed:

- **Hypothesis 1**: There is negative correlation between $X_1$ and $\beta$ coefficient.
- **Hypothesis 2**: There is positive correlation between $X_2$ and $\beta$ coefficient.
- **Hypothesis 3**: There is negative correlation between $X_3$ and $\beta$ coefficient.
- **Hypothesis 4**: There is negative correlation between $X_4$ and $\beta$ coefficient.
- **Hypothesis 5**: There is negative correlation between $X_5$ and $\beta$ coefficient.
- **Hypothesis 6**: There is negative correlation between $X_6$ and $\beta$ coefficient.
- **Hypothesis 7**: There is positive correlation between $X_7$ and $\beta$ coefficient.
- **Hypothesis 8**: There is negative correlation between $X_8$ and $\beta$ coefficient.

### 4. Correlation Analysis of $\beta$ Coefficient and Accounting Variables

$\beta$ coefficients of 14 listed commercial banks are shown in Table 2:
Table 2. β coefficient Estimation of Individual Stock.

| Name of Bank                        | β Coefficient | Name of Bank                        | β Coefficient |
|-------------------------------------|---------------|-------------------------------------|---------------|
| Bank of Beijing                     | 0.603         | Bank of Nanjing                     | 0.971         |
| Industrial and Commercial Bank of China | 0.403        | Agricultural Bank of China         | 0.535         |
| China Everbright Bank               | 0.901         | Shanghai Pudong Development Bank Co., Ltd. | 0.557         |
| Huaxia Bank                         | 0.730         | Industrial Bank Co., Ltd.           | 0.731         |
| China Construction Bank             | 0.604         | China Merchants Bank                | 0.559         |
| China Minsheng Bank                 | 0.687         | Bank of China                       | 0.711         |
| China Minsheng Bank                 | 0.546         | China Citic Bank                    | 0.865         |

Based on β coefficients, computing the correlation coefficient & significance of β coefficients and accounting variables. Results are shown on Table 3:

Table 3. Correlation Coefficients of β coefficient and Accounting Variables.

| Accounting Variables | β Coefficient |
|----------------------|---------------|
| $X_1$                | -.532         |
| Pearson Correlation  |               |
| Significance(Two tails) | .050         |
| $X_2$                | .491          |
| Pearson Correlation  |               |
| Significance(Two tails) | .075         |
| $X_3$                | .108          |
| Pearson Correlation  |               |
| Significance(Two tails) | .714         |
| $X_4$                | .136          |
| Pearson Correlation  |               |
| Significance(Two tails) | .644         |
| $X_5$                | -.537         |
| Pearson Correlation  |               |
| Significance(Two tails) | .047         |
| $X_6$                | -.036         |
| Pearson Correlation  |               |
| Significance(Two tails) | .903         |
| $X_7$                | .632*         |
| Pearson Correlation  |               |
| Significance(Two tails) | .015         |
| $X_8$                | -.480         |
| Pearson Correlation  |               |
| Significance(Two tails) | .082         |

*Correlation is significant when confidence level is 0.05.

The following statements could be concluded from correlation coefficient analysis between β coefficient and accounting variables:

Two conclusions can be arrived at after analyzing the correlation coefficients between β coefficient and accounting variables:
Firstly, correlation directions of most accounting variables and β coefficient are accordant with previous hypotheses. Among which, only $X_3$ and $X_4$ are not accordant with hypotheses. Secondly, as a whole, the correlation between β coefficient and accounting variables is weak. And it is same as the conclusions from literature. The following 5 variables share high significance level with β coefficient: $X_7$ (0.632), $X_5$ (-0.537), $X_1$ (-0.532), $X_2$ (0.491) and $X_8$ (-0.480). Only 2 of the 5 variables pass significance test.

5. **Regression Analysis of β Coefficient and Accounting Variables**

5.1. **Primary Regression**

We run multiple linear regression of β coefficient and accounting variables. The regression results are on following tables (Table 4, Table 5 and Table 6):

| Model | R | R Square | Adjusted R Square | Error of Std. Estimation |
|-------|---|----------|--------------------|-------------------------|
| 1     | .960a | .921 | .794 | .072326296 |

| Model | Quadratic Sum | Degrees of Freedom | Mean Square | F | Sig. |
|-------|---------------|--------------------|-------------|---|------|
| 1     | .304          | 8                  | .038        | 7.262 | .021b |
| Residual | .026          | 5                  | .005        |       |      |
| Sum   | .330          | 13                 |             |       |      |

| Model | Non-std. Coefficient | Std. Coefficient | β | t | Sig. |
|-------|-----------------------|------------------|---|---|------|
| B     | Std. Error            |                  |   |   |      |
| 1     | (Constant)            | 5.090            | 1.093 | 4.657 | .006 |
| $X_1$ | -.054                 | .020             | -.474 | -2.742 | .041 |
| $X_2$ | .007                  | .004             | .375 | 1.603 | .170 |
| $X_3$ | .959                  | .850             | .407 | 1.128 | .310 |
| $X_4$ | -.121                 | .057             | -.665 | -2.124 | .087 |
| $X_5$ | -.096                 | .027             | -.604 | -3.562 | .016 |
| $X_6$ | -.015                 | .016             | -.372 | -.945 | .388 |
| $X_7$ | -.082                 | .125             | -.270 | -.655 | .541 |
| $X_8$ | -.079                 | .029             | -.757 | -2.720 | .042 |

After analyzing regression results, we can get following conclusions:

Firstly, degree of fit of regression equation is good. $R$ square and the adjusted $R$ square are both high, and it shows better explanation of the selected accounting variables to β coefficient. Hence, this model brings good accuracy and low deviation.

Secondly, significance of regression equation is good. Its significance level passes $F$ test. This indicates significant regression effect of the equation. Furthermore, there is significant linear correlation between β coefficient and the selected accounting variables.

Thirdly, the significance of regression coefficients is weak. Under confidence level of 90%, 4 coefficients pass significance test; under confidence level of 95%, 3 of them do. Comparatively, there are significant effects of $X_1$, $X_2$, $X_7$ and $X_8$ to β coefficient.

Fourthly, there is multilinearity in regression equation.
Generally, it can be concluded that there is multicollinearity between variables when VIF>10. From test results of this study, VIF of $X_7$ is 10.720 (VIF>10) and VIF of $X_6$ is 9.767 (VIF≈10). Therefore, multlinearity does exit in this regression equation.

Fifthly, primary regression equation is

$$\beta = -0.054X_1 + 0.07X_2 + 0.959X_3 - 0.121X_4 - 0.096X_5 - 0.015X_6$$

$$- 0.082X_7 - 0.079X_8$$

5.2. **Optimization of Regression Equation**

This research adopts the most useful method stepwise regression analysis to solve multicollinearity. Meanwhile, White Test of regression result of Model 4 is done to test whether there is heteroskedasticity in regression equation. DW Test is done to test if there is autocorrelation in this equation.

Based on regression results, final regression equation is:

$$\beta = -0.052X_1 - 0.066X_5 + 0.099X_7 - 0.036X_8 + 3.362$$

This equation shows good statistics meaning in fit goodness, equation significance, coefficient significance and so on. And no defects such as heteroscedasticity, autocorrelation and multicollinearity. Therefore, it is reliable to use this equation to fitting the correlation between $\beta$ coefficient and part of accounting variables.

6. **Conclusions**

This study focuses on listed banks in China and analyzes their $\beta$ coefficient, its estimation and the correlation analysis with accounting variables. Following conclusions are concluded:

Firstly, from $\beta$ coefficient estimation of individual stock, mean value of $\beta$ coefficient is less than 1. It means that listed banks in China share lower systematic risk. When stock market rises, profit in banking plate is limited. But when stock market goes down, resilience of banking is strong. This indicates that under the background of high systematic risk in stock market in China, banking plate could stabilize market index.

Secondly, from correlation analysis of $\beta$ coefficient and accounting variables, correlations between $\beta$ coefficient and majority of variables are accord with hypotheses, but several variables are not. Meanwhile, the correlations between majority of variables and $\beta$ coefficient are not significant. This indicates that there is a disjoint between systematic risk of Chinese listed banks and accounting information.

Thirdly, from the results of multiple linear regression analysis, four accounting variables entering equation (net asset rate of return, liquidity scale, non-performing loan rate and core tier one capital adequacy ate) have significant with $\beta$ coefficient of listed banks. And this influence is in accordance with financial theories. It means that the above four accounting variables will influence significantly systematic risk of these banks. They could take targeted countermeasures such as financial management to lower the risks.

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