Rela
tion between Financial Flexibility and
Probability of Default: KMV Model

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Abstract

Background/Objectives: Investment sources are allocated to economic activities through financial markets. One important topic is studying and evaluation of credit risks that is breach probability for reimbursement of granted facilities by customers. Methods/Statistical Analysis: This research evaluated the effects of financial flexibility independent variable on the probability of default dependent variable. This was investigated by gathering data from 101 companies receiving bank facilities from 2009 to 2013. To measure credit risk of companies, KMV Model has been used. The study hypotheses tested using combinational data, and for data analyzing and evaluating multi-variable regression model and study’s hypotheses test, we used E-views software. Findings: This research identifies some of the effective factors related to financial flexibility affecting default probability. The results show that there is a reverse and significant relation between financial flexibility and default probability. Also, there is a reverse and significant linear relation between flexibility and default probability of companies with high and low financial leverages, too with small and large sizes. Thus, relation rate varies in different levels of firm sizes and financial leverages, which indicates the effect of company size and financial leverage variables on relations between independent and dependent variables. Application/Improvements: Regarding to the results, it is recommended that banks and financial institutions and companies that sell credits notice financial flexibility, financial leverage, company sizes, and the effects of these variables on debt default when granting facilities.

Keywords: Credit Risk, Financial Flexibility, KMV Model, Leverage, Probability of Default, Size

1. Introduction

Study of performances of different countries shows that there is a relation between investment and advanced economic level; countries with more efficient pattern for allocation of capital to economic sectors encounter more economic advancements and, in turn, more social welfare. Investment sources are allocated to economic activities through financial markets. Banks and financial institutions’ credit market is one of these markets. This is done by granting credits to customers. Therefore, one important topic is studying and evaluation of credit risks that is breach probability for reimbursement of granted facilities by customers. Measurement of this risk, among the others, is very important. Since market data and present value of company’s assets warn for present situation of a company and future expectations, a model should be used that does not merely depend on accounting data and uses current market data for anticipation of credit risks, too. In this research, we use both market situation and extracted data from financial reports of company. Structural models are used for measurement of credit risk suggested by Merton in 1974. One of the structural models is KMV Model, which has been created in 1980. This research identifies some of the effective factors related to financial flexibility affecting default probability.

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2. Research Background

Table 1 shows some of the recent researches dealing with financial flexibility and probability of default.

3. Hypotheses

**Main hypothesis:** There is a relationship between financial flexibility and probability of default.

The hypothesis is sub-divided into the following secondary hypotheses for further analysis:

**First sub-hypothesis:** There is a relationship between financial flexibility and default probability of companies with high financial leverages.

**Second sub-hypothesis:** There is a relationship between financial flexibility and default probability of companies with low financial leverages.

**Third sub-hypothesis:** There is a relationship between financial flexibility and default probability of companies with small sizes.

**Fourth sub-hypothesis:** There is a relationship between financial flexibility and default probability of companies with large sizes.

4. Methodology

The present research is an applied research based on its purposes and is classified as a correlation research according to its methodology and nature. The needed information is obtained through access to financial statements, notes to financial statements and financial reports of the considered firms. The statistic sample includes all of the listed firms in Tehran’s Stock Exchange during 2009–2013. With regard to above mentioned requirements, 101

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**Table 1.** Research history about financial flexibility and probability of default

| No. | Research topic                                           | Author(s)          | Year | Research findings                                                                 |
|-----|----------------------------------------------------------|--------------------|------|----------------------------------------------------------------------------------|
| 1   | Financial flexibility, leverage, and company size        | Byoun S.¹          | 2007 | • A reverse relation between financial flexibility, leverage, and company size.  |
| 2   | Flexibility value                                       | Gamba and Triantis⁴| 2009 | • Flexibility value depends on foreign supply, tax rate, cash keeping opportunity cost, potential growth opportunities, and capital redemption. |
| 3   | Size, share return, asset return fluctuation, leverage, B/M, beta, default probability | Gharghori P. et al.⁵ | 2009 | • A direct relation between default of probability, B/M, leverage, asset return fluctuation.  
• Reverse relation with size and share return.  
• Direct and weak relation with beta. |
| 4   | Financial flexibility and capital structure             | Clark B.²          | 2010 | • Flexibility is the most important factor affecting capital structure.  
• Companies with higher final flexibility are more willing to increase their capital and debt capacity reserve for future years. |
| 5   | Credit risk evaluation                                 | Ngurah G et al.⁷   | 2012 | • A bank can decrease inefficient loans by data-mining techniques and can be classified as one efficient bank. |
| 6   | Banking rules in an economy with credit risk and liquidity shock | Dasilva M.et al.⁴  | 2013 | • Bank policy-makers can decrease output fluctuations by setting policies for enhancement of financial stability and efficiency. |
companies per year with the sum of 505 years-firms are considered as the sample for a five-year period and the needed data are extracted from the sample. Variables of this research are:

4.1 Independent Variable

**Financial flexibility:** MVOC is a criterion for financial flexibility value which indicates a company ability to use investment opportunities. According to Clark (2010), coefficients are calculated by model 2 and are substituted in model 1.

\[
MVOC = \lambda_1 + \lambda_2 \frac{C_{t-1}}{M_{t-1}} + \lambda_3 \frac{CF_{t}}{TA_{t}} + \lambda_4 MB_{t} + \lambda_5 \frac{Dep_{t}}{TA_{t}} + \lambda_6 \text{Size}_{it} + \lambda_7 \frac{FA_{t}}{TA_{t}} \text{ (1)}
\]

\[
r_{it} = \lambda_0 + \lambda_1 \frac{\Delta C_{it}}{M_{t-1}} + \lambda_2 \frac{\Delta CF_{t}}{TA_{t}} + \lambda_3 \frac{\Delta M_{t-1}}{M_{t-1}} + \lambda_4 \frac{\Delta Dep_{it}}{TA_{it}} + \lambda_5 \frac{\Delta FA_{it}}{TA_{it}} + \lambda_6 \Delta \text{Size}_{it} + \lambda_7 \frac{\Delta FA_{it}}{TA_{it}} + \lambda_8 \frac{\Delta \text{Size}_{it}}{TA_{it}} + \lambda_9 \frac{\Delta FA_{it}}{TA_{it}} + \lambda_10 \frac{\Delta M_{t-1}}{M_{t-1}} + \lambda_11 \frac{\Delta CF_{t}}{TA_{t}} + \lambda_12 \frac{\Delta M_{t-1}}{M_{t-1}} + \lambda_13 \frac{\Delta Dep_{it}}{TA_{it}} + \lambda_14 \frac{\Delta FA_{it}}{TA_{it}} + \lambda_15 \frac{\Delta FA_{it}}{TA_{it}} + \lambda_16 \frac{\Delta M_{t-1}}{M_{t-1}} + \lambda_17 MB_{it} + \lambda_18 \text{Size} + \epsilon_{it} \text{ (2)}
\]

4.2 Dependent Variable

**Probability of default:** Usually “Default Distance” (DD) is used in credit risk literature, which indicates number of standard deviations of asset expected values at maturities from default points.

\[
DD = \ln L - \ln A_i \left( \mu - \frac{\sigma^2}{2} \right) (T) \left. \frac{\sigma \sqrt{T}}{\mu} \right|_{\phi(-DD)} \text{ (3)}
\]

4.3 Control Variable

Control variables used in the research are as follows:

- **Leverage (LEV):** It equals to total debts ratio to book value of equity.
- **Firm size (Fsize):** It is equal to natural logarithm of year’s selling.
- **Beta:** Beta is used to calculate systematic risk in exchange price index.

\[
\beta = \frac{\text{cov}(Rm, Ri)}{\sigma^2 Rm} \text{ (4)}
\]

\[
\text{Ri: Company stocks return}
\text{Rm: Market index stocks return}
\sigma^2 Rm: Variance of Rm
\]

**Growth:** Ratio of company’s capital market value to its book value.

\[
\text{Growth} = \frac{P_i}{BV_i} \text{ (5)}
\]

P_i: Capital market value of company
BV_i: Capital book value of company

5. Results of Hypotheses Testing

Assumptions test results by Eviews software is shown in the following tables.

5.1 Testing Results of the Main Hypothesis

The test result of this assumption is shown in Table 2.

| Variables | R | T-Statistics | Sig of the Model | Adjusted R Square | Durbin-Watson | F-Statistics | N |
|-----------|---|--------------|------------------|------------------|---------------|--------------|---|
| \(\beta_0\) | 1/159 | 216/898 | 0.00 | 0/478 | 2/413 | 5/477 | 0/000 | 504 |
According to Table 2, the prob(F-Statistic) value equals to 0.000 indicating the model meaningfulness at the 90 percent confidence level. Generally, adjusted determination factor shows that about 47 percent of default probability changes are covered and clarified by this model. Also, there is a reverse and significant relation between flexibility and default probability; finally, this theory has been accepted and the regression model is presented as follows:

\[
\ln(\text{PROB}) = \frac{1}{159} - \frac{2}{14}(\text{MVOC}) + \frac{4}{22}(\text{Growth}) + e_t
\]  

5.1.1 Testing Results of the First Sub-hypothesis

Test results of this hypothesis are presented in the Table 3 as below:

According to Table 3, the prob(F-Statistic) value equals to 0.000 indicating the model meaningfulness at the 90 percent confidence level. Generally, adjusted determination factor shows that about 53 percent of default probability changes are covered and clarified by this model. Also, there is a reverse and significant relation between flexibility and default probability; also, there is a reverse and significant linear relation between flexibility and default probability of companies with high leverage. Finally, this theory has been accepted and the regression model is presented as follows:

\[
\ln(\text{PROB}) = \frac{1}{112} - \frac{2}{63}(\text{MVOC}) - \frac{0}{001}(\text{Beta}) + \frac{6}{10}(\text{Growth}) + e_t
\]

5.1.2 Testing Results of the Second Sub-hypothesis

Test results of this hypothesis are presented in the Table 4 as below:

According to Table 4, the prob(F-Statistic) value equals to 0.000 indicating the model meaningfulness at the 90 percent confidence level. Generally, adjusted determination factor shows that about 74 percent of default probability changes are covered and clarified by this model. Also, there is a reverse and significant relation between flexibility and default probability; also, there is a reverse and significant linear relation between flexibility and default probability of companies with low leverage. Finally, this theory has been accepted and the regression model is presented as follows:

\[
\ln(\text{PROB}) = \frac{1}{180} - \frac{3}{17}(\text{MVOC}) + \frac{0}{0007}(\text{Beta}) + \frac{5}{75}(\text{Growth}) + e_t
\]

5.1.3 Testing Results of the Third Sub-hypothesis

Test results of this hypothesis are presented in the Table 5 as below:

According to Table 5, the prob(F-Statistic) value equals to 0.000 indicating the model meaningfulness at the 90 percent confidence level. Generally, adjusted determination factor shows that about 33 percent of default probability changes are covered and clarified by this model. Also, there is a reverse and significant relation between flexibility and default probability; also, there is a reverse and significant linear relation between flexibility and default probability of companies with small sizes.

Table 3. Results of the first sub-hypothesis testing

| Variables | R   | T- Statistics | Sig of the Model | Adjusted R Square | Durbin-Watson | F-Statistics | N |
|-----------|-----|---------------|------------------|-------------------|---------------|-------------|---|
| $\beta_0$ | 1/112 | 267/204       | 0.00             | 0/532             | 2/040         | 158/443     | 253 |
| MVOC      | -2/63 | -20/489       | 0.00             |                   |               |             |     |
| Beta      | -0/001 | -2/344       | 0/019            |                   |               |             |     |
| Growth    | 6/10  | 8/111         | 0.00             |                   |               |             |     |

Table 4. Results of the second sub-hypothesis testing

| Variables | R   | T- Statistics | Sig of the Model | Adjusted R Square | Durbin-Watson | F-Statistics | N |
|-----------|-----|---------------|------------------|-------------------|---------------|-------------|---|
| $\beta_0$ | 1/180 | 160/587       | 0.00             | 0/740             | 2/369         | 14/434      | 252 |
| MVOC      | -3/17 | -11/945       | 0.00             |                   |               |             |     |
| Beta      | 0/0007 | 8/341         | 0/019            |                   |               |             |     |
| Growth    | 5/75  | 4/858         | 0.00             |                   |               |             |     |
Finally, this theory has been accepted and the regression model is presented as follows:

\[ \text{Ln}(\text{PROB}) = \frac{1}{0.64} - \frac{5}{69}(\text{MVOC}) + \frac{9}{0.06} (\text{Growth}) + e \]

(9)

5.1.4 Testing Results of the Fourth Sub-hypothesis

Test results of this hypothesis are presented in the Table 6 as below:

According to Table 6, the prob(F-Statistic) value equals to 0.000 indicating the model meaningfulness at the 90 percent confidence level. Generally, adjusted determination factor shows that about 79 percent of default probability changes are covered and clarified by this model. Also, there is a reverse and significant relation between flexibility and default probability; also, there is a reverse and significant linear relation between flexibility and default probability of companies with large sizes. Finally, this theory has been accepted and the regression model is presented as follows:

\[ \text{Ln}(\text{PROB}) = \frac{125}{1.125} - \frac{0.7}{1}(\text{MVOC}) + \frac{0.007}{4} (\text{Beta}) \\
+ \frac{86}{4}(\text{Growth}) + e \]

(10)

6. Discussion and Conclusion

The results show that there is a reverse and significant relation between financial flexibility and default probability in the listed companies in Tehran Stock Exchange. Also, relation rate varies in different levels of company sizes and financial leverages, which indicates the effect of company size and financial leverage variables on relations between independent and dependent variables. This result conforms to that of Byoun1. Regarding to the results, it is recommended that banks and financial institutions and companies that sell credits notice financial flexibility, financial leverage, company sizes, and the effects of these variables on debt default when granting facilities.

7. References

1. Byoun S. Financial flexibility, leverage, and firm size. SSRN. 2007; 1–20.
2. Clark B. The impact of financial flexibility on capital structure decisions: Some empirical evidence. SSRN 1499497. 2010; 1–25.
3. Dasilva M, Divino A. The role of banking regulation in an economy under credit risk and liquidity shock. North American Journal of Economics and Finance. 2013; 109–15.
4. Gamba A, Triantis A. The value of financial flexibility. The Journal of Finance. 2009; 63(5):263–96.
5. Gharighori P, Chan H, Faff R. Default risk and equity returns: Australian evidence. Pacific-Basin Finance Journal. 2009; 17:580–93.
6. Morton R. On the pricing of corporate debt: the risk structure of interest rates. Journal of Finance. 1974; 29(2):449–70.
7. Ngurah G, Nawangpalupi C, Rian F. Assessing credit risk: an application of data mining in a rural bank. Procedia Economics and Finance. 2012; 1(4):406–12.
8. Puccia M, Jones R. Financial Flexibility, ratings direct. 2009; 1–15.